Introduction to the Special Issue: Digital Academia. Investigating Science and Higher Education in the Digital Age

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Introduction to the Special Issue: Digital Academia. Investigating Science and Higher Education in the Digital Age

Einleitung zum Sonderheft: Digitale Transformation in Forschung und Hochschulbildung erforschen

Introduction au numéro spécial : étudier la transformation numérique dans la recherche et l'enseignement supérieur

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1 Introduction[1]

The digital age has transformed many aspects of contemporary life, and academic work is no exception – just envision the manifold activities revolving around issues such as open science, digital skills, and the data sciences. The everyday use of digital technologies and the political discourse on digitalization have become pervasive in research and higher education. This special issue brings together articles that examine various aspects of digital academia, from the emergence of new research fields to the organizational transformation of universities and the use of social media in academic communication. By incorporating various sociological perspectives, this volume contributes to a deeper understanding of digital technologies' roles in shaping the present and future of science and higher education. While this special issue encompasses various perspectives, it focuses on the case of the Swiss higher education system. From our perspective, the contribution and added value of this volume are threefold. It probes the fruitfulness of approaches to the digitalization of research and higher education, focusing on the case of Switzerland. Second, it offers empirical insights that are not only relevant from a sociological standpoint but also can provide orienting knowledge for actors in the Swiss higher education and research system. Finally, the special issue offers perspectives and foundations for further comparative studies that reach beyond Switzerland. In this introduction, we frame this issue in a broader and more conceptual way to provide context for its

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individual contributions and hint at fruitful perspectives and avenues for further research on digital academia for the Swiss case and beyond.

We conceive of digital academia as the entanglement of various practices, discourses, forms of expertise, and institutional arrangements, as well as of actors, interests, strategies, and power relations concerning the development, dissemination, and use of digital technologies in science and higher education. In our perspective, this concept encompasses several sociological inquiry levels. The *first* level, a macro perspective, involves studying science and higher education as social systems that are embedded in broader society and that have established their modes of communication and observation as well as institutions of self-governance. This includes the specificities of national research and higher education systems and their transformation through digitalization. *Second*, we consider a field perspective to be important, one that focuses on the level of disciplines and specialties in the science system (Jacobs 2014). The emergence of new scientific fields, such as digital humanities or data sciences, as well as the transformation of existing disciplines and research practices, including computational biology or digital sociology, closely relate to the digital transformation of science. The *third* level is the organizational perspective, in which we focus on universities and other research and higher education institutions that digital tools, devices, and platforms affect, but that simultaneously have actively contributed to the further development and dissemination of such sociotechnical systems. *Finally*, a micro perspective involves examining the experiences of researchers, teachers, and students who are challenged by new forms of digital teaching and learning, changing scientific methods and modes of knowledge production, and demands for communication and visibility of research results and publications through social media and other platforms. New digital learning opportunities and changing skill demands in labor markets require higher education organizations and national education policies to monitor and adapt to these developments.[2]

Although we cannot address this broad topic in every detail, we briefly highlight some of the analytical insights we draw from the current state of the sociological study of the digitalization of science and higher education:

First, we note that digital transformation further increases existing forms of competition over status and reputation between universities (Brunsson and Wedlin 2021; Krücken 2021), but also between higher education and research systems due to large investments in sociotechnical systems such as artificial intelligence (AI) by corporations, nation-states, universities, and other organizational actors worldwide. The results of current research suggest that these trends will continue or even soon accelerate, with proclamations of a "global race" for technological innovation in scientific fields and higher education fueling them. However, the increased impor-

2 For a similar (albeit not identical) perspective regarding the general study of the Swiss higher education system, see the position paper, "Producing and sharing knowledge on the Swiss higher education and science system" by the network called Research on Higher Education and Science (REHES) (Tratschin et al. 2020).

tance of competition does not mean that cooperation is becoming less significant. While competition and cooperation clash in some cases (Musselin 2019), cooperation can be understood as a behavioral strategy in competitive settings (Musselin 2019; Arora-Jonsson et al. 2020). Thus, competition and cooperation interrelate in complex ways and should be investigated accordingly.

Second, these investments in science and higher education, together with the underdetermined, ambiguous nature of the notion of digitalization (see section 1), open new spaces and opportunities (Eyal 2013) – for example, for alliances between universities and their environment, as well as for new actors in digital higher education. As our examples and the contributions to this special issue show, actors in universities and disciplines succeed in institutionalizing new fields when they manage to establish concepts that are broad enough to include actors from inside and outside their organizations or research communities. Thus, participants in these spaces do not necessarily need to share a common understanding, but rather need to be committed to the institutionalization of such new forms and activities (Tratschin 2021; Saner 2022).

