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**Digital Education Platforms and Schooling: New Challenges and Alternatives Toward Education Equity and Children's Rights**

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# The Critical Study of Digital Platforms and Infrastructures: Current Issues and New Agendas for Education Technology Research

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**Abstract:** Digital platforms have become integral to contemporary schooling. Google Classroom, Compass, Office 365, EdQuire, ClassDojo and Canvas are just some of the many platforms that litter students' and teachers' computers today. While students may have only one school to physically attend, there is a labyrinth of digital enclosures for them

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to navigate as part of their schooling. The rise of digital platforms in education has occurred at an erratic rate—sometimes through function creep, sometimes through whole system mandates, and certainly the global pandemic has accelerated their rise. In this article we consider how platforms have become an infrastructure in education and the implications this has for teaching, learning and the relationships between key stakeholders. We provide an overview of the education research into platforms to date, highlighting areas that require further empirical and theoretical investigation. We conclude the article by outlining a research agenda for critical platform studies in education.
**Keywords**: platformization of education; infrastructuring; research overview; critical platform studies; research agenda

**El estudio crítico de las plataformas e infraestructuras digitales: Temas actuales y nuevas agendas para la investigación en tecnología educativa**
**Resumen:** Las plataformas digitales se han convertido en parte integral de la escolarización contemporánea. Google Classroom, Compass, Office 365, EdQuire, ClassDojo y Canvas son sólo algunas de las muchas plataformas que ensucian las computadoras de estudiantes y profesores en la actualidad. Si bien los estudiantes pueden tener solo una escuela a la que asistir físicamente, existe un laberinto de recintos digitales por los que pueden navegar como parte de su educación. El auge de las plataformas digitales en la educación se ha producido a un ritmo errático: a veces a través de funciones progresivas, a veces a través de mandatos de todo el sistema, y ciertamente la pandemia mundial ha acelerado su ascenso. En este artículo consideramos cómo las plataformas se han convertido en una infraestructura en la educación y las implicaciones que esto tiene para la enseñanza, el aprendizaje y las relaciones entre las partes interesadas clave. Proporcionamos una visión general de la investigación educativa sobre plataformas hasta la fecha, destacando áreas que requieren mayor investigación empírica y teórica. Concluimos el artículo delineando una agenda de investigación para estudios de plataformas críticas en educación.
**Palabras clave:** plataformatización de la educación; infraestructura; descripción general de la investigación; estudios de plataformas críticas; agenda de investigación

**O estudo crítico das plataformas e infra-estruturas digitais: Questões actuais e novas agendas para a investigação em tecnologia educacional**
**Resumo:** As plataformas digitais tornaram-se parte integrante da escolaridade contemporânea. Google Classroom, Compass, Office 365, EdQuire, ClassDojo e Canvas são apenas algumas das muitas plataformas que hoje ocupam os computadores de alunos e professores. Embora os alunos possam ter apenas uma escola para frequentar fisicamente, existe um labirinto de recintos digitais para eles navegarem como parte da sua escolaridade. A ascensão das plataformas digitais na educação ocorreu a um ritmo errático – por vezes através do aumento de funções, por vezes através de mandatos de todo o sistema, e certamente a pandemia global acelerou a sua ascensão. Neste artigo consideramos como as plataformas se tornaram uma infraestrutura na educação e as implicações que isso tem para o ensino, a aprendizagem e as relações entre as principais partes interessadas. Fornecemos uma visão geral da pesquisa educacional em plataformas até o momento, destacando áreas que requerem investigação empírica e teórica adicional. Concluímos o artigo delineando uma agenda de pesquisa para estudos críticos de plataformas em educação.
**Palavras-chave:** plataformização da educação; a infraestrutura; visão geral da pesquisa; estudos críticos de plataformas; agenda de pesquisa

# The Critical Study of Digital Platforms and Infrastructures: Current Issues and New Agendas for Education Technology Research

In his book *The Shock of the Old,* historian of technology David Edgerton (2011) argued that our obsession with technological progress is misplaced, as it is founded on a "futurist" bias overly fascinated with innovation, which makes us oblivious to the quietly transformative nature of mundane forms of technology. As he puts it at the very beginning of the book: "is the condom more significant in history than the aeroplane?" (p. 1). This argument applies quite well to education, where the enduring trope of a static ("stuck in the 20th century") institution in desperate need of technological innovation overshadows the less visible ways in which "boring" tools and infrastructures influenced change, not in a deterministic fashion of course, but in concomitance with broader cultural and economic shifts. The argument also echoes the critical view that many educational technologies are historically associated with low-grade administrative aspects of schooling, which tend to operate in the background but still have a cumulative effect on the nature of teachers' work and indirectly impact upon the learning experiences of students (Selwyn, 2022). The key point that we wish to foreground with this introduction is that the relationship between technology and educational change is complex and not always in plain sight.

