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Sustainable Digital Sovereignty: Interdependencies Between Sustainable Digitalization and Digital Sovereignty

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Sustainable Digital Sovereignty

Interdependencies Between Sustainable Digitalization and Digital Sovereignty

Sustainable Digital Sovereignty*

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This work has been funded by the Federal Ministry of Education and Research of Germany (BMBF) (grant no.: 16DII136, 16DII131, 16DII137 – "Deutsches Internet-Institut").

Abstract

This study is dedicated to the interdependencies between digital sovereignty and sustainable digitalization, which need to be explicitly linked to an increasing degree in political discourse, academia, and societal debates. Digital skills are the prerequisites for shaping digitalization in the interest of society and sustainable development.

* This is the English (and slightly revised) version of Herlo B., Ullrich A., Vladova G. (2022) Verantwortungsvolle demokratisch nachhaltige digitale Souveränität Wirkungszusammenhänge von Nachhaltigkeit und digitaler Souveränität. Kurzstudie im Rahmen der CO:DINA Forschungslinie „Digitale Souveränität und Nachhaltigkeit – Sozial-ökologische Perspektiven für eine selbstbestimmte Digitalpolitik". Wuppertal, Berlin. https://codina-transformation.de/wp-content/uploads/CODINA_Kurzstudie_SozioOekologischeDigitaleSouveraenitaet-1.pdf

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1 Introduction

The growing importance of concepts of sovereignty in the digital (Floridi, 2020; Lambach & Oppermann, 2022; Schmidt et al., 2021) along with the far-reaching consequence and potential of digital transformation itself urgently calls for global sustainability strategies to be expressly intertwined with digital sovereignty issues (Fritzsche et al., 2022) in order achieve a transformation that is at once human-centered and sustainable. And vice versa, the currently growing role of digital sovereignty in political discourse, at the national and European levels and beyond, as well as its implications for people, the environment, and technology, make it clear that questions and requirements of socio-ecological sustainability must be increasingly integrated into how digital sovereignty is understood.

Currently, and at least since the COVID-19 pandemic, it has become crystal clear that a lack of digital sovereignty and the *digital divide* at all three levels[1] (cf. Van Deursen & Helsper, 2015) has led to a shaping of the digital space that is far from being self-determined and defined by individuals, which in turn leads to increasing social and digital inequities (Pohle & Thiel, 2021; Rolan et al., 2020). All the while, the links between digitalization and sustainability are becoming increasingly obvious. From a social, ecological, and economic perspective, the focus is ever more on whether and how digitalization can contribute to greater sustainability. Among other things, we will examine how much sustainability is already being considered in the conceptualization of digitalization (cf. Lange & Santarius, 2018; Stuermer et al., 2017) or how digital technologies can contribute to achieving the United Nations Sustainable Development Goals (cf. Castro et al., 2021; Ullrich, 2022).

For this study, we have framed the digital sovereignty of individuals and collectives as opportunities and capacities for active engagement with the digital with self-determination and -assuredness and the capacity to co-create digitalization processes (Couture & Toupin, 2019; Pohle, 2020) – toward a more equitable future for people and the environment. Central links between environmental policy issues and issues of a more equitable and inclusive digital transformation are, to our understanding, *digital literacy and digital education, social and digital inclusion, reduction of inequalities, and an orientation toward the common good* (Ahel & Lingenau, 2020; Caniglia et al., 2018; Felber, 2018; Ostrom, 1990; Špiranec et al., 2019; Van Deursen & Helsper, 2015). Many of these are also explicitly mentioned under the Sustainable Development Goals (United Nations, 2022). These include, for example, education for all, reducing inequality, and peace, justice, and strong institutions as societal goals, thus combining the aspects of sustainability and digital sovereignty (Herlo et al. 2022).

A socially and ecologically sustainable digital sovereignty, as discussed here, incorporates the effects of digitalization on all people and the environment and at the same time addresses aspects of democracy, participation, and involvement. We argue that the focus must be on shaping digitalization in the interest of society and for sustainable development across the economic, ecological, and social. *At the central intersection of the discourses brought together here, it is therefore essential for us to take on the question of competencies as our point of departure.*

[1] These included three experts from business associations, three representatives and experts from the automotive industry, and two experts from the electronics industry. For the clothing sector, the analysis focused on reports from Just Style, Sourcing Journal, and Apparel Resources, as well as discussions at the Copenhagen Fashion Summit 2020 and 2021, GFA CEO Agenda 2021, and Sourcing Journal Summit 2020.

1.1 Subject and objectives of the study

In this study, a normative framing of the topics of digital sovereignty and sustainable digitalization takes place from the perspective of competence, which is central here, and thus of empowerment[2] of society. On the one hand, the respective objectives are elaborated and qualified on the basis of current discourses. It is necessary, in so doing, to reframe or rethink central aspects that, in our understanding, enable us to strive toward *enabling* society and, accordingly, to directly integrate the necessary conditions for such *enabling*. Both those affected by and those involved in a sustainable digital transformation have to be brought along, because problems such as inequality, access, or co-determination rights in the physical world, get exacerbated in the digital world. This means that the negative social and ecological consequences of digital action cannot always be experienced directly, for example when people are subjected to a decision that occurs automatically. The differentiated treatment of people by algorithmic systems based on their digital footprint, i.e., their online behavior, whether in social media channels, shopping, or based on their social-demographic data (gender, age, sexual orientation, residential address), is quite clearly nontransparent just as the indirect consumption of resources in the application of such technologies is hardly tangible. Furthermore, the near monopoly of agency by a few global players and their strict adherence to the profit motive makes it not only difficult to enforce transparency and accountability, it also prevents the development of artificial intelligence models that emphasize data parsimony using smaller and, most importantly, better curated data sets to enable greater fairness and eliminate discrimination. Along with this, one aspect that has played an insufficient role in the digital world thus far is an orientation toward the common good over private gain.

The aim of this study is to identify particularly relevant connections between digital sovereignty, sustainable digitalization, and the skills needed for sustainable digital sovereignty. We highlight the individual dimensions that emerge as particularly topical, yet have received little attention to date. We intend to use them as prerequisites for defining a set of tools to analyze sustainable digital sovereignty. These will then be further developed in additional, in-depth studies. This in itself poses the challenge of first making tangible the three variables – sustainable digitalization, digital sovereignty, and the competencies required – and then tracing how effects of the respective components are intertwined.

Scientific and application-oriented work already exists on the topic areas, which this study initially addresses in an exploratory manner in order to ascertain how the topics are handled in the respective fields – with the aim of providing an overview of the status quo, but also identifying blind spots and linking the fields together within our selected dimensions. However, the main purpose of this study is to highlight the complexity of the interdependencies and the need for further research.

[2] Following the empowerment approach of Amartya Sen and Martha Nussbaum, who frame empowering people as realizing opportunities on the path to sustainable social development.

1.2 Structure of the study

The study is structured as follows: In *section 2*, the authors explain the study procedure and then delve deeper into the findings of the individual areas of *digital sovereignty, digital literacy, and sustainable digitalization in sections 3–5*. We ascertain the goals laid out the literature (including among scientific publications, position papers, and policy papers) for each respective area. We determine which objectives are particularly relevant for practice and which indicators, i.e. criteria and benchmarks, can be used to qualify these goal descriptions. *Section 6* traces links between the respective area goals, and finally formulates three central theses in *section 7*. The theses refer to the interdependencies between the three core areas and the various levels of actors involved in initiation, implementation, and execution. The authors then derive key areas for action recommendations from these focal points. These are to be understood as exemplary and emergent from among the numerous current fields of action for a socio-ecologically digital sovereignty. The study concludes with a reflection and an outlook for further research and discussion intended to stimulate a deeper dive into and exploration of individual issues and interdependencies.

2 Underlying procedure

Explorative and qualitative methods of an interdisciplinary approach are particularly suitable for thinking about digital sovereignty in connection with sustainable digitalization as areas that remain elusive from the perspective of empowerment and competence. The study is divided into three key phases:

1. Collecting goals and corresponding indicators (criteria that attempt to show how the goals can be qualified or achieved) to bring about digital sovereignty, sustainable digitalization, and the necessary skills for socio-ecological digital sovereignty. This is done with discourse analysis.
2. Looking at possible interdependencies, i.e., mutual influence within and between the goals and indicators regarding digital sovereignty and sustainable digitalization from the perspective of competence.
3. Elaborating on the leading-edge and most relevant, in our view, aspects of socio-ecological digital sovereignty from a competence perspective, as well as formulating recommendations for action.

The complexity of the subjects under consideration, coupled with the fact that research in these areas is in its infancy, while the conditions, constellations, and consequences of certain decisions on the path to digital transformation are only just beginning to undergo scientific evaluation, make it necessary to initially build on existing concepts and existing knowledge. We do this based on current scientific discourses, position, and strategy papers. However, that which we identify as the status quo (listed as targets and indicators in the appendix) is presently under the aegis of strong interests at the local, (trans)national, or global level. It must therefore always be framed as a normative setting and as a strategic assertion of sovereignty, which can be evaluated differently depending on the perspective adopted – on whether (trans)national, primarily economic interests at national / EU level (see, for example, the German government's current digital

strategy) or digital rights in a post-growth era are at the forefront of considerations (for example, the Mozilla Foundation's report on Digital Rights and Climate and Environmental Justice, 2022). The challenge, in our view, is to relate the different interests and perspectives to each other and to focus on a socio-ecologically digital sovereignty that considers the well-being of all – and we are well aware of the difficulty of such an endeavor.

In order to illustrate this complexity, the three areas under consideration will first be linked to common concepts. For sustainability, these include the Sustainable Development Goals (SDGs) as well as relevant literature on sustainable digitalization, which has contributed enormously to the analysis of current digitalization processes in recent years. The construct of digital sovereignty is linked to concepts that are being discussed at the international and European level (such as the orientation toward the EU Commission's Digital Compass and the sovereignty concepts of indigenous communities). The two fields have not yet been sufficiently researched on their own, nor have they been sufficiently thought of in conjunction (Fritzsche et al., 2022). Initially, therefore, these will be taken into consideration separately. The unifying element for the study is the competence that contributes to the empowerment of individuals and collectives and thus represent a necessary prerequisite for realizing socio-ecological digital sovereignty. These are the third pillar of the considerations and are therefore initially also treated in isolation. With the help of a selective peer literature analysis, the results of this initial concept development can be expanded and the magnitude latent within sustainable digitalization, digital sovereignty, and digital skills can each be conceptualized by means of goals and indicators (characteristics and criteria that make these goals concretely tangible). Once these goals and indicators are defined, the groundwork for merging them can be laid.