Third, by understanding digitalization as a transversal issue that transcends multiple fields of knowledge, we point to the emergence of new interdisciplinary fields as well as processes and practices of boundary work and boundary crossing (Gieryn 1983; Lamont and Molnár 2002) at various levels in the academic world. This includes increasing collaboration between not only universities and their environments, as mentioned above, but also disciplines and scholars in different research fields, leading to new practices and modes of knowledge production, which digital tools and platforms often enable. We will elaborate on these general analytical insights in the introduction by reviewing recent social science research on the digital transformation of academia and by drawing on the results of our projects and their contributions to this special issue.

The articles collected in this volume address these general insights in various ways. As mentioned, they all focus empirically on digital academia in the Swiss context (and in one case, in German-speaking countries), but they also reflect on this sociotechnical transformation's broader implications. We do not claim that the observations in this introduction are universally valid for all higher education and research systems: Most of the work we review here is based on research conducted by scholars from the Global North, that is, Europe, North America, and Australia. While some of these studies are relevant to developments and experiences in science and higher education in the Global South, we recognize that our focus has certain limitations.

Therefore, in this extended introduction, we review and discuss only a small selection of recent works on the digitalization of higher education and research in sociology and higher education research. In *section 2,* we discuss the digital transformation of higher education and research from a discursive perspective. In *section 3,*

we emphasize the changing boundaries of knowledge production. In *section 4,* we investigate the emergence of new fields and the transformation of existing disciplines and research practices. In *section 5*, we review universities' and other higher education organizations' digital activities and organizational efforts as well as the opportunities and challenges induced through these changes. In *section 6*, we shed light on new learning opportunities and changing skill requirements that are articulated in higher education and labor markets in the digital age. In the concluding *section 7,* we briefly introduce the five contributions to this special issue.

2 Digital Transformation as a Societal Discourse

In many areas of society, digitalization is seen as a fundamental change. The central buzzwords of "big data," "artificial intelligence," "blockchain," "quantum computing," or "cybersecurity" are treated as expressions of digitalization in the societal debate. Digitalization and its associated technologies are considered major challenges with disruptive potential – for instance, regarding labor markets and higher education – but are also associated with opportunities. A recent example is the discussion of large language models, such as ChatGPT, whose societal potential and dangers have also been discussed in terms of education (Kasneci et al. 2023) and research (Kalla and Smith 2023).[3] The discussion of individual technologies such as ChatGPT is embedded in a broader discourse on digitalization being conducted in the public as well as in the business community or in government strategies. Digitalization has thus become one of the central self-descriptions of present society. This discourse on comprehensive societal change, which is condensed in the concepts "digital transformation" or "digitalization" and is associated with new technological capabilities and solutions, is of a rather recent nature, although modern society has been using computer technology for many decades with great implications (Gugerli 2022). Taking the literal meaning of "digitization" – that is, the transformation of analog into digital values – one can conclude that the digital age started at the latest with the invention and diffusion of computer technology in the mid-20th century. Therefore, the distinctive attribute of the present is obviously not that society is experiencing digitalization (of analog values) for the first time. Of course, we concede that computer technology has greatly developed since its invention and that it certainly has gained momentum with greater penetration of everyday life in the form of laptops, smartphones, and wearables, as well as the associated increase in the production and availability of data. Therefore, we do not argue that there is nothing new occurring or claim even that modern society has always been digital in some sense, as Armin Nassehi (2024) elaborated in his much-discussed book "Patterns: Theory of the

3 Crompton and Burke (2023) discuss the implications of AI technologies for higher education more generally, as do the contributions in Roumate (2023) for scientific research.

Digital Society." However, a distinctive feature of the present digital transformation lies in that society has begun to describe itself in terms of the digital, with effects on various societal sectors such as politics and higher education. In our perspective, the issue of digitalization shares some commonalities with other publicly discussed terms such as globalization: Although the globalization of the 1990s certainly was not the first globalization process in human history, it was the first era in which society created a word to describe this reality of extending patterns of communication, trade, and travel (cf. Vobruba 2009).[4] Similarly, modern civilization has conferred new meaning to the phrase "digital transformation" and organized a discourse of societal emergency around it. This has led to a common belief that digital transformation "changes everything" and that digital transformation will create a completely new world order – a one-for-one disruption of old by new – as more data, connectivity, and digital intelligence eradicate global boundaries and upend the old order. However, while the distance-diminishing effects of digital technologies blur national boundaries, national borders often coincide due to language, culture, regulatory frameworks, or sticky knowledge. Both effects apply to the higher education system, which has always been globally situated but the transmission of tacit knowledge maintains it as do people instead of tools.

