

This is a pre print version of the following article:

Laws of Edu-Automation? Three Different Approaches to Deal with Processes of Automation and Artificial Intelligence in the Field of Education / Decuypere, M.; Alirezabeigi, S.; Grimaldi, E.; Hartong, S.; Kiesewetter, S.; Landri, P.; Masschelein, J.; Piattoeva, N.; Ratner, H.; Simons, M.; Vanermen, L.; VANDEN BROECK, Pieter. - In: POSTDIGITAL SCIENCE AND EDUCATION. - ISSN 2524-485X. - 5:1(2023), pp. 44-55. [10.1007/s42438-022-00360-x]

Terms of use:

The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. For all terms of use and more information see the publisher's website.

13/01/2025 18:14

(Article begins on next page)

Laws of Edu-Automation?

Three Different Approaches to Deal With Processes of Automation and Artificial Intelligence in the Field of Education

In April 2022, 12 scholars gathered in Leuven (Belgium) for an international symposium. All participants had a background in educational research, and all approached current evolutions in the educational field through a critical lens – be that lens informed through philosophical, sociological, or other related disciplines. The aim of the symposium was to collectively outline ‘laws of edu-automation’, an idea that was inspired by Pasquale’s recently published (2020) *new laws of robotics*. Pasquale’s *new laws of robotics* are a reworking and further elaboration of the *laws of robotics* originally advanced by science fiction writer Isaac Asimov (1942); a set of rules to which all future autonomous machines were expected to abide. Asimov’s rules command:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

In his book, Pasquale – a Professor of Law – clearly shows how these original *laws of robotics* are rife with ambiguities and problems when one starts thinking about their practical implementation, especially in legal terms. For that reason, and in response to the growing adoption of artificial intelligence (AI) in all spheres of society, Pasquale advanced the *new laws of robotics*:

1. Robotic systems and AI should complement professionals, not replace them.
2. Robotic systems and AI should not counterfeit humanity.
3. Robotic systems and AI should not intensify zero-sum arms races.
4. Robotic systems and AI must always indicate the identity of their creator(s), controller(s), and owner(s).

In an age of increased advances in automation and AI, Pasquale’s new laws of robotics are intended to operate as *anticipatory ethics* that outline not only which technologies can/should be created (and how then, precisely); they equally, crucially, shape the legal actions that ought to be undertaken when robotic systems enter society (Pasquale 2020). The education sector is no exception in this regard, where processes of automation and AI increasingly shape and reconfigure educational practices and make them generally more ‘machine like’. However, we equally see that technologies are always differentially adopted in education, and that concrete usage of techniques of automation and AI in education is always highly context dependent and human shaped (Perrotta et al. 2021; Selwyn 2019). As Zawacki-Richter and colleagues (2019: 1) state, this usage is at present still relatively modest in contemporary educational practices,

because “it is still unclear for educators how to make pedagogical advantage of [AI] on a broader scale, and how it can actually impact meaningfully on teaching and learning” (see equally Chen et al. 2020). In this respect, it is important to distinguish between ‘AI’ on the one hand and ‘automation’ on the other since not all automation practices are necessarily AI induced (cf. Perrotta In Press). Indeed, automating activities is something that has always been present in the educational sector (e.g., the automating of time and lesson activities through the school bell; the automating of movement and coordinated bodily activities in PE classes; etc.), for better or for worse.

In sum, then, even though the (new) laws of robotics have been hugely influential and have had important ramifications for thinking about the adoption of AI and practices of automation in society, both sets of laws are designed and framed from a legal and juridical perspective – after all, they are formulated as *laws*. The main idea behind the symposium was to advance laws that did not necessarily have a legal or juridical point of departure but primarily originated from ‘within’ the field of education, that is, constructed *by* and *for* educators, and that would hence be specifically tailored to the educational sector. The symposium started from the contention that recent evolutions of automation in education (such as learning and classroom analytics; eye tracking; the proctoring and grading of examinations; the increasing deployment of facial recognition software; and so on) might require new frameworks that can assist in both developing *and* critically thinking about new automated technologies and their deployment in the educational field, and this beyond contemporary hypes in the field that research automation and/or AIED (AI in or for education) (Nemorin et al. 2022). This contention originated from voices within the field that have posited that there is a huge lack of critical reflection on the challenges and risks of AIED; that the field has no strong connection to pedagogic perspectives and ideas (even though professional expertise and judgement remains a key factor in the successful adoption of AIED); and that the field should more strongly address ethical and privacy concerns (e.g., Baker 2016; Chen et al. 2020; Zawacki-Richter et al. 2019; Zhang & Aslan 2021).