In the next step, we pursue a conceptual and qualitative approach that brings together the effective interdependencies, as a result of the elaboration of the goals and indicators of the three constructs and the lessons learned, with demands from practice and civil society. Our method was to correlate the existent relationships on the basis of literature findings, enriched by an initial expert workshop with academic and non-academic representatives of a variety of fields of practice. The workshop provided a forum to discuss the preliminary results and qualified them in order to hone in on specific, currently particularly potent aspects of digital sovereignty that is at once social and ecological. The results of this approach were then condensed and sharpened into three theses.

In the final phase, the interrelationships were expanded; the relationships between the goals and indicators were modeled; the theses were qualified in a second expert workshop; and relevant areas for recommendations for action were formulated. The aim is to identify approaches for further action and to draw attention to the most pressing research avenues. In conclusion, we formulate the need for further assessments with regard to the feasibility of measures in the various fields of action.

3 Digital sovereignty as a guiding principle for a sustainable democratic future

Digital sovereignty has become a key concept in the discussions of many governmental bodies at international as well as national and EU level, but also in scientific and civil-society efforts toward democratic, human-centered, and sustainable developments in the digital. The concept of digital sovereignty as a guiding principle for a sustainable and democratic future in the digital age encompasses different aspects of sovereignty and self-determination that relate to the societal and individual level as well as to the level of the state and politics, civil society, and organizations. Its processual nature (Fritzsche et al., 2022) allows different perspectives on digital sovereignty as a basis for social development and participation, as well as economic development at the local, national, and global levels (the latter, for example, in terms of reducing dependencies, but also with a view to reducing inequalities). Different emphases can therefore be set depending on the perspective, for example, with regard to disadvantage and discrimination by digital technologies, to questions of data access and control, or vis-a-vis digital transformation oriented toward the common good. Increasingly, however, and at least since the COVID-19 pandemic, it has become clear that digital sovereignty should also be demanded and indeed required in the efforts to meet sustainability goals (Digital Summit, 2020; Floridi, 2020; Fritzsche et al., 2022). In order to work out the connections between the social, political, economic, and ecological perspectives, one needs to take a holistic view of digital sovereignty. This overarching perspective connects the goals and fields of action at all the aforementioned actor levels – those of the state and politics, of organizations (public institutions and companies), civil society, and individuals / society at large.

Although the term remains controversial (Pohle & Thiel, 2021; Rone, 2021), the consensus on digital sovereignty is predominantly as an indispensable prerequisite for independent state and economic action – and for individual self-determination in the digital realm. What is relevant here and also novel – especially with regard to how to implement sustainable democratic digital sovereignty – is that it occurs on the basis of cooperation and collaboration between actors; sovereignty requires new partnerships between business and the state (Lambach & Oppermann, 2022); it crystalizes with the recognition and protection of human rights in the digital realm; and it thrives on value-driven digitalization that is reflected in the design and in the development and application of digital technologies (e.g., the privacy-by-design approach). In this regard, digital sovereignty raises questions of participation, transparency, and accountability at multiple levels, making it a central element in discourses about digital issues per se (Couture & Toupin, 2019; Lambach & Oppermann, 2022; Pohle & Thiel, 2021).

In democratic states, and especially at the EU level, the concept of digital sovereignty is increasingly associated with values and goals that are strongly aligned with universal fundamental rights (Pohle, 2020). Digital sovereignty is thus strongly normatively charged in Germany and at the EU level, as it is considered to be a "prerequisite for being able to help shape the process of digital transformation and to act in a self-determined manner in the digital space" (Fritzsche et al., 2022). This trend brings European values into focus and increasingly includes people's informed and self-determined ability to act online into how digital sovereignty gets conceptualized. To this end, the various models of democratic digital sovereignty bring debates about human rights into the digital sphere (Wright, 2020). Democratic digital sovereignty, as a conceptual distinction from assertions of sovereignty by

authoritarian regimes or a "laissez-faire Internet" (what is also referred to as the "Californian Internet"), must balance various factors in both the analogue and digital worlds, such as sovereignty in the sense of regulation and control (Floridi, 2020) and the protection of individual rights in the digital world: *"In an age when analogue reality is increasingly managed and controlled by digital reality, the socio-political sovereignty on both appears to be essential for a better democracy and coordinated cooperation to tackle global problems, to make society fairer, and development at least sustainable"* (Floridi, 2020, p. 8).

In our study, we understand digital sovereignty as an emergent process continuously unfolding and as a prerequisite to the capacity to participate aptly, shrewdly, and discerningly in the digital transformation. Following Floridi (2020), a weaving together of sovereignties, intertwining the individual, the community, the (trans- and supra-)national, and the subnational (see, e.g., the arguments in support of indigenous peoples' data sovereignty (Kukutai & Taylor, 2016)), both analogue and digital, seems to make the most sense as a guiding principle to us – a weave that, if successfully designed, offers high-tensile democratic legitimacy, diversity, and flexibility.

In this context, the goal of **promoting digital literacy** is one of the pillars of digital sovereignty. To achieve digital literacy, individuals and collectives need to be empowered to orient and inform themselves (Ministry of State for Digitalization, 2020), to engage critically and consciously with digital technologies and develop data awareness (Federal Ministry of Education and Research, 2019), to understand the impact of the digital transformation on people and the environment, and to actively participate and engage (politically) in civil society (Sá et al., 2021). Educational activities and pedagogical offerings, as well as informal learning venues, are just as important as deep and well-informed public debates about social-technical systems and their societal implications (Gräf et al., 2020).

This study highlights another goal on the road to democratic digital sovereignty: the **realization of digital rights**. This goes hand in hand with the promotion of democratic participation and citizen involvement (Rone, 2021) as well as the implementation of a value-driven design process (Benjamin, 2019; Simon, 2016), an awareness of non-discrimination and fairness in the development of artificial intelligence (Spielkamp, 2022; Wright, 2020), or the protection of users and individuals by state actors as well as from the state (Wright, 2020).

In order to realize digital sovereignty, **ensuring democratic capacity to act** is also crucial. This includes transparency about how decisions are made (for example, in the regulation but also the production of digital technologies (Wright, 2020)), regulating disinformation, hate speech, and defamation (Rone, 2021), developing democratic technologies (Bendiek & Stürzer, 2022), taking into account the sovereignty of collectives (Kukutai & Taylor, 2016), adapting digitalization to the needs of society by all actor levels (Gräf et al, 2018), or shaping parliamentary discussions, public consultations, and deliberative forms of public debate both within nation-states and across the EU (Rone, 2021), and avoiding unilateral dependencies (Schroeder & Falk, 2022).

Promoting discussions and negotiations about how digital technologies are produced, used, and implemented, and how they shape our daily lives, also contributes to **improving the digital (core) infrastructure**. Improving the digital infrastructure sometimes means using open standards and open-source software and promoting projects where the results are placed under an open source license (Lambach & Oppermann, 2022). The development of standards that ensure democratic practices and individual privacy also emerges as another important area for action to improve digital (core) infrastructure (Roberts et al., 2021; Wright, 2020). Standards also play a key role in public administration to ensure secure, traceable, and legally binding transmission of data.

From the perspective of the European Commission, the **promotion of emerging technologies** is an important strategic goal. This includes investing in the next generation of supercomputers as well as enhancing EU capacity to develop and regulate artificial intelligence and ensuring that new technology development is in line with EU values (European Commission, 2020b; Roberts et al., 2021).

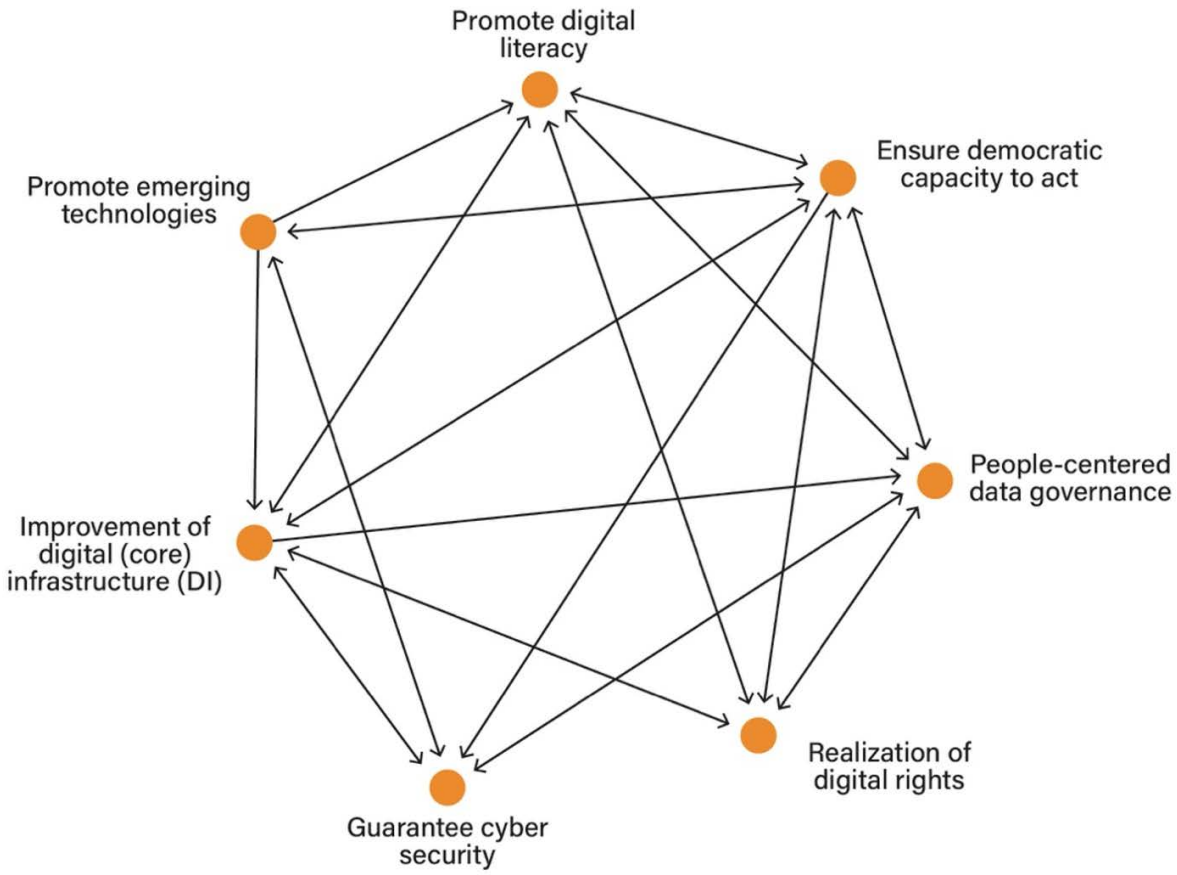
An important task in the areas of production, regulation, and use of digital technologies is to **promote cyber security**, namely in terms of encryption and surveillance defenses (European Commission, 2020a; Fritzsche et al., 2022), risk management and resilience (Kar & Thapa, 2020), and the promotion of key security technologies, for example, as government use and promotion of open-source solutions (Kar & Thapa, 2020), which lead to greater trust, commitment, and security due to their transparency.

