LEARNING ANALYTICS IN A TIME OF PANDEMICS: MAPPING THE FIELD

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Abstract

The coronavirus pandemic has impacted global society in many ways, not least education, with schools and universities moving many teaching and learning practices online. This paper examines the response of educational institutions in employing learning analytics, an approach which includes the collection and analysis of student data to understand and optimise teaching and learning. A systematic review of publications is undertaken and key themes identified in an attempt to answer the question: How did learning analytics allow educators to respond to learners' risks and challenges during the pandemic? This study illustrates issues around the rapid adoption of technological solutions outside of the institution; inequality of internet access; considerations of data privacy and longer term consequences; and the need for an agile, but considered policy response.

Introduction

It is estimated that 1.5 billion students have been affected by a rapid move to online learning which has provided the potential to "reshape schools, the idea of education, and what learning looks like in the 21st century" (Anderson, 2020; par.4). Despite its significant impact, it may be argued that the pandemic has also created space to reconsider how to create evidence-informed learning with technology in higher education.

Williamson et al. (2020) suggest that "Education has become an emergency matter, and along with it, educational technologies have been positioned as a frontline emergency service" (p.107). As institutions pivoted to and Emergency Remote Online Teaching (EROT), some technology providers have identified an opportunity "with potentially long-term consequences for how public education is perceived and practised long after the coronavirus has been brought under control" (Williamson et al., 2020; p.108). EdTech companies have had space to claim that education is broken and that technology can fix it (Teräs et al., 2020). We might conclude that "At the present time, public education has

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been *forcibly decentralised* into students' own homes, *largely disaggregated from the institutions* and practices of education and instead repositioned as a form of home-schooling mediated by technology tools, edu-businesses and other institutions" (Williamson et al., 2020; pp.108-109; emphasis added).

While it is possible to overestimate the permanent impact of the pandemic on education, there is little doubt that it has changed the relationship between education and educational technology providers (Teräs et al., 2020). There are indications that the massive adoption of technology to ameliorate the impact of the disruption has shifted the use of technology "from just content dissemination to augmenting relationships with teachers, personalization, and independence" (Anderson, 2020; par.8). Much of this change emerges from and depends on data, and more specifically, on student data. Fonseca et al. (2020) state that "Educational data usability and accessibility is even more relevant in the context of the global pandemic" (p.1). The bibliometric mapping and analysis by Rodrigues et al. (2020) identifies learning analytics as one of the topics most studied in 2020.

As higher education has moved online, institutions have had significantly greater access to student data (Khalil & Belokrys, 2020). Where Learning Management Systems (LMSs) had functioned primarily as digital repositories for materials and resources for many, they now became indispensable aspects of teaching and learning during Covid. Taking on "an enhanced infrastructural role, moving from a background position to being a dominant medium through which institutions, staff and students interact" (Williamson & Hogan, 2021; p.28). In the process, LMS providers "built interoperable integrations with third-party platform plug-ins to enable data mining at scale from the increasing participation of students in digitally-mediated education" (Williamson & Hogan, 2021; p.28).

At the same time, teaching and learning also moved to digital spaces *outside* of the LMS, such as Zoom, to social media and to Instant Messaging Services such as Facebook's Messenger and WhatsApp. Previously, teaching and learning were largely centralised in the LMS, but became effectively unbundled, not only with regard to the use of other digital spaces, but also the number of providers having access to students' data. The adoption of, for example, digital proctoring "solutions" to ensure examination integrity and uses of "tracing" apps to ensure Covid-safe campuses, "introduce bio-surveillance and epidemiological monitoring on to campuses, thereby raising critical issues related to data security, privacy and ethics, as well as the risk that health data might be repurposed or monetised in the 'after-life' of the pandemic" (Williamson & Hogan, 2021; p.50).