One recent, not-in-plain-sight educational change that interests us particularly is "platformisation". Platformisation refers to "the penetration of infrastructures, economic processes and governmental frameworks of digital platforms in different economic sectors and spheres of life, as well as the reorganisation of cultural practices and imaginations around these platforms" (Poell et al., 2019, p. 1). In the context of education, platformisation is a phenomenon that impacts multiple aspects of education at the same time: the policy dimension, the organisation of curricula and the practical context of teaching and learning just to name a few. "Digital platforms in education" is a catch-all phrase that, for us, apprehends the entire modern landscape of educational technology. This includes a variety of tools, services, and solutions used across various educational levels - primary, secondary, and tertiary. While these technologies serve different purposes, they share a common focus on data utilization and a shift towards cloud-based systems. Key components of this landscape include interactive, game-like applications, advanced tutoring software, online assessment tools, learning management systems (LMSs), and massively open online courses (MOOCs). Our goal in this article is to develop a reflective analysis of how platformisation has become a topic of research and critique in education. We believe this is a timely exercise, in which we take stock of the progress made and consider what we believe to be important challenges at a time of great uncertainty, with "platformed" technologies such as cloud computing and AI poised to disrupt many taken-for-granted educational assumptions.

The article is organised as follows. In the first section, we restate a crucial conceptual affinity that others have highlighted before us: digital platforms and infrastructures have a lot in common. We provide an accessible summary of this argument to then focus on the educational context, where platforms-as-infrastructures are involved in multiple aspects of administration and pedagogy, influencing the nature of teaching, and spilling over into cognate areas such as parental involvement. Next, we elaborate on the initial argument by suggesting that an interest in the "logics" underpinning platforms-as-infrastructures helps us shift the analytic focus from discrete software environments to platformisation, framed as a more structural phenomenon driven by three principles: datafication, interoperability and predictive surveillance. We then provide an overview of the critical study of platforms and infrastructures. This is the principal section of the paper, and it serves a twofold purpose: a) to give credit to a body of work which, over the past decade, has equipped us with conceptual and empirical resources to make sense of platformisation, and b) to discuss emerging

lines of inquiry which are particularly relevant for education. We focus on three emerging areas of study: platformisation and learning; platformisation and educational justice; and platformisation and democratic education. We explore the main arguments and points of interest, while also highlighting the gaps and tensions. We conclude the article with suggestions for a future research agenda on platformisation in education.

## Framing our Argument: Educational Platforms as Infrastructures

Typically, we think of infrastructures as things like roads, railways, electricity grids, and the internet. Infrastructures make up the backbone, nervous system and circulatory network of the "body politic", enabling participation and engagement but only if citizens/users comply with restrictions, control measures and access conditions. For example, you need a ticket to ride on a train. At the same time, infrastructures are not just physical objects in geographic space, they are social phenomena, with contested sociotechnical standards, political manoeuvres around financing and control, and forms of social engineering that seek to reshape identities and cultures. Infrastructures create "ways of being in the world" (Larkin, 2013, p. 330), which produce particular types of citizenship. Infrastructures, as Bowker & Star (1999, p. 41) explain, "provide the tools—words, categories, information processing procedures—with which we can generate and manipulate knowledge". For example, platforms as a new form of information infrastructure change the spatial-temporal dimensions of work, emphasising "a culture of instantaneity and ever-increasing connectivity" (Aroles et al., 2019, p. 290).

Infrastructures enact their influence through a careful orchestration of potentialities, that is, what Keller Easterling (2014) calls "dispositions", referring to the propensities inscribed in physical and symbolic space: "It is not the shape of the game piece but the way the game piece plays, it is not the text but the constantly updating software that manages the text" (p. 13). Therefore, the power that flows through infrastructure cannot be equated with traditional forms of hierarchical control, because it operates more subtly through a diagrammatic logic of "active forms" that generate real and symbolic capacities: multipliers enabling mass-production and standardisation, switches generating effects at a distance, wirings connecting components, and governing protocols formalising norms for the utilisation and extension of the infrastructure.

What this means for schools and education is only now beginning to be investigated. Of course, schooling was always based on infrastructural active forms: custom-designed buildings to ensure constant visibility and crowd control, curriculum and assessment standards that engendered uniformity, and enforceable disciplinary protocols that produced compliance. Digital platforms overlay their active forms on top of this pre-existing system. For example, Google uses its classroom learning management system (Google Classroom) to multiply the adoption of Google's Chromebooks and the institutional reliance on its proprietary cloud services. Similarly, Google Classroom uses a central application programming interface (API) in a switch-like fashion to govern the flows of student data, as well as the integration of other apps and automated services into its "classroom ecosystem" (Perrotta et al., 2020). As the active forms of platforms like Google Classroom take hold, they change and extend the type of work teachers must engage in to do their job (Pangrazio et al., 2023). Beyond traditional teaching responsibilities, educators are now required to become proficient in the curation, cleaning, and interpretation of various forms of educational and administrative data, while often involved in the maintenance of characteristically ad-hoc digital and physical infrastructures. While these tasks may help harness the wealth of data available through educational platforms, they also entail an additional workload that, at times, can offset the efficiencies promised by technology. An important consequence of these shifts in educational work is that teachers are framed as lacking platform-friendly competences. They are thus invited to

"upskill" by gaining corporate-sponsored certifications and are encouraged to adopt a teaching approach characterized by flexibility, readiness to adapt, and a commitment to working anytime and anywhere (Ideland, 2021).

