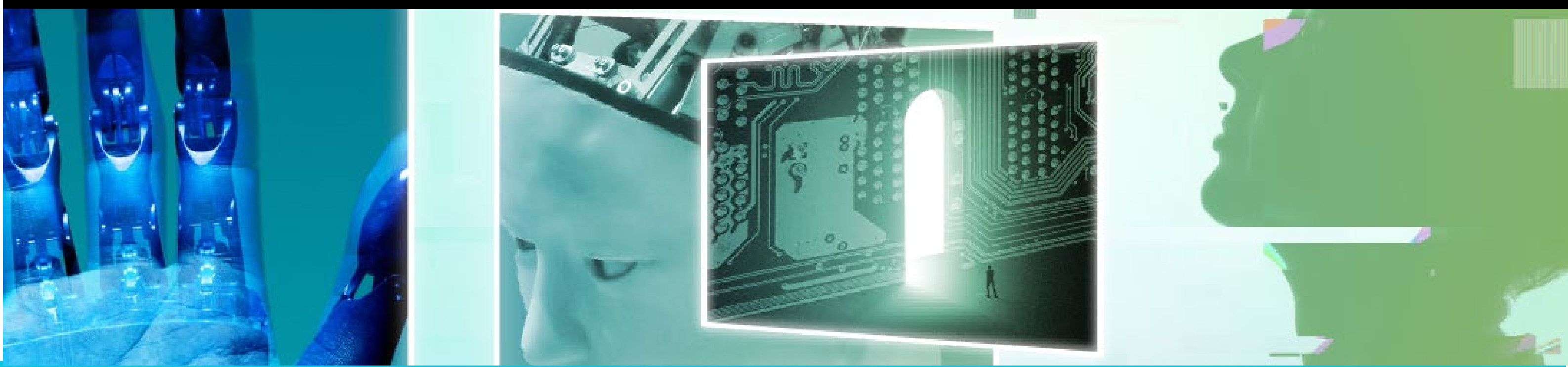
Centre for Sociodigital Futures

Supported by: Economic and Social Research Council

www.bristol.ac.uk/censof e: censof-enquiries@bristol.ac.uk t: @SociodigFutures CenSoF on LinkedIn



ESRC Centre for Sociodigital Futures

Education's sociodigital promises: A briefing paper and research agenda

Ben Williamson, Carolina Valladares-Celis, Arathi Sriprakash, Jessica Pykett, Keri Facer

June 2023

Education's sociodigital promises: A briefing paper and research agenda

Ben Williamson, Carolina Valladares-Celis, Arathi Sriprakash, Jessica Pykett, Keri Facer
June 2023

Cite as: Williamson, B., Valladares-Celis, C., Sriprakash, A., Pykett, J., Facer, K. (2023) Education's sociodigital promises: A briefing paper and research agenda, Briefing Paper 1, Bristol: Centre for Sociodigital Futures.

Contents

Education's sociodigital promises: a briefing paper and research agenda

Ben Williamson, Arathi Sriprakash, Jessica Pykett, Keri Facer

About this paper

This briefing paper is part of the work of the ESRC Centre for Sociodigital Futures Learning domain. Its aim is to make visible, and to open for discussion, our early thinking about how sociodigital futures are being envisaged and made in relation to four key areas with significance for formal education. It outlines our current assumptions, the literature that these are based upon, and the ethical questions and site of research that we think will follow. We hope that in making this public, we will find others – researchers, educators, policy-makers, journalists, technologists and designers - interested in the same lines of inquiry with whom we might collaborate over the lifetime of the centre.

What sociodigital futures are being claimed in education, by whom and how?

Education has long been a sector in which images of the future, particularly of technologically enhanced futures, have been used to make promises about transformation and change. In this briefing paper we highlight four key areas of contemporary sociodigital practice in which a set of claims about the future are becoming dominant in relation to formal education today: automating learning; interoperable learning; immersive learning; biological learning. We outline the key characteristics of each and the claims made about their futures by their advocates, point briefly towards some of the challenges such dominant sociodigital futures pose, and conclude by suggesting that future research needs to elaborate on how alternative forms of practice could question these dominant trajectories and open up the possibility of re-imagining learning in service of students, sustainability and social justice.

