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# Education, Governance and Labour Markets in Digital Transformation

Insights and Considerations from  
the National Research Programme  
'Digital Transformation' (NRP 77)



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# 1

## Foreword

Digital transformation is the result of a long-term, far-reaching process. As early as the late 1980s, researchers examined how digital technologies were reshaping value creation and organisational structures. With the advent of the web in the second half of the 1990s, this discussion gained political and economic relevance as an increasing number of companies began embedding digital technologies systematically into their strategies. With the rise of smartphones, social media, big data applications, and cloud infrastructures, the term ‘digital transformation’ became firmly established as a descriptor for a comprehensive societal shift that continues to influence economic, social, and political systems in lasting ways.

In response to these developments, the Swiss Federal Government mandated the Swiss National Science Foundation in 2017 to implement the National Research Programme on ‘Digital Transformation’ (NRP 77). The aim was to provide scientifically grounded insights into pressing questions concerning education, ethics, trustworthiness, and governance, and the labour market in the context of digital transformation, thereby strengthening the evidence base for policy development. With a budget of 30 million Swiss francs, the programme enabled an extensive and interdisciplinary exploration of the opportunities and challenges associated with this transformation.

The pace and scope of change became evident shortly after the start of the research projects. The COVID-19 pandemic in 2020 triggered an abrupt shift in working and living arrangements that fully leveraged digital tools. Remote work and digital forms of interaction quickly became the norm, and essential societal functions migrated temporarily – and in some cases durably – into digital environments. These experiences acted as a catalyst for technological, organisational, and cultural adaptation, with direct implications for public policy, regulation, and public administration.

At the end of 2022, the momentum intensified once more with the introduction of generative artificial intelligence (GenAI) to the public, including ChatGPT, which rapidly established itself as an accessible, everyday technology. The swift uptake of this technology across society and the economy illustrates how tightly coupled technological innovation and public expectations have become. At the same time, this shift is transforming the research landscape

itself: methodologies, data foundations, and epistemic practices are evolving rapidly, with significant implications for knowledge-based policymaking.

Although GenAI was not present at the time of the writing of the research call in 2018, most of the observations arising from NRP 77 research on digital transformations are applicable to digital transformation including these current technological capabilities.

The results of the 46 research projects of NRP 77 are now available. To be interpreted meaningfully, they must be placed in the context of today's technological, economic, and societal conditions. The findings offer differentiated insights into profound societal transformations that extend well beyond individual sectors. They provide evidence-based guidance for policymakers, public authorities, economic actors, and civil society – guidance that is essential to ensure that digital transformation is socially equitable, democratically legitimate, and economically productive.

This publication synthesises the core insights from the 46 projects and formulates 12 concrete policy considerations. These are intended to support the political debate, inform strategic decisions, and contribute to a future-oriented governance framework for digital transformation in Switzerland.



**Abraham Bernstein**

President of the Steering Committee  
of NRP 77 'Digital Transformation'

## 2

# Executive summary

Digital transformation is reshaping all sectors of society, offering significant opportunities while also posing complex challenges. The National Research Programme on ‘Digital Transformation’ (NRP 77) explored a wide range of issues related to the integration of digital technologies, focusing on their impact on education, governance, and the labour market. Its findings highlight the need for a balanced approach that embraces innovation while safeguarding societal values. Ensuring that Switzerland remains at the forefront of digital transformation requires concerted efforts across multiple domains, including education, regulation, industry-wide initiatives, and public engagement.

The conclusions of the NRP 77 Steering Committee, presented in this document, build on five years of interdisciplinary research and expert analysis. They aim to support ongoing policy development and guide future actions. While research can offer solutions to specific questions, the broader societal trade-offs and priorities should be set through democratic processes. Hence, it remains the challenge of policymakers, educational institutions, governing bodies, businesses, and civil society to determine how best to implement them.

The findings of NRP 77 contribute to an informed public debate, providing evidence-based guidance for decision-makers in politics, academia, and industry. The programme’s outcomes could help shape Switzerland’s digital landscape, ensuring that technological progress aligns with societal well-being and long-term economic resilience.

In education and learning, findings emphasise the need for life-long digital skills development, educators’ upskilling, and structured learning frameworks. In ethics, trustworthiness, and governance, the programme sheds light on reliability and disinformation challenges, reinforcing the importance of transparent digital infrastructures. In the digital economy and labour market, research highlights how automation should augment rather than replace human capabilities, advocating for policies that support inclusive workforce transitions.

Far-reaching global developments during the five-year programme, such as the COVID-19 pandemic starting in early 2020 and the public release of OpenAI's ChatGPT in late 2022, underscored the urgency of optimising and enhancing Switzerland's digital transformation strategy. These events accelerated digital adoption and reinforced the need for policies that balance technological innovation with ethical safeguards.

Together with geopolitical developments these events underscore the growing urgency for Switzerland to implement forward-thinking digital transformation policies. A strategic approach is essential to ensure that individuals, businesses, and institutions are not only equipped to adapt to technological changes but can also leverage digital advancements to drive innovation, economic growth, and societal well-being. To keep up with the accelerating pace of technological advancement, sustained investment is essential for Swiss policymakers and decision-makers into forward-looking research related to digital transformation – including in education, ethics/governance, and labour markets.

### **NRP 77 'Digital Transformation'**

Digitalisation and social change are shaping each other and transforming nearly all areas of life in Switzerland. While digital transformation offers major opportunities – such as new business models, efficient work processes, and greater participation – it also raises concerns about jobs, personal freedom, democracy, and artificial intelligence.

Mandated by the Swiss federal government, the National Research Programme 'Digital Transformation' (NRP 77) investigated these dynamics to identify opportunities, reduce risks, and develop policy-relevant solutions. With a total budget of CHF 30 million, research was carried out in 46 projects across three programme modules between 2020 and 2025.

Further information and results from the individual projects can be found at [nrp77.ch](https://nrp77.ch).

# 3

## Introduction and scope of the programme

The rapid advancement of digital technology has profoundly transformed many aspects of daily life in Switzerland impacting these broad areas: 1) education, learning, and digital change (education); 2) ethics, trustworthiness, and governance (ethics/governance); and 3) the digital economy and labour market (labour). In education, digital transformation impacts children and adults with changes in the processes of teaching and learning, and raises important questions about the kinds of education and skills required across the lifespan. Central to the topic of ethics/governance is safeguarding the compatibility of digitalisation with public values and fundamental rights as well as creating conditions for the trustworthiness of digital infrastructure and services. At the same time, digitalisation offers new opportunities and creates new challenges for communication, participation, and decision-making. In the area of labour and the economy, employees confront significant modifications to the organisation and content of work, requiring new policies and approaches. These new forms of digitally enhanced work and online labour marketplaces are transforming traditional employment models and creating novel economic dynamics.

Given the accelerating pace of technological and social change, it is crucial for Switzerland to understand and address the challenges associated with increasing digitalisation. To understand digital transformation's opportunities and risks, policymakers require evidence-based strategies to maximise benefits while mitigating negative effects to society. As a broad-ranging issue, digital transformation is being studied extensively in all developed industrial nations, including Switzerland, with dedicated research and investment programmes (see the following section §3.1 for Swiss programmes).

**Table 1: Digital terms and descriptions**

Term	Focus	Example
<b>digitisation</b>	Data: converting analog information to digital formats.	Scanning documents to save in a digital format (e.g. PDFs portable document format or photos in jpeg or gif).
<b>digitalisation</b>	Processes: integration of digital technologies into existing processes, aiming to improve efficiency and service delivery.	Offering an online catalogue to search services. Providing an app to allow users to search online for availability.
<b>digital transformation</b>	Comprehensive societal transformation in which digital technologies fundamentally change and reshape processes, structures, practices, and ways of thinking in areas such as the economy, education, politics, and everyday life.	Creating a fully digital platform which changes how people interact with the provider of goods or services with digital solutions and dependencies.

## 3.1 NRP 77: Research into digital transformation

Switzerland’s approach is encapsulated in the Digital Switzerland Strategy, which is binding for the Federal Administration while serving as a guideline for all other stakeholders involved in digitalisation. Its vision statement declares that Switzerland consistently prioritises digital offerings for the benefit of everyone, regardless of gender, age, or origin (digital first). It makes targeted use of the opportunities offered by sustainable digital transformation so that everyone benefits.

Digital transformation is essential for Switzerland, given its high-wage economy, export-oriented industries, and innovation-driven sectors. It plays a crucial role in maintaining global competitiveness, sustaining skilled employment, and ensuring the country’s continued strength in fields such as precision machinery, finance, and life sciences amidst evolving global dynamics. Research serves as a key instrument for providing policymakers with the evidence needed to develop effective, forward-looking measures.

In response to the growing demand for evidence-based decision-making in digital transformation, the Swiss Confederation has defined a comprehensive action plan. This plan aligns with and contributes to global digital transformation efforts through research, innovation, and education initiatives. Additional national strategic programmes supporting digital transformation include the [Digital Switzerland Strategy](#), [Digital Public Services Switzerland](#), and [NRP 75 Big Data](#).

The Swiss plan parallels in many ways the plans and initiatives of its neighbours and allies in the European Union such as the [EU Digital Strategy](#), [Europe's Digital Decade](#), and the [EU 2030 Digital Compass](#).

In 2018, as part of this strategic plan, the Secretariat for Education, Research and Innovation (SERI) mandated the Swiss National Science Foundation (SNSF) to develop and implement the National Research Programme on 'Digital Transformation' (NRP 77).

The SNSF's National Research Council appointed an international Steering Committee (SC) to oversee the strategic management of the NRP 77. The SC developed the programme concept, which was approved by the Federal Council on 21 September 2018. The SC launched two call for research proposals, selected the top submissions, and administered the CHF 30 million in funding over the five-year period concluding in December 2024.

NRP 77 focused on three key interconnected thematic modules – each of which touches directly on the sectors and societal dynamics that underpin Switzerland's economic competitiveness and social resilience – to research how digital transformation is reshaping society:

- 1 Education, learning, and digital change.** In public schools, higher education institutions, and other learning organisations, new technologies raise issues of how teaching and learning practices might be reconfigured to meet didactic goals and assessments, and how the curriculum may need to change to ensure people have the appropriate knowledge and skills in contemporary times.
- 2 Ethics, trustworthiness, and governance.** In judiciary and democratic processes, crucial digital transformation issues include fundamental rights, reliability, public values, communication, and public participation at local, cantonal, and federal levels.
- 3 Digital economy and labour market.** In employment, productivity, and economic configurations, digital transformation is driving major shifts in labour demand, skill formation, and the organisation of work.

The NRP 77 calls for proposals resulted in 46 projects selected across the three thematic modules (see Section 6.4 List of the 46 NRP 77 projects). Many projects incorporated cross-cutting elements and interdisciplinary approaches. The overarching goal was to support academic research in developing insights for evidence-based interventions, offer policy considerations to inform governance frameworks, and facilitate responsible and successful digital transformations.

## 3.2

# Planned inquiry and adaptation

NRP 77 was initiated in 2018 to address the accelerating digital transformation and its implications for Swiss society. At the time, digitalisation was already reshaping education, governance, and the economy, but many of the challenges associated with artificial intelligence (AI) and human-machine interaction were still emerging or not evident to the general public. Major events have reshaped the landscape, including the COVID-19 pandemic and the subsequent acceleration of digital communication and coordination tools, as well as the public release and rapid diffusion of generative artificial intelligence (GenAI).

Over the course of its three-year preparation, calls for proposals, selection period, and five-year research timescale, NRP 77 supported research that explored the original call topics and where feasible, adapted to the major global changes. In this way, the research provides current insights for policymakers, businesses, and the public sector and although some factors could not be fully covered in the current programme, most findings are translatable to ongoing digital transformation. This exemplifies the constant progress of digital technology, which necessitates continued funding in forward-looking research to keep pace with future developments (see Section 5 Epilogue).

The programme's interdisciplinary approach brought together technology experts, researchers, and stakeholders to conduct research into the most effective solutions for digital integration. Rather than isolating technological progress from its broader context, many projects explored how digital systems are reshaping fundamental aspects of Swiss society. By funding research that considered the impact of technological advancements from an ethical and societal perspective, NRP 77 fostered a more holistic understanding of digital transformation's role in Switzerland's future.

## 3.3

# Synthesis of research

With this synthesis report, the Steering Committee of the NRP 77 summarises the key findings of the 46 research projects, puts them into the context of relevant external research evidence, and formulates a series of suggestions or policy considerations for relevant actors in politics, public education, administration, economy, and civil society to review. The publication is intended as a contribution from science to the political, public, and professional debate as well as to strategy and action planning in policy and practice. Further information on NRP 77 and the published results of its 46 projects can be accessed via the [www.nfp77.ch](http://www.nfp77.ch) website.

While this document outlines the potential value of these findings, decisions regarding their adoption and implementation rightly rest with policymakers and other relevant decision-makers, who must weigh the evidence alongside broader societal priorities and public interest.

# 4

## Key findings and policy considerations

The NRP 77 body of research provides key insights into the multi-faceted challenges and opportunities of digital transformation across the various sectors. Its findings emphasise the importance of collaborative, context-specific approaches to fostering digital skills, promoting inclusive design, and addressing the societal implications of technological advancements. When reviewing the research results across the three modules – which can be referred to in shorthand as education, ethics/governance, and labour markets – the Steering Committee observed four overarching themes or policy considerations in addition to recommendations specific to each module.

In total, the Steering Committee formulated twelve policy considerations, each reasoned and supported by evidence. A policy consideration therefore refers to an evidence-based stimulus intended to inform political debate, decision-making, or policy action.