Similarly, the relationship that parents have with their children's education has also changed, with Hartong and Manolev (2023) describing this process as a kind of "parental (educational) professionalisation". For several decades, parental involvement in education has been on the rise, especially as the scope of education has expanded to include personal and emotional well-being beyond the boundaries of the school. Consequently, parents and guardians have taken on both explicit and implicit roles related to discipline, motivation, and academic performance. In response to these historical shifts, Hartong and Manolev argue that digital platforms have adapted to facilitate and accelerate the engagement of parents in processes of data-driven surveillance. In many comparable education systems, such as those in Europe, the United States, and Australia, parents are now expected to cultivate a semi-professional familiarity with the digital infrastructures used by schools. This involvement encompasses routine administrative tasks like managing school payments and granting approvals for student absences. However, it also extends to interacting with a variety of behavioural indicators integrated into educational platforms. These indicators include elements like badges, the setting of SMART (Specific, Measurable, Achievable, Relevant, and Time-Bound) goals, monitoring well-being and mood, among others. All told, the transformation of parental engagement in education, as facilitated by digital platforms, is a phenomenon that raises important questions about equity and inclusion within our educational systems.

While the increased involvement of parents in their children's education can have numerous benefits, such as improved communication and academic support, it is crucial to recognize that this engagement is not uniform and can be influenced by structural factors, including socio-demographic variables and access to technology. Not all families have equal access to digital resources, including computers, smartphones, and reliable internet connections, which can significantly impact a parent's ability to engage. Furthermore, the traditional family unit is evolving, with diverse family structures becoming increasingly common. The non-conventional nature of many family units, such as single-parent households and blended families, can complicate the dynamics of parental engagement. In keeping with their "existential" reliance on standardisation, digital platforms assume a certain level of availability and involvement that may not align with the realities of these diverse family structures.

It is important to note at this point that not all platforms are the same, even though they all share an emphasis on standardisation and homogeneity. While the expansion and influence of platforms created by Big Tech companies such as Google (Google Classroom), Microsoft (Microsoft Education 365), and Apple (Apple Education), is increasing in education, there are many other platforms which are locally developed and/or serve niche purposes. For example, currently Google makes the two most popular apps in Australian primary schools, however, also in the top 10 are apps for learning and creating such as Literacy Planet, Mathletics, Lensoo Create, and of course, Minecraft (Rennie et al., 2019). Kerssens and van Dijck (2021) categorise the platforms in schools into two groups: digital learning platforms (DLP), which facilitate student learning and the delivery of content, and learning management and support systems (LMS), which are largely administrative. While the individual software environments warrant empirical attention, in this article we are more concerned with the "logics" that underpin the design and implementation of platforms as educational infrastructures.

## A Focus on "Platform Logics"

As we write in 2023, the global educational community is still reeling from the unprecedented disruption caused by the COVID-19 pandemic, with the great online pivot that

occurred in 2020 dramatically accelerating the platformisation of the sector. The Organisation for Economic Co-operation and Development (OECD)—an historical champion of global education reform along neoliberal lines (Sellar & Lingard, 2013)—framed it as a once in a lifetime opportunity, claiming it was "unlikely that economies and societies will return to pre-Covid patterns" and highlighting "the growing importance of digital technologies and communications infrastructures in our daily lives, with governments increasingly putting digital strategies at the centre of their policy agendas" (OECD, 2020, p. 1).

The overenthusiasm (and overinvestment) in such strategies fuelled by the global lockdowns is now undergoing a process of stabilisation, accompanied by mass retrenchments in the technology sector. Moreover, while digital platforms saved education systems from collapsing, the actual experiences of digital organisation and delivery of curricula were far from optimal. In some of the worst affected contexts, sudden platformisation had the opposite effect of increasing negative beliefs about the role of technology in education (Scarpellini et al., 2021). Nonetheless, the pandemic represented a "perfect storm" for a massive increase in digital infrastructure development meant to withstand temporary and localised fluctuations in adoption. As such, the path is arguably set for a steady penetration into education of the platform logics that interest us here: surveillance, automation, algorithmic personalisation (a machine that knows you better than you know yourself), the infinite reproducibility of digital items, planetary networks of data centres—power hungry and in constant need of cooling—and finally the possibility to access analytic services on a "just in time" and "on-demand" basis. Key to the work platforms can do in a school is their interoperability with other platforms, as this facilitates connections and data flows (Liss, 2013). Intraoperability, on the other hand, refers to vertical connections between proprietary platforms. Intraoperability connects platforms in schools to a more centralised commercial actor that can channel data as a proprietary asset (Kerssens & Dijck, 2021). Platformisation driven by intraoperability effectively enables the privatisation and commercialisation of online public education and extends the reach of datafication.