Universities have been a relevant context for developing and diffusing digital technology since the mid-20th century. In the 1950s, when software had not yet been considered a product, companies and universities developed software together according to cooperative academic principles (Schrape 2021, 128). In Switzerland, the ETH in Zurich was relevant to the early years of computer research (Nef and Wildi 2007), and it was not without reason that IBM decided to establish its first research center outside the United States in the Zurich region in 1956. In the 1960s and 1970s, Stanford University and the Massachusetts Institute of Technology (MIT) played important roles in the rise and success of two major technology regions in the United States: Silicon Valley and Route 128 in Massachusetts (Saxenian 1996). Subsequently, university students and researchers have contributed to the proliferation and development of Internet-related software. Overall, universities and research institutions have been central actors in developing digital technology for decades. In addition, universities not only contribute to the research and development of computer technology, but they are increasingly incorporating digital technologies into their teaching and administrative activities, leading to contemporary universities' varying "degrees of digitization" (Selwyn 2014). For example, they have adopted learning management systems such as Moodle, ILIAS, or OLAT, some of which were developed as spin-offs from academic teaching and research activities; they have established institutional repositories for research publications; and they have implemented enterprise resource-planning software such as SAP. More recently, because

4 For instance, digital technologies for distance education were associated early on with the paradigm of neoliberal globalization (Clegg et al. 2003).

of the COVID-19 pandemic, universities invested heavily in video telephony and online chat software such as Zoom, Microsoft Teams, or Cisco Webex to cope with the social distancing measures public health authorities implemented (Williamson 2021a; Bolin 2022).

However, with the recent rise of the discourse on digital transformation, universities are expected to address this issue and the challenges and opportunities associated with it more explicitly in areas such as research, teaching, or administration. Universities respond to this expectation by increasing and showcasing activities that can be meaningfully connected with the issue of digital transformation (Selwyn 2014). To boost research capacities, the create new competence centers and chairs dedicated to topics such as digital law, digital marketing, or digital religion, while their students learn digital skills and study for degrees in the digital humanities, data sciences, or computational social sciences. As organizations, they adopt digital strategies, create digital transformation offices, and appoint vice presidents for digital transformation. Therefore, the issue of digital transformation has certainly already influenced the university landscape. While universities are, of course, well known to absorb many issues that circulate in their environments in some way, it is quite striking how comprehensively the issue of digital transformation has been addressed. Universities not only acknowledge the issue through selected activities but tend to highlight the issue and bundle many activities through strategy papers and other forms of public self-presentation, thereby implying or stating they, in fact, are digital universities – such as the University of Geneva did in their digital strategy (2018, 2019). Digital transformation seems to be an issue that not only affects certain areas and groups in universities – which may have been the case with topics such as bio- and nanotechnology (Biniok 2013; Bartlett et al. 2018; Ribeiro et al. 2023) – but possibly extends to the whole of an organization in nearly all its activities. Digital transformation has implications for universities as organizations and is considered a matter of strategic positioning (Tratschin et al., this issue).

3 Digital Transformation Changes the Boundaries of Knowledge Production

Beyond society's self-description, digital transformation has facilitated new forms of knowledge production (Nowotny et al. 2003) in various fields outside academia, such as business, state administration, rating agencies, think tanks, and many more. Digital technologies have reconfigured key practices of the academic field: In research, building on web-crawling and bibliometric analyses, digital tools and platforms continuously and automatically monitor and assess scientific endeavors and their output (Burrows 2012; Franzen 2018), leading to new forms of digital visibility, accountability, and (e)valuation. Private and for-profit actors own and control many of these services, such as Altmetrics, ResearchGate, and Google Scholar. While some

observers point to the democratizing and inclusive effects of opening the scientific field (cf. Dickel and Franzen 2015), others point critically to new forms of forced flexibility, control, and surveillance (van Dijck 2014; Desrochers et al. 2018) that emerge in digital academia.

Digital infrastructures allow academics to make scientific data and publications widely available (e. g., open data and open access) (Franzen 2018; Plantin et al. 2018). Although some of these platforms originated in open science movements aimed at democratizing scientific research, science and research funding agencies have partially incorporated these instruments into their funding requirements (e. g., through mandatory data management plans and open-access clauses). This institutional arrangement of transparency, accessibility, and accountability also reinforces the role of rankings (Espeland and Sauder 2016) for scientific institutions through the increasing availability of various data sources and their linkages, leading to new forms of competition over status and reputation (Brankovic et al. 2018; Brunsson and Wedlin 2021; Krücken 2021). Further research is needed to investigate whether this new visibility regime increases pressure on researchers at the individual level (Frey and Rost 2010). The immediate transition to remote communication through digital infrastructures during the COVID-19 pandemic also raises questions about the social, economic, and environmental costs of face-to-face scientific conferences. Digital technologies enable research collaborations that might alter previous ways of building trust and agreement through face-to-face interactions (Collins et al. 2023). At the same time, new forms of collaboration between scientists and amateurs have emerged in citizen science (Franzen 2019; Franzen et al. 2021) and crowd science (Franzoni and Sauermann 2014) projects, which digital platforms and research tools often enable. Researchers and research institutions are increasingly required to present and communicate their activities publicly, both in traditional formats and on social media (Fürst et al., this issue).

