



Big Data, Black Boxes and Bias:

The Algorithmic Identity and Educational Practice

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Authorship Statement

Throughout my candidature I have published research articles and delivered conference presentations. Both drew directly from my doctoral project and were used to express my ideas in formation, as well as communicate the findings from the research. The publications are listed below, followed by presentations and Doctoral Program Participation.

Publications during enrolment

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- Arantes, J.A. (2020). The servitization of Australian K-12 educational settings. *Postdigital Science and Education*. <https://doi.org/10.1007/s42438-019-00097-0>
- Arantes, J. A. (2019). Equity implications of predictive analytics in K-12 classrooms. *Ubiquitous Learning. An International Journal*, 12(2), 63-84. <https://doi.org/10.18848/1835-9795/CGP/v12i02/63-84>
- Arantes, J. A. (2019). Big data, black boxes and bias: The algorithmic identity and educational practice. In E. Misfeldt, & A. Siebert-Evenstone (Eds.), *First International Conference on Quantitative Ethnography: Conference Proceedings Supplement - Doctoral Consortium* (pp. 63-65). Published at <http://icqe19.epistemicanalytics.org/wp-content/uploads/sites/9/2019/11/ICQE-2019-proceedings-supplement-final2.pdf>
- Arantes, J. A. (2019, 12 August). Ban smartphones in schools. Not because they're disruptive, but because of this [Web blog message]. *Australian Association for Research in Education (AARE): EduResearch Matters*. Published at <https://www.aare.edu.au/blog/?p=4307>.
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- Arantes, J. A. (2019). Big data, black boxes and bias. Poster Presentation at *the 2nd Heidelberg Computational Humanities Summer School (HCH19)*, 15-19 July 2019, Heidelberg, Germany. Abstract Published at <https://docplayer.net/153665749-Summer-school-of-computational-humanities-book-of-abstracts.html>
- Arantes, J. A. (2019). Potential implications of predictive analytics in K-12 education. Presentation at *Twenty-sixth International Conference on Learning: Learning to make a social difference*, 24-26 July 2019, Belfast, Ireland. Abstract published at <https://thelearner.com/assets/downloads/learner/L19FinalProgram.pdf>
- Arantes, J. A. (2019). Algorithmic logics and K-12 pedagogies. Paper presented at the *12th International Conference on e-Learning & Innovative Pedagogies*, 2-3 May 2019 Hobart, Australia. Abstract published at <https://ubi-learn.com/assets/downloads/e-learning/Q19FinalProgram-1.pdf>
- Arantes, J. A. (2019). Provocation, The platformization of education. Presentation at the *Digital Educational Futures Workshop*, 15 February 2019, Melbourne, Australia.
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Abbreviations

AACP	The Apps in Australian Classrooms Project
ACCC	Australian Competition and Consumer Commission
ACEL	The Australian College of Educational Leadership
AHRC	Australian Human Rights Commission
AI	Artificial Intelligence
API	Application Programming Interface
ATSI	Australian and Torres Strait Islander
BETA	(Australia's) Behavioural Economics Team
ENA	Epistemic Network Analysis
HCII	Human-Computer Interaction Institute
HR	Human Resources
HREC	Human Research Ethics Committee
ICT	Information and Communications Technology
LA	Learning Analytics
NAPLAN	The National Assessment Program – Literacy and Numeracy
NSW	New South Wales
OHS	Occupational Health and Safety
PIA	Privacy Impact Assessment
PISA	Programme for International Student Assessment
QLD	Queensland
SA	South Australia
SHEILA	Supporting Higher Education to Integrate Learning Analytic
STS	Science & Technology Studies