### **Note to readers:**

On the following pages, you will find numbered arrows on the right-hand side. These refer to external web addresses and lead directly to the corresponding publications. By clicking on the respective arrow, you will be taken to the linked source.

# Policy considerations from NRP 77

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## Cross-cutting topics

### **CONSIDERATION 1**

Adopt a participatory co-creation approach to digital solutions

### **CONSIDERATION 2**

Develop inclusive digital solutions and remove structural barriers

### **CONSIDERATION 3**

Recognise and adapt to evolving human-machine interactions

### **CONSIDERATION 4**

Facilitate data availability and accessibility

## Education

### **CONSIDERATION 5**

Promote lifelong digital skills

### **CONSIDERATION 6**

Provide continuous digital upskilling of educators

### **CONSIDERATION 7**

Develop structured approach to EdTech innovation

## Governance

### **CONSIDERATION 8**

Involve the population more fully in political processes

### **CONSIDERATION 9**

Integrate ethics and stakeholder input into digital design

### **CONSIDERATION 10**

Strengthen the independent media landscape

## Labour market

### **CONSIDERATION 11**

Leverage employee digital capabilities

### **CONSIDERATION 12**

Provide digital support for jobseekers and counsellors

# 4.1

## Cross-cutting themes on digital transformation

In the analysis of all three modules, a set of cross-cutting themes emerged in addition to module-specific findings, revealing critical conditions for effective digital transformation. First, successful digital transformation requires a co-creation approach, with technology experts, researchers, and stakeholders collaborating to design and implement context-specific solutions, particularly in education but also in other sectors. Second, authorities and organisations need to ensure inclusive, participatory design in the digital domain, avoiding the exclusion of certain groups and removing barriers to their uptake of these new technologies. Third, society must adapt to continuously evolving dynamics of human-machine interactions and configurations, particularly since reliance on these tools can influence decision-making. Finally, data access is critical for evidence-based policymaking, yet increasing control by private platforms raises concerns about accessibility, privacy, and sustainability, necessitating policies that promote open research data while balancing privacy. These cross-cutting insights are discussed first, followed by findings specific to the education, ethics/governance, and labour modules.

## CONSIDERATION 1

### **Adopt a co-creative approach to digital solutions**

In the rapid digital transformation of Swiss society, technological advancements hold great potential to enhance learning and professional practices. However, research reveals that the successful integration of digital tools is not guaranteed, as their effectiveness depends on their alignment with user needs and institutional workflows. Many professions need to change their occupational procedures and professional workflows, and engage in a co-creation approach, if they want to leverage the potential of digital transformation. In the field of education, for example, serious games designed to support learning have emerged as powerful tools for engaging students. In journalism, the growing reliance on digital tools for creation and dissemination of stories result in a focus on new skills and new categories of expertise and adaptation to new industrial logics.<sup>1</sup> Similarly, in higher education, learning analytics tools offer data-driven insights, but their adoption remains low because instructors struggle to integrate them into their teaching practices.<sup>2,3</sup> Meanwhile, in healthcare, digitalisation is transforming the transmission of patient care information, but fragmented systems and usability challenges hinder seamless communication exchange.<sup>4</sup> Innovators and regulators are increasingly promoting inclusive co-creation by aligning on a shared vision, making it a condition for funding and approvals, and setting standards to support collaboration and interoperability.<sup>5</sup> These examples underscore a critical reality: without active collaboration among the relevant stakeholders – educators, healthcare professionals, researchers, and technology developers – digital innovations risk failing to deliver their intended benefits.

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At the heart of these challenges lies a fundamental issue: the frequent absence of co-creation and participatory design in the development and implementation of digital solutions. Ideally, the design process includes all stakeholders who use these technologies, which in education could be students, parents/guardians, teachers, researchers, educational leaders, or policy makers. Research findings consistently highlight that digital tools designed in isolation from practitioners as well as citizens as end-users may fail to integrate smoothly into existing workflows and practices, leading to inefficiencies and resistance to adoption. As an example of a more productive approach in the education sector, the collaborative design of serious games between teachers, researchers, and computer scientists can increase the likelihood that they meet pedagogical objectives and gain acceptance among teachers.<sup>6</sup> Similarly, involving healthcare practitioners in the design of clinical information systems can help prevent workflow disruptions and usability shortcomings that may contribute to critical incidents in hospital settings.<sup>4</sup> Such participatory approaches, can not only increase uptake and use by relevant stakeholders, but also help towards a wider shift in cultural practices. Research shows that co-creation in participatory budgeting in democratic elections can foster high efficiency and equality by ensuring that even minority groups benefit, thereby reducing inequality and strengthening social cohesion.<sup>7</sup> In all these cases, co-creation – the involvement of professional users and end-users in the design, evaluation, and iterative development and/or use of digital tools – proves to be a crucial success factor for digital transformation efforts.

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To address these systemic gaps, policy initiatives should prioritise inclusive co-creation and participatory methodologies in digital technology development. Governments, institutions, and enterprises should invest in platforms and frameworks that facilitate collaboration between users, developers, researchers, and other relevant stakeholders. By institutionalising participatory approaches, policymakers can ensure that digital transformation efforts are not only technologically relevant but also practical, sustainable, and beneficial to the professionals who rely on them to who rely on them to meet the needs of the populations they serve.

## CONSIDERATION

# 1

### **Adopt a co-creative approach to digital solutions**

To increase the acceptance and effectiveness of digital applications, a participatory and co-creative approach should be applied that involves technology experts, researchers, practitioners, users, and interest groups.

## CONSIDERATION 2

### **Develop inclusive digital solutions and remove structural barriers**

The aim of the Digital Switzerland Strategy is to ensure that the entire population benefits from a digital transformation that is responsible and sustainable – ecologically, economically, and socially. The vision statement explicitly commits to prioritising ‘digital offerings for the benefit of everyone, regardless of gender, age, or origin.’ Yet in practice, digital technologies may not be equally welcomed, accessible or usable by all segments of Swiss society. To fulfil its inclusive vision, such strategies must pay particular attention to the needs of groups likely to be marginalised – including older adults, people with disabilities, and other disadvantaged minorities – who may face diverse structural, technological, or value-based barriers to using digital infrastructure and services – or may reject using them altogether.

The demographic shift toward an aging population has placed increasing pressure on elder care services, prompting the exploration of smart home health technologies to supplement traditional caregiving in Switzerland.<sup>8</sup> These technologies offer promising solutions, particularly for health monitoring and supporting older individuals, thereby providing reassurance to both caregivers and the elderly themselves. However, their successful integration into elder care remains fraught with challenges. Research indicates that smart home health technologies cannot replace human care entirely, as older individuals require substantial technical support and customisation options to use them effectively. More importantly, while technology may extend independent living, its design and implementation should align with the diverse preferences and capabilities of older generations and privacy requirements, ensuring that the care experience remains both effective and dignified.

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The rapid advancement of AI and robotic technologies further complicates the landscape of digital elder care.<sup>9</sup> While emerging innovations hold potential for enhanced caregiving, the trajectory of their development remains uncertain, and ethical concerns continue to emerge alongside technological capabilities. As different generations within the elderly population exhibit varying levels of acceptance and digital literacy, policymakers should acknowledge that a one-size-fits-all approach is inadequate. Some of the oldest individuals express reservations about relying on technology, valuing human interaction over automated care solutions and voicing concerns about potential privacy risks. Furthermore, personal philosophies surrounding aging influence attitudes toward health monitoring; while some people may welcome early disease detection and intervention, others view such measures as unnecessary intrusions into the natural aging process. Research also examines the impact of digital technology on caregivers, noting that it not only alters their professional roles but may also diminish aspects of their work they find most meaningful. To develop effective and inclusive digital solutions, policies should accommodate these generational and individual-level differences, ensuring that technology serves as an enabler rather than an imposition. Without such considerations, the imposition of technology risks alienating those who do not find digital solutions intuitive, necessary, or even physically feasible, thus exacerbating inequalities in access to quality care, education, employment or other life activities.

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Regarding people with disabilities, studies show that digital technologies have the potential to improve access to vocational and professional education and training for lifelong qualifications and thus ultimately to the labour market.<sup>10</sup> However, the mere presence of digital media is not sufficient to ensure digital participation of people with disabilities. There are new risks of exclusion, such as poor accessibility

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of learning content, lack of awareness on the part of education providers, or individual differences in access, skills, and handling of new technologies for people with disabilities. Students with disabilities often face additional effort, because they must overcome digital barriers or deal with missing or inaccessible information about the accessibility of educational institutions. Providing appropriate resources and adjustments – such as interpreters, induction loops, or accessible software and learning materials – can help ensure meaningful participation.<sup>11</sup> Additionally, when participatory budgeting is used in democratic elections, involving people directly in co-creating decisions can give minority groups a voice, strengthen social cohesion, and reduce the digital divide.<sup>7</sup>

These societal shifts are mirrored in businesses and other employers who are reshaping their internal structures to adapt to emerging digital technologies and ideally drive innovation. Firms leveraging digital tools experience shifts in employment relationships, with enhanced performance monitoring and increased reliance on incentive-based compensation.<sup>12,13</sup> At the same time, these technologies can enable more decentralised decision-making, empower employees, and foster innovation and engagement. In the course of this transformation, organisations face growing concerns that connected workplaces – where people, processes, and technologies are digitally integrated – may blur ethical boundaries through pervasive digital surveillance and unequal access to opportunities. However, without robust governance and effective enforcement structures, the benefits of digital transformation risk being unevenly distributed, reinforcing existing workplace power asymmetries through intensified algorithmic control and, ultimately, undermining employee well-being.<sup>14–16</sup>

The digital divide manifests starkly in the realm of education and job-seeking behaviours, particularly along gender and age lines. Research reveals that female university students are less inclined to invest in digital skills, driven by lower perceived returns on such competencies, misconceptions about skill requirements, and less interest in digital-intensive careers.<sup>17–20</sup> These patterns persist beyond academia, where female and older jobseekers not only rate their digital skills lower than their male and younger counterparts but also exhibit hesitancy in pursuing roles that require skill adjustments or offer lower wages.<sup>21</sup> Such trends underscore systemic biases that shape career trajectories, reinforcing existing labour market inequalities. One study finds that digital participation in vocational and professional education is rarely systematic, underscoring the need for further training organisations to prioritise inclusion and accessibility to ensure equal access for persons with disabilities.<sup>11</sup> Addressing these barriers demands targeted interventions – raising awareness about skill investment benefits, providing structured digital upskilling programmes, and fostering cultural shifts to encourage adaptability for marginalised or underrepresented groups in job transitions.

The roots of digital skill disparities for women trace back to deep-seated societal constructs, including gendered stereotypes that shape early perceptions of science, technology, engineering, and mathematics (STEM) and technology-intensive fields. Studies highlight that women’s underrepresentation in these domains is less about inherent disinterest and more about exclusionary cultural norms that signal misalignment between their identities and digital careers.<sup>22</sup> A masculine-leaning culture in fields such as engineering and computer science fosters a lower sense of belonging for women, further compounded by limited early exposure and diminished self-efficacy.<sup>23</sup> Effective policy responses should therefore go beyond curriculum adjustments and skill assessments to encompass broader cultural transformations.

Schools, universities, employers, government agencies, and other societal actors should each do their part to foster an environment that supports equal opportunities to contribute to digitalisation and benefit from its potential for better jobs and higher wages. Measures to achieve this include diversifying role models, reshaping media narratives, and ensuring that educational and professional environments are visibly inclusive.

## CONSIDERATION

# 2

### **Develop inclusive digital solutions and remove structural barriers to digital participation**

Effective digital solutions take into account the diversity of societal groups, including those currently without equal access to digital technologies, and thus ensure broad acceptance and social justice. Deeply rooted stereotypes and systemic barriers contribute to the digital divide; these barriers need to be identified and specifically removed to ensure social participation.

## CONSIDERATION 3

### **Recognise and adapt to evolving human-machine interactions**

In an era defined by digital transformation, the integration of computational tools into human work and decision-making processes is reshaping not just industries but also fundamental human relationship configurations. Nowhere is this shift more pronounced than in high-stakes environments. A bellwether application is healthcare, where the doctor-patient dynamic is increasingly influenced by medical technology (MedTech) applications. Research highlights that while AI can enhance healthcare job satisfaction and alleviate labour shortages, poorly designed human-AI teaming can lead to overreliance, loss of situational awareness, and risks to patient safety.<sup>24,25</sup> Moreover, AI's presence in team-based decision-making environments disrupts traditional knowledge-sharing structures, potentially fostering innovation but also altering human-to-human interactions in ways that require careful consideration.<sup>26,27</sup> Reliability in AI-driven decision-making, particularly in medical diagnostics, remains a critical concern. While AI holds promise in supporting clinical decisions, studies reveal that computerised decision-support tools do not necessarily enhance diagnostic accuracy and can even introduce unintended risks, such as reduced trainee consultations and misplaced reliance on algorithmic outputs.<sup>28</sup> About one in ten diagnoses in the emergency room is incorrect and the study shows that an AI-based diagnostic support had no measurable effect to improve that for patients in emergency treatment – either in terms of medical, economic or procedural outcomes.

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A critical challenge in implementing AI-driven systems is ensuring that users can effectively interact with and understand these technologies. Research from NRP 77 suggests that in healthcare, explainable AI (XAI) systems with targeted or

context-specific explainability may provide doctors and patients with better comprehension about the use of AI in clinical settings. However, even targeted explainable AI models still demand that physicians possess enough technical understanding to use them and communication skills to be able to explain their usage to patients, expanding the paradigm of AI-doctor-patient shared decision-making.<sup>29,30</sup>

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This transformation extends beyond healthcare, influencing the dynamics of education, the structure of labour markets, and the skills required for future employment. Previous work has shown, for example, how the use of dashboards influences how teachers understand their students<sup>31</sup> and repositions the role of the teacher in ways that can exclude them from central aspects of pedagogic practice.<sup>32,33</sup> This possibility calls for a balanced, values-driven approach within education systems to pilot and evaluate AI or robots in the classroom before scaling up. Keeping human teachers at the centre is key to ensure technology empowers the core of teaching, and prioritises the social, emotional, and ethical dimensions where AI and robots fall short.