In higher education, the digital transformation is inherently connected to the rise of digital platforms for learning, teaching, research, university management, and other activities. New ecosystems of digital platforms in higher education entail the marketization and commodification of higher education data, for example, by automatically measuring and evaluating students' performance data in learning analytics systems (Komljenovic 2022; Williamson and Komljenovic 2022). The COVID-19 pandemic and its subsequent university closures further exacerbated these trends, as higher education institutions, teachers, and students globally were forcefully moved to online modes of interaction (Stanisavljevic and Tremp 2020), giving way to forms of "emergency digitization" of higher education (Cone et al. 2022). This was only possible through the widespread use of video-based teaching, teaching forums, chats, messaging services, and tutoring and examination systems. While some of these services and platforms originated in the fast-growing EdTech industry, others have been repurposed for educational contexts and higher educa-

tion institutions, including the particularly successful services of Zoom and MS Teams. Some observers have commented on this as the "uberisation" (Bolin 2022) or platformization of higher education (Williamson 2022). In parallel, new forms of knowledge certification have emerged beyond universities and other higher education institutions (e. g., Google Diplomas, massive open online courses [MOOCs], or open educational resources). This has led to a partial loss of state regulation of the access, quality, and value of university education as well as the resulting degrees (van Dijck and Poell 2015; Selwyn et al. 2015).

The diffusion of digital technologies, algorithms, and platforms in higher education over the last two decades has been associated with several new actors within and outside academia, including for-profit universities, EdTech start-ups (partly spin-offs from traditional universities, e. g., Perusall), big tech companies (e. g., Google Classroom, Microsoft Education), knowledge providers (e. g., Pearson Inc.), and venture capital firms (e. g., Emerge Education) (Siemens et al. 2015; Williamson 2017; 2018: Jarke and Breiter 2019; Williamson 2021b; Williamson and Komljenovic 2022). These organizations act as forerunners in the digital transformation of science and higher education, in collaboration with and supported by government agencies, international organizations, and think tanks (Förschler 2018; Getto and Kerres 2018; Williamson 2021a). Drawing on the narrative of disrupting education and knowledge production in the 21st century (Selwyn 2013), these new actors in higher education particularly influence the defining perspectives on what constitutes digital (higher) education, for example, through new methods and techniques of data collection and analysis, such as learning analytics systems. Beyond these material investments and financial commitments in sociotechnical systems, they have created and promoted future visions of digital (higher) education in the 21st century through white papers, media reports, policy documents, and social media activities. These include discourses of digital re-schooling (such as 21st-century skills or 4 Cs: critical thinking, creative thinking, communicating, and collaborating; see section 5) as well as of de-schooling (self-empowered learning, MOOCs, etc.) (Selwyn 2013; Saner 2019; Bolin 2022; Williamson and Komljenovic 2022). By formulating such promising futures and referring to each other's visions, they help coordinate these conceptions of digital education's discursive field and thereby shape its further development.

4 The Emergence of New Fields and the Transformation of Existing Disciplines and Research Practices

Digital transformation has led to not only structural changes at the societal level but also the proliferation of new scientific fields, disciplines, and specialties (cf. Jacobs 2014) as well as the transformation of existing ones. As sociological studies

of science and research have shown, the emergence of new fields of research and knowledge is characterized by seemingly contradictory processes of differentiation and specialization and, in contrast, recombination and aggregation (Biniok 2013; Stichweh 2013; Merz and Sormani 2016): New sub-disciplines and specialties differentiate themselves through conceptual emphases and methodological innovations, thus they hardly show any content-related references to each other. Disciplines are the sum of differentiated specializations (Campbell 1969; Lemaine et al. 1976; Stichweh 1979). The internal differentiation of science is also a mechanism by which the field responds to strong growth and increasing competition in heavily researched areas (Weingart 2001).

In this sense, there is nothing new in that the scientific field constantly produces new differentiations, disciplines, and specialties. However, the digital transformation of knowledge production, particularly the emergence of vast amounts of scientific data, immense computing capacities, and algorithmic procedures for their analysis, has accelerated change and the emergence of new (sub-)disciplines. Following Kuhn (1996), Hey et al. (2009) identify a fourth paradigm in these changing conditions of scientific knowledge production. This paradigm denotes an epochal shift in knowledge production, which was previously based on experiments (experimental science), models and generalizations (theoretical science), or simulations (computational science) toward an "exploratory science" (Kitchin 2014, 3).