Numerous authors and strategy papers are dedicated to **human-centered data governance** as a milestone on the path to democratic digital sovereignty. For example, they call for open data: Data generated by companies can be an important source of information for public policies and their implementation; likewise, data collected by public authorities (e.g., air quality, climate, satellite imagery) should be made available under open data programs or licenses to enable the development of (commercial) applications (Mozilla Insights, 2022). In the context of data governance, privacy and data protection are central (De la Chapelle & Porciuncula, 2021). The voices calling for public good data governance, transparency, trust, and criticality in the data marketplace (Roberts et al., 2021) are getting louder and seeking to limit the power of platforms or quasi-monopoly over services such as social media (Floridi, 2020).

In our first expert workshop, the dimensions and aspects of digital sovereignty identified in the literature were expanded to include a number of such perspectives. From the point of view of practitioners, special attention was paid to the potential of local actors and local solutions and practices (keywords being: local solutions and use of digital technology, community networks, develop their own infrastructures and policies for the use and access, locally based initiatives for developing and managing the infrastructures and their own use practices, sustainable communities). Common good approaches, commons, and platform cooperativism were also touted in the workshop as being relevant to sustainable digital sovereignty (platform cooperativism, worker owned platforms, cooperatives). Emphasis was placed on democratic aspects such as participation, justice, equity, inclusion, diversity, concrete fields of action such as open knowledge, open data, and open source, as well as questions about digital colonialism and extraction, and about labor conditions of tech workers or click farms ("click work" conditions and workers' rights – especially when digitalization has led to an increase in the "extractive, abusive" gig economy).

The area of digital literacy at the levels of individuals, civil society, the state, and organizations was discussed in the workshop as central to empowering society for a sustainable and democratic digital future. For this reason, too, we are devoting special attention to this area within the scope of the study. The following figure (1) illustrates how goals may be formulated for digital sovereignty and their interdependencies.

Figure 1: Objectives of digital sovereignty and their relations



4 Digital competence as an enabler for socio-ecological digital sovereignty

Digital competence, also referred to as digital literacy, was first defined in 2006 at European level as one of the keys to lifelong learning (Vuorikari et al., 2022):

"Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competences related to cybersecurity), intellectual property related questions, problem solving and critical thinking." (p. 3)

A similar definition of the term can be found in Kirchherr et al. (2018, p.6), where digital citizen skills are described in the context of the Future Skills Framework belonging to basic digital skills "... through which people are able to navigate and actively participate in a digitized environment." Fundamental digital skills also include competence in digital ethics, defined as the ability to "critically question digital information as well as the effects of one's own digital actions and to make appropriate ethical decisions." Among other things, this significantly influences sustainably relevant actions of individuals. In the context of digital sovereignty, digital literacy is regarded as a central dimension of the management and design of digitalization processes.

This also includes the critical, socio-politically embedded digital literacy that individuals need to face the risks and challenges of digitalization. As Ragnedda (2018) summarizes, shrewd digital competence is needed to adequately address key issues of participation and to address the growing digital divide at all three levels – 1) Internet access, 2) competent use of digital devices, 3) beneficial use and design of digital technologies.

In the context of this study, the understanding is that **people need to be empowered for individual and democratic digital self-determination** in order to also be able to positively influence the cultures, practices, and visions of organizations, governments, and civil society with their digital skills and thus contribute to sustainable digital sovereignty. At the organizational level, for example, **workers need digital competence** to deal with the introduction of new technologies, while **leadership needs it to make strategically relevant decisions** for organizational development in the digital society. On the social and political level, for example, Mertz et al. (2016) discuss how citizens and individuals as users and consumers of digital content face intensifying and diversifying usage of digital media that will most certainly result changes in their opportunities to participate independently and actively in political decision-making. Thus, the self-determined use of digital media is becoming increasingly crucial, especially in terms of media savvy and judging the quality of the content being digested. A key objective is to **avoid a digital divide and promote inclusion**. A lack of digital self-determination or limited digital skills are sometimes seen as causes of / signs for social exclusion and disadvantage in society, the labor market, and the education system (Mertz et al., 2016).

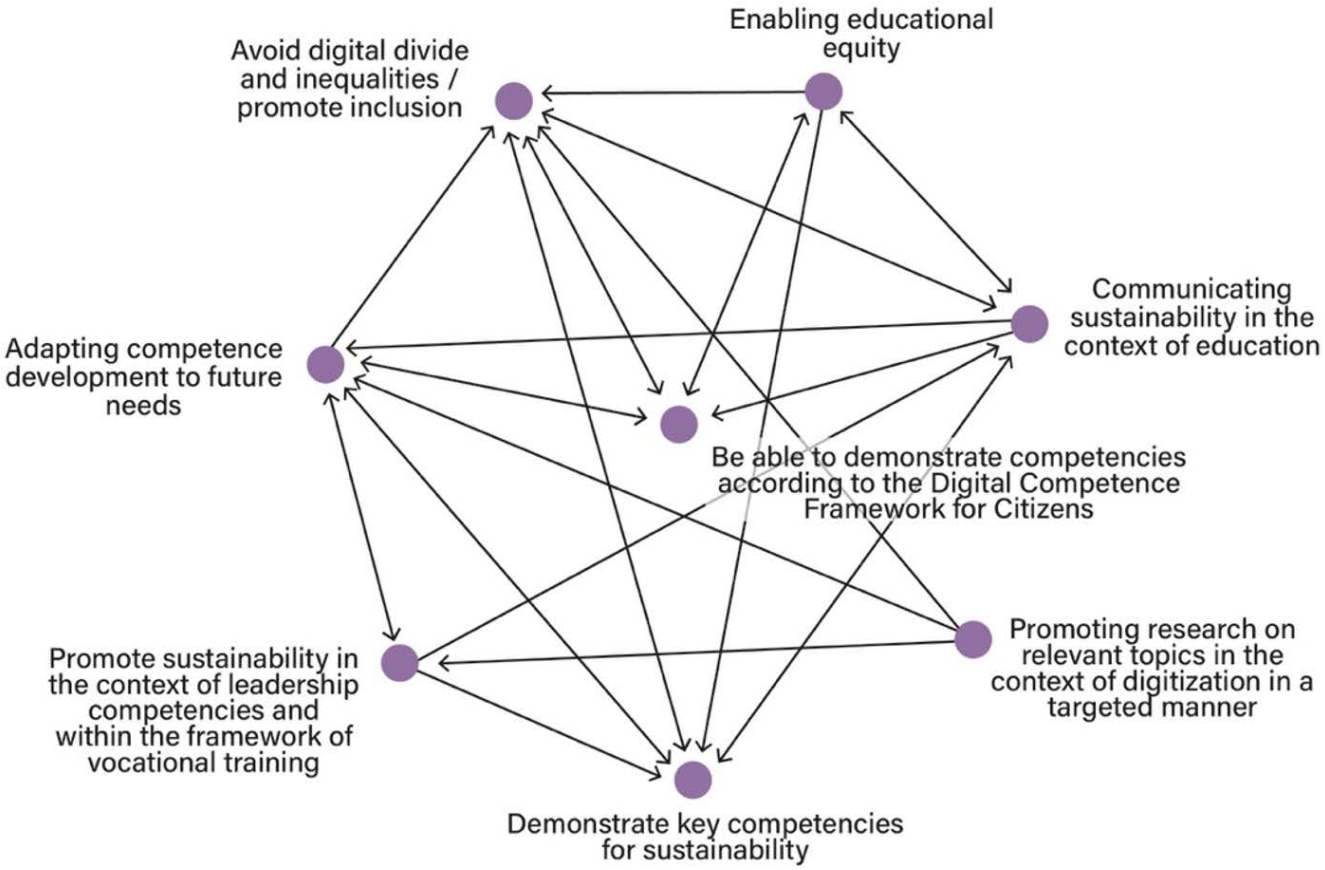
It is particularly important to "respect, protect, and promote digital self-determination from an ethical, legal, or political perspective" (Mertz et al., 2016), for which the necessary framework conditions must be created at the level of organizations, governments, and civil society. The role of the state is especially decisive (Gräf et al., 2020) in **shaping the framework for competence acquisition at the individual level and adapting competence development to future needs in order to promote sovereign action** – taking into account educational equity and inclusion. Potential leverage is available in tailoring educational programs or ensuring a free press. In the debate about sovereignty, both the level of the democratic state and the level of the individual are taken into account – in particular the autonomy and self-determined ability of citizens and non-citizens to act and the resulting need to strengthen digital literacy (Fritzsche et al., 2022).

Individuals' digital competencies also influence actions that shape one's understanding of sustainability goals across all spheres – social, environmental, and economic. **Teaching an understanding of sustainability in school and higher education**, for example, raises awareness of environmental protection and sustainability in the context of ICT skills, as well as critical thinking and personal responsibility in the use of digital technologies and the Internet (Ridsdale et al., 2015). In this context, **research on sustainability and digital sovereignty at universities** should also specifically be promoted.