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In the broader digital landscape of human-AI interactions, it might be more helpful to think about appropriately ‘relying’ on digital artefacts through transparent design and accountability measures rather than ‘trusting’ them – trust being a concept that is more appropriate when used in the context of people rather than machines. We do not need to nor should we trust AI; it is a digital tool that we need to be able to rely on to produce expected outcomes in the same way that we rely on many other tools and machines, the inner workings of which we also may not fully or even remotely understand.<sup>34</sup> To build a robust society that effectively integrates digital solutions, policies should reflect the evidence that digitalisation and AI adoption is not a mere technical upgrade but a reconfiguration of human relationships and institutional structures. Professionals should be trained not just in AI literacy but in strategies for effective human-AI collaboration, including appropriate reliance, communication, speaking up, and decision-making.<sup>26</sup> What flows from the research is that digital technologies should be designed with a better awareness for the contexts for which they are being designed and for supporting more positive human-machine relations. In this configuration, the humans must be held accountable to control the machines, algorithms, and AI to design-in fairness and transparency. The success of human-AI interaction hinges not only on technological capability but also on fostering a society that adapts to and critically assesses the evolving relations between humanity and technology.

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## CONSIDERATION

# 3

### **Recognise and adapt to evolving human-machine interactions**

To build a resilient society and implement effective digital solutions, it is essential to recognise that introducing computational tools transforms human interactions and that various patterns of relationships and divisions of labour between human and machine actors may emerge – patterns that are complex, diverse, and require continuous reflection and adaptation.

## CONSIDERATION 4

### Facilitate data availability and accessibility

Digitalisation has enabled the creation of data and digital tools that facilitate the collection and analysis of vast amounts of data. Data have become an invaluable source allowing evidence-based insights and decision making. Researchers increasingly rely on access to diverse and comprehensive datasets to drive evidence-based recommendations for policymaking, yet systemic barriers may impede their ability to obtain and utilise such data. Public authorities often lack the capacity necessary to conduct meaningful policy evaluations, given the complexity of data-informed decision making and the constraints of regulatory timelines.<sup>35,36</sup> Before implementing policies, policymakers should consider what kind of data are necessary to evaluate the policy in the future. —→ 35  
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Similarly, research on spatial economies demonstrates how proprietary datasets, such as those sourced from mobile phone companies, provide critical insights into urban mobility patterns but remain largely inaccessible to the broader research community.<sup>37,38</sup> Even when substantial datasets are created, as seen in a study on tax competition in the digital economy, they are often not shared or remain inaccessible due to legal and data protection concerns around repurposing publicly available information, raising concerns about sustainability and replicability.<sup>39</sup> Nevertheless, the existence of the Swiss Centre of Expertise in the Social Sciences (FORS) data repository provides a model for centralised, structured data access.<sup>40</sup> The convergence of research data and real-world data is not only meaningful for research but also for data-driven economy (e.g. data access in data spaces). —→ 37  
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A major complication in data accessibility stems from the tension between privacy regulations, contractual challenges in data access, and the need for research access. The use of web scraping, which is often essential for gathering real-time or large-scale data, frequently conflicts with platform terms of service, limiting researchers' ability to build and validate datasets. This conflict results in inefficiencies and missed opportunities for cross-sectoral insights, as evidenced by findings on e-commerce and regional disparities. For researchers, it is often unclear whether the collection of data for instance via web scraping is allowed and how this data can be stored and made available to the research community for replication purposes as well as for further research. Research data comparison is further complicated by the need for the alignment of categories in defining and classifying the digital economy, as tax and regulatory definitions evolve over time. What is currently considered part of the digital economy might not be considered as such in the future.<sup>39</sup> The proposed Swiss Communications Platform Act, which adapts provisions similar to the EU's Digital Services Act, is intended to facilitate access to data of very large platforms for research purposes.<sup>41</sup> —→ 39  
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A call for research infrastructure that allows both protection and access to data – such as research data centres and secure linkage frameworks – emphasises the need for systematic solutions that balance privacy with analytical utility.<sup>40</sup> To address these challenges and ensure the sustainability of data-driven research, policymakers and funders should prioritise mandated data access for researchers and structured data accessibility initiatives. The Swiss National Science Foundation provides guidelines, but without enforceability their impact remains limited. Establishing centralised research data repositories, as demonstrated by the FORS, could enhance data sustainability, while investing in secure data linkage infrastructure – such as the proposed Swiss Linkage Centre – would facilitate responsible data sharing.

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## CONSIDERATION

# 4

### **Facilitate data availability and accessibility**

For a foundation of evidence-based policymaking, ensure that researchers have timely, secure, and fair access to relevant data for their studies to facilitate the replication and validation of research. Policymakers should consider possibilities to evaluate policies from the outset.

# Education, learning, and digital change

## 4.2

Digital transformation in education offers significant opportunities to enhance learning processes yet faces challenges in implementation and reach. NRP 77 projects explored questions of digital change in learning and education across the lifespan, with some projects explicitly focused upon inclusivity, ensuring young learners, individuals with disabilities, and older people, gain the digital competencies needed for active participation in a rapidly changing society. The program also focused upon initiatives in formal education at all levels that supported transformation, to enhance teacher training at the intersection between the digital and pedagogy, highlighting the importance of equipping educators with the skills to navigate digital resources effectively. Furthermore, studies found that structured approaches to educational technology (EdTech) and institutional support are essential for integrating digital tools to foster engagement and educational gains across the sector-wide ecosystem.

## CONSIDERATION 5

### Promote lifelong digital skills

As digitalisation continues to reshape many professional fields and civic engagement, Switzerland should ensure that individuals across all age groups and professional sectors are equipped with the necessary digital skills.<sup>42,43</sup> Digital skills encompass the ability to: use digital devices and applications; find, evaluate, create, and share information; collaborate and participate online; and solve problems using digital tools. They also include critical reflection on digital media, including its social, ethical, and environmental implications, and the capacity to adapt as technologies rapidly evolve. AI-related digital skills, as framed by the OECD, extend these competencies to understanding how AI systems work at a basic level, using AI tools effectively and ethically, recognising their limitations and risks (such as bias or misuse), and exercising human judgement when interacting with or relying on AI-enabled systems.<sup>44,45</sup>

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In primary education, research underscores the importance of explicitly teaching computer science concepts rather than assuming children will develop an understanding through casual interactions with technology. Early exposure to fundamental concepts such as the infrastructure of the internet provides a critical foundation for more advanced digital competencies later in life.<sup>46</sup> Although such skills are challenging to define and measure, NRP 77 research has demonstrated that computational thinking skills can be assessed and nurtured throughout compulsory schooling.<sup>46–48</sup> By integrating computational thinking as part of the curriculum across all school levels, educators can systematically develop digital problem-solving abilities that are increasingly essential in the modern workforce. To make these advancements effective, teacher training should be prioritised to ensure educators themselves possess the confidence and expertise to facilitate digital learning (see Consideration 6).

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However, it is important not to teach digital competences in isolation, as all foundational skills such as reading, writing, mathematics, and social development, are important. Indeed, NRP 77 research highlights that early foundational skills training is crucial for preparing individuals for a rapidly evolving labour market, and embedding foundational skills in school curricula improves adaptability across occupations. Research outside the NRP 77 framework demonstrates that in early education, foundational skills are often intertwined with fostering the competencies needed in an increasingly digital world.<sup>44</sup> Thus, innovative curricula and pedagogy are required to ensure young people are equipped with the skills and knowledge they need.

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Beyond early and secondary education, digital skills development should also extend to older adults who may experience a wider array of life circumstances. For example, adults aged 50 or over may need support for digital skills to support them to work as professionals in fields experiencing rapid technological change, such as healthcare.<sup>43</sup> While digital technologies offer significant benefits, older individuals are more likely to face barriers to digital access and usage. The so called 'grey digital divide' is not merely a function of age but also of generational differences in exposure to digital tools and axes of social, economic and cultural disadvantage.<sup>49</sup> To bridge this gap, tailored learning environments should address the unique needs of older learners, providing structured pathways for acquiring and reinforcing digital competencies, whilst also attending to other aspects of digital inequality experienced by marginalised and excluded groups.

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In the workplace, such as in healthcare, digitalisation has transformed patient information management. Yet interoperability issues and usability challenges persist, creating inefficiencies and disruptions in clinical workflows. Research highlights that in hospitals with well-integrated digital systems, fewer workflow interruptions occurred and less patient critical IT related events were seen. However, for these benefits to be realised there is a need for more structured digital education within nursing and medical training programs.<sup>4</sup> For such digital education programmes to be successful requires consideration of the digital divides that can exist amongst the workforce, older adults, and also those of all ages with different educational, socio-economic, and cultural backgrounds than the mainstream.

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To navigate these challenges, a lifelong, structured approach to digital skills development is essential. Policies should promote the clear definition and differentiation of digital skills by level and subject, ensuring that educational initiatives are targeted and effective. In primary and secondary education, computational thinking – as well as critical engagement with technology and its consequences for society and responsible use – can be designed, analysed, and assessed, taking into consideration the situated nature of computational thinking activities.<sup>48</sup> For older adults, digital literacy initiatives should be designed with accessibility in mind, offering flexible learning formats that accommodate varying levels of prior knowledge and functional ability.<sup>49</sup> In professional sectors such as healthcare, continuous digital skills training should be incorporated into professional development frameworks, with institutions providing ongoing support and assessment to ensure seamless integration of digital tools into clinical practice.

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## CONSIDERATION

# 5

### **Promote lifelong digital skills**

To promote the development of digital skills throughout life, digital skills should be defined, differentiated and integrated into school curricula, vocational training, and university and continuing education according to educational levels and subject areas; their continuous development should be systematically monitored.

## CONSIDERATION 6

### **Provide continuous digital upskilling of educators**

In classrooms and on campuses around the world, digital transformation is reshaping education, offering new opportunities to enhance learning. Yet, despite the potential of digital tools – such as augmented reality (AR), virtual reality, learning analytics, digital games, intelligent tutoring systems, and the use of robots or AI – many teachers and professors face significant barriers in integrating them effectively.<sup>50,51</sup> For example, NRP 77 research highlights that while the use of digital teaching media can enrich many educational subjects, including science, technology, engineering, and mathematics (STEM) education, the inconsistent quality of available materials and the lack of structured evaluation training leave many educators struggling to identify reliable resources. Other research in the programme also demonstrated that Swiss vocational schools emphasise more interactive teaching than general schools, and their teachers show stronger digital usefulness and competence beliefs but lower technological pedagogical knowledge, highlighting the need to account for contextual culture and personal–school factors in teacher training for technology integration.<sup>52</sup> Similarly, research illustrated that AR applications hold great promise for immersive learning, but their effectiveness is hindered by high development costs, poor curriculum alignment, and a lack of teacher preparatory training for subject-specific implementation.<sup>50</sup> Likewise, learning analytics in higher education could enhance teaching by providing real-time insights into student engagement, yet adoption remains slow due to the complexity of implementation and a lack of user-centred design.<sup>2</sup> These challenges highlight a fundamental issue: the education system has not yet fully equipped teachers with the skills and support necessary to navigate digital transformation effectively.

The core problem is the complexity of the skills required. It is not simply about teachers developing skills to access and use technology, but also the appropriate pedagogies to support digital integration. Research reveals that digital technologies are often used to support more passive forms of learning, while the use of technology for more active forms of learning, and particularly more constructive and interactive forms of learning are far less frequent.<sup>53</sup> To support high quality technical integration where technology is used to support all forms of learning – passive, active, constructive, and interactive – formal training to support teachers is central.<sup>51</sup> Schools often focus on basic digital literacy rather than developing teachers' ability to critically assess and apply technology in pedagogically appropriate ways that promote deeper learning. There tends to be a focus on operational skills, that is, how to make a technology work in isolation, rather than supporting the development of these skills in relation with educators' pedagogical expertise, and knowledge of the subject matter to be taught. In other words, there is a lack of attention to the development of technological pedagogical content knowledge.<sup>54</sup>

Research findings stress the importance of considering the interplay between personal and school-related factors when training teachers in technology integration.<sup>52</sup> Teacher training programs should focus not only on the technical aspects but also on the subject-specific teaching application of digital tools.<sup>50</sup> Such challenges are further compounded by disparities in technological access – ranging from outdated devices to the quality of connectivity – creating inequities between institutions and preventing educators from fully leveraging these innovations.<sup>51</sup> In higher education, learning analytics have the potential to inform instructional strategies, but without training in data-driven pedagogy, many instructors struggle to make meaningful

use of these insights. Additionally, inadequate infrastructure and/or training – ranging from outdated devices to restrictive policies on digital use or insufficient understanding – prevents educators from fully leveraging these innovations or integrating them into lessons in ways that enhance learning.<sup>2</sup> Without a clear strategy for upskilling teachers, digital transformation in education remains fragmented, limiting its ability to enhance on both teaching quality and student success.