In attempting to approach automation from ‘within’ the educational field, it was the explicit intention of the symposium to embrace a *normative positioning* towards these recent evolutions: rather than developing reflections on how to instrumentally ‘better’ future developments of automation in education, or merely critiquing the field of AIED for having potentially harmful effects, it attempted to pose the normative question *what education should be expecting or demanding of automation* (Selwyn et al. 2021). In that regard, the term *edu-automation* seeks to propose ways of conceptualizing and imagining automation as an educational endeavor; that is, not (only) as a purely technical-factual matter that is subsequently translated into educational practice, but equally as a matter of educational concern.

To prepare and structure the making of collective laws, each participant of the symposium was asked to draft one law of edu-automation in advance, accompanied by a short elucidation that described the necessity and importance of the law. Shortly after this preparatory exercise was emailed to all participants, it became clear that formulating a law of edu-automation was not an easy exercise at all. Almost all participants let the organizers know how difficult they found the

exercise. In addition, some of the participants expressed a clear discomfort in drafting a law, and more particularly in having to take up a normative stance. The individual laws were intended to serve as input for collective discussions during the symposium: participants who had constructed laws with a similar theme, were grouped together and were given the task to merge their different individual laws (and the attached text) into one. The subgroups were asked to write up their law and an accompanying elucidation according to three principles: write in a *constructive* tone towards the field (and not a dismissive one), in a *nuanced* manner, and in *accessible language* (and not only for an academic audience). The idea was that, at the end of the day, the symposium would result in a set of laws that would be presented in the form of a concise public manifesto.

However, this is not what happened. Constructing laws of edu-automation seemed a task too daunting and too complex for a one-day symposium. From the beginning of the day, discussions on automation or automated practices as well-established educational practices emerged, clearly emphasizing the importance of asking whether edu-automation constitutes something genuinely new or is something that has always, to a greater or lesser extent, been present in education. In that respect, our discussions showed that the phenomenon of automation in education is not so easily graspable, and furthermore, the very concept of ‘edu-automation’ points to many different things at once. In other words, the symposium made clear that we cannot approach edu-automation in an essentializing manner, and that we rather need a variety of approaches and viewpoints that tackle the challenge of edu-automation from different angles. Moreover, different approaches to taking a normative stance regarding automation appeared in the group discussions. This rendered the work of harmoniously outlining collective laws extremely challenging. In addition to these analytical complexities, the short amount of time might not have worked as productively as envisaged. Next hereto, law-making is perhaps equally a process that requires a particular set of (juridical and legal) knowledge and abilities to be taken up by educational researchers, be it a group of authors or an individual writer.

Even though the symposium did not meet its expected goal of drafting a concise manifesto, it did succeed in unfolding three different approaches to dealing with processes of automation in the field of education, and associated evolutions in the field of AIED. In what follows, we present these three approaches in the form of textual accounts narrating the collective thinking that took place in each group. The accounts show and summarize the discussions that were held in each group, and equally display various ways of approaching edu-automation from a normative point of view. Perhaps needless to say, since we were all working in one specific group only, the different approaches developed in each group are not necessarily collectively endorsed by all the authors of this article. The variety and substantial differences between the three accounts clearly show that edu-automation cannot be approached single sided, and that in order to come to a profound understanding of this phenomenon, we need to deploy a variety of theoretical, educational and normative standpoints and positions.

Automated technologies in education should come with Pedagogical Terms and Conditions

As soon as all participants had dispersed across the seminar room, we read, discussed, and wrote about edu-automation in an attempt to formulate a law that could express a normative position collectively. Initially, this seemed a feasible goal. One of our agreed-upon positions revolved around the statement (or claim) that automation does not – and perhaps, should not – simply replace professions, but instead alters and/or complements them. Whether a chatbot assists educators in performing a range of administrative tasks by responding to students’ frequently asked questions, or artificial intelligence helps educators monitor student engagement on a digital platform by, for instance, tracking the “time on task”: professionals always, necessarily, find themselves relating to these technologies, the organizations that design them, and the educational and pedagogical ideas they embody (Baker 2016; Perrotta In Press).