These platform logics impact all relationships within the educational sphere. They are systemic rather than associated with any specific app or platform. As mentioned in the introduction, talking about logics of platformisation and infrastructuring, rather than digital platforms as individual software systems, affords a more sociological and historical conceptualisation of the phenomenon and its challenges. It enables, for example, to appreciate how datafication—"the collection of data at all levels" (Jarke & Breiter, 2019, p. 1) —didn't suddenly become a defining feature owing exclusively to the success of apps and LMSs. Instead, it found fertile ground as a general governance logic that builds on long track records of performative quantification in many education systems around the world (Ball, 2018; Gorur, 2017; Williamson & Piattoeva, 2019). As platformisation envelops post-pandemic education, the research community can therefore turn to a body of literature which, over the past decade, illuminated platformisation as a systemic collection of infrastructural logics and sociotechnical processes. The key highlight emerging from this literature is of course the gradual emergence of platform ecosystems, fuelled by rapidly growing pools of student data, which includes traditional assessment measures, but also multiple other forms of proxy data generated through engagement with learning management systems, anti-plagiarism software, managed productivity apps, and so forth.

These sociotechnical arrangements are systemic and paradigmatic in another sense: they are not only concerned with localised governance but provide a broader rationale for the institutional reform of education along neoliberal lines. They indeed "lubricate" the cogs of educational marketisation (Robertson, 2019), chiefly by allowing commercial technology companies to establish contractual agreements with educational institutions, to then plug into their databases and offer affordable, cloud-based analytical capabilities. At its core, this approach aims to familiarise educational stakeholders, including administrators, teachers, parents, and students, with proprietary

infrastructures such as Microsoft and Google productivity suites, Amazon's cloud-based backend systems, and a multitude of edtech applications that forge licensing agreements with educational institutions, to then nudge users toward premium and personalised subscriptions (Williamson et al., 2022). The business model of platformisation is therefore founded on what David Beer called the "promissory rhetoric" of data: personalisation, prediction, convenience, efficiency, and ease of deployment (Beer, 2018). These promises are however offered on a pay-as-you-go basis, with schools reconfigured as tenants plugging their operations into multiple sockets while remaining oblivious of the interests, negotiations and technical complexities.

This certainly applies to personalisation, which has been a "promotional" feature of platformed education for a while, evolved from an early enthusiasm for technology-enhanced learning and energised by the rise of AIED over the past decade (Luckin & Cukurova, 2019). The specific nature of this algorithmic personalisation is, to a critical observer familiar with the dynamics of datafication, merely a process of decomposition, operationalisation and, ultimately, measurement, with learning often conceptualised as a binary and individualistic pursuit. In some cases, like the ASSISTments Intelligent Tutoring System (widely used in the US), this "personalised learning" explicitly reflects the pass/fail binary of high stakes testing (Perrotta & Selwyn, 2020).

This initial discussion about the complex and often problematic nature of the platform logic in education frames our argument and acts as a bridge between the previous section and the next. On the one hand, it seems clear that understanding and defining platformisation in education requires a multidisciplinary engagement with related areas of scholarship, accompanied by a critical inclination to look beyond the promissory rhetoric and its attendant algorithmic infrastructures. On the other hand, the dynamic and rapidly changing nature of our object of analysis means that research interests are far from settled, and new problematics are indeed emerging that require our attention. The next sections will expand on these two points.

## Taking Stock and Looking Ahead: Platform Studies in Education

To further clarify the definitional ground, we begin this section by returning for a moment to the concept of platform. This is a deliberate move that will help the reader grasp the conceptual progression—from platforms to platformisation—that we articulated in the previous section. This paves the way for a discussion of four foundational "first principles" of platformisation: programmability, network effects, value capture, and automated governance.

Platforms are often described in the mainstream discourse as support systems that enable connections between people, contexts and resources. They mediate social interactions and economic transactions, using digital affordances to increase efficiencies through automation, instantaneous communication and economies of scale. However, this emphasis on mediation does not mean that platforms are neutral actors. They subtly intervene in the dynamics they arbitrate, adapting like chameleons to different institutional environments (Vallas & Schor, 2020, p. 281), while imposing their distinct techno-economic norms on human relations (van Dijck & Poell, 2013; Van Dijck et al., 2018). These norms have been explained as the "operational logics of software" (Bucher, 2018, p. 61) which shape engagement through algorithmic prediction and reinforcement-based behavioural modification. Framing platformisation as a collection of operational logics is a productive exercise because it implies the existence of a paradigm that reflects shared properties and assumptions and is applicable to multiple institutional contexts.

The shift from dry and neutral technological signifier (platform) to a more complex understanding (platformisation) arguably originated in the cultural studies of computer games (Montfort & Bogost, 2009). During the early 2010s, it became clear that "platform" was a flexible descriptive category denoting various operational logics, which could be adapted to multiple objects

of analysis: game console systems are platforms, proprietary software environments (e.g., Microsoft and Apple) are also platforms, and so are social media and content-sharing applications like Facebook and YouTube. Gillespie (Gillespie, 2010) argues that the discursive work of the term platform helps to position these rather eclectic digital tools in the cultural imaginary. In particular, he identifies four definitions of platform—architectural, functional, figurative and political—which are each drawn upon to develop its discursive resonance and power. Adopting the term, Gillespie (2010) argues, is strategic on the part of developers and designers, as it has connotations with openness, functionality, empowerment and neutrality, thereby papering over the more questionable and hidden aspects of their political economy. Nevertheless, these cognate entities share several key aspects, which can be summarised as follows:

a) Programmability and the reliance on computational protocols and affordances (Application Programming Interfaces or APIs) which enable integration and communication between platforms and across "platform ecosystems" (Helmond, 2015). APIs operate as active forms, e.g. sockets, plugs and switches (Easterling, 2014), which, as explained in section 2, regulate practices and have political implications: whoever controls the switches exerts a form of power.
b) An existential reliance on "network effects"(Metcalfe, 2013) whereby the more people join a platform, the more valuable it becomes for its users and its owners.
c) The co-existence of distinctive business models through which the platform extracts value from transactions and assets (Srnicek, 2017). Such models include, for instance, data monetisation and loss leading. In the former scenario, data are captured through algorithmic surveillance and sold for marketing purposes, which in most cases entails selling personal information to enable personalised advertising. In the latter scenario, a valuable service (e.g., a well-designed webmail service like Gmail) is offered for free, which leads to universal "locked in" adoption of other services or functionalities that belong to a broader, proprietary platform ecosystem. Tailored "premium" services are then developed and sold once network effects of a sufficient magnitude have been reached.
d) A tendency to establish algorithmic (automated) oversight over seemingly fragmented processes which are essential to our everyday participation in society: interpersonal relations (Facebook), public discourse (Twitter), urban transportation and infrastructure (Uber), and so forth (Plantin & Punathambekar, 2018). This oversight generates "multisided" marketplaces (markets that connect different groups of users sharing the same platform) which benefit from efficiencies in management and resourcing while, simultaneously, enabling extensive corporate control.

As many contexts transitioned towards the technical-economic model of platformisation summarised above, the academic discourse gradually shifted from an interest in discrete software applications to a more environmental focus on datafied ecologies populated by multiple actors: hardware suppliers, software developers, cloud service providers, and traditional economic and institutional (public) entities. This scholarly interest in platformisation as a generalised process reflects a trend where multiple interoperating platforms have achieved such enormous scales, that they can "co-exist with public infrastructures, and in some cases compete with or even supplant them" (Plantin et al., 2018, p. 301).

The implications for public and democratic governance became soon apparent (Danaher et al., 2017; Williamson, 2016) with a growing critical awareness of how platformed infrastructures enable distributed responsibility for decisions and practices and the creation of dependencies

between the public sector and technology providers, all in the name of efficiency, simpler (and more profitable) transactions, less regulation, more automation, more standardisation, more on-demand and personalised access. This disruptive effect "reconstructs relations of authority, creates new political entities, and establishes new interpretative frameworks" (Espeland & Stevens, 1998, p. 323).

At the heart of all of it is of course data. Platformisation is indeed made possible by the rendering into commensurable data of many social and human aspects which could not be quantified until recently (Mayer-Schönberger & Cukier, 2014). A great deal of such data is behavioural and simply "left behind" (trace data) as people engage daily with an automated tracking infrastructure which does not much measure but "registers", seeking to capture a more genuine—frameless—version of reality not coloured by human interpretation (Andrejevic, 2020).

Let us stop here. Our aim is not to provide an exhaustive review of critical platform studies, as we merely seek to convey the significance of this area of scholarship and its broad contribution in terms of knowledge advancement. As we stated in the introductory section, the first part of our twofold goal was to give credit to a body of work which has produced valuable interdisciplinary insights which have enabled a critical and social-scientific understanding of platformisation. Having accomplished that, we now move to the second part: a discussion of possible developments and wide-open lines of inquiry from a distinctively educational perspective. We have identified three relationships that, for us, are emerging as key problematics for the next few years: platformisation and learning, platformisation and educational justice, and platformisation and democratic education.

**Towards a Research Agenda—Part 1: Platformisation and Learning**

How do people learn within and across digital platforms? This question has been mostly tangential in critical examinations of platformed infrastructures in education. The broad consensus in critical circles is that traditional forms of labour-intensive and human-centred pedagogy are being replaced by reductionist and efficiency-driven paradigms that rely heavily on surveillance and quantification. Williamson, for instance, argued that platforms have introduced forms of pseudo-theory whereby learning is redefined around the dictates of commensurability and inductivist discovery. These pseudo-theories conflate the languages of learning science and computer science to reconfigure learning according to a distinctive epistemology whereby "data can reveal insights that previous theories have failed to explain" (Williamson, 2017, p. 119). Williamson's position is emblematic of a broad critical orientation (shared by who writes) which has had the unintended consequence of leaving all affirmative accounts of platformed learning to hybrid corporate-academic discourses (e.g., learning analytics and AI in Education or AIED), which assert, unchallenged, empirical and evidence-based authoritativeness on this matter. Can some of that more affirmative (and empirical) dimension of learning be reclaimed, without compromising on the critical and political sensibilities which have served us so well? We believe that this question is well worth asking and may indeed open interesting lines of inquiry. After all, platformisation can create issues, but it does not always lead to a predetermined outcome, and while governance through surveillance and automation can certainly be oppressive, there is still some unpredictability to it. It is possible to resist or otherwise exercise subtle forms of non-compliance (Selwyn & Pangrazio, 2018), which could result in more adaptable and agentic scenarios. A possible working thesis might be that the platform logics configure their own distinctive space-time—a "topological" system overlayed on the pre-existing arrangements of schooling (Decuypere, 2021). As teachers, students, parents and other stakeholders navigate this topological system, they learn to mediate between the requirements of the infrastructure and the human drive to "make a home". The anthropological literature offers a promising point of departure to explore learning within and across platformed topologies. Here, learning is understood as participation and belonging in urban infrastructures: a "heterogenous