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To bridge this gap, policymakers should commit to long-term, continuous teacher training, ensuring that digital competencies evolve alongside technological advancements as part of a wider strategy of cultural change. Research underscores that pedagogical content knowledge does not naturally extend to the ability to transfer this through new digital or EdTech approaches, meaning that upskilling should be deliberate and ongoing.<sup>55</sup> Universities and teacher training institutions should integrate subject-specific digital training into their programmes, equipping educators to evaluate and apply digital tools effectively. Schools could foster a culture of digital innovation by providing teachers with structured time to explore new technologies, encouraging interdisciplinary collaboration, and investing in stable, accessible digital infrastructure. In higher education, learning analytics should be embedded within existing platforms in a way that prioritises ease of use and instructional relevance.<sup>2</sup>

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## CONSIDERATION

# 6

### **Continuously strengthen the digital skills of educators**

The continuing education of teachers/instructors/professors in the use of digital tools must be secured on a permanent basis; at the same time, investments in a cooperative education ecosystem are necessary in order to develop practical and effective digital teaching formats in primary, secondary, and tertiary schools/higher education institutions.

## CONSIDERATION 7

### Develop structured approaches to EdTech innovation

In the evolving landscape of education, the use of digital technologies presents an unprecedented opportunity to redefine learning and teaching. Research highlights, for example, that immersive technologies like virtual reality (VR)<sup>56,57</sup> and augmented reality (AR)<sup>58</sup> can enhance learning by making abstract concepts more tangible and engaging, particularly in primary and outdoor education settings.

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However, adoption and use of education technology (EdTech) have been suboptimal, not only due to the need for educator skills and appropriate infrastructure as in the previous policy consideration #6, but also due to educator and institutional hesitation from largely practical concerns about costs and resources, and the pedagogical value of digital transformation. For example, in schools there are hesitations due to concerns about costs, practicality, and the potential over-reliance on digital tools at the expense of real-world interactions for young children. In upper secondary schools it is recognised that while digital technologies hold significant potential, their effectiveness depends on pedagogical alignment.<sup>59</sup> As seen in the Swiss education system, past attempts at digital transformation have stumbled when technology was introduced without a clear pedagogical framework, leading to inefficient implementations and a need for improved trust among educators and policymakers.<sup>60</sup>

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These insights underscore a critical need for structured digital integration that prioritises the development of supportive cultures for transformational change within educational institutions. Such policies need to ensure appropriate resourcing, training and support for teachers to use EdTech in ways that supports pedagogic aims. Schools should establish clear strategic priorities that align digital transformation with pedagogical goals, fostering a school-wide culture of change. Schools should also ensure stable and secure infrastructure, provide targeted digital teaching materials, and allocate time for professional development.<sup>61,62</sup> Without these essential elements of resourcing and support, digitalisation risks becoming an underutilised or superficial addition rather than a transformative force in education. These risks similarly apply to other educational institutions. Universities, secondary schools, and primary schools should invest in professional development and co-creation, fostering mutual learning communities, and ensuring dedicated time for implementation to strengthen the capacity of schools to adapt and innovate.<sup>63</sup>

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For digital transformation to flourish, there is a need to strengthen support from responsible entities to empower schools and universities to develop their own strategies and be allocated dedicated time for implementations. Such a shift will require clear policy guidance and resourcing. Responsible entities should set clear priorities, aligning technological advancements with well-defined pedagogical goals to avoid technology-driven EdTech solutions that lack educational depth.<sup>64</sup> Yet it will also require efforts to create a sustainable eco-system across the sector, that provides opportunities for mutual learning.

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Mutual learning and research are central to informing educational change. For example, the higher education sector actively engages with digital transformation, both as a subject of research and as a means to enhance educational practices. However, this engagement varies: while some institutions prioritise showcasing digital initiatives to maintain their competitive edge, others focus on substantial advancements in digital education and infrastructure. This competitive landscape highlights the adaptability of Swiss universities and their capacity for innovation, yet it also underscores the need for structured, evidence-based approaches to evaluate

and guide digital transformation efforts.<sup>65</sup> A great deal then must happen at the level of the individual school or university. However, it is also important to create a sector wide eco-system. Ultimately, digital transformation in education should be an iterative, knowledge-driven process that incorporates lessons from past failures, that enables individual institutions to develop their own strategies, while sharing and learning across the sector.

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Such a shift can also entail design collaborations, sometimes with the commercial sector, where educators, researchers, and policymakers co-create EdTech products that are both practically and pedagogically sound, shaping the future design of EdTech.<sup>2,53</sup> Policymakers should advocate for adaptable digital infrastructures that support diverse learning contexts, ensuring that EdTech solutions remain relevant and scalable.<sup>66</sup> Such future co-designed tech development should also recognise that embedding tools into existing platforms rather than developing standalone systems can reduce adoption costs and encourage evidence-based teaching practices.<sup>2</sup> Moreover, strategic investments in open-source and interoperable EdTech technologies can ensure long-term sustainability, mitigating the risks of obsolescence and proprietary limitations.<sup>58</sup>

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To create a sustainable and effective digital transformation in Swiss public education, a research-informed and participatory approach is therefore warranted. By embracing a structured approach – one that emphasises learning from past experiences, fostering cross-sector collaboration, strategically deploying resources, and collaboration of the future design of technologies for education – the education sector can establish a robust and sustainable digital innovation ecosystem, where EdTech serves as an enabler to meaningful learning and teaching.

## CONSIDERATION

# 7

### **Develop structured approaches to EdTech innovation**

A structured, learning-centred approach within the Swiss EdTech ecosystem promotes agile and sustainable innovation. Targeted support from competent bodies enables schools and universities to develop their own digital strategies, strategic resource allocation, knowledge sharing, learning from mistakes, and collaboration across all stakeholders.

# 4.3

## Ethics, trustworthiness, and governance

The accelerating integration of digital technologies into public and private institutions has brought urgent questions of ethics, trustworthiness, and governance to the forefront of research and policy discussions. NRP 77 projects investigated the balance between transparency and privacy, e.g. in judicial systems, where anonymisation tools are developed to safeguard personal data. Research also examined AI's role in democratic innovation, addressing the perceived legitimacy and fairness of algorithmic decision-making in the news and social media, its influence on voting behaviour, and its increasing use in media and news outlets.<sup>67,68</sup> Additionally, ethical frameworks have been crafted to navigate challenges like the impact of the Internet of Things (IoT) on workplace surveillance and cybersecurity, ensuring technology aligns with societal values and democratic principles. These initiatives aim to create legal and governance structures that support equitable and ethical digital integration.

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## CONSIDERATION 8

### **Involve the population more fully in political processes**

In an era where democratic legitimacy is increasingly challenged, the interplay of digital technologies and citizen engagement offers both promise and complexity.<sup>69</sup> Legitimacy in democratic processes is multifaceted, encompassing input legitimacy (citizen participation), throughput legitimacy (process fairness), and output legitimacy (satisfaction with outcomes). Innovations, such as digital participatory budgeting, prompt separate evaluations of each dimension.<sup>70</sup>

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Participation is very resource intensive and people's opportunities to get actively involved are limited. Therefore, participatory approaches should only be used with caution, in selected cases – such as in deadlocked situations, at the initiative of citizens (opt-in), or in cases of high urgency and/or uncertainty.<sup>71</sup>

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Research indicates that while fair and transparent decision-making processes are critical, they alone cannot compensate for dissatisfaction with the final outcomes. Proportional voting methods enhance perceived fairness, inclusivity, and representativeness compared to majoritarian methods, underscoring the potential of tailored voting mechanisms in fostering broader democratic legitimacy.<sup>70</sup> However, the implementation of such methods requires careful consideration of accessibility, transparency, and public trust to ensure their success in varying political and social contexts.

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Digital democratic innovations, such as the Demokratiefabrik, illustrate the potential of technology to bridge societal divides and reinvigorate political participation.<sup>72</sup> While digitalisation has been linked to challenges such as polarisation and disinformation, it can also offer opportunities to enhance democratic engagement, particularly among traditionally disengaged populations. Observations in research suggest that structured digital participation may foster constructive deliberation, reducing negative perceptions of opposing viewpoints. Nonetheless, participation biases seem to persist, mirroring traditional political engagement patterns, and digital platforms require substantial investment in infrastructure, security, and maintenance.

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## CONSIDERATION

# 8

### **Involve the population more fully in political processes**

The increased involvement of the population throughout the entire policy cycle strengthens the legitimacy and fairness of digitalised democratic processes.

## CONSIDERATION 9

### **Integrate ethics and stakeholder input into digital design**

Several concepts or values – such as fairness, trustworthiness, and privacy – are used to assess digital solutions. Yet these concepts are not universally understood or applied: their meanings often vary across different communities such as computer science, social science, and policymaking. Moreover, efforts to uphold one value may conflict with others, creating trade-offs that must be navigated. Therefore, the successful design, implementation, and governance of digital technologies require careful clarification of how such values are defined and prioritised in each case. Recognising such conflicting values and definitions highlights the need for all stakeholders to engage in open discussions about value definitions and potential trade-offs.

For instance, trust in technology is often presented as an ideal. However, philosophical research highlights that it seems a mistake to anthropomorphise digital artefacts; trust is a concept that applies most appropriately to social relationships, whereas technology should be assessed in terms of reliability and accountability.<sup>34</sup> In domains such as medicine, where AI algorithms are leveraged for diagnostics and patient risk prediction, stakeholders should engage in open-ended discussions about the desired functionalities and limitations of these technologies.<sup>73–75</sup>

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Similarly, instead of viewing digital tools such as algorithms or AI models as neutral or inherently fair entities, decision-makers should acknowledge the complexities of both fairness concepts and digital technologies and frame the deployment of digital tools in ways that align with broader societal values.<sup>76</sup> This perspective underscores the importance of designing digital technologies with considerations of context-specific fairness, ensuring that the technology serves human interests

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without reinforcing biases or detaching professionals from interpersonal responsibilities. Moreover, the research emphasises that fairness is not merely a technical challenge but a deeply philosophical and moral issue requiring interdisciplinary engagement.<sup>77</sup> Developers and policymakers should integrate insights from mathematics, decision theory, and social sciences to construct AI models that represent and model just (or fair) distributions of risks and benefits.<sup>78</sup> The legal, ethical, and societal dimensions of fairness often diverge, making it imperative for regulatory frameworks and technology development to bridge these gaps effectively. —→ 77 —→ 78

Without robust mechanisms for assessing and mitigating biases, AI risks perpetuating systemic inequities rather than alleviating them.<sup>79,80</sup> Consequently, educational reforms should prioritise algorithmic fairness, embedding interdisciplinary curricula in computer science course programmes to equip future developers with the tools to navigate these ethical dilemmas.<sup>81</sup> —→ 79 —→ 80 —→ 81

To operationalise such concepts and implement digital solutions effectively, public and private actors should translate contested notions such as trust, fairness, and privacy into actionable frameworks. Governance should evolve in tandem with technological advancements, as highlighted in research findings on the challenges of anonymisation in legal data and insights on AI governance.<sup>82</sup> Research reinforces that stakeholders' perception of AI fairness is contingent on both technical robustness and the transparency of governance structures.<sup>83</sup> Thus, achieving socially aligned AI requires a dual approach: refining AI's technical capacities to detect and mitigate biases while fostering institutional mechanisms that reinforce moral and legal accountability. —→ 82 —→ 83

## CONSIDERATION

# 9

### **Integrate ethics and stakeholder input into digital design**

Embed mechanisms such as stakeholder dialogue, ethical impact assessment, and context-specific decision-making into the design, implementation, and governance of digital solutions to ensure that competing values and trade-offs are reconciled in transparent and accountable ways.

## CONSIDERATION 10

### **Strengthen the independent media landscape**

The digital age has ushered in transformative changes to how information is produced, distributed, and consumed, presenting both opportunities and challenges for democratic societies.

Research highlights that artificial intelligence such as algorithmic selection by news recommender systems (NRS) is increasingly used in journalism, yet NRS adoption remains experimental and fraught with tensions.<sup>67,68</sup> Media professionals recognise the potential of NRS in news distribution to enhance user engagement but prioritise —→ 67 —→ 68

maintaining editorial control and transparency to avoid eroding media trust. Users, meanwhile, express scepticism about algorithmic recommendations, particularly for critical topics like politics, fearing manipulation and loss of autonomy. This seems to indicate users prefer – at least for now – human editing for socially relevant content.<sup>84</sup> —→ 84

At the same time, the digital transformation has disrupted traditional business models of news media, threatening the role of journalism as a cornerstone of democracy, as evidenced by declining trust in institutions and reduced political participation among those who consume little or no news.<sup>85</sup> Furthermore, individuals with lower digital or media literacy and political interest are less equipped to navigate complex information environments, leaving them more vulnerable to disinformation and less likely to engage in democratic processes. While users increasingly inform themselves via social media, professional media remain crucial for providing independent journalism. On the one hand, public service media and technology such as voter advice applications can play a crucial informational role across ideological and geographic divides, but their effectiveness depends on maintaining high-quality, trustworthy content and adequate usage by the public.<sup>86</sup> On the other hand, newspapers face existential threats as their business models erode.<sup>87</sup> Where municipalities address the difficulties of local media by producing their own publications that mimic journalistic formats, they risk further weakening independent journalism.<sup>88</sup> This blurring of boundaries between journalism and public sector communication can undermine democratic accountability. It is thus vital to clearly distinguish the roles of municipalities and the media, upholding journalism’s critical function of independently evaluating and contextualising municipal communications. —→ 85  
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To address these challenges, it is essential to adopt a multi-pronged policy approach that fosters a healthier information ecosystem and, ultimately, a more resilient democracy in the digital age. First, media outlets that decide to invest in responsible NRS design will need to ensure transparency, user control, and alignment with both journalistic and democratic values. Policymakers also have a role to play in incentivising these practices.<sup>89</sup> The findings suggest that strengthening civic education to foster political interest should take priority over media literacy initiatives, as political interest – rather than news usage – drives political knowledge and democratic participation.<sup>85</sup> Comprehensive training on algorithms, AI, and the importance of journalism for democracy should target both the general population and media professionals. Third, media organisations require financial support for independent journalism.<sup>90</sup> Finally, strengthening public service media as a unifying force remains crucial. —→ 89  
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## CONSIDERATION

# 10

### **Strengthen the independent media landscape**

Investing in robust, independent media structures, incentivising responsible use of AI in journalism as well as strengthening civic and media literacy education contribute to democracy.