Dominant modes of sociodigital practice

Sociodigital practices emerge out of the connections between technologies, social relations and everyday life. Each of these areas of sociodigital practice tend to have some common orientations. Their dominant modes not only shape how education is practiced but also steer how the future of education is imagined and understood. Today, these dominant modes are often oriented towards:

- **Power at scale:** sociodigital infrastructures and processes often seek to draw in or capture large sets of people and institutions (e.g. students and schools), and often at a global scale. Arguably, sociodigital practices are intensifying the power and control that education systems and practices hold over vast populations. What alternative visions of the purpose and role of education are being foreclosed in this process?
- **Efficiency:** sociodigital infrastructures and processes tend to value and prioritise the efficiency of education delivery, measurement, surveillance and evaluation. Other kinds of values and priorities for education are arguably at risk of being diminished or overlooked in this process. How might ideals of sustainability or participation or social justice in educational relationships, for example, be valued and supported through sociodigital practices?
- **Extraction for external interests:** dominant sociodigital infrastructures and processes are by and large led by for-profit industries which seek to extract value from educational actors and institutions (e.g. student data). Interests that are external to education communities tend to

drive these sociodigital practices (wealth extraction, industry expansion) rather than interests oriented towards the common good. Can sociodigital practices foreground ideas of participation, sovereignty, communing, and building education futures with community interests at the centre?

Four domains of socio-digital practices and promises

Automating Learning: AI in education

Forms of automation are being introduced into education, accompanied by claims of their transformative future potential for teaching, learning and administration. Artificial intelligence has been a feature of both academic research and commercial interest in the future of education for more than 50 years, originally figuring in imaginaries of automated classrooms and intelligent tutoring systems driven by the synthesis of cognitive and computing sciences in the 1960s. By the 2010s, the original visions and practices of AI in education (AIED) had been replaced by a 'big data' approach in which digital data traces generated through everyday educational activities could be captured, analysed, and translated into 'actionable' intelligence. Variously known as 'learning analytics', 'educational data mining', or 'education data science', by the 2020s the big data approach has become characterized once more as AI, incorporating many of the methods and visions of the wider technology research and development sector and the technology industry. This 'datafication' of education has been framed for at least a decade by its advocates in terms of digital 'disruption' and 'transformation', with AI figured as 'revolutionary' for the future of education.

In the mid-2020s, AIED has taken another turn with the rising industry and media emphasis on 'generative AI' such as large language models (LLMs), chatbots, and other audio and image transformer models. This form of AI, it is now claimed, will be transformative at all levels of education, particularly by enabling students to gain access to knowledge on-demand, supporting their studying routines and completion of assignments, or by enabling teachers to produce pedagogic plans and curriculum materials more efficiently. One current vision for AI in education is personalized learning assistants that incorporate real-time data analytics for tracing student learning, coupled with automated text synthesis enabled by LLMs and multimodal interfaces that can facilitate students' access to content in ways that are adaptive and customized according to individual needs.

Many different actors make claims about AI futures of education, ranging in register from techno-determinist hype about progress to data-informed scenarios and speculations. The education technology industry (EdTech) has been closely involved in the development of big data and AI approaches in education, incorporating practices of mass data extraction, analysis and automation into various products and services targeted at schools and universities. Academic research scientists in domains like learning analytics and AIED, as well as the 'learning sciences' more broadly, are supported by a political economy of funding, professional associations, international conferences, and publications (journals, handbooks, special issues), and are invited to contribute to special events and reports on AIED convened by international organizations such as the OECD and UNESCO. Large philanthropic and investment vehicles like the Gates Foundation, Chan Zuckerberg Initiative and Schmidt Futures are leading advocates of AI's transformative future in education.

AI is also being integrated into many other applications and services, positioned as a 'foundational' technology that will make it possible for imaginaries of automated education to become material and durable. Multinational technology corporations (Big Tech) are involved in AIED as back-end infrastructure providers of AI facilities to third party EdTech, and as cloud computing, analytics and machine learning providers to institutions. Large AI operators are already integrating generative AI functionality into third party EdTech products to either support students' learning or assist teachers in generating lesson content. OpenAI, for example, is partnering with Khan Academy on an AI chatbot tutor and long-term plans to offer 'disruptive' alternatives to school or college education.

Google and Microsoft have announced plans to integrate chatbots into the enterprise systems they provide educational institutions. Financial EdTech investors have shifted their attention to AIED applications and startups too, based on valuations indicating it as a prospective area of significant market growth and therefore promising profitable long-term income streams. In sum, AIED is once again the object of significant imaginative claims in education, with these promissory claims feeding into financial investments and technical integrations that are intended to materialize such imaginaries in durable sociodigital arrangements.