In this context, several new fields of knowledge have emerged, including the data sciences (Brandt 2016; Saner 2019; 2022; Prietl and Raible, this issue), the digital humanities (Antonijević 2015; Klein 2015; Piotrowski and Kemman, this issue), and the computational social sciences (Lazer et al. 2009; Alvarez 2016; Lazer et al. 2020). These new fields combine disciplinary knowledge, theories, and expertise with new methods of data collection, storage, and analysis, mainly from statistics and computer science, a process through which the digitalization of scientific research in the second half of the 20th century facilitated. Several recent studies emphasize the role of boundaries and boundary work in the emergence of these fields, for example, for the data sciences (Saner 2022; Prietl and Raible, this issue) and the digital humanities (Klein 2015; Piotrowski and Kemman, this issue). Boundary work describes the symbolic and social demarcation of boundaries (Lamont and Molnár 2002) between scientific and non-scientific fields as well as within scientific disciplines and professions (Gieryn 1983; 1999; Klein 2015). Interdisciplinary fields are founded on permeability and the crossing of boundaries of people, ideas, methods, and epistemic practices. However, at the same time, new fields of knowledge compete with existing disciplines for resources, personnel, and space in universities (Merz and Sormani 2016), often resulting in "disciplinary turf wars" (Ribes 2019, 515; Abbott 1988).

Such new fields are often undetermined or underdefined (Piotrowski and Kemman, this issue) and therefore, they offer promising "space[s] of opportunities" (Eyal

2013, 177; Saner 2022) for various actors across social fields and scientific disciplines. Their institutionalization relies on building networks across scientific disciplines and academia to generate media attention, research funding, and demand from non-scientific employers. Although data science has been rapidly institutionalized in many universities globally over the past decade, this seems a much more difficult endeavor in the case of the digital humanities. For the latter, interdisciplinarity can be a major obstacle to its widespread adoption and institutionalization (for the Swiss case, see Piotrowski and Kemman, this issue).

In addition to the emergence of new research fields, we witness the digital transformation of existing scientific disciplines, such as precision or personalized medicine (Trajanoski 2012; Hoeyer 2019), data-centric biology (Leonelli 2014; 2016), and big-data physics (Bartlett et al. 2018). Similar to previous cases, the exponential growth of data (e. g., at CERN [European Organization for Nuclear Research] or in the Human Genome Project) and the new computational tools and methods required have fundamentally modified the way knowledge and insights are produced (Kitchin 2014; Leonelli 2014). Nevertheless, as Bartlett et al. (2018, 3) argue, "the computational aspect in biology and physics is often subjugated as a tool, a service even, to be used by those with disciplinary grounding in the sensibilities of their discipline." In the digital humanities and social sciences (Burrows and Savage 2014; Halford and Savage 2017) but also in the data sciences (Ribes 2019), struggles and conflicts over the "locus of legitimate interpretation" (Collins and Evans 2007, 120; Bartlett et al. 2018) of the central research objects can be observed between the disciplines involved. Research in the computational biosciences points to a further collaborative change in the division of scientific labor (Bartlett et al. 2018; Ribeiro et al. 2023). The widespread use of advanced digital tools and devices, such as robots, AI-assisted data analytics, and machine-learning algorithms, has significantly changed laboratory work in various scientific disciplines. The persistence of so-called mundane knowledge work has led to a digitalization paradox: Although laboratory robots and algorithmic data analysis should enable the automation of manual (e. g., pipetting) and repetitive scientific practices, they have conversely created various other routine activities for which they offer no replacement (e. g., maintenance of laboratory robots) (Ribeiro et al. 2023).

5 Digital Transformation of Higher Education Organizations

The relevance attributed to digitalization in higher education systems is mirrored in the activities of higher education organizations (Hassan 2017; Barton et al. 2019; Gilch et al. 2019; Henke and Pasternack 2020). Globally, universities declare digital transformation as a major strategic and operational issue (Getto and Kerres 2017): "In recent years, universities worldwide have been experiencing rapid impactful

changes, which are influenced by technological advancement and social e-trends towards digitalization. Like all other revolutionary changes, digital transformation involves intense adjustment/re-adjustment" (Hashim et al. 2022, 3172). Therefore, universities as organizations are adapting to the digital transformation and showing initiative in addressing the issue. For example, MIT launched the MIT Initiative on the Digital Economy (MIT Initiative on the Digital Economy 2020), while Brown University launched the Brown University Digital Transformation Project (Brown University 2021). King's College London also established a Centre for Digital Culture (King's College London 2021), and the University of Zurich launched a Digital Society Initiative (Digital Society Initiative 2019). Some universities in the Global South are also moving forward with digital strategies, such as in South Africa (Ngcamu 2019) and Colombia (Branch et al. 2020, 45).

Many studies have investigated the digitization-related aspects of higher education. Although universities often see digitization as a challenge and opportunity that affects the entire university organization, noticeably in the literature, the topic of digitization has been thoroughly examined alongside different university sub-areas. For example, many studies in higher education have examined the use of digital technologies in university teaching (Daenekindt and Huisman 2020) and topics such as e-learning (e. g., Jones and O'Shea 2004; Njenga and Fourie 2010; Pates and Sumner 2016; Bauer et al. 2020), MOOCs (e. g., Dennis 2012; Yuan and Powell 2013; O'Connor 2014; Al-Imarah and Shields 2019), and online learning platforms or open education (e. g., Murphy et al. 2013; Williamson 2021b).