# Digital economy and labour market

## 4.4

Digitalisation reshapes labour markets, affecting job dynamics, skill requirements, and employment strategies. Digital transformation challenges organisations to deploy digital tools such as AI either as a tool for augmentation or in order to replace jobs. Policy measures should strengthen employees' digital competencies, enabling mobility across employers and industries, alongside tools that enhance job matching. Moreover, research highlights how technologies such as online job platforms and big data analytics can support more effective job placement, labour market monitoring, and the adaptability of displaced workers. Interdisciplinary approaches are increasingly used to analyse these transformations and to guide policymakers and firms in fostering sustainable careers amid ongoing digital change.

## CONSIDERATION 11

### **Leverage employee digital capabilities**

The task-based framework of technological change<sup>91,92</sup> provides theoretical ground- → 91  
 ing for understanding labour market impacts of digital transformation. In response → 92  
 to technological change, firms determine which tasks to automate and which to aug-  
 ment through human-technology complementarity.<sup>92,93</sup> With regard to skills, digital → 92  
 transformation generates two distinct challenges. First, technological change funda- → 93  
 mentally restructures task bundles within occupations. Some tasks no longer require  
 human execution, others become newly complemented by technology, and entirely  
 new task categories emerge. Second, incumbent employees often lack certain skills  
 to work with new technology such as AI or carry out entirely new tasks. As a conse-  
 quence, firms are required to choose between internal reskilling/upskilling invest-  
 ments and external hiring of workers who already possess the corresponding skills.

Empirical findings highlight the necessity of aligning digital technology invest-  
 ments with innovation capabilities and emphasise that technology alone does not  
 drive productivity but thrives best when integrated with strategic workforce develop- → 94  
 ment.<sup>94</sup> Consistent with this practice, firms that adopt digital technologies are more  
 likely to provide workplace training, including continuous training and expanded  
 apprenticeship programs.<sup>95,96</sup> Successful human-AI collaboration requires develop- → 95  
 ing competencies beyond technical skills, including calibrating prudent reliance in → 96  
 AI, communicating effectively within human-machine teams, making joint decisions,<sup>97</sup> → 97  
 fostering appropriate reliance, and addressing ethical considerations.<sup>28,30</sup> → 28  
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If firms do not have the organisational capacities to invest in training their workforce, the alternative is to either hire new employees with appropriate digital skills on the labour market or to invest in automation in order to replace workers. Both strategies are involved with costs and external hiring in addition depends on the availability of workers possessing the required competencies. Thus, employees as well as job seekers should have incentives to invest in training for updating their digital skills in order to sustain or improve their employability.<sup>98</sup>

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## CONSIDERATION

# 11

### **Leverage employee digital capabilities**

To increase the likelihood of a successful introduction of digital technologies, firms as well as employees, should regularly invest in updating employees' digital capabilities.

## CONSIDERATION 12

### **Provide digital support for job seekers and counsellors**

In the ever-evolving landscape of the labour market, job seekers often find themselves navigating a complex digital terrain where search/matchmaking algorithms and platform design shape their access to employment opportunities. Recent research highlights how the structure of online job boards (e.g., default filters, occupational classifications, and the prominence of job attributes) significantly influences which positions job seekers view and apply for.<sup>99</sup> However, this digital infrastructure is not always optimised for efficient job matching. Public employment services, therefore, should take proactive steps to refine digital tools, ensuring that job seekers are presented with skill-based job recommendations and real-time information on job competition, enabling them to make more informed decisions.<sup>100</sup>

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Policymakers should ensure that gig workers have access to targeted career counselling, including programmes offered by regional public employment services (e.g. the Regionales Arbeitsvermittlungszentrum (RAV) and the Office régional de placement (ORP)), to help them navigate the risks and instability of platform-based work.<sup>101,102</sup>

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Employment advisors need tools and labour market data that reflect not just the number of vacancies, but also the level of competition in different job segments, to help guide job seekers toward realistic opportunities.<sup>100</sup> For example, integrating indicators such as application volume into job platforms, alongside skills-based matching tools that highlight adjacent occupations, can encourage greater openness among both job seekers and hirers, strengthening counsellors' guidance and job-search strategies.<sup>100</sup>

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One of the critical challenges identified is the disconnect between job seekers' search strategies and actual labour market conditions. Many job seekers focus on the sheer number of job vacancies rather than assessing competition levels or aligning

opportunities with their skill sets.<sup>100</sup> Experimental findings show that providing skill-based job recommendations increases job-finding success, while recruiters facing labour shortages are more inclined to engage candidates from different occupational backgrounds. This mismatch presents an opportunity: by leveraging data analytics and digital tools, job seekers can be guided toward viable career transitions, particularly in high-demand fields. Personalised job recommendation systems, incorporating labour market tightness data and considering the overlap between skills required for the offered job and skills of the applicant, could significantly enhance matching efficiency, ensuring that job seekers are not only aware of open positions but are also equipped to assess their competitiveness within those roles.

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To address these challenges, policymakers and employment services should embrace data-driven strategies that dynamically refine job-matching processes. For example, the integration of advanced causal machine learning methods can optimise the assignment of unemployed individuals to active labour market programmes, ensuring that public resources are allocated effectively.<sup>35,36</sup> By continuously collecting and analysing job platform data, authorities can develop a responsive and adaptive employment support system that not only helps job seekers navigate the digital job market more effectively but also strengthens overall labour market efficiency.

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## CONSIDERATION

# 12

### **Provide digital support for jobseekers and counsellors**

Digital tools and strategies help to match jobseekers' skills more precisely with job vacancies and increase the effectiveness of counselling.

# 5

## Epilogue

These policy considerations presented by the NRP 77 Steering Committee reflect an interdisciplinary set of findings by Swiss and international academic experts on key societal areas of digital transformation, emphasising inclusive co-creation, lifelong digital skills development, and the empowerment of educators, institutions, and workers. They stress the need to anticipate technological change, ensure the compatibility of digital technologies with public values and fundamental rights through ethical governance, and ensure broad access to data as a public good. Together, they form a roadmap for embedding digital change across education, democratic institutions and the media, and the economy and labour markets. To contextualise these policy considerations effectively, they should be framed as part of a broader societal transformation while highlighting shared responsibilities across sectors and bridging strategic intent with practical implementation.

## 5.1

# Recent developments that impacted digital transformation

Since the 2018 launch of NRP 77, global developments have reshaped the digital transformation landscape, many of which exceeded the scope of the five-year programme. The COVID-19 pandemic clearly accelerated digitalisation across sectors,<sup>103</sup> while generative AI may potentially revolutionise automation and knowledge work. Meanwhile, concerns over Switzerland's digital sovereignty have grown due to increasing dominance by the big tech companies outside of Europe – in the US (e.g., Google, Amazon, Microsoft, Meta, Apple) and in China (e.g., Baidu, Alibaba, Tencent, Xiaomi, Huawei).

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Furthermore, the geopolitical situation has changed dramatically since late 2024 across many regions of the world. These shifts have made addressing the issues arising from digital transformation in Switzerland more urgent and complex, raising concerns about surveillance, monopolies, democratic erosion, polarisation, and sovereignty.<sup>69</sup> This evolving landscape calls for continued analysis to navigate new digital-era challenges.

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## 5.2

# Insights from NRP 77 that could be applied to global challenges

As society undergoes rapid digital transformation, the world faces unprecedented challenges – geopolitical conflict, climate-driven extreme weather, societal polarisation, and the spread of misinformation. While these topics were not central at the time of the research call, several of this program's policy insights offer valuable guidance for addressing them.

Notably, the programme underscores the importance of fostering an educated and digitally literate population, encouraging active political participation, and promoting adaptable labour skills. These elements are foundational for building resilient societies capable of responding to complex global disruptions. For example, digital upskilling and civic engagement can help counter disinformation and strengthen democratic governance, while inclusive digital solutions and co-creation approaches can support beneficiary empowerment and equitable access to emerging technologies. In this sense, the lessons from NRP 77 can inform broader strategies for shaping a sustainable, democratic, and future-ready global digital society.

## 5.3

# Recommendations for continued funding

Having noted the rapidly evolving digital transformation landscape across the three research areas, as well as the breadth of ongoing research in related domains across Swiss society, the Steering Committee refrains from prescribing specific future research directions. Instead, considering the accelerating pace of technological advancement, the Committee underscores the need for sustained investment into forward-looking research by Swiss policymakers and decision-makers to keep pace with ongoing developments in all domains of the digital transformation including education, ethics/governance, and labour markets.

## 5.4

# Outlook and conclusion

Switzerland stands at a pivotal moment in its digital transformation, with NRP 77 offering critical insights into how education, ethics/governance, labour, and society can adapt to rapid technological change. To remain resilient, democratic, inclusive, and future-ready, coordinated policies must prioritise digital literacy, equity, and ethical innovation. Building on NRP 77's findings, Switzerland can confidently navigate toward a human-centred digital future.

# 6

## Annexes

### 6.1

### Bibliography/References

1. Lindblom, T., Lindell, J., & Gidlund, K. (2024). Digitalizing the Journalistic Field: Journalists' Views on Changes in Journalistic Autonomy, Capital and Habitus. *Digital Journalism*, 12(6), 894–913. <https://doi.org/10.1080/21670811.2022.2062406>
2. Cai, Z., Davis, R., Tormey, R., & Dillenbourg, P. (2024). Learning Analytics Beyond Traditional Classrooms: Addressing the Tensions of Cognitive and Meta-Cognitive Goals in Exercise Sessions. In R. Ferreira Mello, N. Rummel, I. Jivet, G. Pishtari, & J. A. Ruipérez Valiente (Eds.), *Technology Enhanced Learning for Inclusive and Equitable Quality Education* (Vol. 15160, pp. 81–86). Springer Nature Switzerland. [https://doi.org/10.1007/978-3-031-72312-4\\_9](https://doi.org/10.1007/978-3-031-72312-4_9)
3. Cai, Z., Davis, R. L., Mariétan, R., Tormey, R., & Dillenbourg, P. (2025). Jupyter Analytics: A Toolkit for Collecting, Analyzing, and Visualizing Distributed Student Activity in Jupyter Notebooks. *Proceedings of the 56th ACM Technical Symposium on Computer Science Education V. 1*, 172–178. <https://doi.org/10.1145/3641554.3701971>
4. Bürkle, T., Lueg, C., Salzmann, P., Salini, D., Von Kaenel, F., Löffel, K., Meier, L., Moozhyyil, S.-M., Perrini, S., Trede, I., Volpe, A., & Holm, J. (2022). Digi-Care: Exploring the Impacts of Digitization on Nursing Work in Switzerland. In T. Bürkle, K. Denecke, J. Holm, M. Sariyar, & M. Lehmann (Eds.), *Studies in Health Technology and Informatics*. IOS Press. <https://ebooks.iospress.nl/doi/10.3233/SHTI220321>
5. Blasimme, A., Landers, C., & Vayena, E. (2025). Fostering inclusive co-creation in digital health. *Fostering Inclusive Co-Creation in Digital Health*, 8, 311. <https://doi.org/10.1038/s41746-025-01724-w>
6. Jaccard, D., Suppan, L., Sanchez, E., Huguenin, A., & Laurent, M. (2021). The co.LAB Generic Framework for Collaborative Design of Serious Games: Development Study. *JMIR Serious Games*, 9(3), e28674. <https://doi.org/10.2196/28674>
7. Carpentras, D., Hänggli Fricker, R., & Helbing, D. (2024). Empowering minorities and everyone in participatory budgeting: An agent-based modelling perspective. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 382(2285), 20240090. <https://doi.org/10.1098/rsta.2024.0090>
8. Tian, Y. J. A., Wangmo, T., & Savulescu, J. (2025). Misalignments of values and preferences: Finding an ideal elder care arrangement. *Journal of Medical Ethics*, jme-2024-110559. <https://doi.org/10.1136/jme-2024-110559>
9. Wangmo, T., Duong, V., Felber, N. A., Tian, Y. J. (Angelina), & Mihailov, E. (2024). No playing around with robots? Ambivalent attitudes toward the use of Paro in elder care. *Nursing Inquiry*, 31(3), e12645. <https://doi.org/10.1111/nin.12645>
10. Antener, G & Bannwart Garibovic, J. (2025). Digitale Teilhabe: Keine Selbstverständlichkeit. *Digital Participation: Not A Matter Of Course*. Transfer. *Berufsbildung in Forschung Und Praxis*, 10(5). <https://transfervet/digitale-teilhabe-keine-selbstverstaendlichkeit>
11. Steiner, O., & Kaiser, F. (2023). E-Inclusion of People with Disabilities in Vocational and Professional Education and Further Training Organisations in Switzerland: First Results of a Quantitative Survey. In M. Antona & C. Stephanidis (Eds.), *Universal Access in Human-Computer Interaction* (Vol. 14021, pp. 417–433). Springer Nature Switzerland. [https://link.springer.com/10.1007/978-3-031-35897-5\\_30](https://link.springer.com/10.1007/978-3-031-35897-5_30)
12. Lehmann, J., & Beckmann, M. (2025). Digital technologies and performance incentives: Evidence from businesses in the Swiss economy. *Swiss Journal of Economics and Statistics*, 161(1), 1. <https://doi.org/10.1186/s41937-024-00132-3>
13. Lehmann, J., & Beckmann, M. (2024). Digital Transformation in Switzerland: The Current State and Expectations (Version 1). arXiv. <https://doi.org/10.48550/ARXIV.2412.12784>
14. El Bouchikhi, M., Weerts, S., & Clavien, C. (2024). The internet of things deployed for occupational health and safety purposes: A qualitative study of opportunities and ethical issues. *PLOS One*, 19(12), e0315671. <https://doi.org/10.1371/journal.pone.0315671>