For that reason, the relations between technology, user, producer, and educational practice became a key topic in our discussion and initial attempts to formulate a law. In addition, we discussed the lack of transparency that concerns the labor occurring ‘behind the scenes’, and that often results in difficulties when one aims to adopt practices of edu-automation. For instance, the difficulty to articulate which educational and pedagogical values such technologies should uphold precisely or the difficulty to articulate what practitioners would prefer to see inscribed in the technology they are choosing to use. More specifically, first, the *transparency and visibility* of the human and technical work preceding and making edu-automation became the focus, and this out of a concern for *who* and *what* is (allowed to get) involved in the design process. A second important focus point was the need for a form of *collective responsabilization* in the field of edu-automation, where cognitive/affective ‘spaces of translation’ are established that create a meaningful (and responsabilizing) encounter between the different languages of design, legal regulation, education, and pedagogy (cf. Callon 1984).

This group discussion was heavily inspired by the individually written laws. It soon became clear that all the individually drafted laws argued that designing and introducing automation in education is not a neutral endeavor and, therefore, should be made visible and open to reconfiguration (cf. Zawacki-Richter et al. 2019). What was at stake in all the individual laws, was the possibility for those actors involved in education (e.g., educators, students, school leaders, ICT coordinators, ...) to discuss what *educational* and *pedagogical* values are and could be inscribed into automated technologies, and how these technologies should enter an educational setting (or not). Somewhat dissatisfied with how ‘terms and conditions’ traditionally operate on websites and platforms – typically presenting contractual, juridically-informed texts that users are expected to merely accept or decline – we sought an alternative way of relating to automated technologies. More specifically, we wanted to think away from ‘terms and conditions’ that risk rendering pedagogical dimensions of edu-automation irrelevant and unquestionable. Terms and conditions do not always help to understand the precise relation that *educational* professionals and students are entering in (e.g., whether a technology of edu-automation is developed with behaviorist or constructivist pedagogies and learning theories in mind) and, consequently, risk discouraging producers’ and users’ reflective thinking about both the possibilities and the constraints that practices of edu-automation potentially open for, and at the same time also impose on, education.

Considering our initial stress on transparency and responsabilization, as well as our conviction that the introduction of automated technologies should be open to potential modification and reconfiguration, we began to discuss and formulate the idea of ‘*Pedagogical Terms and Conditions*’ (PTaC) that could offer educational actors a material basis or possible anchor point for ongoing *reflection* on (e.g., to understand what edu-automation means and how it differs from more traditional forms of automation), and the potential *(re)configuration* of, automated technologies (Suchman 2007). The common law was, quite simply, phrased as: “*Automated technologies in education should come with Pedagogical Terms and Conditions*”. The pedagogical alternative to the classic ‘terms and conditions’ was imagined as a way for producers *and* users to enter a more complex decision-making process that would make the design philosophies, pedagogical ideas, adopted learning theories, the inscribed user architecture, etc., of edu-automation more visible, transparent, and hence, prone to potential modification. Such an understanding of *pedagogical* terms and conditions would, we hope, permit more collective responsabilization of the designers of practices of edu-automation. Moreover, the PTaC would allow educational and pedagogical language to take center stage, as opposed to (only) technical and juridical languages that are presently dominating the terms and conditions of automated educational technologies. The group came to an agreement that, with regard to edu-automation, the PTaC should make clear: (a) what is automated; (b) why it is automated; (c) how it is automated; as well as (d) who was/is involved in these processes of automation (e.g., hidden crowdwork). Through this clarification, central moments of pedagogical inscription/modeling should be made visible. Also, and related to that, the PTaC must clarify the (often hidden) teacher and student workload related to the usage of automated educational technologies (e.g., Perrotta In Press). Next to these *content*-related elements, the PTaCs *form* was equally discussed, and it was stipulated that its language must be: (a) accessible, that is, not hidden away but displayed overtly; (b) readable, in the sense that it is understandable by both teachers and students; and (c) educationally meaningful, i.e., addressing teachers and students as being teachers and students, and not as ‘generic’ end users.