In the initial workshop held as part of this study, the experts addressed the interdependencies between the different levels and also identified other ways in which digital skills can have an impact. One example is unwanted controls of digital spaces or power asymmetries of digital platforms. These can only be recognized and counteracted if individuals in their respective spheres of influence, especially political decision-makers, have the necessary skills to assess opinion formation and influence, the economic consequences for companies and people, or cultural influences and long-term dependencies. In this context, the participants discussed terms such as "digital colonization," "indigenous technology development," and "digital and cultural imperialism," as well as the crucial role that digitalization plays for freedom and equality. They warned against "transferring the problems of the physical world to the digital world" and, to avoid that, they suggested empowering people to participate in democratic and political processes through continuing education and skills development. Individual digital skills and empowering people to act in a self-determined manner were closely related to sustainability in the discussion. Knowledge of how technologies, energy consumption, and climate change are interrelated was repeatedly touted as indispensable for one's own behavior. This is directly linked to grasping socially and economically relevant processes, such as "what the footprint of tech oligarchies is and how energy production is increasingly being controlled by them," or "rebound effects of digital-borne efficiency improvements." Equally critical is people's understanding of how they can control the data they generate and what opportunities exist to influence relevant policy-making processes.

How thoroughly digital goals are interrelated becomes quite evident at this stage. The goals identified and defined in our workshop are summarized in figure 2 along with their interdependencies.

Figure 2: Objectives of competence building for digital sovereignty and sustainable digitalization and their relations



5 Sustainable digitalization as a design and development principle for socio-ecological digital sovereignty

The concept of sustainability is often divided into the spheres of social, environmental, and economic sustainability (see Barbier, 1987). The ecological sphere primarily concerns the use of natural resources, focusing not only on consumption but also on the impacts, residues, and waste generated by the use of digital technologies, among other things. In this sense, pollution prevention includes resources such as air, water, soil, and waste. Thus, environmental sustainability addresses production as well as use and consumption aspects (Lozano & Huisingh, 2011).

Social sustainability includes aspects like standard of living, education, and community-enhancing opportunities, including equity and equal rights. In addition, environmental justice and the responsible use of natural resources provide a link between social sustainability and the environment at both the local and global levels. However, as Goodland (1995) points out, social and environmental sustainability are linked in an even more fundamental way, as environmental sustainability, or the maintenance of life-support systems, is a prerequisite for social sustainability.

From a post-growth perspective and related sufficiency considerations, stable structures that support the long-term existence of economic organizations, such as research and development, financial participation mechanisms, and redistribution as well as approaches to address fairness for services performed in society, or the development of sustainable business models are all aspects of economic sustainability. In this sense, economic sustainability refers to the ability to promote the aforementioned aspects and thus ensure continued existence of whole societies.

To address the challenges facing humanity and thus provide a foundation for sustainable development for people and the environment, the United Nations (UN) has formulated 17 Sustainable Development Goals as part of its 2030 Agenda (United Nations, 2022). The SDGs are further specified in 169 targets (Hák et al., 2016), and 240 global indicators have been itemized to enable measurement and thus monitoring of target achievement. The agenda pursues the common objective of transformation toward a world in which all people act in an environmentally sound, socially just, and economically efficient manner (UN General Assembly, 2015). The interdependent objectives primarily address five core issues, aka the “five Ps”: people, planet, prosperity, peace, and partnership, which serve as guidelines for action and concretize the relationships between the goals. Goals include ensuring quality education (SDG #4), reducing inequalities (SDG #10), responsible consumption and production (SDG #12), and climate action (SDG #13) (United Nations, 2022).

Mostly, digital transformation and sustainability transformation of business and society have been considered separately, with a few exceptions (European Digital SME Alliance, 2020; Fritzsche et al., 2022; Lange & Santarius, 2018; Wallimann-Helmer et al., 2021). This is insufficient, however, for both transformations are indeed interdependent and can cross-fertilize one another. Fritzsche et al. (2022) elaborate three levels of meaning for sustainable digitalization: 1) the sustainable design of digital technologies, 2) the use of digital technologies to achieve sustainability, and 3) the realization of sustainable systemic change.

The objective of **sustainable design of digital technologies** (Fritzsche et al., 2022) includes aspects like developing and deploying climate-neutral CPU models and server centers, on the hardware side, and applications that reduce energy consumption, on the software side. Digital technologies must additionally be built such that they can be repaired relatively easily, and a certain degree of accessibility must be present for the differently-abled. Politicians and the state bear the responsibility for creating the framework conditions to regulate digital markets appropriately.

Another objective for sustainable digitalization is **achieving sustainability through digital technologies** (Fritzsche et al., 2022).This means using digital technologies to pursue and achieve primarily environmental, but also social sustainability goals. Resource management is already being promoted by digital technologies at the level of industry and society. The same can be done in private households to regulate energy consumption according to demand. In the sphere of social sustainability, moreover, digital technologies can be used to provide information and participation opportunities for individuals and thus achieve a higher degree of social inclusion.

Sustainable digitalization is frequently invoked for the **realization of lasting systemic change** (Fritzsche et al., 2022). This means that social innovations and sustainable business models must gradually substitute the conventional approach of steady growth, while at the same time bringing about a change in behaviors and practices among those involved and affected.

Based on society's obvious need to undergo fundamental changes, with the primary action mechanisms being digitalization, Lange and Santarius (2018) develop three guiding principles for sustainable digitalization: 1) digital sufficiency, 2) consistent data protection, 3) orientation toward the common good in the distribution of the benefits of digitalization.

The goal of **realizing digital sufficiency** refers intentionally thinking of information and communication technologies in terms of their longevity and their multipurposefulness (technology sufficiency). Data sufficiency addresses the design of digital technologies with regard to using data parsimoniously. Sufficiency of use addresses the user's behavior directly. Here, the focus is on aspects such as repairing instead of buying new, or purchasing and reusing second-hand devices (Lange & Santarius, 2018).

The **achievement of consistent data protection** is seen as a further objective of sustainable digitalization. This speaks to the necessity of guaranteeing maximum privacy protection by devices as well as applications. Furthermore, how the principle of data sufficiency is applied becomes an important indicator of data protection itself, due to the transmission of less data in the first place (Lange & Santarius, 2018). In its essence, consistent data protection can be achieved most successfully through data ownership by the users themselves. This subsumes the application of and compliance with far-reaching data protection rules for private-sector actors.

Orienting the distribution of the benefits of digitalization increasingly **toward the common good** is another relevant objective in the context of sustainable digitalization. To this end, the Internet – as it was conceived at the beginning – must once again be understood as a common good that is developed by its users. Along with this, individual areas should also be accessible to all without barriers and not dominated by individual private interests. This means bringing an end to digital feudalism and the dissolution of all its vestiges (Lange & Santarius, 2018). The aspect of open source as well as cooperative platform design are further indicators for increasing the orientation toward the common good.

The *European digital SME Alliance* (2020) identifies three key pillars of sustainable digitalization: 1) sustainable digitalization in the B2B sector, 2) development and use of green technologies and the circular economy, and 3) a policy and regulatory framework conducive to innovation.

Sustainable digitalization in the B2B sector is characterized by long-term synergetic partnerships in digitalization projects and associated investments between traditional and digitally innovative companies. A key requirement for the implementation of such sustainable partnerships in the digital transformation is the talents and skills, abilities and competencies of the people who help shape it, as many requirement profiles will change, especially with regard to the competent use of digital tools (European Digital SME Alliance, 2020).

Strengthening the circular economy can be promoted, for example, through the existence of a right to repair, existing circular economy models for hardware, or the affordability of high-quality repairs (European Digital SME Alliance, 2020). In addition, especially in the context of increasing efficiency through the use of digital technologies and their sustainable design, so-called **rebound effects**[3] must be **identified and minimized** (Tretter et al., 2020). This involves understanding the impact of efficiency savings and developing mitigation strategies to counteract rebound effects.

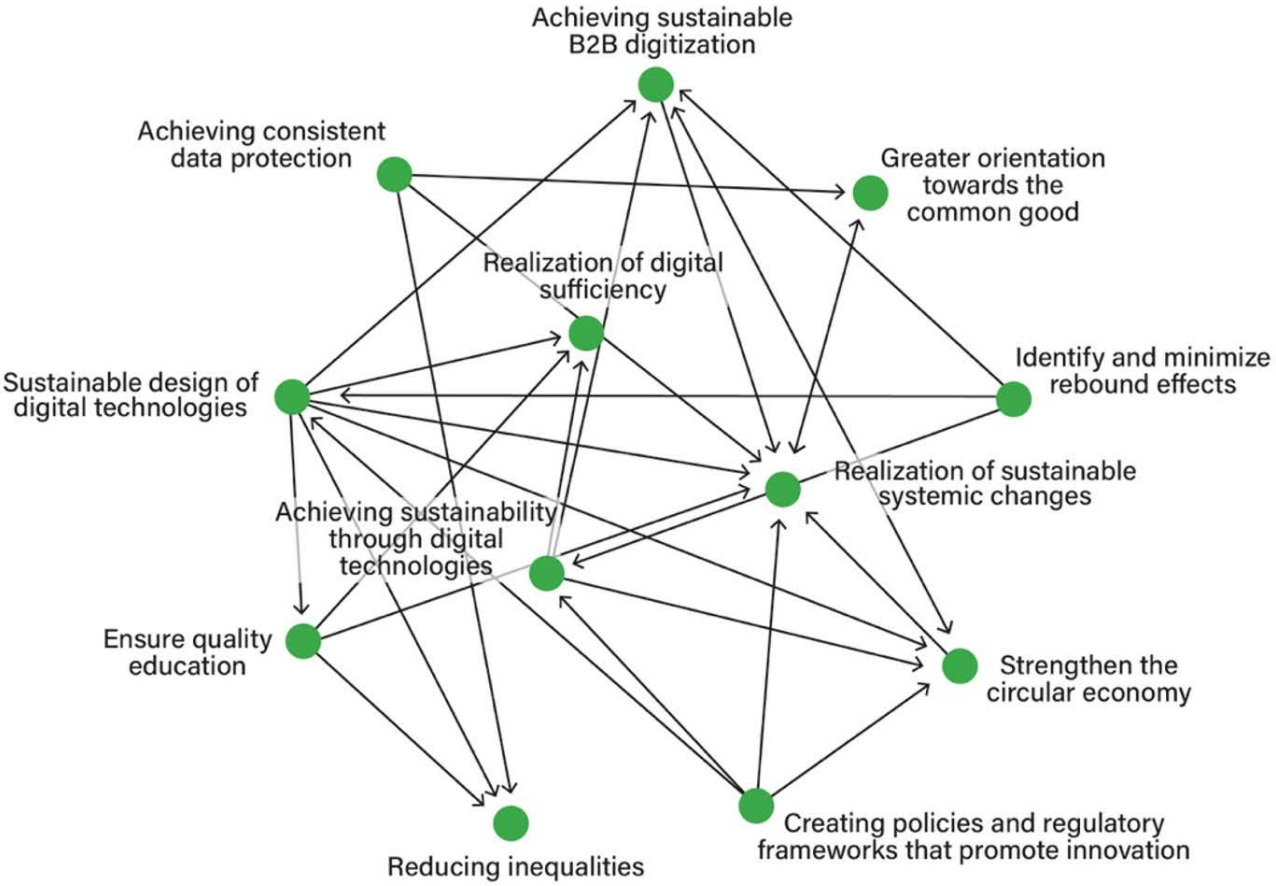
The aspects listed here represent objectives of sustainable digitalization in the context of socio-ecological digital sovereignty, supplemented by the two SDGs of *reducing inequalities and guaranteeing quality education* (United Nations, 2022). These objectives are a conceptualization of the spectrum of sustainable digitalization and its characteristics.