15. Mettler, T. (2024). The connected workplace: Characteristics and social consequences of work surveillance in the age of datification, sensorization, and artificial intelligence. *Journal of Information Technology*, 39(3), 547–567. <https://doi.org/10.1177/02683962231202535>
16. Mettler, T. (2025). Re-Thinking Algorithmic Control: Common Assumptions, Controversies, Misconceptions. 2025 Eleventh International Conference on eDemocracy & eGovernment (ICEDEG), 139–144. <https://doi.org/10.1109/ICEDEG65568.2025.11081667>
17. Strobl, R., & Wunsch, C. (2024 in preparation) Skill-related Job Preferences of University Students. University of Basel (version 30 December 2024) <https://drive.google.com/file/d/1AyRJ2002Mkj9yF04naLxjjdzcGFpJtjF/view?pli=1>
18. Strobl, R., & Wunsch, C. (2024). Students' Beliefs about Digital Skills [In preparation]. <https://data.snf.ch/grants/grant/187462>
19. La Russa, F., Strobl, R., & Wunsch, C. (2024). Students' Perceived Returns to Skills [In preparation]. <https://data.snf.ch/grants/grant/187462>
20. Kahn, S., & Ginther, D. (2018). Women and Science, Technology, Engineering, and Mathematics (STEM): Are Differences in Education and Careers Due to Stereotypes, Interests, or Family? In S. L. Averett, L. M. Argys, & S. D. Hoffman (Eds.), *The Oxford Handbook of Women and the Economy* (pp. 766–798). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780190628963.013.13>
21. Wunsch, C., Rochlitz, F., & Arni, P. (2025). Jobseekers' skills and job search behaviour. *Swiss Journal of Economics and Statistics*, 161(1), 11. <https://doi.org/10.1186/s41937-025-00142-9>
22. Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology*, 6. <https://doi.org/10.3389/fpsyg.2015.00049>
23. Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin*, 143(1), 1–35. <https://doi.org/10.1037/bul0000052>
24. Bienefeld, N., Keller, E., & Grote, G. (2025). AI Interventions to Alleviate Healthcare Shortages and Enhance Work Conditions in Critical Care: Qualitative Analysis. *Journal of Medical Internet Research*, 27, e50852. <https://doi.org/10.2196/50852>
25. Bürkle, T. & IOS Press (Eds.). (2022). *Healthcare of the Future 2022: Digital health – from vision to best practice!* Healthcare of the Future, Amsterdam, Netherlands. IOS Press. [https://journals.sagepub.com/doi/pdf/10.3233/SHTI292\\_fm](https://journals.sagepub.com/doi/pdf/10.3233/SHTI292_fm)
26. Bienefeld, N., Kolbe, M., Camen, G., Huser, D., & Buehler, P. K. (2023). Human-AI teaming: Leveraging transactive memory and speaking up for enhanced team effectiveness. *Frontiers in Psychology*, 14, 1208019. <https://doi.org/10.3389/fpsyg.2023.1208019>
27. Bienefeld, N., Keller, E., & Grote, G. (2024). Human-AI Teaming in Critical Care: A Comparative Analysis of Data Scientists' and Clinicians' Perspectives on AI Augmentation and Automation. *Journal of Medical Internet Research*, 26, e50130. <https://doi.org/10.2196/50130>
28. Hautz, W. E., Marcin, T., Hautz, S. C., Schaubert, S. K., Krummrey, G., Müller, M., Sauter, T. C., Lambrigger, C., Schwappach, D., Nendaz, M., Lindner, G., Bosbach, S., Griesshammer, I., Schönberg, P., Plüss, E., Roman, V., Ravioli, S., Werthmüller, N., Kölbener, F., ... Zwaan, L. (2025). Diagnoses supported by a computerised diagnostic decision support system versus conventional diagnoses in emergency patients (DDX-BRO): A multicentre, multiple-period, double-blind, cluster-randomised, crossover superiority trial. *The Lancet Digital Health*, 7(2), e136–e144. [https://doi.org/10.1016/s2589-7500\(24\)00250-4](https://doi.org/10.1016/s2589-7500(24)00250-4)
29. Arbelaez Ossa, L., Rost, M., Lorenzini, G., Shaw, D. M., & Elger, B. S. (2023). A smarter perspective: Learning with and from AI-cases. *Artificial Intelligence in Medicine*, 135, 102458. <https://doi.org/10.1016/j.artmed.2022.102458>
30. Lorenzini, G., Arbelaez Ossa, L., Shaw, D. M., & Elger, B. S. (2023). Artificial intelligence and the doctor–patient relationship expanding the paradigm of shared decision making. *Bioethics*, 37(5), 424–429. <https://doi.org/10.1111/bioe.13158>
31. Jarke, J., & Macgilchrist, F. (2021). Dashboard stories: How narratives told by predictive analytics reconfigure roles, risk and sociality in education. *Big Data & Society*, 8(1). <https://doi.org/10.1177/20539517211025561>
32. Selwyn, N. (2019). *Should robots replace teachers? AI and the future of education*. Medford, MA, USA: Polity Press. <https://research.monash.edu/en/publications/should-robots-replace-teachers-ai-and-the-future-of-education>
33. Perrotta, C., Gulson, K. N., Williamson, B., & Witzemberger, K. (2021). Automation, APIs and the distributed labour of platform pedagogies in Google Classroom. *Critical Studies in Education*, 62(1), 97–113. <https://doi.org/10.1080/17508487.2020.1855597>
34. Budnik, C. (2025). Can We Trust Artificial Intelligence? *Philosophy & Technology*, 38(1), 10. <https://doi.org/10.1007/s13347-024-00820-1>
35. Bodory, H., Mascolo, F., & Lechner, M. (2024). Enabling Decision Making with the Modified Causal Forest: Policy Trees for Treatment Assignment. *Algorithms*, 17(7), 318. <https://doi.org/10.3390/a17070318>

36. Lechner, M. (2023). Causal Machine Learning and its use for public policy. *Swiss Journal of Economics and Statistics*, 159(1), 8. <https://doi.org/10.1186/s41937-023-00113-y>
37. Steentoft, A., Lee, B.-S., & Schläpfer, M. S. (2022). Interpretable Prediction of Urban Mobility Flows with Deep Neural Networks as Gaussian Processes. Center for Regional Economic Development (CRED) Research Paper No. 36. University of Bern. [https://www.cred.unibe.ch/forschung/publikationen/cred\\_research\\_papers/index\\_ger.html](https://www.cred.unibe.ch/forschung/publikationen/cred_research_papers/index_ger.html)
38. Steentoft, A., Lee, B.-S., & Schläpfer, M. (2024). Quantifying the uncertainty of mobility flow predictions using Gaussian processes. *Transportation*, 51(6), 2301–2322. <https://doi.org/10.1007/s11116-023-10406-z>
39. Arioldi, D., Barisone, L., & Mocci, A. (2024). Agglomeration or Taxation? This is the Question for the Digital Economy. In Preparation. (See NRP 77 project of D'Ambros and Parchet at <https://data.snf.ch/grants/grant/187353>).
40. Schiller, D. H., & Hanselmann, M. (2025). Das erweiterte Potenzial von Bildungsdaten: Datensichtbarkeit. VEO-Report 2. Zenodo. <https://doi.org/10.5281/ZENODO.14772704>
41. Swiss Federal Department of the Environment, Transport, Energy and Communications (DETEC). (2025, October 29). New law on communication platforms and search engines: Start of consultation proceedings [Press Release]. News Service Bund The Portal of the Swiss Government. <https://www.bakom.admin.ch/en>
42. Vuorikari, Riina, Kluzer, Stefano, Punie, Yves, & European Commission Joint Research Centre. (2022). DigComp 2.2, The Digital Competence framework for citizens. Publications Office of the European Union. Luxembourg, 2022, ISBN 978-92-76-48882-8, doi:10.2760/115376, JRC128415. <https://www.unesco.org/sdg4education2030/en/knowledge-hub/digital-competence-framework-citizens-22>
43. Speck, S., Ruther, L., & Misoch, S. (2023). Digital Participation Among People Aged 50+ in Switzerland: Insights to Course Offers and Training Experiences: Proceedings of the 9th International Conference on Information and Communication Technologies for Ageing Well and E-Health, 48–58. <https://doi.org/10.5220/0011851900003476>
44. OECD. (2025). How's Life for Children in the Digital Age? OECD Publishing. <https://doi.org/10.1787/0854b900-en>
45. OECD. (2025). Empowering learners for the age of AI: An AI literacy framework for primary and secondary education. OECD Publishing. <https://ailiteracyframework.org/>
46. Babari, P., Hielscher, M., Edelsbrunner, P. A., Conti, M., Honegger, B. D., & Marinus, E. (2023). A literature review of children's and youth's conceptions of the internet. *International Journal of Child-Computer Interaction*, 37, 100595. <https://doi.org/10.1016/j.ijcci.2023.100595>
47. Babari, P., Hielscher, M., Edelsbrunner, P. A., Honegger, B. D., Waldvogel, B., & Marinus, E. (2023). Using Concept Cartoons for Assessing Children's Conceptions about the Internet. Proceedings of the 18th WiPSCE Conference on Primary and Secondary Computing Education Research, 1–4. <https://doi.org/10.1145/3605468.3605496>
48. Piatti, A., Adorni, G., El-Hamamsy, L., Negrini, L., Assaf, D., Gambardella, L., & Mondada, F. (2022). The CT-cube: A framework for the design and the assessment of computational thinking activities. *Computers in Human Behavior Reports*, 5, 100166. <https://doi.org/10.1016/j.chbr.2021.100166>
49. Hämmerle, V., Reiner, J., Ruf, E., Lehmann, S., & Misoch, S. (2022). Beyond the Digital Divide: Digital Skills and Training Needs of Persons 50+: Proceedings of the 8th International Conference on Information and Communication Technologies for Ageing Well and E-Health, 276–282. <https://doi.org/10.5220/0011068200003188>
50. Stolzenberger, C., Frank, F., Trefzger, T., & Brovelli, D. (2023). Realexperiment und Modell mit AR vereinigen: Verstehen in der Elektrizitätslehre mit Augmented Reality erleichtern – zwei Apps im Überblick. Preprint Zenodo. <https://doi.org/10.5281/ZENODO.14537433>
51. Antonietti, C., Schmitz, M.L., Consoli, T., Cattaneo, A., Gonon, P. & Petko, D. (2023). More formal, please! The impact of teachers' formal and independent professional development on the quality of technology integration. In E. Langran, P. Christensen & J. Sanson (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 2392-2397). New Orleans, LA, United States: Association for the Advancement of Computing in Education (AACE). <https://www.learntechlib.org/primary/p/222136/>
52. Cattaneo, A., Schmitz, M.-L., Gonon, P., Antonietti, C., Consoli, T., & Petko, D. (2025). The role of personal and contextual factors when investigating technology integration in general and vocational education. *Computers in Human Behavior*, 163, 108475. <https://doi.org/10.1016/j.chb.2024.108475>
53. Antonietti, C., Schmitz, M.-L., Consoli, T., Cattaneo, A., Gonon, P., & Petko, D. (2023). 'Development and validation of the ICAP Technology Scale to measure how teachers integrate technology into learning activities.' *Computers & Education*, 192, 104648. <https://doi.org/10.1016/j.compedu.2022.104648>

54. Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research*, 32(2), 131–152. <https://doi.org/10.2190/OEW7-01WB-BKHL-QDYV>
55. Küng, J., & Brovelli, D. (2025). The Impact of Teacher Training on the Evaluation and Selection of STEM Augmented Reality Applications and TPACK Self-Assessment. *Frontiers in Psychology, Educational Psychology*(accepted, in press). <https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2025.1657028/abstract>
56. Martarelli, C. S., Dubach, J., Schelleis, N., Cacchione, T., & Tempelmann, S. (2025). Virtual reality in primary science education: Improving knowledge of the water cycle. *Educational Technology Research and Development*, 73(2), 999–1024. <https://doi.org/10.1007/s11423-024-10431-4>
57. Schnyder, S., Dubach, J., Dall'Olio, L., Tempelmann, S., Cacchione, T., & Martarelli, C. S. (2025). Are primary schools ready for immersive virtual reality? Resistance among stakeholders. *Humanities and Social Sciences Communications*, 12(1), 1304. <https://doi.org/10.1057/s41599-025-05702-1>
58. Mercier, J., Chabloz, N., Dozot, G., Ertz, O., Bocher, E., & Rappo, D. (2023). BiodivAR: A Cartographic Authoring Tool for the Visualization of Geolocated Media in Augmented Reality. *ISPRS International Journal of Geo-Information*, 12(2), 61. <https://doi.org/10.3390/ijgi12020061>
59. Schmitz, M.-L., Antonietti, C., Consoli, T., Cattaneo, A., Gonon, P., & Petko, D. (2023). Transformational leadership for technology integration in schools: Empowering teachers to use technology in a more demanding way. *Computers & Education*, 204, 104880. <https://doi.org/10.1016/j.compedu.2023.104880>
60. Selwyn, N. (2016). *Education and technology: Key issues and debates* (Second edition). Zed Books. <https://doi.org/10.5040/9781474235952>
61. Petko, D., Antonietti, C., Schmitz, M.-L., Consoli, T., Gonon, P., & Cattaneo, A. (2022). Digitale Transformation der Sekundarstufe II: Erste Ergebnisse einer repräsentativen Bestandsaufnahme in der Schweiz. *Gymnasium Helveticum*, 76(5), 20–21. <https://doi.org/10.5167/UZH-223928>
62. Petko, D., Cattaneo, A., Gonon, P., Antonietti, C., Consoli, T., Hartmann, M., Michos, K. & Schmitz, M.-L. (2025). Digital Transformation in Upper Secondary Schools Final Report of the DigiTraS II Project. *Digitale Transformation der Sekundarstufe II. Schlussbericht des DigiTraS II Projektes*. Universität Zürich & Eidgenössische Hochschule für Berufsbildung EHB. <https://www.ehb.swiss/forschung/publikationen/petko-d-cattaneo-gonon-p-antonietti-c-consoli-t-hartmann-m-michos-k-schmitz>
63. Mercier, J., Ertz, O., & Bocher, E. (2025). 'Look at the trees': A verbal nudge to reduce screen time when learning biodiversity with augmented reality. *Computers in Human Behavior Reports*, 18, 100614. <https://doi.org/10.1016/j.chbr.2025.100614>
64. Petko, D., Koehler, M. J., & Mishra, P. (2024). Placing TPACK in context: Looking at the big picture. *Computers and Education Open*, 7, 100236. <https://doi.org/10.1016/j.caeo.2024.100236>
65. Saner, P., & Rost, K. (2025). Competition for students in the digital era: Scientific disciplines as drivers of study program innovation in Swiss higher education. *Higher Education*. <https://doi.org/10.1007/s10734-025-01548-3>
66. Consoli, T., Schmitz, M.-L., Antonietti, C., Gonon, P., Cattaneo, A., & Petko, D. (2024). Quality of technology integration matters: Positive associations with students' behavioral engagement and digital competencies for learning. *Education and Information Technologies*. <https://doi.org/10.1007/s10639-024-13118-8>
67. Blassnig, S., Mitova, E., Strikovic, E., Urman, A., De Vreese, C., Hannák, A., & Esser, F. (2024). User Perceptions of News Recommender Systems and Trust in Media Outlets: A Five-Country Study. *Journalism Studies*, 25(10), 1182–1204. <https://doi.org/10.1080/1461670X.2024.2364628>
68. Blassnig, S., Strikovic, E., Mitova, E., Urman, A., Hannák, A., De Vreese, C., & Esser, F. (2024). A Balancing Act: How Media Professionals Perceive the Implementation of News Recommender Systems. *Digital Journalism*, 1–23. <https://doi.org/10.1080/21670811.2023.2293933>
69. World Economic Forum. (2025). *Global Risks Report 2025* (No. (20th ed.)). World Economic Forum. <https://www.weforum.org/reports/global-risks-report-2025/>
70. Hänggli Fricker, R., Wellings, T., Zai, F., Yang, J. C., Majumdar, S., Bernhard, L., Weil, L., Hausladen, C. I., & Pournaras, E. (2024). Exploring legitimacy in a municipal budget decision in Switzerland: Empirical insights into citizens' perceptions. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 382(2285), 20240098. <https://doi.org/10.1098/rsta.2024.0098>
71. Hänggli, R., Pournaras, E., & Helbing, D. (2021). Human-centered Democratic Innovations with Digital and Participatory Elements. *DG.O2021: The 22nd Annual International Conference on Digital Government Research*, 227–233. <https://doi.org/10.1145/3463677.3463708>
72. Gianola, G., Wyss, D., Bächtiger, A., & Gerber, M. (2024). Empowering local citizens: Assessing the inclusiveness of a digital democratic innovation for co-creating a Voting Advice Application. *Local Government Studies*, 50(1), 174–203. <https://doi.org/10.1080/03003930.2023.2185228>

73. Budnik, C. (2024). Künstliche Intelligenz und Vertrauen im medizinischen Kontext. *Zeitschrift Für Praktische Philosophie*, 11(1). <https://doi.org/10.22613/zfpp/11.1.17>
74. Arbelaez Ossa, L., Milford, S. R., Rost, M., Leist, A. K., Shaw, D. M., & Elger, B. S. (2024). AI Through Ethical Lenses: A Discourse Analysis of Guidelines for AI in Healthcare. *Science and Engineering Ethics*, 30(3), 24. <https://doi.org/10.1007/s11948-024-00486-0>
75. Vokinger, K. N., Feuerriegel, S., & Kesselheim, A. S. (2021). Continual learning in medical devices: FDA's action plan and beyond. *The Lancet Digital Health*, 3(6), e337–e338. [https://doi.org/10.1016/S2589-7500\(21\)00076-5](https://doi.org/10.1016/S2589-7500(21)00076-5)
76. Baumann, J., Hertweck, C., Loi, M., & Heitz, C. (2022). Distributive Justice as the Foundational Premise of Fair ML: Unification, Extension, and Interpretation of Group Fairness Metrics (Version 3). arXiv. <https://doi.org/10.48550/ARXIV.2206.02897>
77. Baumann, J., & Loi, M. (2023). Fairness and Risk: An Ethical Argument for a Group Fairness Definition Insurers Can Use. *Philosophy & Technology*, 36(3), 45. <https://doi.org/10.1007/s13347-023-00624-9>
78. Baumann, J. (2024). Identifying, Mitigating, and Anticipating Bias in Algorithmic Decisions. *Proceedings of the AAAI Conference on Artificial Intelligence*, 38(21), 23385–23386. <https://doi.org/10.1609/aaai.v38i21.30393>
79. Dolata, M., & Schwabe, G. (2021). How Fair Is IS Research? In S. Aier, P. Rohner, & J. Schelp (Eds.), *Engineering the Transformation of the Enterprise* (pp. 37–49). Springer International Publishing. [https://doi.org/10.1007/978-3-030-84655-8\\_3](https://doi.org/10.1007/978-3-030-84655-8_3)
80. Dolata, M., Feuerriegel, S., & Schwabe, G. (2022). A sociotechnical view of algorithmic fairness. *Information Systems Journal*, 32(4), 754–818. <https://doi.org/10.1111/isj.12370>
81. Hertweck, C., Baumann, J., Loi, M., & Heitz, C. (2023, June 7). FairnessLab: A Consequence-Sensitive Bias Audit and Mitigation Toolkit. *CEUR Workshop Proceedings. EWF'23: European Workshop on Algorithmic Fairness, Winterthur, Switzerland*. <https://ceur-ws.org/Vol-3442/paper-13.pdf>
82. Nyffenegger, A., Stürmer, M., & Niklaus, J. (2024). Anonymity at Risk? Assessing Re-Identification Capabilities of Large Language Models in Court Decisions. *Findings of the Association for Computational Linguistics: NAACL 2024*, 2433–2462. <https://doi.org/10.18653/v1/2024.findings-naacl.157>
83. Sentinella, R., Schnegg, M., & Möller, K. (2023). A management control oriented governance framework for artificial intelligence. *Swiss Journal of Business*, 77(2), 162–184. <https://doi.org/10.5771/0042-059X-2023-2-162>
84. Strikovic, E., Blassnig, S., Mitova, E., Urman, A., Esser, F., & De Vreese, C. (2024). Opportunity structures for user acceptance of news recommender systems (NRS): A multi-country survey study of relationships between individual-level factors and evaluations of NRS. *New Media & Society*, 14614448241263765. <https://doi.org/10.1177/14614448241263765>
85. Vogler, D., Weston, M., Ryffel, Q., Rauchfleisch, A., Jürgens, P., Eisenegger, M., Schwaiger, L., & Christen, U. (2023). Mobile News Consumption and Its Relation to Young Adults' Knowledge About and Participation in Referendums. *Media and Communication*, 11(1), 6–18. <https://doi.org/10.17645/mac.v11i1.6029>
86. Walder, M., Fivaz, J., Schwarz, D., & Giger, N. (2024). Explaining the (non-) Use of Voting Advice Applications. *Digital Government: Research and Practice*, 5(3), 1–29. <https://doi.org/10.1145/3689214>
87. Dalmus, C., Kalbermatter, U., Burger, J., Künzler, M., & Dahinden, U. (2024). Just weather and cheese? Analysis of the content of Swiss local media online with different business models. *Studies in Communication Sciences*, 24(2), 189–208. <https://doi.org/10.24434/j.scoms.2024.02.3100>
88. Burger, J., Wellinger, D., Künzler, M., Autenrieth, U., Fetz, U., Schädler, T., Dalmus, C., & Dahinden, U. (2023). Lokaljournalismus und Gemeindegemeinschaft: Bestandesaufnahme der Schweizer. In *Lokaljournalismus und Gemeindegemeinschaft: Bestandesaufnahme der Schweizer Lokalkommunikation auf Ebene der Lokalmedien und der Gemeinde: Studie*. Fachhochschule Graubünden. [https://localcommunication.fhgr.ch/wp-content/uploads/sites/13/2023/11/2023\\_Lokalkommunikation\\_Burger\\_et\\_al.pdf](https://localcommunication.fhgr.ch/wp-content/uploads/sites/13/2023/11/2023_Lokalkommunikation_Burger_et_al.pdf)
89. Mitova, E., Blassnig, S., Strikovic, E., Urman, A., De Vreese, C., & Esser, F. (2023). When Worlds Collide: Journalistic, Market, and Tech Logics in the Adoption of News Recommender Systems. *Journalism Studies*, 24(16), 1957–1976. <https://doi.org/10.1080/1461670X.2023.2260504>
90. Burger, J., Künzler, M., & Autenrieth, U. (2024). Innovations in local media (funding) in Switzerland. In M. L. Young & A. Hermida (Eds.), *Novel Directions in Media Innovation and Funding* (pp. 43–52). The Global Journalism Innovation Lab School of Journalism, Writing, and Media University of British Columbia. [https://journalisminnovation.ca/wp-content/uploads/2024/03/GJIL-Report-Novel-Directions-in-Media-Innovation-and-Funding\\_.pdf](https://journalisminnovation.ca/wp-content/uploads/2024/03/GJIL-Report-Novel-Directions-in-Media-Innovation-and-Funding_.pdf)
91. Acemoglu, D., & Autor, D. (2011). Skills, Tasks and Technologies: Implications for Employment and Earnings. In *Handbook of Labor Economics* (Vol. 4, pp. 1043–1171). Elsevier. [https://doi.org/10.1016/S0169-7218\(11\)02410-5](https://doi.org/10.1016/S0169-7218(11)02410-5)

92. Acemoglu, D., & Restrepo, P. (2019). Automation and New Tasks: How Technology Displaces and Reinstates Labor. *Journal of Economic Perspectives*, 33(2), 3–30. <https://doi.org/10.1257/jep.33.2.3>
93. Autor, D., Chin, C., Salomons, A., & Seegmiller, B. (2024). New Frontiers: The Origins and Content of New Work, 1940–2018. *The Quarterly Journal of Economics*, 139(3), 1399–1465. <https://doi.org/10.1093/qje/qjae008>
94. Brynjolfsson, E., Li, D., & Raymond, L. (2025). Generative AI at Work. *The Quarterly Journal of Economics*, 140(2), 889–942. <https://doi.org/10.1093/qje/qjae044>
95. Gathmann, C., Kagerl, C., Pohlen, L., & Roth, D. (2024). The pandemic push: Digital technologies and workforce adjustments. *Labour Economics*, 89, 102541. <https://doi.org/10.1016/j.labeco.2024.102541>
96. Muehleemann, S. (2025). Artificial intelligence adoption and workplace training. *Journal of Economic Behavior & Organization*, 238, 107206. <https://doi.org/10.1016/j.jebo.2025.107206>
97. Bienefeld, N., Boss, J. M., Lüthy, R., Brodbeck, D., Azzati, J., Blaser, M., Willms, J., & Keller, E. (2023). Solving the explainable AI conundrum by bridging clinicians' needs and developers' goals. *Npj Digital Medicine*, 6(1), 94. <https://doi.org/10.1038/s41746-023-00837-4>
98. Bessen, J., Goos, M., Salomons, A., & Van Den Berge, W. (2025). What Happens to Workers at Firms that Automate? *Review of Economics and Statistics*, 107(1), 125–141. [https://doi.org/10.1162/rest\\_a\\_01284](https://doi.org/10.1162/rest_a_01284)
99. Beerli, A., Fiorin, S., Gulyas, A., Kopp, D., Khoshnama, M., & Siegenthaler, M. (2024). The Role of Job Benefits in Job Search Evidence from a Large-Scale Online Field Experiment. 7th LISER and IDSC of IZA Workshop Papers. [https://population-economics.committee.socialpolitik.de/sites/default/files/2025-01/Siegenthaler%20Value\\_of\\_Job\\_Benefits%20%285%29\\_0.pdf](https://population-economics.committee.socialpolitik.de/sites/default/files/2025-01/Siegenthaler%20Value_of_Job_Benefits%20%285%29_0.pdf)
100. Klaeui, J., Kopp, D., Lalive, R., & Siegenthaler, M. (2023, March 31). Labor Demand and Supply Across Occupational Boundaries. IZA Summer School 2023, Bonn, Germany. [https://conference.iza.org/SummerSchool\\_2023/klaeui\\_j33802.pdf](https://conference.iza.org/SummerSchool_2023/klaeui_j33802.pdf)
101. Zwettler, C., Straub, C., & Spurk, D. (2024). Kicking off a Gig Work Career: Unfolding a Career Learning Cycle of Gig Workers. *Journal of Career Assessment*, 32(4), 650–677. <https://doi.org/10.1177/10690727231212188>
102. Affolter, L., Spurk, D., & Straub, C. (2025). Living a calling despite the challenges of the gig economy? The role of meaning-making and work alienation. *Journal of Vocational Behavior*, 162, 104175. <https://doi.org/10.1016/j.jvb.2025.104175>
103. International Monetary Fund staff, Shibata, I., Pizzinelli, C., Tavares, M., Medici, A., Li, L., Oikonomou, M., Soh, J., & Jaumotte, F. (2023). Digitalization During the COVID-19 Crisis. *International Monetary Fund*, 2023(003), 1. <https://doi.org/10.5089/9798400232596.006>