Edu-automation should pluralize our interdependencies with contextualized ecological and socialized worlds

There is a tendency in critical education technology research to write from an anthropocentric and atomistic position that keeps the technological and the human apart. This did not make much sense to us, particularly from a sociomaterial and Science and Technology Studies (STS) research standing that emphasises relationality and heterogeneity. Thereby the world we study is an emergent and relational effect that comes into being through heterogeneous socio-material practices across humans and non-humans (e.g. Law and Singleton 2013; Gorur, Hamilton, Lundahl, & Sjödin 2019). In this understanding, ‘nature,’ ‘technology,’ ‘education’ or ‘society’ do not exist in pure forms as separate domains, but are always already hybrid; that is, they are effects of materially diverse and variously entangled practices. Moreover, understanding and accepting the relational and processual character of the world means that we can try to affirm and amplify some practices for some effects – the effects that we deem ethically and politically desirable.

The anthropocentric and atomistic view of life characteristic of Western modernity has led to a separation of the human and the non-human. This binary division has in turn impacted our knowledge practices, including some widely accepted critiques about the consequences of the digitalization and automation for education. For instance, one of the most salient critiques has focused on automation leading to the replacement of core educational values and warm human relationships with cold, quantitative, rationalized, and computer-coded optimization (Selwyn et al. 2021). In this critique, first, we see a prioritization of humans over non-humans – the damaging effects of technologies on humans form a primary matter of concern. Second, technology and education are held apart; that is, the logic of technology is seen as distinct from – even opposite to – the logic of education, and the only outcome of their association is a complete takeover. Instead of questioning the validity of such observations, we emphasize how critical stances emerge from and reflect specific onto-epistemological assumptions that consequently enable some forms of critique – and thus alternatives – while precluding other. Our ensuing critique of automation is embedded in relational thinking. Our proposed law consequently seeks to amplify different *forms of relationality*: interdependencies among humans and between humans and the more-than-human world.

The school provides ample examples of relationality that can be and often are amplified. Ideally, the school is premised on the assumption that who you can become and what you can learn is not determined by your past and background and is not (pre)defined. School starts from the assertion of pedagogical equality: passing through the school gate, you are no longer a son or a daughter, or a citizen, but a pupil/student/écolier like all others. Moreover, school equally offers students ‘time for the world’, (Arendt 1960/2006) where something(s) can start to really matter (becomes matter) and give a hold, precisely in times where there is very little that holds and attaches, i.e., ‘forms’ us. This assumes and enables both detachments and re-attachments: the school offers you the world in an artificial way, in order for you to connect to it – and become a participant in it – in new ways. What matters to us is that school is not just an occasional environment of learning whereby learning could be defined, de/pre/scribed, and analyzed (and then automated) isolated or independent from the place (space-time-situation-atmosphere) where it happens. *Scholastic* learning initiates new attachments (to a place, to a time, to a situated and offered matter), and is actively enhancing (inter)dependencies between others and matter.

Thinking particularly with the term of *attachment*, we wanted to equally amplify planetary attachments that have been largely destroyed by modern societies’ anthropocentrism and technological fetishism. By worshiping immanent technological progress, they disregard our dependence on ecosystems and nourish extractive practices that continue to damage the living planet. Kaminska (2019) offers a telling comparison, arguing that the ICT sector is already using 50 percent more energy than the entire global aviation sector, though global aviation is frequently seen as a driver of environmental degradation. The environmental costs arise from the immediate usage of devices and software, but also from the short- and long-term effects of mining and waste storage (see, for example, Selwyn 2022). Moreover, as automation expands to new domains and increases its computational powers, its impact on the environment is likely to increase.

Among our group, however, this focus also raised questions about whether the school is the right context to make such demands. Or rather, are there not too many demands made on education already – on the human and societal attachments and interdependencies that education must nurture? We ended up agreeing that planetary concerns and actions are easily left unattended precisely because they seem to belong everywhere and nowhere in particular. That is why we proposed that edu-automation should challenge the understanding of ecosystems as a passive background of human-made progress and as an extractable and controllable resource. Instead, it should bring into view the critical reliance of technologies on ecosystems and the consequences of technologies for ecosystems (Edwards 2003). Ecosystems are the vital infrastructures on which other infrastructures and technologies depend, for instance, on the metabolic connections between technology and nature through fuel and waste (Edwards 2003: 221; also Haff 2014). We suggest that automation, when developed and deployed, should intensify these attachments in addition to weighing the planetary impacts of automation against potential benefits.