What is notably absent from dominant futures-making claims are: attention to the wider effects of AI and automation on the core systems of pedagogy, curriculum and assessment in education; the potential for such developments to exacerbate and intensify existing inequalities in access to knowledge; reflection on the implications for the human at the heart of education and for the way that being human is transformed by these augmentations; questions of authorship in the creation of AI applications; concerns about the quality and accuracy of information and materials generated by AI; issues of student privacy and ownership of data; the carbon footprint of such technologies; the scripting and foreclosure of teacher-student interactions; and the vulnerability of such systems to cyberattacks and malware.

Interoperable Learning: Platforms and Clouds

Digital platforms are online, programmable digital environments that facilitate interaction between different parties, often acting as intermediaries to structure social relations or economic transactions, and which generate data from all interactions conducted through the interface. Platforms have become prevalent across sectors and industries, including digital education platforms. The platformization of education is evident in how incumbent educational publishers have adopted platform models for content delivery, but more so in the EdTech industry. EdTech companies ranging from small startups to multinational corporations have designed platforms for learning management and virtual learning environments, attendance and behaviour monitoring, teaching content markets, school finances, online courses, assessment, and other administrative and pedagogic functions. Platformization is part of a significant discourse and imaginary of 'unbundling' education into discrete educational services, which may then be 'rebundled' as digital products and marketed back to institutions.

Platformization is facilitated by a host of interoperabilities and integrations enabled by 'the cloud'. All digital platforms depend on being vertically integrated into the cloud computing architectures of transnational technology businesses. Cloud operators provide the Platform as a Service architecture that digital education platforms can be built upon. They also provide back-end Infrastructure as a Service for computing power, data collection, storage and analytics, as well as facilities for machine learning and AI. Use of digital education platforms therefore tethers institutional users and customers to large-scale 'stacks' of corporate cloud computing infrastructure. To a significant extent, the datafication of education, and the introduction of machine learning and AI, would not be possible without clouds and the platforms services they enable.

Being cloud-based allows individual platforms to connect and interoperate with other platforms, facilitated by application programming interfaces (APIs) that set coded rules for how one platform can integrate, communicate, and exchange data with another. For example, a Google Classroom API enables thousands of third parties to integrate with Google's online learning environment, including the exchange of data about students. Interoperability is often said to be central to educational improvement as it should ideally enable students to access 'seamless' learning experiences, platforms to access more powerful computing facilities, and rich data to be collected across interconnected ecosystems of cloud-enabled platform services.

Platform and cloud-based models also introduce a specific business model into education. Platforms, including those in education, are central to the logic of 'platform capitalism' as a global form of economic accumulation. Platforms can expand their user base constantly through 'network effects' and are modifiable and scalable, so constantly opening up new value-creating opportunities. Platforms promise to generate long-term earnings in two ways: through subscription fees for access and use, and from extracting value from the data collected through these agreements. Platform owners may therefore be understood as online 'landlords' gathering economic rent from subscribers, and data rent in the shape of digital information that can be made valuable in some way, for example in the development of upgrades or novel products that can be further marketed. The monetization of education data is rarely through sales of data to third parties; its value comes for the platform landlord from the creation of data derivatives and their long-term potential to generate further rent. This business logic is sometimes referred to as rentiership and assetization, where both the platform and the data are considered as assets that can yield ongoing cashflows in the form of economic and data rents. It is highly attractive to EdTech investors, who foresee securing significant returns on investment from holdings in fast-growing and highly scalable education platforms. As such, claims to the future transformation of education through platforms and cloud computing feature multiple premises, from visions of seamless pedagogic and administrative improvement facilitated by platform and cloud interoperability to financial speculation about potential market rewards.

What is missing from these dominant futures, therefore, are: discussions of the implications for public education of its reliance on private company platforms; the implications of education being seen as a site for monetization of student data and the consequent changes in relations between education institutions and students that this might engender; the sharing of profits from such data between state and private actors; the ownership and security of such data; the power of platform providers to limit access to their API to selected education designers and developers and the implications for educational diversity this might entail.