engineering that demands a relational materialism" (McFarlane, 2011, p. 18). This means that learning involves more than just acquiring formal knowledge and skills; it also involves the political and experiential occupation of geographical and symbolic space: learning to dwell (Ingold, 2022) . From this broader perspective, learning can be seen as a dynamic assembling of various resources, materials, histories, and forms of knowledge. Together, these features form a generative spatial grammar that reveals the experiences and struggles involved in creating modern life - including the process of learning to coexist with platformed infrastructures, peacefully or in conflict.

**Towards a Research Agenda—Part 2: Platformisation and Justice (including Environmental Justice)**

Another important area of scholarship is focused on how education platforms increase injustice. We take justice to mean the right to be treated impartially, properly, reasonably and fairly, not only by the law, but also through various institutions and processes in society. Prior to the rise of platforms in education, scholars had already noted how education systems can increase inequality in society (Ball, 2016; Blackmore, 2006). Extending on this, researchers in education are becoming increasingly focused on exploring how education platforms intensify injustice through issues of algorithmic bias, hyper-individualisation, environmental degradation and the westernisation of education infrastructures. We identify three broad areas of concern for platformisation and justice, including: social justice; environmental justice and decolonisation. The overarching goal of this scholarship is a deliberate attempt to move beyond seeing platforms and platformisation as an individual problem and responsibility. This is quite distinct from a rights-oriented approach which focuses on individual needs with scant regard for how individual choices impact on the collective (Blackmore, 2006). Under the concept of "justice", platforms and edtech in general are framed as a collective concern connected to broader, long-standing patterns of injustice (Hintz et al., 2019; Perrotta, 2023).

In recent years, and with rapid increases in platform use during remote schooling, the hidden implications of using education platforms have been brought to light. Perhaps the most prominent work on this topic was a report by the Human Rights Watch (2022), which highlighted the extent of tracking and profiling of children and young people taking place through education platforms. In the report, Human Rights Watch found that 132 products or 80% were found to have tracking technologies embedded that were built by Google. Sixty-three (63) Android apps were found to have at least one embedded Google Software Development Kits (SDKs) giving the company the ability to access children's personal data. Not only is this a breach of children and young people's digital rights but tracking and profiling ultimately leads to categorisation of children and young people, which shapes the opportunities (and challenges) that are made available to them. In this way, platforms are contributing to unfair and unequal education outcomes in which some communities are more vulnerable than others.

These issues are not just limited to platforms made by big commercial tech companies, more local platforms are also implicated in these issues. For example, a platform used by the Queensland Department of Education, OneSchool, used categories and sorting that led to unfair inferences being made about Indigenous students (Clutterbuck et al., 2023). Similarly, Lu and colleagues (2021)found that ClassDojo resulted in targeted manifestations of existing biases around race and ethnicity, dis/abilities, gender and past behaviour of students by teachers. Algorithmic bias has been researched in a variety of contexts like social welfare, policing, the justice system and health (Benjamin, 2019; Eubanks, 2018; Noble, 2018). However, within education systems and schools there has been insufficient assessment of algorithmic biases and their outcomes.

Another focus of this research is addressing the environmental impact of using education platforms. The development of digital infrastructures in education relies increasingly on engineering "openings" for the seamless creation of big data sets and use of predictive infrastructures. These infrastructures bleed into other systems and contexts and, eventually extend their ramifications into the "full stack" of the natural environment with its increasingly depleted resources (Crawford & Joler, 2018; Parikka, 2015). Some areas and populations of the world are affected more than others. For example, the mining of cobalt, an essential mineral in the production of rechargeable batteries, has serious environmental and social impacts in places like the Democratic Republic of Congo, where children as young as six years old work in dirty and dangerous artisanal mines (Faber et al., 2017). In fact, many education researchers now argue there is a need to move beyond the idea of "sustainability" as any notion of sustaining current practices would continue to wreak social and environmental havoc (Facer & Selwyn, 2021; Macgilchrist, 2021). This has led to the digital degrowth and rewilding movements, which call for a radical rethink of how we are using educational technologies. Rather than edtech being seen as a solution, it is seen as part of the problem. Reusing, recycling and considering more ethical and community designed edtech is a start on the road to environmental justice, but it also calls for a rethink of the hyper-individualised and competitive nature of the education system that leads to such problematic edtech consumption and use (Selwyn, 2023).

A final strand of research falling under the umbrella of platforms and justice is focused on decolonising edtech to counter the westernisation of education systems via digital infrastructures. This is the least developed of the three areas discussed but is gathering attention given the recognition of the importance and value of indigenous knowledges, theories and philosophical traditions (Treré et al., 2022). In the more hopeful accounts of education platforms in the Global South[1], platforms are described as enabling access to knowledge and opportunities, however, more critical accounts draw on colonial theory arguing that "technology is changing what we know, as well as how we come to know it" (Adam, 2019, p. 371) and this leads to the intensification of epistemic injustices. This is particularly evident with open educational resources (OER) like MOOCs which assume that education science is universal (Adam, 2019). While platforms may appear to provide some quick and easy solutions to longstanding issues in education, they have an array of hidden consequences that are only just coming to light. It is important that schools and researchers investigate and act on these issues to avoid increasing the marginalisation of students and teachers.