Because universities have often ascribed strategic and hence, organizational significance to digitization in recent years, strikingly, there is comparatively little research that relates digitization in higher education to the university organization level. A recent large-scale review of 17,000 articles published between 1991 and 2018 in higher education-specific journals did not reveal an increasing prominence of topics and notions associated with the organizational aspects of digital transformation (Daenekindt and Huisman 2020).[5] Contributions that discuss the significance of digitization for universities tend to focus on action-oriented aspects and are aimed at university management (Getto and Kerres 2018; Barton et al. 2019; Gilch et al. 2019; Henke and Pasternack 2020; Walgenbach and Körner 2020). Although the generation and use of data and algorithms for organizational decision-making have entered universities, it is also noticeable that, from the extent of an organizational perspective, it is often assumed in a technology-deterministic way that the changes in higher education compare to those in the economy. In contrast, recent research in organizational sociology suggests that digital transformation is not organization-neutral and that the organization influences the way digitalization takes place (Büchner 2018; Graf-Schlattmann 2021; 2022). This corresponds to our observations

5 However, the analysis revealed an increasing presence of the topic of educational technologies with specific terms, such as "learning," "online," and "technology."

that universities have been fundamental in shaping the network infrastructure that has made possible today's digital technologies. Following Graf-Schlattmann (2021; 2022), we therefore understand universities' digital transformation in the sense of a gradual rather than a disruptive, revolutionary change, leading to different "degrees of digitization" (Selwyn 2014) in universities that often depend on the financial resources available as well as the political authorities and funding environments at the local and national levels.

Redrawing the boundaries of knowledge production through digital transformation (see section 2) certainly opens opportunities for established institutions of higher education organization, especially universities. They can expand beyond their traditional stakeholders and their often local or regional "publics" (e. g., students, politicians, media), enabling them to build networks with organizations in other higher education and research systems and with the new actors in EdTech, investors, government agencies, international organizations, and other knowledge providers in the new ecology of digital academia (Getto and Kerres 2018; Komljenovic 2021). Although such collaborations and reciprocal engagements have a long history in fields such as engineering, biotechnology, and computer sciences (Godin 2009), we have recently witnessed increasing popularity of the social sciences (e. g., Social Science One) (King and Persily 2020). They offer not only the possibility of new sources of funding but also potentially even more lucrative access to huge data sets from companies in different economic fields. Such engagements also enable new career paths, with individuals moving between traditional academic positions, industry, the public sector, and nonprofit organizations (Beckert et al. 2008; Ribes 2019; Safavi et al. 2018). In academic science and research, it can lead to new career opportunities for researchers through the emergence of entirely new specialties and disciplines (e. g., in the computational and data sciences, as discussed in section 3).

At the same time, digital transformation creates new challenges for universities: The multiplicity of new actors in knowledge production makes it difficult for traditional researchers and university institutions to make their specific expertise on digital transformation effective and understandable in public discourse. In various knowledge fields, the already crumbling sovereignty over methodological innovation and the focus of research is further eroding (Bartlett et al. 2018; Burrows and Savage 2014; Kitchin 2014). New actors, especially from the tech industry, can invest large amounts of financial capital with which traditional, mostly publicly funded research and higher education systems, can no longer compete. Moreover, gaining access to lucrative organizational data is often difficult or impossible due to corporate interests. These challenges not only create new inequalities in access to knowledge production between traditional and new actors in digital academia but also raise new questions. Which universities and which higher education and research systems, more generally, can even afford to invest in digital transformation? Are we witnessing a collective Matthew effect (Merton 1968; Bol et al. 2018) in

digital academia, where established, well-resourced universities are rewarded for their "excellence" (Münch 2014; Sørensen and Traweek 2022), that is, their researchers' previous academic achievements and successes? Although further research is needed to clarify the answers to these questions, it seems certain that digital transformation and the associated changes in knowledge production intensify the existing (global) competition among universities as organizations as well as science and higher education systems (Münch 2014; Arora-Jonsson et al. 2021; Brunsson and Wedlin 2021; Krücken 2021).

6 New Digital Learning Opportunities and Skill Requirements in Higher Education and Labor Markets

The last two decades have seen an explosion in the availability of digital learning opportunities, such as MOOCs and other forms of digital distance learning. Despite their discursive construction as a "disruption" to traditional higher education learning models (Selwyn 2013; Selwyn et al. 2015; Kirchner and Lemke 2019), digital learning environments are far from new phenomena: Their predecessors, such as forms of correspondence teaching and learning, date back to the mid-19th century (Holmberg 2005). In the last third of the 20th century, their development was linked to the creation of large distance-learning institutions, such as the University of South Africa, the Open University in the United Kingdom, and the University of Hagen in Germany.[6] Traditional on-campus universities have embraced this movement and have started to offer distance and more recently, online learning degrees where "students and teachers are separated by space, time, or both for the majority or the complete duration of teaching and learning" (Siemens et al. 2015, 12). In addition, new information and communication technologies enabled both synchronous and asynchronous learning opportunities, which are referred to by various terms and abbreviations (Holmberg 2005; Siemens et al. 2015).[7]