Edu-automation cannot achieve all this alone. Rather, our vision of the ‘good school’ emerges through mixtures of automated and crafted multi-sensorial attachments, carefully orchestrating sustainable relationships of human-technology and ‘more-than-human species’ for the co-habitation of our planet. In these arrangements, technologies of edu-automation become entities that interact with education and its humans, both transforming and extending their ‘human’ and planetary capacities, whilst the technologies themselves are also subject to how humans take them up in educational practices. We reference here feminist historian of science Donna Haraway’s metaphor of ‘the cyborg’ as a hybrid arrangement of bodily and machinic functions, various technical, non-human artifacts, concepts, and interests (Haraway 1991; Haraway 1995: 175-194). The cyborg suggests what it could be like to make connections without assumptions of comparability: where each is a realization or extension of the capacity of the other, meaning the relation would be of neither equality nor encompassment. It is ‘prosthetic,’ as between a person and a tool. Compatibility without comparability: each extends the other, but only from the other’s position. What the extensions yield are different capacities. In this view, there is no subject-object relation between a person and a tool, only an expanded or realized capability (Strathern 2004: 38).

In order to further create the possibilities of edu-automation, we should constitute and recognize commonalities between all automatons

The discussion of the last group started by unpacking the complexities lying in the term ‘automation’, since ‘automation’ does not necessarily need to be understood in digital terms (cf. supra). This insight was especially important in our discussions, since automation can equally potentially bear an *educational* meaning. That is to say, it was argued that the becoming automatic of some tasks through repeating them over and over and over again, frees up the time and space, and consequently allows for new possibilities to emerge. For instance, a student can work with complex mathematics exercises as a result of being able to automatically apply

multiplication tables. Other examples include moments when writing, walking or driving a car become automatic: all of these automated activities free up time and space, and thus allow for other things to be done at the same time instead. Following this line of thought, through an educational lens, ‘automation’ can have an emancipatory component as well. From this broad point of departure, we traced back the etymology of the term ‘automation’ as attributing a ‘self-moving and self-acting’ character to entities, which we considered as the defining element of the term (Stacey & Suchman 2012). The discussion subsequently moved from the Greek etymology of automation and its origins in Greek mythologies, to its reappearance in the industrial age. In this period, automated systems and machines in factories gained a level of complexity that resulted in the ‘individuation’ of the machine through an acquired level of autonomy (Hui 2018). In the context of Fordist factories, this implied a disconnection between artisans and technical knowledge about the functioning of the machine (i.e., how the machine works). Instead of knowing the inner processes of machines, artisans were turned into mere ‘end users’ who only ‘worked with’ the machine. This, Hui (2018) argues, led to a double enslavement: first, the enslavement of machines (i.e., for the sake of efficiency), and, second, the enslavement of humans (i.e., for the sake of economic profit). Some have argued that these situations are still being more and more intensified (see, for instance, Cave et al. 2020, for a discussion about the enslavement of machines). Equally, even though the idea of automation is promoted within the rhetoric of freeing labour time for humans, these technologies at the same time immediately redefine what these new possibilities of the ‘freed-up’ time could be (see Perrotta In Press). In sum, in view of this contrasting opposition between emancipation and enslavement, we concluded that our law should aim to outline the conditions that make the emancipation of machines, humans, and all beings, possible and hence avoid their enslavement.

Three types of relations between automation and education can be identified by bringing the enslaving and emancipatory modes of automation to the educational context. The first type is the automation *of* education, which entails bringing technical solutions into educational practices with the aim of rendering them more efficient and seamless (e.g., automatic feedback and grading, automatic enrolling of students). The second type is automation *through* education. This type seeks to use education – and learning in general – as a component of developing and training automated systems, such as the training of algorithms. Both types can ultimately lead to either a sort of enslavement (when human and/or machine are exploited in service of efficiency and productivity) or instead to a reimagining, to a redefining and, perhaps, redetermining of new possibilities (cf. Serres 2015). The third type, which we denote as *educational automation*, precisely refers to these educational practices in which automation gains an emancipatory power to free up minds and hands, for thinking and imagining new possibilities.