Immersive Learning: VR and the Metaverse

Virtual Reality (VR), Mixed Reality (MR) and Augmented Reality (AR) are types of digital immersive environments which invite participants to be part of and interact with an imagined world. Collectively referred to as Extended Reality (XR), these immersive realities are said to have three key features: embodied interaction with three-dimensional objects, realism and the simulation of presence. This means that the worlds they create are seen as adaptable, they can invent 'impossible' worlds, enhance current worlds, and provide a multi-sensory richness to their experience. Their worlds can be set in the past, present and future - and their appeal is often seen as enabling people to 'travel through time' or experience distant or accessible experiences. In MR and AR, simulated worlds are blended with a user's actual physical surroundings, while VR worlds are generally more enclosed, and CAVE technologies allow for full embodied immersion in a room without headsets. VR devices became more interactive and more embodied in the 1980s with the development of the Head Mounted Display and Data Gloves. Current engineering research is further advancing the fidelity of VR, the 'foldability' of space, use of physiological, emotional and speech sensors and incorporating additional haptics and even simulation of smell. So too they are trying to solve the problem of 'cybersickness' that some users feel, and headsets are not currently recommended or warrantied for use by children under 13 or for longer than 30 mins at a time. The entertainment, arts and culture sectors have led developments and innovations, inviting participants to occupy and experience the imaginative worlds of Disney films, or to participate with art installations through movement, or blending realities through theatrical and location-based performances.

New markets in educational XR include initiatives which have capitalised on the wide-spread shift towards online learning during the global covid pandemic, or selling educational VR products and services directly to schools including for virtual fieldtrips, science labs, anti-racism education and history (e.g. ClassVR; PrimeVR). The idea of a 'metaverse' popularised by the rebranding of Facebook to Meta in 2020 imagines the internet itself as a more immersive environment in which people can interact seamlessly with multiple decentralised institutions, corporations and platforms. Courses and educational experiences are also marketed within a 'metaverse' (not necessarily that of Meta), via online immersive learning environment (e.g. Eduverse, Avantis World 'educational theme park', Athenaverse) or courses about business opportunities in the metaverse (e.g. University of Pennsylvania's Business in the Metaverse Economy course). Yet it has been pointed out that the metaverse remains an idea which doesn't yet exist. Nonetheless, consulting on the educational potential of immersive technologies itself has become a growth industry and teachers can engage in new forms of digital labour, become 'edupreneurs' and 'Google-certified', advising on and participating in this new XR educational marketplace. Within these worlds, there are said to be novel opportunities for students to become content creators and develop the skills for the 'new digital economy', which of course is already well underway.

Google, Apple, Facebook Technologies and Microsoft Corporation have all invested in VR for education, suggesting that the notionally 'decentralised' Web 3.0 in fact continues to be dominated by a few key corporate actors. The Apple ARKit platform exists for developers to create AR apps and Amazon Web Services have an EdStart programme to finance edtech start-ups to bring VR/AR products to market. Global policy and consulting organisations such as OECD, UNESCO and World Bank are also actively describing and directing XR educational futures. The OECD speculates that XR technologies could change our very experiences of reality, how we communicate and how we relate to natural environments. The World Bank see it as improving embodied skills training and providing new virtual campus environments which will build emotional capabilities and social connections. UNESCO have described how VR will make learning more fun and engaging, help children to face future challenges, and enhance classroom observation and expert monitoring. Metaverse Education Council, made up of tech entrepreneurs, education and psychology consultants and venture capitalists, which has a stated mission to develop guidelines, standards and protocols for online educators. They present a vision of a borderless world which imagines a post nation-state future focussed on the individual.

These actors focus most on painting a picture of the future of education rather than setting out how pedagogies fit for XR could be used to cultivate the imagination and help users to collectively shape future worlds. XR from this perspective seen as disruptive, decentralised and blurring the boundaries between education and entertainment. Supported by the appearance of dedicated research journals like *Computers & Education: X Reality*, current and emerging research focuses on enhancing learner engagement, interaction, experiential and embodied learning. There is an emphasis on learning gain and efficiency, as well as skills training, simulated environments, task performance and knowledge retention. So too these environments are said to have scope for building empathy and improving relationships, being useful in shaping learner motivation, addressing psychopathologies and offering novel opportunities for emotional self management. At a higher level, there is a promise of digital inclusion, addressing global development challenges and building global citizenship. Meanwhile, critical research has focused on how the long promised digital commons has never materialised and indeed could become more enclosed within XR environments. Concerns have been raised about intensifying the embodied experiences of cyberbullying and harassment, and about the datafication of immersive participation.

What is missing from these dominant futures for XR in education are: discussions of student and teacher authorship of XR environments; the ethics of voyeurism and surveillance in immersive experiences; the implications of full immersion for imaginative capacities; the ongoing question of ownership of participant data as well as ownership of the platforms that are enabling these technologies; and the nature of the futures that are being designed and presented as inevitable for immersive training simulations or entertainment purposes.