These new digital learning opportunities do not dissolve the old system but complement it. Therefore, even during the COVID-19 pandemic, classroom teaching returned to universities. However, the availability, accessibility, and mastery of digital learning tools reinforced earlier discussions about digital skills, digital divides, and potential (new) digital inequalities in many ways (Engzell et al. 2021; Laufer et al. 2021; van de Werfhorst 2021). The concept of digital skills – as well as its

6 The equivalent in the Swiss higher education system is UniDistance, founded in 1992.

7 The introduction of digital technology has also brought a plethora of terms and abbreviations, such as "online learning, web-based learning, blended learning, e-learning, learning management systems (LMS), computer-aided instruction (CAI), computer-supported instruction (CSI), technology-enhanced learning (TEL), Internet-based training (IBT), and virtual learning environments (VLE), which to a large extent all fall under a broad definition of distance education" (Siemens et al. 2015, 13).

neighboring concepts of 21st-century skills, the 4 Cs, and the key skills – is embedded in encompassing discussions about the future of labor markets (Frey and Osborne 2017) and jobs (World Economic Forum). It mainly results from discussions about digital divides due to new information and communication technologies since the mid-late-1990s, which builds on work regarding knowledge gap research since the 1970s (Zillien 2009; Ragnedda and Muschert 2017). Helsper and van Deursen (2015, 127) found that the theoretical discussions "around digital literacy and inclusion, digital skills, in particular, have gained prominence after decades of focusing on access." As broadband connections and mobile devices (laptops, smartphones, tablets, etc.) have become more widespread over the past two decades, this first dimension of the digital divide has become less important (Lutz 2019).[8] Correspondingly, policy efforts and academic conceptualizations since the mid-2000s have shifted their focus to the second and third dimensions of the digital divide, digital skills and outcomes. Nevertheless, recent sociological research has pointed to the persistence of social inequalities, such as class, gender, and race and ethnicity, which are remapped and reinforced in digital tools, such as learning platforms, algorithms, and AI systems, not least due to the forced closure of schools and universities during the COVID-19 pandemic (Büchi et al. 2021; Engzell et al. 2021; Festic et al. 2021; Hargittai 2021; Kelly 2021; van de Werfhorst 2021; Janschitz 2022).

An important function of any higher education system is to provide education to produce skilled professionals for the labor market. Therefore, building and fostering new skills has become a central topic in research on higher education and labor markets (Frey and Osborne 2017; Börner et al. 2018). Digital skills represent an attempt by higher education and labor market policies to translate qualification and skill profiles necessary to cope with the digital transformation's challenges. Despite its ambiguity, as multiple meanings remain (Helsper and van Deursen 2015), digital skills can be understood as a policy instrument to tackle skills shortages (Cappelli 2015): Numerous studies, policy reports, and other publications have pointed to the growing mismatch between labor markets' demand and supply, especially in technology- and knowledge-intensive fields, such as information communication technology, finance, insurance, and health (Börner et al. 2018; Sheldon 2020; Staatssekretariat für Bildung, Forschung und Innovation SBFI 2017; Staatssekretariat für Wirtschaft SECO 2017). While formulating practical responses to close such gaps (e. g., through common skills frameworks, investments in STEM subjects, reducing entry barrier for underrepresented groups), these publications establish new relationships between the multiple fields involved. The repeated discussions and imperatives for action to address impending skills shortages can be interpreted as collective visions about the structure and further development of labor markets and economic fields more generally (Fitzgerald et al. 2018; Saner 2019). Among

8 However, more recently, the effects of the COVID-19 pandemic have once again highlighted the importance of this dimension (Büchi et al. 2021; Engzell et al. 2021; Festic et al. 2021).

other scenarios, this includes the increasing dependency of various fields on digital platforms, cloud computing, data processing algorithms, and related ways of thinking (such as computational thinking).

7 Contributions to the Special Issue

The first contribution to this special issue, by Philippe Saner, is an investigation of the digital transformation of higher education and research policy in Switzerland. Drawing on Foucault's work and sociological discourse theories, higher education and research policies are conceptualized as a discursive field that combines conflictive and cooperative statements, strategies, investments, regulatory frameworks, and other policy measures by organizations in different sectors. Saner argues that actors in the discursive field prove powerful when they succeed in convincing others of their views and objectives in such a way that divergent, potentially contradictory visions converge. The author analyzes documents about digitalization in Swiss higher education and research policy between 1998 and 2020, a period that profound institutional change characterized, using a social science approach to discourse analysis. The analysis shows that actors in the field of higher education and research policy use open, ambiguous terms to characterize digitalization, creating a polyphony in the subject. Despite a pronounced rhetoric of process and transformation, the documents reveal a surprising continuity and stability in the discourse on digitalization. At the same time, knowledge fields such as the data sciences, AI, and robotics are framed as fundamental basic sciences for addressing the future challenges in a data-driven approach. They are considered central factors for competitiveness, not only of higher education and research but also of the economy and the nation-state.