The interrelations between these goals abound (see figure 3). For example, sustainable design of digital technologies leads to an economy that becomes "circular" (Liu et al., 2021). High-quality education, in turn, raises awareness for frugal use and movement in the digital environment (cf. Santarius et al., 2022). In the first workshop, particular emphasis was placed on the goal of digital sufficiency. It was also pointed out that some objectives do conflict, particularly in the context of sustainable digitalization. For example, digital technologies may help bring about more environmental sustainability; yet, if they themselves are not designed to be sustainable, their use leads to significant resource consumption and thus harms the environment. The workshop emphasized the circular economy, data privacy, and the competencies necessary for sustainability.

The complexity of sustainable digitalization is well illustrated by the objectives within each area and their interdependencies. Figure 3 depicts the interrelations identified.

[3] Rebound effects describe an increased demand for resources that stem from an increase in efficiency. An incentive to drive more can arise from greater engine efficiency, for example, negatively offsetting potential CO2 savings through lower emissions. In addition to this direct effect, other environmentally relevant behavioral changes are possible, e.g., the money saved is invested in air travel (cf. German Federal Environment Agency, 2019).

Figure 3: Objectives of competence building for digital sovereignty and sustainable digitalization and their relations



6 Perspective of sustainable digitalization on competencies and digital sovereignty

From this perspective, individuals and collectives must be enabled to use digital technologies sustainably and to use them in a targeted manner to realize ecological and social – as well as economic – added value. This empowerment requires creating an awareness of what implications are associated with the development and application/use of digital technologies in the three spheres of sustainability. It must go beyond mere competence building for sustainability and also starts with the skills to design and use, but also to sensibly use (digital) technologies. The working and learning conditions, as well as the reusability of contents, methods, and results, thus represent essential cornerstones of competence building in terms of sustainable job qualification.

Digital literacy is an enabler of sustainable digitalization. The aforementioned concept of the *digital divide* in particular therefore requires special attention in the interplay between digital sovereignty and sustainable digitalization. As the recent literature highlights, the first and second levels of the *digital divide* address 1) inequalities in access to and 2) use of the Internet, while the third level refers to the 3) tangible outcomes that are produced online and are also of social value (Ragnedda, 2018, p. 2366). Ragnedda (2018) correlates digital inequalities with the digital capital an individual or group possesses and its further interactions with social, economic, personal, political, and cultural forms of capital. He defines digital capital as "the accumulation of digital skills (information, communication, security, content creation, and problem solving) and digital technology" (Ragnedda 2018, p. 2367). This analysis shows that skills and knowledge, as well as sociocultural and sociopolitical background, determine how individuals are able to translate their digital experiences into social outcomes: It is not only knowledge, digital skills, and motivation but also the skills and real opportunities to use digital capital as currency to obtain other resources that can improve the lives of individuals. In a highly digitized society, it is crucial to not only have access (access to the Internet and to digital technologies) but also to be able to confidently navigate and make the most of the digital arena (Ragnedda, 2018, p. 2373). At both the national and transnational levels, it is highly important to address all three levels of the digital divide in order to develop models of democratic digital sovereignty that take into account universal human rights and comprehensive sustainability.

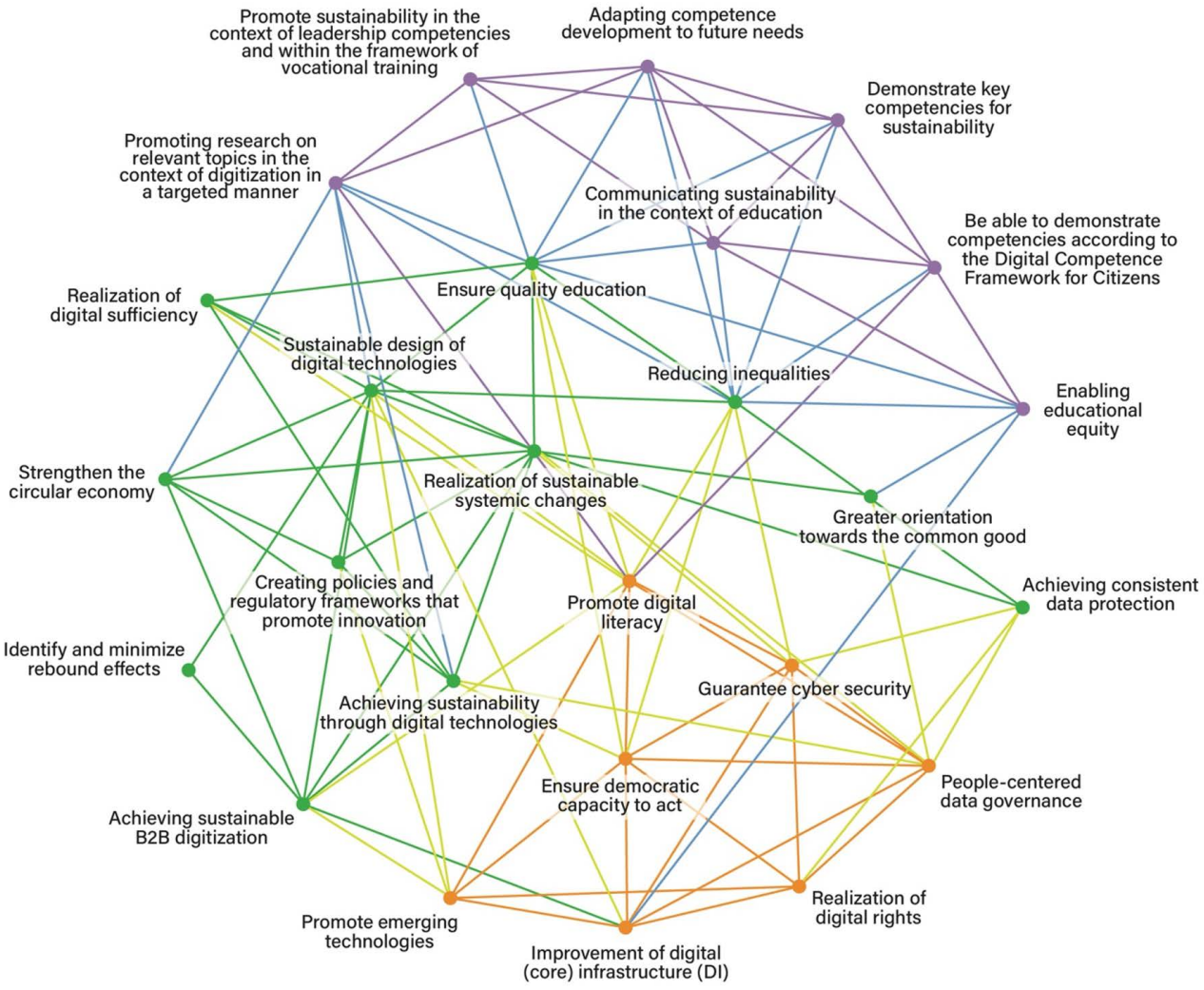
Building on the individual goals and their interrelations, a model of competence-based socio-ecological digital sovereignty is illustrated below, which is able to qualify the relations among them. The three constructs are interwoven through the interactions between the individual goals, thus spanning the broad space of interdependencies amid the various aspects and factors of competency-based social-ecological digital sovereignty.

By means of the relations, dependencies between individual objectives can be brought into focus. For example, reusable digital technology leads to greater sustainability of core digital infrastructures (Hustad & Olsen, 2021). Furthermore, a robust core digital infrastructure promotes democratic agency by enabling decision-making and participation mechanisms to be executed in the digital world despite spatial separation or temporal offset (Gulliver et al., 2021). Targeting emerging technologies enables the expansion of the sustainability focus into the very design of digital technologies technologies (Khattak et al., 2022).

In this light,[4] it becomes obvious that the interactions between the goals are highly complex. Promoting digital literacy, designing digital technologies sustainably, guaranteeing high-quality education, and stimulating research on relevant topics in the context of digitalization are central objectives for bringing about sustainable systemic changes toward socio-ecological digital sovereignty.

[4] The more centrally the goals are located in the figure, the more important they are in the network of skills-based social-ecological digital sovereignty.

Figure 4: Goals and interdependencies of socio-ecological digital sovereignty.



7 Exemplary theses regarding these interdependencies and action recommendations

Based on the findings of the literature review and the first expert workshop, three central theses were formulated for this study. The theses exemplify the interrelations between digital sovereignty, sustainability, and digital literacy. In the second expert workshop (in August 2022), a discussion took place specifically dedicated to formulating these theses and generally on possible interdependencies between the objectives of the three areas. The participants had the opportunity to familiarize themselves with the goals and their associated indicators (cf. appendix) in advance and to demonstrate links between the goals and dimensions directly in the workshop based on their experience and professional expertise.

In addition to the theses and the goals, the workshop also focused on the interaction between the various actor levels – the state and politics, organizations (public institutions and companies), civil society and individuals / society. The participants discussed how the individual goals and the indicators that characterize them address the actor levels and what recommendations for action can be derived from them.

In considering the dimensions of sustainability and sovereignty, in general and with reference to the various actor levels, numerous intersections were identified in the overall model through the interconnectedness of the goals and indicators. Crucial for formulating the central theses was the insight from the literature review and from the first workshop that digital literacy and skills play a central role – they are an essential part of digital sovereignty as well as being an educational objective in the area of sustainable digitalization. The digital literacy goals identified in the literature review link up with both digital sovereignty and sustainability and are relevant across actor levels.