## 6.2

# Glossary

Term	Definition
<b>artificial intelligence (AI) system</b>	An AI system is a machine-based system that can, for a given set of human-defined objectives, make predictions, content, recommendations, or decisions influencing real or virtual environments. AI systems are designed to operate with varying levels of autonomy.
<b>augmented reality (AR)</b>	AR is a technology that merges computer-generated digital information – like graphics, text, and audio – with the real world, providing an enhanced, interactive experience that users can see and interact with through a device's display.
<b>causal machine learning</b>	Methods that combines machine learning with causal inference to answer cause-and-effect questions of interventions by accounting for confounding variables, enabling data-driven, personalized decision-making.
<b>EdTech</b>	Educational technology (EdTech) is the broad field and practice of using digital tools, software, hardware, and theories to enhance teaching, facilitate learning, and improve educational outcomes.
<b>explainable AI (XAI)</b>	AI systems that are designed so people can understand and interpret how they produce their outputs. XAI aims to make AI systems more transparent and interpretable.
<b>generative AI</b>	A type of artificial intelligence that creates new content, such as text, images, and code, by learning patterns from massive datasets.
<b>Internet of Things (IoT)</b>	The networking of physical objects ('things') that are connected to the internet so they can collect data, share it, and eventually act on it.
<b>machine learning</b>	A set of techniques that allows machines to improve their performance and usually generate models in an automated manner through exposure to training data, which can help identify patterns and regularities rather than through explicit instructions from a human.
<b>serious game</b>	A serious game (also: applied game) is a game designed for a practical purpose, not just entertainment. This purpose may be learning, training, behavioural change or simulation.
<b>STEM</b>	The grouping of quantitatively based subjects is a common abbreviation for four closely connected areas of study: science, technology, engineering, and mathematics (STEM).
<b>tertiary education</b>	Education after secondary school. This includes universities, colleges, and vocational schools.
<b>virtual reality (VR)</b>	Technology that immerses a person in a fully computer-generated environment, usually through a headset.

## 6.3

# Abbreviations and acronyms

Abbreviation	Full term
<b>AI</b>	artificial intelligence
<b>AR</b>	augmented reality
<b>EDK</b>	Swiss Conference of Cantonal Ministers of Education Erziehungsdirektorinnen und – direktoren (EDK) Conférence des directrices et directeurs cantonaux de l'instruction publique (CDIP)
<b>FORS</b>	Forum Suisse pour l'étude des sciences sociales (FORS) Swiss Centre of Expertise in the Social Sciences Schweizer Kompetenzzentrum für Sozialwissenschaften DE
<b>GenAI</b>	generative AI
<b>IT</b>	information technology
<b>ICT</b>	information and communications technology
<b>IoT</b>	the Internet of Things
<b>NRS</b>	news recommendation service
<b>NRP</b>	National Research Programme
<b>SC</b>	Steering Committee
<b>SNSF</b>	Swiss National Science Foundation
<b>STEM</b>	science, technology, engineering, and mathematics
<b>VR</b>	virtual reality

## 6.4

# List of the 46 NRP 77 projects

The reader is directed to the [NRP 77 website](#) and [data portal](#) for the full listing of research output from each of the topics.

Principal Investigator	Title of research topic	Module name
Prof. Gabriela Antener Institut Integration und Partizipation Hochschule für Soziale Arbeit Fachhochschule Nordwestschweiz, Olten	<b>Digital participation of people with disabilities in vocational training</b>	Education, learning and digital change
Dr. med. Marc Audétat Interface science-société Université de Lausanne, Lausanne	<b>Robots in school: trust, interactions and institutions</b>	Education, learning and digital change
Prof. Ingo Barkow Schweizerisches Institut für Informationswissenschaft (SII) Departement Medien Information Kommunikation Fachhochschule Graubünden, Chur	<b>More than the sum of its parts: the amplified potential of educational data</b>	Education, learning and digital change
Dr. Mathias Beck KOF – Konjunkturforschungsstelle ETH Zürich, Zürich	<b>Digital transformation: how it changes organizations, performance, and markets – a multi-level analysis</b>	Digital economy and labour market
Dr. Nadine Bienefeld Arbeits – und Organisationspsychologie D-MTEC ETH Zürich, Zürich	<b>Artificial intelligence as a teammate: How to achieve a successful collaboration</b>	Digital economy and labour market
Prof. Dorothee Brovelli Forschung und Entwicklung Pädagogische Hochschule Luzern, Luzern	<b>Teacher competencies for digital transformation in STEM teaching</b>	Education, learning and digital change
Prof. Marlis Buchmann Soziologisches Institut Universität Zürich, Zürich	<b>How digitalisation is changing task and skill profiles of occupations</b>	Digital economy and labour market
Prof. Marc Bühlmann Année Politique Suisse Universität Bern, Bern	<b>Increased democratic participation thanks to digitalisation?</b>	Ethics, trustworthiness and governance
Prof. Thomas Burri Law School Universität St. Gallen, St. Gallen	<b>What does it mean to have human control over intelligent machines?</b>	Ethics, trustworthiness and governance

<b>Principal Investigator</b>	<b>Title of research topic</b>	<b>Module name</b>
Dr. Markus Christen UZH Digital Society Initiative University of Zurich, Zürich	<b>Promoting trust in cybersecurity through ethics and law</b>	Ethics, trustworthiness and governance
Dr. Marco D'Ambros CodeLounge, Software Institute Facoltà di scienze informatica Università della Svizzera italiana, Lugano	<b>Companies and tax competition in the digital economy</b>	Digital economy and labour market
Prof. Dr. Sarah Dégallier Rochat Technik und Informatik Bernser Fachhochschule, Biel/Bienne	<b>Can new technologies humanise automation?</b>	Digital economy and labour market
Prof. Pierre Dillenbourg Computer-Human Interaction in Learning and Instruction (CHILI) EPFL, Lausanne	<b>Using learning analyses in universities</b>	Education, learning and digital change
Prof. Mark Eisenegger Abteilung Öffentlichkeit & Gesellschaft IKMZ Universität Zürich, Zürich	<b>The importance of journalism for the digital information behaviour of young adults</b>	Ethics, trustworthiness and governance
Prof. Bernice Elger Institut für Bio – und Medizinethik (IBMB) Universität Basel, Basel	<b>Embracing technology: AI, health data and ethical issues in everyday clinical practice</b>	Ethics, trustworthiness and governance
Prof. Olivier Ertz Institut d'ingénierie des Médias (MEI) HEIG-VD, Yverdon-les-Bains	<b>Biodiversity and augmented reality: A future of learning?</b>	Education, learning and digital change
Prof. Frank Esser Institut für Kommunikationswissenschaft und Medienforschung (IKMZ) Universität Zürich, Zürich	<b>The role of news recommendation systems in digital democracies</b>	Ethics, trustworthiness and governance
Prof. Nathalie Giger Faculté des Sciences de la Société Université de Genève, Genève	<b>Does digital information and news consumption endanger democracy?</b>	Ethics, trustworthiness and governance
Prof. Regula Hänggli Departement für Kommunikationswissenschaft und Medienforschung Universität Freiburg, Fribourg	<b>Trust and legitimation in the digital democracy</b>	Ethics, trustworthiness and governance
Prof. Dr. Wolf Hautz Universitäres Notfallzentrum, Inselspital, Universität Bern, Bern	<b>Does information technology improve medical diagnoses?</b>	Digital economy and labour market

<b>Principal Investigator</b>	<b>Title of research topic</b>	<b>Module name</b>
Prof. Christoph Heitz Institut für Datenanalyse und Prozessdesign ZHAW Zürcher Hochschule für Ange- wandte Wissenschaften, Winterthur	<b>Socially acceptable and fair artificial intelligence</b>	Digital economy and labour market
Prof. Dominique Jaccard Media Engineering Institute COMEM – HEIG-VD HES-SO Centre St-Roch, Yverdon	<b>A digital laboratory for the collaborative design of digital educational games</b>	Education, learning and digital change
Prof. Ulrich Kaiser Institut für Betriebswirtschaftslehre Universität Zürich, Zürich	<b>How important are IT skills for professional success?</b>	Digital economy and labour market
Dr. Michaela Knecht Institut Mensch in komplexen Systemen Hochschule für Angewandte Psychologie Fachhochschule Nordwest- schweiz (FHNW), Olten	<b>Omnipresent work: how to separate job and private life</b>	Digital economy and labour market
Prof. Matthias Künzler Institut für Multimedia Production (IMP) Departement Angewandte Zukunfts- technologien Fachhochschule Graubünden, Chur	<b>Local journalism and municipal communication under digital transformation</b>	Ethics, trustworthiness and governance
Prof. Michael Lechner Institut suisse de recherche en économie empirique (SEW-HSG) Université de Saint-Gall, Saint-Gall	<b>Opportunities and risks of data-driven labour market policies</b>	Digital economy and labour market
Dr. Florian Liberatore Department of Business Law School of Management and Law Zurich University of Applied Sciences (ZHAW), Winterthur	<b>How to optimally organise temporary jobs using online platforms</b>	Digital economy and labour market
Prof. Andreas Lienhard Kompetenzzentrum für Public Management Universität Bern, Bern	<b>Court decisions in the field of tension between transparency and privacy</b>	Ethics, trustworthiness and governance
Prof. Eva Marinus Institut für Medien und Schule Pädagogische Hochschule Schwyz, Goldau	<b>'How does this work?' Children's conceptions of computer science and programming</b>	Education, learning and digital change
Prof. Corinna Martarelli Fakultät für Psychologie FernUni Schweiz, Brig	<b>The usefulness of virtual reality in science classes</b>	Education, learning and digital change

<b>Principal Investigator</b>	<b>Title of research topic</b>	<b>Module name</b>
Prof. Tobias Mettler IDHEAP Swiss Graduate School Public Administration Quartier University of Lausanne, Lausanne	<b>The Internet of Things to Promote Health in the Workplace</b>	Ethics, trustworthiness and governance
Prof. Sabina Misoch Institut Alter Bernener Fachhochschule (BFH), Bern	<b>Digital skills and training needs of people over 50</b>	Education, learning and digital change
Prof. Klaus Möller Direktor Institute of Accounting, Control & Auditing Universität St. Gallen, St. Gallen	<b>Governance and legal framework for artificial intelligence manage- ment</b>	Ethics, trustworthiness and governance
Prof. Francesco Mondada Mobile Robotic Systems Group EPFL – STI – IEM Swiss Federal Institute of Technology, Lausanne	<b>Are our children developing computer-complementary skills?</b>	Education, learning and digital change
Prof. Dominik Petko Institut für Erziehungswissenschaften Universität Zürich, Zürich	<b>The digital transformation at the upper secondary education level</b>	Education, learning and digital change
Prof. Edy Portmann Human-IST Institut Departement für Informatik Universität Fribourg, Fribourg	<b>How to turn a smart idea into a smart city</b>	Digital economy and labour market
Prof. Katja Rost Soziologisches Institut der Universität Zürich, Zürich	<b>Digital strategies: universities and fields of study as the agents of change?</b>	Education, learning and digital change
Dr. Patrizia Salzmann Gischig Swiss Federal Institute for Vocational Education and Training SFIVET, Zollikofen	<b>Digital technologies in clinical care: does communication have to be relearned?</b>	Education, learning and digital change
Prof. Peter Schaber Ethik-Zentrum Universität Zürich, Zürich	<b>Is it wise to blindly trust digital applications?</b>	Ethics, trustworthiness and governance
Dr. Michael Siegenthaler KOF – Konjunkturforschungsstelle ETH Zürich, Zürich	<b>Strategies for job hunting on online job platforms</b>	Digital economy and labour market
Prof. Dr. Caroline Straub New Work Institute Bernener Fachhochschule Wirtschaft, Bern	<b>Gig Work, a new phenomenon on the Swiss labour market</b>	Digital economy and labour market

<b>Principal Investigator</b>	<b>Title of research topic</b>	<b>Module name</b>
Prof. Effy (Eftychia) Vayena Departement Gesundheitswissen- schaften und Technologie (D-HEST) ETH Zürich, Zürich	<b>Digital health for the benefit of the entire population</b>	Ethics, trustworthiness and governance
Prof. Maximilian von Ehrlich Departement Volkswirtschaftslehre Universität Bern, Bern	<b>The role of digitalisation in the spatial distribution of the economy</b>	Digital economy and labour market
Prof. Dr. Tenzin Wangmo Institut für Bio – und Medizinethik (IBMB) Universität Basel, Basel	<b>Smart Home technology used in the care of elderly people</b>	Ethics, trustworthiness and governance
Prof. Conny Wunsch Wirtschaftswissenschaftliche Fakultät Universität Basel, Basel	<b>The Swiss labour market in the digital transformation</b>	Digital economy and labour market
Prof. Carmen Zahn Institut für Kooperationsforschung und -entwicklung Hochschule für Angewandte Psychologie FHNW, Olten	<b>Group process quality in digital learning</b>	Education, learning and digital change

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# 7

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