Biological Learning: Biosensory Education Science

Various forms of biological data are increasingly claimed to offer insights into the embodied correlates of learning, cognition and education outcomes. What might be termed a biosensory approach to the sciences of learning and education is taking shape in which new digital instruments and infrastructures are employed to generate and analyse various forms of digital bioinformation. The findings from such analyses in relation to the biological bases of learning processes and educational outcomes are claimed by some to be potentially transformative in terms of future education policy and practice. This biological orientation stems from two key sets of developments: advances in genomic technologies and methodologies which, it is claimed, now make it possible to identify the genetic aspects underpinning social and behavioural phenotypes, traits and outcomes; and the development of neurotechnologies for non-invasive sensing and analysis of brain data in relation to non-medical conditions, often coupled with facial and electrodermal biometric sensors for detecting aspects of human affect from biologically embodied signals. Both have been adopted in relation to education, supported by various claims of educational enhancement.

Education genomics refers to an emerging body of research that has appeared since the invention of big data-led approaches to genomic analysis in the early 2000s. Education-focused studies with samples of bioinformation generated from up to 3 million individuals have been conducted, identifying the highly polygenic molecular genetic associations that underpin educational outcomes and their interaction with environmental factors. Such studies are enabled by developments in bioinformatics devices and infrastructures, including genome-wide association study methodologies for data-mining very large samples of genetic data; microarray chips and laser scanning laboratory robots for genotyping bioinformational samples; biobanks for the storage and organization of digital DNA data; and high-powered software for calculating polygenic scores that predict an individual's likely disposition to a particular trait or outcomes based on their genetic profile. For some, polygenic scoring potentiates new forms of 'precision education' where education could be customized to students' genetic strengths and weaknesses. The UK Government Office for Science has published a report supportive of advances in genetics and education, claiming such work can capitalize on the UK's cutting-edge infrastructure for medical genomics to produce insight into the biological architecture of learning and education processes. Research in this area is generously funded by major research councils internationally and is dependent upon innovations in the biotechnology industry, with data supplied by both public and private biobanks.

Neuroeducation signifies the application of neuroscience in educational research and various products. Part of the increasing salience of neuroscience in education in recent years, and optimistic projections of its relevance to future policy and practice, is due to innovations in neurotechnologies, such as portable brain scanning devices. Portable brain scanning has made it possible for researchers to study neural processes that are involved in real-world educational experiences and enabled claims to be made about the neural correlates of learning and cognition. Commercial companies have sought to promote neurotechnologies to gauge students' attention and engagement in real time as a source of insight for educators to act on. Scientists have begun to imagine forms of neuro-adaptive education where mobile brain scanning could be integrated with personalized learning platforms so that educational resources might be adjusted according to real-time calculations made using students' brain data. Such work can also incorporate biophysiological and psychophysiological sensors, such as electrodermal biometric wearable devices or facial emotion detection technologies, for capturing the embodied and affective dimensions of learning and cognition.

Such research is strongly supported by influential international organizations like UNESCO, particularly through its International Bureau of Education, and the OECD, which promotes high-tech neuroscience as transformative for understanding and intervening in learning, and is heavily advocating policy proposals for governments to invest in 'brain capital'. The brain capital agenda, also promoted by major think tanks like Brookings, is concerned with boosting economic dynamism, optimizing brain performance and productivity, and preparing brain-ready populations for new industries in the knowledge economy. For some scientists and supporters, integrating neuroscientific and genomic modes of analysis promises to unlock the biologically-embedded molecular structures and processes that underpin learning, cognition, and educational outcomes. In short, a promissory vision is taking shape in which the future of education could involve an increasing array of biosensory technologies and methods for scanning and data-mining student bodies for biological traces of learning processes and dispositions. Already, the use of genomic methods and neurotechnologies to analyse, and potentially even intervene in, complex human behaviours at a biological and molecular level is the subject of emerging debates regarding regulation, ethics and rights.

What is missing from these dominant futures-making claims are: concerns about the mobilisation of biological explanations for student achievement that could lead to the reallocation of educational attention and resources to biomedical forms of intervention; discussions of the limitations and non-representativeness of current biobank data in terms of ancestry; the use of these technologies to reproduce racialised hierarchies in education and their reliance on a return to discredited racial science; examination of methodologically individualist approaches to education which obscure social processes of educational marginalisation; exploitative data extraction of intimate and embodied data; lifelong ownership, rights and privacy issues for students.