## Towards a Research Agenda—Part 3: Platformed Education and Democracy

As a reaction to the social pervasiveness of datafication and platformed logics, a broad consensus has emerged: platformisation should be more "democratic" and responsive to the needs and sensibilities of our diverse and multicultural societies (e.g., UNESCO, 2022). In most cases, such consensus translates into an emphasis on participatory approaches, which indeed have become commonplace in many techno-scientific arenas over the past 30 years (e.g., Grudin & Pruitt, 2002; Muller & Kuhn, 1993). These approaches range from deliberative consultations to encourage the adoption of disruptive innovations, as long as certain ethical criteria are met, to more political co-design paradigms which challenge normative assumptions and pursue social change (Dunne & Raby, 2013). The latter are gaining traction in the critical study of platforms and algorithms, and have informed radical forms of collectivised design that foreground the interests of historically marginalised groups (Ahmed & Irani, 2020; Costanza-Chock, 2020). On the one hand, this discourse

[1] We acknowledge the problematic and imprecise nature of this term given that some countries in the Global South, such as Australia, are not typically or entirely 'third world' or developing. However, it is considered less hierarchical and patronising than other terms such as 'developing' and 'marginalised'.

of "digital democratisation" reflects a broad progressive shift in the relationship between science, technology and society, away from the ivory tower of academia and the secrecy of corporate research and development (R&D) labs and towards more transparent engagement with communities and institutions; on the other, it can be viewed more sociologically as the rise of reflexive forms of social participation in which the privileged status of scientific rank has weakened, to make way for epistemological negotiations in local interpretative communities (Harvey, 2020).

A central element in this more sociological perspective is the notion of risk—real or imagined—associated with science and technology (Beck et al., 1992). Indeed, the high profile techno-scientific controversies of the late 20th century (often caused by actual disasters like Sellafield and the AIDS pandemic in the 1980s), fuelled a discourse of risk and harm that originated in specific groups and local communities directly or indirectly affected, and subsequently entered the realm of public opinion. The result was a lively democratic debate about the governance of science and technology—a debate which, as noted by Birch and colleagues (2020), reflects a familiar tension between pro-market principles vs. market-critical ones, that is, between different philosophical interpretations of how a liberal and social democracy should be organised (e.g., Jonas, 1985; Polanyi, 2018). In Europe, for example, it shaped the responsible research and innovation (RRI) policy theme, which was concerned with the injection of democratic values into science and technology, chiefly through the promotion of social inclusion, gender representation and the shared responsibility for environmental risks. A similar development was the rise of "open innovation", which encouraged the involvement of multiple stakeholders to overcome the arbitrary restrictions that intellectual property rights impose on the collective utility of science and technology (Chesbrough, 2003).

A central tenet in these accounts of technological democratisation is that collective consciousness arises from the uncertain—potentially harmful—nature of market-driven progress, which leads local communities and various interested parties to associate, campaign and agitate around real or probable "negative externalities", that is, the indirect bad outcomes of technological pervasiveness. One of the most accomplished analyses of the intersections between democracy and techno-science has been offered by Callon, Lescoumes and Barthes through the notion of technical democracy (Callon et al., 2011). Technical democracy is a loose framework for the constitution of "hybrid forums" involving experts and laypeople, who engage in a range of interactions where uncertainty and risks become objects of a dialogic negotiation, which in turn does not target conflict resolution and acceptance, but instead the generative exploration of identities and of "possible states of the world" (p. 20). Crucially, this process of democratic mobilisation is framed as a form of "precautionary" inquiry rather than a reactive response founded on mistrust, which may lead to immobility.

Current discussions in the field of critical platform studies in education are showing a strong interest in technical democracy as a paradigm for increasing public engagement and ethics (Thompson et al., 2022). To a certain degree, these discussions revolve around the implicit type of democratic participation to embrace: a pragmatic one that, while open and critical still operates within the boundaries of deliberative consensus, or a more radically pluralistic position that emphasises antagonism, dissent and the formulation of stringent criteria to identify risks and harms (Holloway et al., 2022). It is not this paper's goal to analyse the differences and overlaps between these positions. Suffice it to say that these contributions are, for us, a clear sign of sophistication in the scholarly discourse around the role of platformed infrastructures in education.