Glossary

<i>Term</i>	<i>Description</i>
Aggregated data	Data that is created by compiling and clustering together personal and/or non-personal data of multiple individuals from both local and global contexts
Algorithm	“a set of instructions programmed into a computing system” (AHRC, 2018, p. 26)
Algorithmic bias	The interactions between aggregated de-identified data and personalized data that make up the decision matrix or pipeline for insights and recommendations which contain an inherent tradeoff between accuracy and bias. Also referred to as algorithmic fairness.
Algorithmic identity	An identity formation that works through mathematical algorithms to infer categories of identity on otherwise anonymous beings (Cheney-Lippold, 2011, p. 160).
Algorithmic fairness	The interactions between aggregated de-identified data and personalized data that make up the decision matrix or pipeline for insights and recommendations, which contain an inherent tradeoff between accuracy and bias. Algorithmic fairness is mostly used in technology field, and it is also known as Algorithmic Bias.
Algorithmic governance	A form of ordering or sorting teachers, based on their data and the algorithmic rules that are incorporated into the complex infrastructure within and around classrooms.
Algorithmic system	In this study, ‘algorithmic systems’ is used to represent any commercial digital tool, platform or app that uses big data and predictive or prescriptive analytics. It is an algorithmically informed digital system that can according to a set of human or computer defined goals and objectives, make predictions, recommendations or provide insights that influence decisions in real or virtual environments such as the classroom, school, or teachers’ personal spaces. It uses computational or human input to infer categories of identity on de-identified and anonymized datasets, to formulate options for potential actions.
Application Programming Interfaces	These are tools that allow software to be built, so that software interacts with other software.
Australian Privacy Principles	Regulated under the Privacy Act (Australian Government, 1988), the principals guide privacy legislation and recommendations in Australia
Audio beaconing	Audio beaconing drops a cookie onto a teacher’s personal device, which enables the playing of inaudible ultrasonic code through the

	teacher's personal device's speakers. This code "can be picked up by other smart devices with appropriate software installed and used to link the devices being used by the same person." (ACCC, 2019, p. 389)
Automation	A process operated without direct human input or supervision. Automation can be indirect or without human supervision.
Back-end	The part of a platform or application that performs a task not apparent to the teacher.
Becoming eMorpheus	A teacher or member of the school community that may or may not embrace technology and is aware of how technology is modulated through commercial and state intent that provide a constant means of communicating benefit and solutions. By becoming eMorpheus, they are aware that they are developing an understanding of both benefits and risks associated with its use from transdisciplinary perspectives.
Behavioural micro-targeting	A form of targeted advertising that uses a proxy for the individual they represent, and the "information about millions of people is collected for behavioural targeting, a type of marketing that involves tracking people's online behaviour for targeted advertising" (Borgesius, 2016, p. 1)
Big data	Data too large to be processed by mainstream databases (Power, 2014)
Big tech	Largest and most dominant technology companies in Australian K-12 educational school settings
Biometric software	The collection data related to patterns of how teachers use a device, which enables identification of a specific teacher.
Black boxes	A 'black-boxed' algorithm is described as a system viewed in relation to its inputs and outputs that lacks explicit knowledge of its internal workings - proprietorially protected, complex and increasingly automated. That is, how the algorithm effectively functions, lacks transparency.
Branded schools	Schools who have big tech as a dominant source of technology as part of their educational practice.
Chatbot	A machine learning algorithm, which enables software to interact with humans by initiating and responding to conversations using natural language programming. In this study, chatbots are referred to in a discussion of Edmodo's developing offerings, called 'AskMo.' AskMo is a conversational intermediary between student and Edmodo, circumnavigating the teacher.
Cloud	A method of storing data and applications in external data centres rather than on the teachers' personal device.
Comatose teacher	A teacher that may or may not embrace technology, but not as a result of informed choice about resisting it. The way they perceive