Towards alternatives

Looking across these four areas of sociodigital development in education, raises a set of key questions that require attention:

1 – questions of ownership – what regulatory and technical models should be developed to enable selected, limited and informed transfer of data from students and teachers to these technologies?

2 – questions of authorship and access – how can epistemological and pedagogical monopoly situations be avoided, ensuring that diverse authors of knowledge and teaching practices can continue to make educational resources that are accessible to students? How can these tools be mobilised as resources for diverse human imaginative practices, rather than those of a limited community?

3 – questions of privacy and dignity – what limits on surveillance and extraction of data should be employed, through regulatory, technical and pedagogic practices, to ensure the integrity of student and teacher dignity and privacy?

4 – questions of sustainability – what pathways for edtech development are compatible with international treaties on climate and biodiversity?

5 – questions of humanity – what political, institutional and technological practices can be created to foster dialogue around what it means to be human in a sociodigital world, and what educational practices should therefore be prioritised?

These questions will form the foundation for the work that we do in the Centre for Sociodigital Futures in relation to questions of learning. They inform our concern with the development of sociodigital education practices that are oriented towards: support for students' autonomy and dignity, sustainable futures that recognise the needs of the ecosystems in which we are a part, and education that recognises and aims to repair historic relations of harm through addressing questions of justice.

As we get started on this work, we invite potential collaborators – teachers, researchers, developers, artists, informal educators and others – to explore the research materials that we are drawing on (see below) and to ask the following questions.

- What sociodigital practices and technologies shape your work in education?
- What are their stated purposes?
- Who controls when, how and why these practices and technologies are used?
- What are the observable and felt impacts of these technologies on those who are learning? On you? On the institutions you are a part of?
- What are the 'hidden', or less direct, or longer-term impacts of these technologies on those who are learning? On you? On the institutions you are a part of?
- How are these sociodigital practices and technologies changing how education more broadly is imagined and understood?
- What would you change about how technology and education interact, and why?

Sociodigital practice for learning	Technologies	Key characteristics	Futures claims	Potential ethical dimensions & vulnerabilities	Pathways to Alternative Futures
Automating learning	Artificial Intelligence in education (AIED) Learning analytics Generative AI Chatbots Personalised Learning Assistants	Enables educational data mining Digital data traces used for 'optimising' learning Multimodal interfaces Adaptive and customisable	Schools and universities will use more services for mass data extraction, analysis and automation Educational research will become dominated by the learning sciences driven by new AIED data practices Institutions will embed AIED into their infrastructures and everyday practices AIED investors and startups will cultivate significant market growth based on future valuation of these sociodigital practices	Privacy and digital footprints Who owns the dataCarbon footprint of big data processing and storage Digital divides and exclusion Scripting of pedagogic approaches and content Student and teacher voice in own words is lost Vulnerabilities to cyberattack and ransomware	Data sovereignty practices and legislation developed Education designed around community relationships and needs. Algorithmic reparation in education Establishment of rights to digital detox and data-free sessions in education
Interoperable learning	Platforms Clouds Virtual Learning Environments (VLEs) Learning Management interfaces Application Programming Interfaces	Programmable online infrastructures Enables interaction (social and economic transactions) across different platforms Cloud operators of global (mainly US and China) tech businesses (e.g. Amazon Web Services, Microsoft Azure, Google Web Platform, Huawei Cloud, Alibaba Cloud) Data collection, storage and analytics	Decentralised learning management and educational services brought under one interface Financialisation of cloud services and global expansion through network effects for value-creating opportunities Advances datafication of education and introducing machine learning and AI which rely on 'the cloud' Will codify how platforms integrate, communicate and exchange data with each other Promises a seamless experiences for users	Monopolies of cloud service providers which control vectors of information Enclosure of the digital commons Restrictions on public access to data held in private education data stores Rentiership and value extraction Monetisation of educational data without informed consent Damaging effects of financial speculation – a zero-sum game Vulnerabilities to education system of technical systems failures	Setting up regulatory systems Development of models of community-led and -owned infrastructures Establishing alternative data governance models Regulation or refusal of monopolies in education