The following two papers examine the emergence of new scientific fields in the context of digital transformation but with evidently different results. Bianca Prietl and Stefanie Raible investigate the academic institutionalization of the data sciences in Germany, Austria, and Switzerland. Their research focuses on processes of boundary work that accompany this institutionalization process to understand more clearly current transformations in knowledge production within digital academia. The authors develop a relational perspective that combines insights from the study of professions and the demarcation of science with discourse and practice theory. Empirically, the study is based on in-depth semi-structured qualitative interviews with data science professors at universities in the three countries. The analysis reveals that several lines of demarcation are discursively drawn to construct academic data science on a symbolic level. Specifically, academic data science is distinguished from industrial data analytics and, in contrast, popular notions of big data analytics. Within academia, data science is distinguished from mathematics, statistics, and computer science as well as so-called domains, each of which is presented as

limited in scope. Regarding content, the recent institutionalization of data science resembles that of engineering as a discipline, both in terms of the structuring and organization of its curricula as well as its symbolic construction. The authors conclude that the widespread demand for data science methods in both academic and non-academic domains may delegitimize other – especially non-quantifying – modes of conducting research and knowledge in these areas. Epistemological claims and symbolic demarcation from other disciplines must also be understood as central in the competition for research funding and talent.

In the third paper, Michael Piotrowski and Max Kemman conduct a qualitative study of Swiss universities to examine how institutional structures and definitions of the digital humanities interact. The authors show that the digitization of humanities research practices has led to the emergence of an identifiable field and community of digital humanities. Swiss universities have had opportunities to engage with digital methods in the humanities, and almost half of them have chosen to institutionalize digital humanities visibly. However, the authors conclude that, at least for the digital humanities, digitization does not lead to the emergence of a new discipline. Rather, they show that digital humanities practitioners reluctantly exclude digital humanities from the established system of humanities disciplines. Moreover, they show that professionalization and institutionalization take place in local contexts and lead to different institutional arrangements. Considering these findings, they argue that the emergence of new research fields, such as the digital humanities, is at least partially path dependent. How a new research field should be understood as a discipline or interdiscipline cannot be adequately predicted from research practices, institutional arrangements, or macro phenomena, such as the digitization of society and science. The authors compare the case of digital humanities with that of data science in Switzerland. These two new research fields share the same institutional landscape and are digital, interdisciplinary and only vaguely defined. However, considering these parallels, they also establish a clear difference between data science and digital humanities at the policy and institutional levels. They argue that the introduction of data science at Swiss universities is an example of the close and interconnected relationship among industry, science policy, and universities in the digital age, which has led to the successful institutionalization of data science. In contrast, the institutionalization of digital humanities is more heterogeneous and less far reaching. Therefore, the study allows for an interesting contrast between two new fields of research that closely relate to the discourse of digitalization in science.

In their paper, Luca Tratschin, Katja Rost, and Christian Leder observe that digitalization is strongly reflected in the strategic orientation and self-representation of Swiss universities. They find that these universities have a strong self-description of their positioning in relation to digitization. Against this background, they ask whether digitization partially reconfigures the relationships between Swiss universities. They conclude that the field structure has not changed radically but that some

universities have managed to change their position in relation to other universities. Swiss universities' rapid and strong uptake of digitization does not represent a disruptive event that redefines field relations but a partial repositioning of individual universities accompanies it. Furthermore, the authors observe that the field positions of Swiss universities are reflected in a different form of thematization of digitization: Although both the most dominant and the weakest players in the field of digitization regarding the extent of digitization activities are comparatively reluctant to discuss a digital identity, they note a pronounced articulation of digital identity among organizations in the midfield. They interpret universities' self-description as "digital universities" as an aspirational identity. These universities see an opportunity to raise their profile, but they have not yet been able to implement the approach.

In the final paper, Silke Fürst, Mike S. Schäfer, Daniel Vogler, and Isabel Sörensen present an empirical study on how university managers and administrators in Switzerland use social media in their active public communication. Their contribution is part of a longer systematic study on the field of higher education communication (Fähnrich et al. 2019). One striking result of their survey is the significant differences between types of higher education institutions. For example, the heads of universities of applied sciences attach more importance to the use of social media for university communication than do the heads of communication departments at research universities. However, as the study also shows, the use of social media is not considered the most important in the portfolio of media and media types used. The priority for communication managers is to ensure their universities have a good image and are covered in the daily newspapers, that is, the news media. However, using social media opens new possibilities. Universities of applied sciences, for example, use social media to engage with students, alumni, and potential new students as well as to generate likes, shares and feedback. Overall, the study shows that social media has found its way into the hands of university leaders and communications managers. In doing so, the study explores a specific facet of the digital age at universities.

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