	technology is modulated through commercial and state intent that whisper benefits and solutions, all the while keeping them from ‘waking up’ to risks associated with its use.
Commercial bias	Commercial bias relates to content integrity (the alignment of the content to understood intent by the teachers), commercial conflict of interest influences the role of the teacher more for-profit, than for educational outcomes.
Commercial platforms	Digital platforms including edtech, search engines, social media platforms and other digital platforms that collect data and/or use data analytics underpinned by commercial goals and drivers
Commercialized classrooms	A classroom environment that is connected to the broader infrastructure of commercial data flows due to the presence of commercial apps and platforms that collect, share and use data via cloud technology.
Concealed data practice	It “occurs when suppliers’ terms provide weak privacy protections for consumers while the extent of those terms, the resultant data practices and the consequences of these data practices are concealed from consumers” (Kemp, 2019, p. 11)
Consumer Culture Theory	A relationship as “a social arrangement in which the relations between lived culture and social resources, and between meaningful ways of life and the symbolic and material resources on which they depend, are mediated through markets” (Arnould & Thompson, 2005, p. 376).
Cookie	A text file that collects data from websites such as personal information and de-identified data collected from the teacher. This may include location, device, engagement and browsing history. First-party cookies are used by an app chosen by the teacher to recall information about the teacher. See Web beacons for third party cookies.
Cross tracking device	Multiple methods are combined to identify an individual teacher across different devices. This may be the teacher’s log-ins, combined with de-identified data to create connections between separate devices.
Data	Quantified information that is stored digitally.
Data analytics	Tools used to measure and track the behaviours of teachers online. Tools include those that collect, cleanse and model data.
Datafication	The conversion of the teachers’ digital interactions into data that can be stored and repurposed, which in this study is for profit.
De-identified data	Data collected from teachers that have had personally-identifying information removed.

Device or browser fingerprinting	An embedded technology on the app or email, deliberately not visible to the teacher. “This technology can be used to recognise the same user across multiple online sessions even if cookies are deleted, user login changes or IP addresses are hidden or changed” (ACCC, 2019, p. 388).
Educational Technology	It refers to the process and practices of educational practice necessitating technology.
eMorpheus Theory	A theory that acknowledges that intangible digital identities are present in educational settings, and flags a need to actualize them according to established guidelines, policy and legislation to make them tangible.
Freemium	A business model where both free and paid services and/or content is provided. In the case of edtech, this may be free to use with the monetization of the data collection, or a free trial leading to a subscription model with or without data monetization.
Google classroom	The Google platform which is used in K-12 settings.
Governance	The overarching ecosystem that supports the regulation and oversight of educational practice in the classroom. In this study, it includes commercial algorithmic systems and the regulatory and oversight systems aligned to a consumer, human rights and workplace law, policy and education.
Ideal-typical transdisciplinary approach	An approach to the literature review that adopts reflectivity, to consider interdisciplinary literature beyond education, then re-integrates it into the Australian classroom context to look for new outcomes.
Immanent ethical differences	Practical reasoning is an ethical approach, and by experimentally approaching and evaluating (not judging) decisions, a negotiation or understanding of the forces at play can be illuminated.
Information asymmetries	When individuals cannot access the information, they need to make informed choices about their privacy when negotiating digital platforms.
Information asymmetry	An informational knowledge malalignment between teachers and commercial platforms. In this study, an information asymmetry includes the teacher negotiating educational pedagogies, and the commercial platform negotiating monetizing of the engagement with the platform as a result of educational use of the platform.
IoT	"Internet of Things – the use of internet-connected technology in physical devices that have not traditionally featured such technology, such as cars, household appliances and speakers. This allows these devices to collect, share and make use of data" (ACCC, 2019)