7.1 Theses on the interdependencies

The following three theses summarize the elaborated perspective on the interdependencies between the areas.

Thesis 1
Digital sovereignty begins at the societal level and the level of individuals through digital literacy and thereby permeates all other levels (civil society, politics, economy).

There are numerous facets to formulating the goals for digital sovereignty that expresses the diverse desires of individuals, communities, and societies for access, orientation, self-determined action, future viability, co-determination, and resilience. People who are digitally sovereign bring their knowledge and skills to bear, and thus also their responsibilities and duties, into all fields of activity in their lives and thus help determine the production, regulation, or use of digital technologies – as individuals in the shaping of their everyday lives, as professionals in the course of their career activities, as volunteers, and as civil society actors. If digital sovereignty is to center on people and society and sustainable and equitable living conditions, it needs formats of exchange, inclusion, and awareness for fairness and non-discrimination, for cultural contexts, for local knowledge. And it must be account for gender issues, data protection, and the common good as well as of sustainability potentials and (direct as well as indirect) resource consumption. Informed decisions in technical, spatial / territorial, cultural, organizational, legal, political, and economic aspects can only be made in light of these many factors if they are to be reconciled with democratic agency, with digital rights inscribed into technological standards, and human- and sustainability-centered data governance.

The only way to ensure that measures are taken at all actor levels to adapt digitalization processes to the needs of society is with appropriate digital literacy and knowledge of the connections between competencies at the individual and societal level as well as about the development and design of digital technologies, including political regulation. Individuals and societies can become empowered through deliberative formats, public debates, inclusive learning spaces, and formal and informal collaborations to help shape a socially and ecologically sustainable digital transformation. Addressing inequality, promoting inclusion, and providing equal access for all amount to common goals in the areas of sustainability, skills, and digital sovereignty, side by side with promoting approaches to systemic change that champion the public good.

The participants of the second workshop also identified these goals as the basis for democratic and sustainable digital sovereignty. Democratic agency was ranked as a goal that directly impacts greater orientation toward the common good as well as expanding it by reducing inequalities and promoting inclusion. Digital security, described in the literature with indicators such as "adherence to the commons approach," "government use and promotion of open-source solutions," and "development of common good technologies and systems," was related to the goal of "strengthening the circular economy." In the process, participants pointed out a striking conflict of goals: One economic understanding of innovation (market orientation) is opposed here to an understanding of innovation that comes from civil society (public orientation). This conflict of goals must be addressed by means of negotiation processes between all actor levels.

Thesis 2
The development and targeted promotion of digital literacy (digital skills), especially in the context of digital sovereignty, forms the basis for sustainable digitalization at the level of civil society, politics, and the economy.

The promotion of digital competency (esp. data literacy) is one of the central objectives (see appendix) of digital sovereignty. Indicators identified in the literature include those that have a direct impact on sustainable digitalization. Thus, empowering users to engage with technology and their data critically and conscientiously, as well as knowing about the effective and efficient use of digital technologies, is a prerequisite for sustainable action on the part of civil society. Enabling users to understand and transparently track commercial and governmental powers in the digital sphere can significantly contribute to the common good, one of the key objectives of digital sustainability. Thus, at the actor level, it becomes exemplarily clear how civil society can influence the economy.

Some of the goals in the area of digital literacy (see appendix) address how the preconditions for sustainable digitalization can be created. Thus, the goal of "targeted promotion of research on relevant topics in the context of digitalization" is directly linked to sustainability through the indicators of "providing knowledge, technologies, innovations, etc. to support community implementation of the SDGs" and "supporting collaboration with developing countries and companies to implement SDG solutions." The goal of "sustainability taught in the context of education" has a similar focus. At this point, in particular, the actor level of civil society is linked to that of politics, which bears responsibility for corresponding support measures. Further, once sustainability is taken into account in vocational education and training (as part and parcel of digital skill building), the connection rises to the next actor level: the economy.

In the second workshop, further examples of the interconnectedness of these objectives were highlighted, and thereby of the three areas of this study. For example, the experts directly related the competence goal of "sustainability taught in the context of education" to "realization of sustainable systemic changes" from the area of sustainability, which is described by the following indicators, among others: "resource management through digital technologies in industry and private households" and "sustainable business models emerge and take hold." This also shows a direct connection with the economic actor level. The above-mentioned objective of "targeted promotion of research on relevant topics in the context of digitalization" was linked in the workshop to "sustainable design of digital technologies," which includes the concrete influence on politics (indicator "regulation of digital markets is carried out") as well as the economic field (indicator "software developments that reduce energy consumption").

Thesis 3
Sustainable digitalization creates the conditions for digital sovereignty at the political and economic level and competence development on a societal level.

From a holistic perspective, digital competence is, of course, both a prerequisite and a result of sustainable digitalization. While sustainable digitalization does promote the development of digital skills, it also requires them at the same time. Within the SDG of "ensuring quality education" for members of our society, particular focus is placed on "knowledge of information and communication technologies" and "education for sustainable development." This perspective clearly shows the close interconnection between sustainability or sustainable digitalization and digital skills. Furthermore, a reduction of inequalities and the ancillary improved access to information and knowledge as well as methods, instruments, and institutions of training and knowledge transfer leads to an increase in citizens' and individuals' digital skills as well as their digital sovereignty.

In particular, aspects of common good orientation as well as sustainable systemic changes toward higher inclusion promote both educational aspects and digital sovereignty. In this context, digital technologies can be used in particular to cope with the ubiquitous and demand-oriented provision of information, for example with regard to data protection guidelines and opt-in platform design in the digital world. On the other hand, approaches such as free *massive open online courses* can increase digital literacy.

In the second workshop, the experts delved into the relations between ensuring quality education as well as the positive effects on digital competence, along with those relevant for digital sovereignty. In addition, there was a focus on relationships with sustainable digitalization. The sustainable design of digital technologies promotes the reduction of inequalities, can increase inclusion, and bring about a reduction in the digital divide.

7.2 Recommendations

Here we highlight, by way of example, some of our central recommendations, both at the regulatory level and at the level of production, implementation, and use of digital technologies. In doing so, we focus on many of the indicators uncovered in our literature review. Due to their normative character in bringing about socio-ecological digital sovereignty (see table in the appendix with a list of "goal formulations" and "indicators"), the indicators themselves already point to numerous fields of action that are ripe for essential measures.

Strengthen cooperation

Cooperation and coordination between the various actor levels are at the heart of many goal descriptions in all three dimensions: "digital sovereignty," "sustainable digitalization," and "competence." All actors, especially local and municipal actors, are called upon to create spaces and formats for exchange, learning, and cooperation in order to grasp the complexity and dynamics of the topic area so that these can be addressed to the fullest. This also includes: interministerial / interdepartmental collaboration to break down silos in administrations, for example, or bringing together civil society discourses, creating spaces and formats for linking up the open knowledge and open source community with social movements such as "right to the city,"

organizing round tables and promoting other city-lab-like constructs that think about digitalization and sustainability in conjunction and interrelate diverse bodies of knowledge. It is therefore a matter of promoting measures to bring together different perspectives and interests – in the sense of social and democratic participation.

Create dynamic education and training opportunities

For socio-ecological digital sovereignty, educational offerings must be dynamically adapted to realities of life and work, and needs-based education and training must be promoted. Regular training opportunities must be created for decision-makers from politics, business, and society in order to continuously identify and develop relevant competencies in the area of sustainable digitalization. One suitable measure would be, for example, teaching skills in the areas of sustainability and digitalization in vocational training and life-long learning offers. These skills should not just be established on a voluntary basis; instead, they should be required as a part of one's professional / educational profile.

Recognize and promote inter- and transdisciplinary research

Targeted promotion of inter- and transdisciplinary research projects and international collaborations are needed to account for diverse cultural, social, and societal perspectives in the development of technologies and concepts. This would promote sensitivity and awareness of global perspectives on sustainability and sovereignty. Here, both research funding itself and the research community are called upon to recognize, promote, and practice transdisciplinary and transformative research as relevant to society. This also includes critical digitalization research projects carried out in collaboration with academic and non-academic representatives (partners from politics, administration, SMEs, and civil society), as well as low-threshold transfer formats and horizontal collaborations.

Pursue open access, open knowledge, open source, open data, and public good.

It is crucial to promote open knowledge and open access formats for increasing competence toward digital sovereignty and sustainable digitalization. The promotion and application of open source technologies remains central to the security, transparency, and reliability as well as trustworthiness of sustainable digital infrastructures. For example, we need transparent digital governance and minimum standards that are binding. High quality data is also essential for its positive repercussions on data parsimony as well as fairness and non-discrimination and that favors public good data. Through open data, data generated by companies can serve as a source of information for public policies and their implementation; data collected by government agencies (e.g., air quality, climate, satellite imagery) is made available under open data programs or licenses to enable the development of commercial applications. Regulatory measures that enforce this play an important role here, but so does the social recognition of such openness and common good approaches and the pioneering role of organizations.

Align (technological) developments ecologically and sustainably

Central to this recommendation are, on the one hand, the empowerment and incentivization of digital sufficiency at the individual and societal levels through knowledge transfer and the identification of interrelationships. Public institutes, institutions of further education, training, and knowledge transfer in particular can contribute to this. On the other hand, opportunities must be opened up at the regulatory level, examples of which would be the right to repair, instruments to prohibit planned obsolescence, and obligations to recycle devices, as well as binding environmental standards for the digital core infrastructure. Strengthening demand for durable products and sustainable services should also be pursued both by creating awareness among individuals and through reliable certifications and standards in the assessment of direct and indirect resource use. The potential conflict that arises from

the goals of environmental sustainability and social fairness must be taken into account. Regulation and standardization can simultaneously promote social inclusion. Furthermore, mechanisms must be institutionalized to make data minimization practicable in the first place. Helpful possibilities for this are provided by data economy through user-friendly standardizations, for example by AdTech: restricting microtargeting or monitoring by advertising technology by design and privacy-by-design approaches.