However, to progress further this line of inquiry must confront empirical and indeed democratic challenges which have no easy resolution. For example, the notion of "dialogically negotiated risk" —which as noted earlier has been a key factor in the recent history of techno-scientific democratisation—does not easily apply to platformisation. In the realm of algorithmic

personalisation and invisible datafied surveillance, risk is arguably less conspicuous than in other sociotechnical arenas, and in fact it is often obscured by utilitarian considerations where the efficiencies and benefits that materialise for most mainstream users outweigh the harms experienced by underserved minorities. Despite a growing body of literature highlighting the harms of algorithmic profiling, especially in terms of gender-based inequalities, symbolic violence and racialisation (e.g., Dixon-Román et al., 2019; Eubanks, 2018; Noble, 2018), these harms are still difficult to localise in specific sociocultural and geographic contexts, like for instance when lives in a community are threatened by corporate negligence, or when an entire category of human beings is denied status and representation in relation to existential health risks (e.g., AIDS in the gay community in the 1980s). Moreover, discussions about the democratic design and utilisation of platforms-as-infrastructures must take into account the fragmented nature of contemporary educational governance (Gulson & Sellar, 2019; Williamson, 2016), where progressive digitisation and various attempts at establishing quasi-market conditions have resulted in networked and distributed arrangements comprising state and non-state national actors, as well as cross-national organisations and global corporations. It seems clear that these actors should also be considered as interested parties in the dynamics of digital democratisation that we describe here, either as dialogic partners or antagonists.

An emerging area of interest which is also relevant to this theme is platform cooperativism. While not yet specific to education, the platform cooperativism movement[2] provides a grassroots alternative to the privately owned platforms that have come to dominate many spheres of civic life. Cooperative platforms are based on democratic decision-making and shared ownership, promoting fairness and shared governance. To date the movement has covered a range of initiatives involving agriculture and farming, through to the cooperative university, and could provide the inspiration and resourcing to envision a cooperative education platform.

## Discussion and Conclusion

In this article, we provided a partial synthesis of relevant literature on critical platform studies, acknowledging a constellation of emerging concerns and interests in critical education research, where many (us included) are building upon and extending insights from disciplinary areas which, while influential, have not paid sufficient attention to education and its complexities: media studies, infrastructure studies, critical sociology of technology and science and technology studies (STS). We summarised these concerns and interests as three problematics, which we propose as areas for further research: the relationship between platformisation and learning, the relationship between platformisation and justice, and the relationship between platformisation and democracy.

We believe that investigating these relationships is urgent, as education represents a testbed for platformisation and one of the most sensitive application contexts for disruptive digital innovations more broadly—sensitive because harms and "negative externalities" can be long-lasting and divergent in their ramifications: education is by its very nature projected in the future, despite the unfair accusation of conservative immobility often made against it. At the same time, we believe that this urgency should translate in more decisive support (i.e., funding), which will enable larger empirical studies and comparisons that examine longitudinally and relationally the problematics we just outlined.

This step-change in the scope of research will require a robust examination of the methodological apparatus at our disposal. It was not possible, for reasons of scope, to explore the methodological aspects associated with the critical study of platformed infrastructures in education.

[2] https://platform.coop/

The work carried out so far is mostly qualitative, often benefiting from a relational perspective interested in overflows, intersections and spin-offs: a typically sociological "optic" that retraces relations between local phenomena and broader dynamics and problems: political economies, environmental impacts, and the reproduction of structural inequalities. This apparatus is fit for purpose but can certainly be extended, and we hope that the three relationships we discussed in this paper will also provide some impetus for further methodological innovation. We conclude the article with three suggestions for a future research agenda that accounts for the tensions, compromises and hidden dimensions involved in the design and use of educational platforms.

1. **Research that moves beyond the "platform gaze".** A key feature of platforms is the ways in which they bring together multiple stakeholders – developers, education bureaucrats, teachers, students and families. It is essential that these various experiences of the platform are investigated. There has been a tendency to research platforms from a distance, almost as if from above, to investigate the terms and conditions, the design and interface. While this is important work, it is also essential to investigate how platforms shape teaching and learning as well as the ways in which learner identities are constructed. This means talking to all stakeholders to investigate their first-hand experiences, understandings and concerns in relation to platforms.
2. **Exploring new ways to research platforms.** Our analysis has highlighted that there is an array of hidden consequences to using digital platforms. While current methods steeped in the qualitative tradition are clearly important in investigating user experiences and to a degree platform design, clearly, we need to know more about the "back end". Researchers are now starting to explore a range of born digital methods, which are helping to show things which had until recently been hidden. For example, the RED project[3], an international investigation into digital inequality perpetuated by platforms, is using "packet sniffing" to reveal data traces and journey after generation and collection.
3. **Reimagining platform design and use.** Researchers also need to investigate ways to bring different stakeholders together to improve many of the issues and tensions outlined in this article. Clearly, this is not easy work. However, until edtech designers fully engage with educational bureaucrats and teachers to understand what constitutes best practice in regard to teaching, learning and administrating, the same problems will continue to emerge. Until now stakeholders have remained "siloed" from each other, but there is a need to break down these barriers and understand the array of perspectives and values so that students—arguably the most important stakeholder in the equation—are served best.

While we have discussed an array of issues and challenges associated with education platforms, they are clearly here to stay. However, this does not mean that the education community must accept digital platforms without question, as if the ongoing commercialisation of our education systems is a foregone conclusion. With this in mind, we believe education researchers can play a vital role in changing things for the better. They can investigate, communicate, and act upon the experiences and issues with platform use in schools to people who have the power to initiate change. All members of the education community have a role to play as enacting change calls for a multidisciplinary, multistakeholder approach.

[3] See: https://www.edu-digitalinequality.org/

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