Immersive learning	VR headsets Data gloves Haptics AR mobile apps CAVE technologies Immersive internet/metaverse	Immersive Embodied interaction with three-dimensional objects Realism Simulation of presence Experiencing virtual worlds	Will change experiences of reality, communication and relations to natural environments Become more embodied and multi-sensory Novel opportunities for students to become content creators and develop the skills for the 'new digital economy'. Will build emotional capabilities, empathy and improve relationships Help children to face future challenges Will address psychopathologies Will enhance classroom observation, expert monitoring and acquiring performance data Will improve learning gain, efficiency, skills training, task performance, knowledge retention	Health and safety issues for children, cybersickness Violence, abuse and harassment in online environments Exploitative data extraction of intimate and embodied data Sensory over-stimulation 'Correctional' forms of pre-emptive intervention Ignores structural determinants of educational and psychological inequalities Reduces learning to training and skills Prioritizes the imagination of the tech developer above the user	Recognition of structural injustices (gendered, racialised, classed, etc) in learning processes. Formulation of ethics and governance frameworks
Biological learning	Digital biosensors High powered computing Genomic technologies Neurotechnology devices	Collation of unprecedented volumes of digital bioinformation including research and commercial data banks International, interdisciplinary consortia of biological and data scientists involved Learning conceptualised at a molecular scale	Advent of 'precision education' customised to students' genetic dispositions New collaborations between biotechnology industry, governments and educators Will make genetic correlates with educational achievement and neural learning processes more visible and enable pre-emption and intervention. Enables future investment in 'brain capital', human optimisation and cognitive/affective enhancement for the knowledge economy	Exploitative data extraction of intimate and embodied data. Carbon footprint of high-powered computing Non-representativeness of current biobank data in terms of ancestry Reproduction of racialised hierarchies in education and return to discredited racial science Methodologically individualist approaches which don't address current social processes of educational marginalisation	Disruption of educational hierarchies Partnership with biobanks – including reparative work Formulation of ethics governance frameworks

Readings

Readings on Education and Sociodigital Futures

Facer, K (2012) *Learning Futures: Education, Technology and Social Change*. London: Routledge, https://www.academia.edu/38227317/_Keri_Facer_Learning_Futures_Education_Technolo_f9e20225_fuente_teorica_

Williamson, B. (2017) *Big Data in Education: The Digital Future of Learning, Policy and Practice*. London: Sage.

Facer, K. and Selwyn, N. (2022) Digital Technology and the Futures of Education: Towards Non-Stupid Optimism. Paris: UNESCO https://unesdoc.unesco.org/ark:/48223/pf0000377071

Readings on Automating Learning

Doroudi, S. (2022). The Intertwined Histories of Artificial Intelligence and Education. *International Journal of Artificial Intelligence in Education,* https://doi.org/10.1007/s40593-022-00313-2

Gulson, K. N., Sellar, S. and Webb, P. T. (2022). *Algorithms of Education: How Datafication and Artificial Intelligence Shapes Policy.* University of Minnesota Press.

Jarke, J. and Breiter, A. (2019). Editorial: the datafication of education. *Learning, Media and Technology*, 44(1), 1–6.

Nemorin, S., Vlachidis, A., Ayerakwa, H. M. and Andriotis, P. (2023). AI Hyped? A Horizon Scan of Discourse on Artificial Intelligence in Education (AIED) and Development. *Learning, Media and Technology*, 48(1), 38-51.

Perrotta, C. and Selwyn, N. (2019). Deep learning goes to school: Toward a relational understanding of AI in education. *Learning, Media and Technology*, 45(3), 251-269.

Selwyn, N., Hillman, T., Bergviken-Rensfeldt, A. and Perrotta, C. (2023). Making Sense of the Digital Automation of Education. *Postdigital Science and Education*, 5, 1–14.

Williamson, B. 2023. Governing through infrastructural control: artificial intelligence and cloud computing in the data-intensive state. In Housley, W., Edwards, A., Beneito-Montagut, R. and Fitzgerald, R. (eds). *The Sage Handbook of Digital Society*. London: Sage

Readings on Interoperable Learning

Davies, H., Eynon, R., Komljenovic, J. and Williamson, B. (2022). Investigating the financial power brokers behind EdTech. In Livingstone, S. and Pothong, K. (eds). *Education Data Futures: Critical, Regulatory and Practical Reflections*. London: 5Rights Foundation.

Decuypere, M., Grimaldi, E. and Landri, P. (2021). Introduction: Critical studies of digital education platforms. *Critical Studies in Education*, 62(1), 1-16.

Fiebig, T., Gürses, S., Gañán, C.H., Kotkamp, E., Kuipers, F., Lindorfer, M., Prisse, M. and Sari, T. (2021). Heads in the Clouds: Measuring the Implications of Universities Migrating to Public Clouds. arXiv preprint: arXiv:2104.09462.