Following the aim of creating space and time for educational automation, we focused on the necessary preconditions that allow for the emancipation of humans and automated systems, all at the same time recognizing their interdependencies as well as their differences (see equally previous section). The necessary step for doing so, we reasoned, is to disassemble the division between non-human automated systems, humans and even animals and vegetation, by finding a common element between them. We found this common element between automated

machines, humans, animals, and even vegetation, in the fact that they can all be considered as '*self-acting/moving*' entities. To focus on this common element of 'self-acting' and 'self-moving', we addressed all these entities as 'automatons'. To call all these entities automatons, brings the focus on what all these entities have in common, and how we can then find ways to live together in emancipatory and sustainable ways.

As such, before thinking about specific legislation for a particular 'we', and organizing the living together of this 'we', it is important to 'constitute' this heterogeneous collective of automatons and to endow its members with dedicated fundamental rights. Suppose we should learn to live with algorithmic entities. In that case, the first principle is to recognise the individuality of automatons, which means acknowledging the existence of different types of automatons that all require specific forms of *care*, depending on which type of automaton they are precisely. Also, and similar to other streams of thought that seek to give legal rights to natural entities such as forests and rivers (e.g., Stone 2012), we argued that automatons should have a voice or a *spokesperson* on their behalf. Such spokespersons could gather into committees of ethical conduct that seek to avoid the exploitation and domestication of automatons by, for instance, reducing them to means for specific purposes. Last but not least, there should be *schools of automation*: 'outside' time and space for automatons, in which one can critically study, investigate, and reflect on automation.

Conclusion and outlook

What could be a good set of laws that guide the ongoing development of evolutions in the field of (AIED and) edu-automation? Our symposium could not manage to arrive at a definite conclusion. However, our exercise in collective thinking has shown some of the different features that tie education and automation together. In this respect, it can be argued that each of the three abovementioned approaches put forward a way in which the connection (the hyphen) between *edu-* and *-automation* can be thought. The first group focused on the preceding, often invisible, negotiations of values that emerge and exist when automation meets education, as these values commonly get "snowed under" by seemingly technical decisions and operationalizations, for instance in the field of AI. The idea of 'pedagogical terms and conditions' is a possible pathway to make these negotiations more tangible and visible for educators, and open for collective and participatory discussion between designers, developers, and educationalists. The second group considered this hyphen by approaching education from an inherently normative perspective on the 'good school'. In this case, the function of the hyphen should be in making the planetary (re-)attachments of this junction visible, instead of concealing them. Lastly, the third group worked with the preconditions of making the hyphen of edu-automation possible. Their approach highlights that making edu-automation possible requires creating an inclusive vocabulary in which each entity (human and other-than human) is given fundamental rights. It is only through this engagement that we can get beyond perceiving automation as being a merely neutral instrument in, or conversely, as being an inherent danger to educational practices, and instead get involved in alternative ideas.

In all these cases, the symposium engaged not only with the question of “how could this be otherwise” (Selwyn et al. 2022) but equally with how it, perhaps, *should* be otherwise. This does not mean that the ideas presented here should act as a panacea for dealing with edu-automation in the future. Rather, we hope that this contribution can work as a starting point in dealing with the many normativities surrounding the issue of edu-automation. Furthermore, we hope it can inspire further thinking, engaging, and treating edu-automation not only as something that reaches the educational field ‘from outside’ and that can thus only be acted upon in a reactionary manner. Instead, we argued, educational actors should actively engage in imagining, reflecting, and tinkering with auto-automation *from the inside*. This would imply an active avoiding of simple forms of critique and/or unreflexive adoption, but rather a multiplying and pluralizing of different ways in which edu-automation can be engaged with in concrete educational practices.