Learning Analytics	The measurement, collection, analysis, and reporting of data about learners and their contexts for understanding and optimizing learning and the environments in which it occurs. (Siemens, 2013, p. 1382).
Machine learning	“computing system[s] used to make predictions and conclusions on the basis of data” (AHRC, 2018, p. 26)
Mobile device tracking	The teacher, as a prosumer, can be tracked on their personal mobile device, including the location that tracks the movement of the device, that can then use radio signals to communicate with mobile devices passing nearby.
Multi-modal data	Fine-grained measurements of educational traces [and there are] many sensors [that] can be now used in the domain of education to collect data... across physical and digital spaces (Di Mitri, Schneider, Specht, & Drachsler, 2018, p. 338)
Nudge	A “liberty-preserving approaches that steer people in particular directions, but that also allow them to go their way” (Sunstein, Reisch, & Rauber, 2017, p. 2)
Personal information	"Information or an opinion about an identified individual, or an individual who is reasonably identifiable: <i>f</i> whether the information or opinion is true or not; and <i>f</i> whether the information or opinion is recorded in a material form or not" (Australian Government, 1988).
Personalized learning	Tailoring of educational practice to the individual student. It does not necessitate technology.
Personalization	Tailoring of educational practice to the individual student, through the algorithmic analysis of big data. It does necessitate technology.
Privacy Impact Assessment	A tool to assess privacy implications
Platform capitalism	“Whereby platforms enrol users through a participatory culture and mobilize code and data analytics to realize a business model that prioritizes rapid upscaling and the extraction of revenues from users’ data trails” (Williamson, 2017b, p. 63)
Postdigital	Postdigital theory has emerged in an attempt to make sense of an increasingly digitalized society. Trying to explore what it means to be human in a digital world, it explores the changed relations between humans and technology.
Postdigital Teacher Identities	A teachers’ identity actualization that works through algorithmic systems to infer categories of identity on de-identified or anonymized data and is positioned within current policy and guidelines. The teacher has limited to no control over its construction and how it is used.

Proxies	A proxy is the representation of an attribute. They can be non-sensitive, such as location data, but exploited to derive sensitive attributes such as race and ethnicity.
Science and Technology Studies	A field of research that shows “how (rather than merely tell that) educational practices and actors are relationally composed, assembled and configured. (Decuyper, 2019, p. 136).
Surveillance capitalism	Whereby data collection that relies on mass surveillance is a commodity (Zuboff, 2019).
Targeted advertising	A form of online advertising, whereby advertisers use data collected about teachers, such as age, gender, education, race, socio-economics, online activity) to more precisely target teachers with advertising with which they will most likely to engage.
Teacher-deficit disorder	The state of confusion evident as a result of the process of using data about a teacher that positions them in the deficit. For personalization, disruption occurs as deficits are perpetuated into insights and recommendations, although not necessarily representative of an individual teacher.
Teacher identity	An identity built on personal autonomy and dependent on agency (Zembylas, 2003).
Techno-solutionism	The idea that technology can solve any of education’s perceived problems.
Thick description	The detailed interpretation of qualitative data, in which the researcher makes clear the patterns of relationships, and then places them in context.
Transcendent moral opposition	Where there is a ‘good teacher’ vs ‘evil corporation’ discourse. This is seen to be inaccurate, as many teachers run Youtube channels and hence make them the commercial platform or 'evil corporation'.
Web beacons or pixel tags	Third-party cookies: set by companies other than the app chosen by the teacher and often used for advertising / to track the teacher across different sites.

Abstract

This dissertation adds to a burgeoning conversation in education about the implications of commercial platforms being embedded in classrooms and educational practice. Drawing on a postdigital Deleuzian perspective, the study explores how Australian K-12 teachers are negotiating their educational practice as part of a broader data-driven infrastructure which includes predictive analytics and algorithmic bias. It does this by considering the changing role of the teacher's digital profile through a transdisciplinary lens derived from Education, Media and Communications, and Learning Analytics.

Drawing on twelve months of data generation, consisting of an online survey (N=129), two phases of interviews (N=40) with 23 educators from across Australia, and a platform analysis (Edmodo), the study illuminates a startling correlation between the commercial profiling of teachers and relatively intangible workplace hazards. The findings show that teachers are negotiating commercial platforms as a form of psychosocial risk in the workplace, yet not discussing their concerns due to fears of workplace victimization.

As such, the study uses the findings to offer theoretical and practical approaches, aimed at improving workplace conditions for teachers. Introducing the eMorpheus Theory - a series of practical recommendations for teachers, schools and Australian Departments of Education, the study details a National Strategy in K-12 Educational Settings, suggests Policy and Legislation, and advises methods for Co-regulation and Self-regulation of commercial platforms and data stewardship in schools. The study concludes by detailing recommendations for further research as a result of the workplace issues identified in Australian educational settings.