Kerssens, N. and van Dijck, J. (2022). Governed by Edtech? Valuing Pedagogical Autonomy in a Platform Society. *Harvard Educational Review*, 92(2), 284–303.

Komljenovic, J. (2021). The rise of education rentiers: digital platforms, digital data and rents. *Learning, Media and Technology*, 46(3), 320-332.

Nichols, T.P. and Garcia, A. (2022). Platform studies in education. *Harvard Educational Review*, 92(2), 209-230.

Perrotta, C., Gulson, K.N., Williamson, B. and Witzenberger, K. (2021). Automation, APIs and the distributed labour of platform pedagogies in Google Classroom. *Critical Studies in Education*, 62(1), 97-113.

Van Dijck,, J. and Poell, T. (2018). Social media platforms and education. In Burges,, J., Marwick, A. and Poell, T. (eds). *The SAGE Handbook of Social Media*. London: Sage

Williamson, B., Gulson, G., Perrotta, C. and Witzenberger, K. (2022). Amazon and the new global connective architectures of educational governance. *Harvard Educational Review*, 92(2), 231–256.

Williamson, B. and Komljenovic, J. (2022). Investing in imagined digital futures: The techno-financial ‘futuring’ of edtech investors in higher education. *Critical Studies in Education*, https://doi.org/10.1080/17508487.2022.2081587

Readings on Immersive Learning

Egliston, B. and Carter, M. (2022). ‘The interface of the future’: Mixed reality, intimate data and imagined temporalities, *Big Data and Society,* 9(1), https://doi.org/10.1177/20539517211063689

Golding, D. (2019). Far from paradise: The body, the apparatus and the image of contemporary virtual reality. *Convergence* 25(2), 340-353, https://doi.org/10.1177/1354856517738171

Halpern, O. (2015) The Trauma Machine: Demos, Immersive Technologies and the Politics of Simulation. In: Matteo Pasquinelli (Hg.): Alleys of Your Mind. Augmented Intelligence and Its Traumas. Lüneburg: meson press 2015, S. 53–67, https://doi.org/10.25969/mediarep/1252

Lindberg, S. (2020) Politics of digital learning—Thinking education with Bernard Stiegler. *Educational Philosophy and Theory* 52 (4), 384-396, https://doi.org/10.1080/00131857.2019.1586531

Nash, K. (2018). Virtual reality witness: exploring the ethics of mediated presence. *Studies in Documentary Film* 12(2), 119-131, https://www.tandfonline.com/doi/full/10.1080/17503280.2017.1340796

Roquet, P. (2022) *The Immersive Enclosure. Virtual Reality in Japan.* Columbia University Press

Readings on Biological Learning

Bryan, A. (2022). From the ‘conscience of humanity’ to the conscious human brain: UNESCO’s embrace of social-emotional learning as a flag of convenience. *Compare: A Journal of Comparative and International Education,* https://doi.org/10.1080/03057925.2022.2129956

Gulson, K.N. and Webb, P.T. (2018). ‘Life’ and education policy: intervention, augmentation and computation. *Discourse: Studies in the cultural politics of education*, 39(2), 276–291.

Martschenko, D., Trejo, S. and Domingue, B.W. (2019). Genetics and education: Recent developments in the context of an ugly history and an uncertain future. *AERA Open,* 5(1), 1-15.

Morris, T.T., von Hinke, S., Pike, L., Ingram, N.R., Davey Smith, G., Munafò, M.R., & Davies, N.M. (2022). Implications of the genomic revolution for education research and policy. *British Educational Research Journal*, 1– 21, https://doi.org/10.1002/berj.3784

Parens, E. and Meyer, M.N. (2023). The Ethical Implications of Social and Behavioral Genomics. *Hastings Center Report*, 53(2), S2– S49.

Williamson, B. (2019) Brain Data: Scanning, Scraping and Sculpting the Plastic Learning Brain Through Neurotechnology. *Postdigital Science and Education,* 1, 65–86.

Williamson, B. (2020). Bringing up the bio-datafied child: scientific and ethical controversies over computational biology in education. *Ethics and Education*, 15(4), 444-463.

Williamson, B. (2023). Big bioinformational education sciences: new biodigital methods and knowledge production in education. In Jandric, P., Mackenzie, A. and Knox, J. (eds). *Postdigital Research: Genealogies, Challenges, and Future Perspectives.* 93-114. Cham: Springer, https://doi.org/10.1007/978-3-031-31299-1_6