References

- Arendt, H. (1960/2006). *The Crisis in Culture: Its Social and its Political Significance*. *Between Past and Future* (pp. 194-222). Penguin Press.
- Asimov, I. (1942). Runaround. *Astounding Science Fiction* (March).
- Baker, R. S. (2016). Stupid Tutoring Systems, Intelligent Humans. *International Journal of Artificial Intelligence in Education*, 26(2), 600-614. <http://doi.org/10.1007/s40593-016-0105-0>
- Callon, M. (1984). Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Brieuc Bay. *The Sociological Review*, 32(1_suppl), 196–233. <https://doi.org/10.1111/j.1467-954X.1984.tb00113.x>
- Cave, S., Dihal, K., & Dillon, S. (Eds.). (2020). *AI Narratives: A History of Imaginative Thinking About Intelligent Machines*. Oxford University Press.
- Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and Theory Gaps During the Rise of Artificial Intelligence in Education. *Computers and Education: Artificial Intelligence*, 1, 1-20. <https://doi.org/10.1016/j.caeai.2020.100002>
- Edwards, P. N. (2003). Infrastructure and Modernity: Force, Time and Social Organization in the History of Sociotechnical Systems. In T. J. Misa, P. Brey and A. Feenberg (Eds.), *Modernity and Technology* (pp. 185– 225). The MIT Press.
- Gorur, R., Hamilton, M., Lundahl, C., & Sjödin, E. S. (2019). Politics by Other Means? STS and Research in Education. *Discourse: Studies in the Cultural Politics of Education*, 40(1), 1–15. <https://doi.org/10.1080/01596306.2018.1549700>
- Haff, P. (2014). Humans and Technology in the Anthropocene: Six Rules. *The Anthropocene Review*, 1(2), 126–136. <http://doi.org/10.1177/2053019614530575>
- Haraway, D. (1995). Situated Knowledges: The Science Question in Feminism and the Privilege of the Partial Perspective. In A. Feenberg & A. Hannay (Eds.), *Technology and the Politics of Knowledge* (pp. 175-94). Indiana University Press.
- Haraway, D. (1991). *Simians, Cyborgs and Women: The Reinvention of Nature*. Routledge.
- Hui, Y. (2018). On Automation and Free Time. *Eflux*.
- Kaminska, I. (2019). ‘Just because it’s Digital Doesn’t Mean it’s Green’. Retrieved from <https://ftalphaville.ft.com/2019/03/06/1551886838000/Just-because-it-s-digital-doesn-t-mean-it-s-green/>
- Law, J., & Singleton, V. (2014). ANT, Multiplicity and Policy. *Critical Policy Studies*, 8(4), 379–396. <https://doi.org/10.1080/19460171.2014.957056>
- Nemorin, S., Vlachidis, A., Ayerakwa, H. M., & Andriotis, P. (2022). AI hyped? A Horizon Scan of Discourse on Artificial Intelligence in Education (AIED) and Development. *Learning, Media and Technology*. <https://doi.org/10.1080/17439884.2022.2095568>
- Pasquale, F. (2020). *New Laws of Robotics: Defending Human Expertise in the Age of AI*. The Belknap Press of Harvard University Press.
- Perrotta, C. (In Press). Afterword: Platformed Professional(itie)s and the Ongoing Digital Transformation of Education. *Tertium Comparationis*.
- Perrotta, C., Gulson, K. N., Williamson, B., & Witzemberger, K. (2021). Automation, APIs and the Distributed Labour of Platform Pedagogies in Google Classroom. *Critical Studies in Education*, 62(1), 97-113. <https://doi.org/10.1080/17508487.2020.1855597>
- Selwyn, N. (2019). *Should Robots Replace Teachers? AI and the Future of Education*. Polity.
- Selwyn, N. (2022). *EdTech and Climate Colonialism*. Retrieved from <https://criticaledtech.com/2022/10/02/edtech-and-climate-colonialism/>
- Selwyn, N., Hillman, T., Bergviken Rensfeldt, A., & Perrotta, C. (2021). Digital Technologies and the Automation of Education: Key Questions and Concerns. *Postdigital Science and*

- Education*. <https://doi.org/10.1007/S42438-021-00263-3>
- Serres, M. (2015). *Thumbelina: The Culture and Technology of Millennials*. *Critical Research on Religion*.
- Stacey, J., & Suchman, L. (2012). Animation and Automation: The Liveliness and Labours of Bodies and Machines. *Body and Society*, 18(1), 1-46. <https://doi.org/10.1177/1357034X11431845>
- Stone, C. D. (2017). Should Trees Have Standing?—Toward Legal Rights for Natural Objects. In S. Vanderheiden (Eds.) *Environmental Rights*, (pp. 283-334). Routledge.
- Strathern, M. (2004). *Partial Connections*. Rowman Altamira.
- Suchman, L. (2007). *Human-Machine Reconfigurations*. Cambridge University Press.
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where Are the Educators? *International Journal of Educational Technology in Higher Education*, 16(1), 1-27. <https://doi.org/10.1186/s41239-019-0171-0>
- Zhang, K., & Aslan, A. B. (2021). AI Technologies for Education: Recent Research & Future Directions. *Computers and Education: Artificial Intelligence*, 2, 1-11. <https://doi.org/10.1016/j.caeai.2021.100025>