Sustainable economic system for more regional and global justice

Central here is the focus on and support for local approaches to the circular economy, integration of local knowledge, consideration of local needs and skills, empowerment of local actors, and merging of production and consumption on a local basis (i.e., local emissions must also be compensated locally). A fairer and sustainable economic system also includes compliance with labor standards and their enforcement for workers in the gig economy and in the digital world of work, some of whom are exposed to extremely precarious working conditions and a high level of risk (see, for example, the Berlin Tech Workers Coalition). The social welfare for platform workers must be regulated in such a way that they can be protected against exploitation or discrimination. Measures should also aim for an even distribution of digital literacy across all sectors of society (politics, business, and civil society) and not just among companies and economic actors. This current challenge must be addressed at all actor levels.

Social and digital non-discrimination

It is a political task to create framework conditions for this at the operational level. The focus on non-discrimination should be placed as early as the development stage of technology – a task to be performed in particular by the relevant companies. The underrepresentation of women as well as minorities in the digital sector needs to be addressed, with education and training institutions playing a fundamental role (for example, to introduce more girls to STEM subjects already in early childhood education and to support them in overcoming existing talent stereotypes). On the other hand, the male-dominated work environment must be changed (e.g., structural barriers must be dismantled) and more diversity in terms of gender as well as origin or character must be allowed. Where possible, protected digital spaces that promote non-discrimination and privacy by design (for girls, women, or non-binary people, for example) should also be established, enabled, or expanded. Finally, there is the issue of transparency in decision-making procedures: Traceability of decisions reduces the risk of discriminatory structures and biases or stereotypes from infiltrating algorithmic learning systems via their data sets used for training. Here, too, the regulatory side has a responsibility just as much as the production side of digital technologies.

8 Conclusions

In this study, we initially investigated the relations that exist between sustainability and digital sovereignty in a broadly explorative manner. Digital skills were identified as a key intersection during the course of the study and were included as a third area of inquiry. The three areas were summarized in an initial model and three theses were formulated. In the next step, relations between selected goals were discussed and recommendations for action were derived. In the study, the various actor levels – state and politics, organizations (public institutions and companies), civil society and individuals /

society – were treated in a differentiated manner in order to avoid over generalization. Both the discussion of the theses and the recommendations for action took into account the specifics and roles of these different actor levels.

The discussion of the interdependencies at the actor levels in particular has shown that thinking about the areas of sustainable digitalization and digital sovereignty in conjunction can also reveal challenges and conflicts between goals that are crucial for the development of all three areas. For example, a desirable goal such as innovation can bring together different views of different actors – perspectives on innovation from the economic viewpoint (market-oriented) or from civil society (public-oriented) can indeed benefit from or conflict with each other, depending on the framework conditions and competencies. If the economic actors lack the corresponding competencies, they will not be able to meet the requirement of synthesizing technology design and innovation with sustainability, or human rights with innovation. If the political decision-makers lack the necessary competencies, it will not be possible to create the framework conditions that would enable the mutual enrichment of business and civil society. Furthermore, conflicting goals can arise from the fact that there are differences in digital skills between different generations. At this actor level, the disparity between the decision-makers (often older than 50) and the digital natives (mostly under 25) must be taken into account. Many of the political and economic decisions in the area of sustainable digitalization and digital sovereignty will shape the future of the younger generation.

A mix of methods was used in the preparation of the study – the diversity of the topic made a targeted examination of relevant preliminary work necessary at the beginning; the topicality of the subject made dialogue with experts indispensable in order to qualitatively assess and discuss the reciprocal interrelationships of effects. In addition to the many results obtained, the authors would like to explicitly highlight one particular feature of the impact relationships studied – their enormous complexity. This is partly due to the need to capture latent constructs that can only be described via diverse objectives and via a large set of associated indicators. These flow into the network of interrelations, opening up many different possibilities for analyzing connections and influences. On the other hand, the field under study is extremely dynamic and associated with all kinds of new developments, challenges, and issues that are constantly in need of update. With its results and the identified goals and indicators, the study aims to provide a basis and stimulus for further research and discussion.

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9 Appendix

Goal	Indicator	Reference
Sustainable design of digital technologies	Existence of climate-neutral CPU models and server centers	Fritzsche et al. (2022)
	Software developments that reduce energy consumption	Fritzsche et al. (2022)
	Repairability of digital technologies is guaranteed	Fritzsche et al. (2022)
	Accessibility of digital technologies is available.	Fritzsche et al. (2022)
	Regulation of digital markets is carried out.	Fritzsche et al. (2022)
Achieving sustainability through digital technologies	Digital technologies are used to realize sustainability goals.	Fritzsche et al. (2022)
	Resources are managed with digital technologies in industry and private households.	Fritzsche et al. (2022)
	Digital technologies are used to provide information services and thus achieve inclusion.	Fritzsche et al. (2022)
Realization of sustainable systemic changes	Social innovation are realized.	Fritzsche et al. (2022)
	Sustainable business models emerge and prevail.	Fritzsche et al. (2022)
	Sustainable behaviors are enforced and adopted.	Fritzsche et al. (2022)
Realization of digital sufficiency	Technology sufficiency is present.	Lange & Santarius (2018)
	Data sufficiency is present.	Lange & Santarius (2018)
	Sufficiency of use is present.	Lange & Santarius (2018)
Achieving consistent data protection	Privacy by design is realized.	Lange & Santarius (2018)
	Data sufficiency is available.	Lange & Santarius (2018)
	Data ownership by the users	Lange & Santarius (2018)
Greater orientation towards the common good	Internet as commons	Lange & Santarius (2018)
	Open source	Lange & Santarius (2018)
	Cooperative platforms	Lange & Santarius (2018)
Achieving sustainable B2B digitization	Long-term oriented synergetic partnerships between traditional and digitally innovation companies	European digital SME Alliance (2020)
	B2B relationships create innovation-driven ecosystems	European digital SME Alliance (2020)
	Orientation towards digital business models is in place	European digital SME Alliance (2020)

Strengthen the circular economy	Efficiency across the sector is increased through the use of digital technologies	European digital SME Alliance (2020)
	Reparability of products is technically possible	European digital SME Alliance (2020)
	Reusability of products is made possible	European digital SME Alliance (2020)
	Circular economy models for hardware are available	European digital SME Alliance (2020)
	Right to reparability is enforced	European digital SME Alliance (2020)
	High quality repairs are affordable	European digital SME Alliance (2020)
Creating policies and regulatory frameworks that promote innovation	Holistic legislation that promotes innovation	European digital SME Alliance (2020)
	Forcing openness of software and hardware	European digital SME Alliance (2020)
	Platforms are regulated with regard to interoperability, data processing, and use	European digital SME Alliance (2020)
	Access to data and interoperability between data pools is ensured	European digital SME Alliance (2020)
	Transparency requirements for digital platforms are explicit and implemented	European digital SME Alliance (2020)
	Alternative access to digital platforms is created	European digital SME Alliance (2020)
Identify and minimize rebound effects	Are the effects in terms of greater demand known vis-a-vis a product's efficiency savings?	Tretter et al. (2020)
	Is it known whether and to what extent efficiency savings for one product will lead to increased demand for other products or services?	Tretter et al. (2020)
	Is it known whether increased aggregate demand for resources results as a consequence of efficiency improvements in technologies?	Tretter et al. (2020)
	Can the probability of occurrence of rebound effects be estimated?	Tretter et al. (2020)
	Can the magnitude of the rebound effects be quantified?	Tretter et al. (2020)
	Do mitigation strategies exist to counter rebound effects?	Tretter et al. (2020)
Reducing inequalities	Percentage of population reporting having felt personally discriminated against	United Nations (2022)
	Equal access for all	United Nations (2022)
	Proportion of the population who are refugees	United Nations (2022)
	Share of tariff lines set at 0 applied to imports from developing countries and those on the road to development	United Nations (2022)

Ensuring quality education	Participation rate in organized learning before entering elementary school	United Nations (2022)
	Participation rate of youth and adults in formal and non-formal education and training.	United Nations (2022)
	Proportion of young people and adults with knowledge of information and communication technology (ICT)	United Nations (2022)
	Extent to which global citizenship education and education for sustainable development are mainstreamed in national education policies, curricula, teacher training, and student assessments	United Nations (2022)
	Proportion of schools providing basic services	United Nations (2022)
	Proportion of teachers with the required minimum qualifications	United Nations (2022)
Promoting research on relevant topics in the context of digitization in a targeted manner	Providing knowledge, technologies, innovations, etc. to support community implementation of the SDGs	Ahel & Lingenau (2020)
	Promoting transdisciplinary approaches in science	Ahel & Lingenau (2020)
	Supporting collaboration with developing countries and companies to implement SDG solutions	Ahel & Lingenau (2020)
Adapting competence development to future needs	Teaching future-relevant and digital competencies in teaching and learning	Ahel & Lingenau (2020)
Enabling educational equity	Supporting socially and educationally disadvantaged groups	Niesyto (2009)
	Recognizing and counteracting processes of discrimination	Niesyto (2009)
Communicating sustainability in the context of education	Training students to conduct research on sustainable development	Ahel & Lingenau (2020)
	In alignment with the SDGs, higher education for sustainable development addresses unspecified, highly complex real-world problems such as climate change, environmental pollution, resource depletion, phosphorus and nitrogen overproduction, biodiversity loss, or inequitable wealth distribution.	Brudermann et al. (2019)
	The curricula are enriched with approaches to internationalization and digitization of higher education to promote transnational collaborations for sustainability.	Canigilia et al. (2018)
	The school acts as the main agent of social change, educating people capable of creating a sustainable world.	Otero & Ortega (2020)
	Imparting competencies in the areas of sustainability and digitization in vocational (continuing) education and training	Arcelay (2021), Liakhovych et al. (2021)

Promote sustainability in the context of leadership competencies and within the framework of vocational training	Future managers are trained in an interdisciplinary manner with an understanding of complexity.	Gitelman (2019)
	In organizational leadership, culture and operations: Implement the principles of the SDGs through self-created structures and operational decisions	Ahel & Lingenau (2020)
	In external leadership - strengthen public engagement and participation	Ahel & Lingenau (2020)
	Support the design of SDG policy	Ahel & Lingenau (2020)
Demonstrate key competencies for sustainability	Individuals are capable of systems thinking	Rieckmann (2017)
	Individuals can act with anticipation	Rieckmann (2017)
	Individuals can act competently in accordance with defined norms.	Rieckmann (2017)
	Individuals can demonstrate strategic action in relation to sustainability.	Rieckmann (2017)
	Individuals can act collaboratively	Rieckmann (2017)
	Individuals can demonstrate critical thinking	Rieckmann (2017)
	Individuals develop self-awareness / can act self-reflectively.	Rieckmann (2017)
	Individuals can solve problems successfully.	Rieckmann (2017)
Avoid digital divide and inequalities / promote inclusion	Eliminate deficiencies in (elementary) digital experience	Sá et al. (2021)
	Arouse interest in the use of technologies and counteract fears	Sá et al. (2021)
	Enable access to technologies, e.g., through ownership of digital devices or Internet access.	Sá et al. (2021)
	Promote digital skills; enable use or knowledge of new versions of technologies	Sá et al. (2021)
	Create diverse and flexible uses for technologies	Sá et al. (2021)
	Enable digital access for all	Sá et al. (2021)
	Encourage and support digital taste; Help individuals figure out how they can benefit from the digital world, i.e., individuals define their personal goals in using digital devices and networks.	Sá et al. (2021)
	Increase digital readiness through skills development	Sá et al. (2021)
Be able to demonstrate competencies according to the Digital Competence Framework for Citizens	Information and data literacy	Vuorikari et al. (2022)
	Communication and collaboration	Vuorikari et al. (2022)
	Digital content creation	Vuorikari et al. (2022)
	Safety	Vuorikari et al. (2022)
	Problem solving	Vuorikari et al. (2022)

Promote digital literacy	Educational measures / pedagogical offerings to teach critical thinking, media literacy, and digital competence	Gräf et al. (2020)
	Educational institutions enable individuals to orient and inform themselves	State Ministry for Digitalization (2020)
	Informed Decision Making: Users can make informed decisions [be technologically literate or competent in the use of digital tools].	Pohle & Thiel (2021)
	The users can deal critically and consciously with the technology and their data (data awareness).	Pohle & Thiel (2021)
	Understanding commercial and governmental powers in the digital sphere	Couture & Toupin (2019)
	Knowledge, about the effective and efficient use of digital technologies	Sá et al. (2021)
	Technical and cognitive competencies to conduct research based on digital media and to assess the quality and truthfulness of information	Sá et al. (2021)
	Knowledge of the relationship between technology and personal life and how to properly interact with others using digital technologies.	Sá et al. (2021)
	Inequality in terms of teachers‘ competencies in more digitalized societies	Rangel-Pérez et al. (2021)
	Active participation in the life of civil society, especially through the search for and exchange of information, the learning or improvement of technical and interdisciplinary skills, and general human development	Sá et al.
	Carefully consider the scope and impact of digital information on others and on society as a whole	Sá et al. (2021)

Realization of digital rights	Democratic participation and citizen involvement are promoted	Rone (2021)
	The embedding of values in technology is critically questioned	Avila Pinto (2018)
	A value-oriented design process is consistently implemented	Benjamin (2019)
	Privacy and human rights by design	Wright (2020)
	Testing systems for possible discrimination	Benjamin (2019)
	The right to anti-discrimination in the digital space is protected	Spielkamp (2022)
	Awareness of non-discrimination and fairness in AI development is present	Spielkamp (2022)
	Individuals are protected from their own state	Wright (2020)
	State actors protect users / individuals through regulation	Bundesregierung (2019)
	Human rights debates are transferred to the digital sphere	Roberts et al. (2021)
	Consumer rights are protected (less tracking practices, less ad tech, etc.)	Bendiek & Stürzer (2022)
	Prevention of discriminatory practices by market leaders (Adaptation of digitization to the needs of society)	Spielkamp (2022)
	Citizens and civil society ensure that digitization is adapted to society‘s needs	Gräf et al. (2020)
Ensure democratic capacity to act	There is clarity about what is a legitimate restriction.	De la Chapelle & Porciuncula (2021)
	Democratic acceptance of the digital transformation is secured.	Schroeder & Falk (2022)
	The legal, technical and ideal conditions for avoiding one-sided dependencies are in place.	Schroeder & Falk (2022)
	The development of democratic technology is enabled	Bendiek & Stürzer (2022)
	Decentralized regulation (regulatory strategies as non-state-centered forms of governance) is guaranteed.	Rone (2021)
	Parliamentary discussions, public consultations, more deliberative forms of public debates both within nation states and EU-wide are developed and shaped.	Rone (2021)
	Collective digital sovereignty is taken into account, community control over technologies and digital infrastructures is enabled.	Schroeder & Falk (2022)
	Resilience through the work of civil society is promoted.	Wright (2020)
	Individuals actively participate in political and social processes, make their voices heard and defend their rights.	Schroeder & Falk (2022)
	Disinformation, hate speech and defamation are regulated; monitoring of political statements on the Internet.	Rone (2021)
	Transparency about the way decisions are made is ensured.	Rone (2021)

Improvement of digital (core) infrastructure (DI)	(EU owned) data storage capacity / cloud capacity is being developed.	De la Chapelle & Porciuncula (2021)
	Use of open standards and open source software	Lambach & Oppermann (2022)
	Control of processes (e.g. cloud computing)	Floridi (2020)
	Preferential or higher funding for projects whose results are placed under an open source license.	Digital-Gipfel (2020)
	Instruments to promote growth, employment, and competitiveness through targeted infrastructure investments are currently being developed.	Roberts et al. (2021)
	All people will have unrestricted access to digital opportunities and technologies.	Roberts et al. (2021)
	The EU will be able to operate with less dependence on foreign technologies.	Roberts et al. (2021)
	It ensures that companies and data in the EU are not subject to the laws of third countries due to the storage of data abroad.	Roberts et al. (2021)
	Standards are developed that ensure democratic practices and the protection of individual privacy.	Wright (2020)
	Partnership between business and government to work hand in hand with all stakeholders in inclusive processes.	Lambach & Oppermann (2022)
	Programs to promote research in relevant technologies	Steiner & Grzymek (2020)
	The states ability to control key technical infrastructure (e.g., cables, satellites, smart cities) and the flow of information within and across its borders	Floridi (2020)

Guarantee cyber security	(Stronger) surveillance defenses and encryption are provided for existing risk management and resilience (prevention; protection; response; recovery)	Fritzsche et al. (2022)
	Strategic partnerships are entered into: States and non-state actors cooperate on selected technologies based on trust and shared values.	Kar & Tharpa (2020)
	Existing risk management and resilience (prevent; protect; respond; recover)	Kar & Tharpa (2020)
	Adherence to the commons approach: government use and promotion of open source solutions (Commons), developing technologies and systems for the common good	Kar & Tharpa (2020)
	Improve national cybersecurity capabilities, build EU-level collaboration, promote a culture of risk management and incident reporting among key economic actors	European Union (2016)
	Promotion of key security technologies	Lambach & Oppermann (2022)
	Strengthening the legal and regulatory security architecture in cyberspace at national and EU level.	Lambach & Oppermann (2022)
	Proposals for security certificates for digital products and processes	Lambach & Oppermann (2022)
	Strategies to promote key technologies and innovations in cybersecurity (market interventions, research funding).	Steiner & Grzymek (2020)
	Holistic protection of digital infrastructure by the state in conjunction with other areas such as data protection, public health and safety, etc.	Fritzsche et al. (2022), De la Chapelle & Porciuncula (2021)
Promote emerging technologies	Strengthen the EU‘s capacity to develop and regulate artificial intelligence (AI)	Roberts et al. (2021)
	Ensure that the development of new technologies is in line with EU values.	Roberts et al. (2021)
	Promote EU competitiveness by improving R&D and fostering partnerships with member states and the private sector.	Roberts et al. (2021)
	Funding research and development for digital technologies	Federal Council (2020)
	Invest in the development of the next generation of supercomputers	Roberts et al. (2021)

People-centered data governance	(Comprehensive) European control over data	Roberts et al. (2021)
	Enabling experiments	De la Chapelle & Porciuncula (2021)
	Ensure that frameworks are future-proofed	De la Chapelle & Porciuncula (2021)
	Users have control over the data they generate.	Roberts et al. (2021)
	Open data: Data generated by companies is a source of information for public policies and their implementation; data collected by public authorities (e.g., air quality, climate, satellite imagery) is made available under open data programs or licenses to enable the development of commercial applications.	De la Chapelle & Porciuncula (2021)
	Data of public interest are made available.	Mozilla Insights (2022)
	Data governance models (e.g., data communities, cooperatives, trusts, collaboratives, trustees, and marketplaces) are being developed.	Mozilla Insights (2022)
	Facilitate data sharing, (obligations to) ensure interoperability and competitiveness.	European Union (2020b)
	Control of storage, analysis and flow of data and information, control of standards and protocols between sectoral institutionalized processes	Floridi (2020), Wright (2020)
	Bridging silos (cross-sector)	De la Chapelle & Porciuncula (2021)
	Control of hardware (e.g. cell phones)	Floridi (2020), Wright (2020)
	Protection of privacy and data	De la Chapelle & Porciuncula (2021)
	Limiting the power of platforms, controlling services such as social media	Roberts et al. (2021), Floridi (2020)
	Promoting data governance for the common good.	Roberts et al. (2021)
	Promotion of data communities (digital commons)	Fritzsche et al. (2022)
	Promoting transparency, trust, and criticality in the data marketplace	European Union (2020b)
	Fair competition and data protection	Bendiek & Stürzer (2022)
	Interoperability and liability	Bendiek & Stürzer (2022)
	Deliberation, representation, inclusion	Hummel et al. (2021)
	Ensuring consumer protection through improved transparency	Hummel et al. (2021)
	Promote services of general interest related to data ownership, management and liability	Roberts et al. (2021)
	Recognition of the fundamental rights of the persons concerned	Wright (2020)

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Das Verbundvorhaben CO:DINA – Transformationsroadmap Digitalisierung und Nachhaltigkeit vernetzt Wissenschaft, Politik, Zivilgesellschaft und Wirtschaft, um neue strategische Stoßrichtungen für eine sozial-ökologische Digitalisierung zu identifizieren. Vielfalt in Denkweisen, Perspektiven und Erfahrungen ist die Voraussetzung, um die Komplexität der Digitalisierung besser zu verstehen und grundlegenden Fragen insbesondere zur Künstlichen Intelligenz mit tragfähigen Lösungsansätzen zu begegnen. Dabei entstehen Netzwerke zwischen Akteursgruppen, die bislang unzureichend verbunden waren. So wird die politische und gesellschaftliche Handlungsfähigkeit für einen sozial-ökologisch-digitalen Wandel gestärkt.

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