The variety, volume and granularity of student data and its use to provide educators with glimpses of the complexities of learning have always been central to learning analytics. Empirical findings demonstrate how learning analytics has positively impacted on student

success and retention (Ifenthaler & Yau, 2020); informed instructional design (Macfadyen et al., 2020); work and cognitive load (Curum & Khedo, 2021); and, through learner-facing dashboards, provided students and instructional teams with insight into student progress and the potential of failure (Verbert et al., 2020). So given its potential to offer insight, how did learning analytics facilitate the response of institutions and educators to support learning during the pandemic?

Research Design and Methodology

A well-defined research question that is "unanswered but answerable" (Alexander, 2020; p.7) forms the foundation for systematic reviews. Such reviews are explicit and systematic about the methodology to identify, select and evaluate relevant research, resulting in an analysis of included studies (Moher et al., 2009; Okoli, 2015). The central research question for this systematic review was: How did learning analytics allow educators to respond to learners' risks and challenges during the pandemic? In conducting this systematic review, we used the guidelines and checklist of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) (http://www.prisma-statement.org) to ensure transparency not only in the research process, but also in the analysis (Moher et al., 2009).

Search parameters

After establishing the question guiding the systematic review, we must define the boundaries or parameters that delimit the search. This review used the research database Scopus, the largest interdisciplinary database of scholarly articles (Schotten et al. 2017). Scopus yielded a total number of 162 downloadable articles for the search terms "learning analytics" AND "Covid" (51% of found articles), as well as "learning analytics" AND "pandemic" (31%), and "learning analytics" AND "corona" (11%), and after duplicates were removed, resulted in 80 articles. As comparison, a search on Web of Science (WoS) with these search terms only produced in 8 articles.

Specifying the Corpus of Search Terms

As highlighted above, the three searches shared "learning analytics" as a key term and alternated with "Covid", "pandemic" or "corona" across all fields. The corpus of search terms is directly related to get the widest possible sense of any published research referring to a combination of relevant terms. While it is generally accepted that the Covid pandemic emerged in late 2019, we did not impose a limiting timeframe for the Scopus search.

Delimiting the Search

Delimiting the search may have excluded other scholarly considerations for how educators collected, analysed and used student data without specifically mentioning "learning

analytics". As this systematic review aimed to address "learning analytics" as research focus and practice, we considered the delimitation justified.

Overview of the iterative process of inclusions and exclusions

Figure 1 gives an overview of the cycles of search results per research term corpus as discussed above.
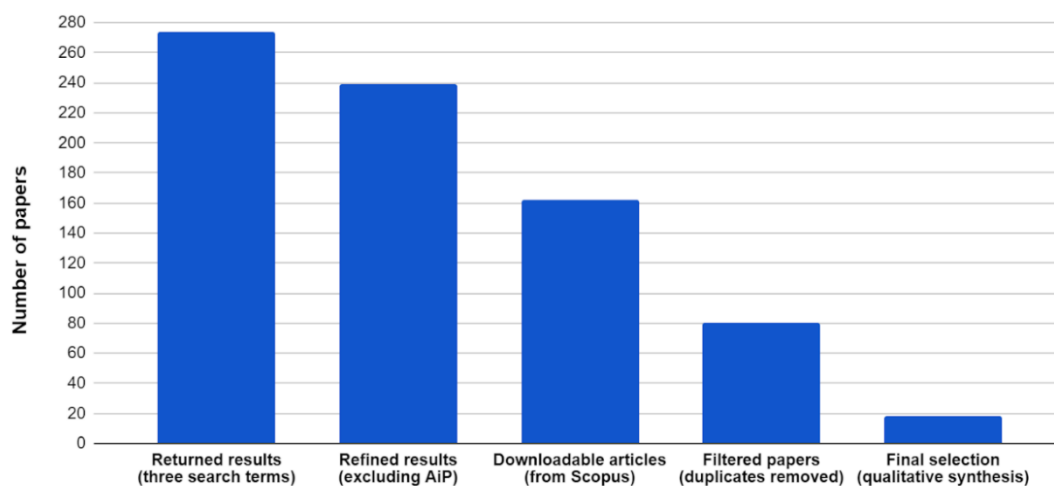

Figure 2. An overview of the outcome of the iterative process of inclusions and exclusions

There were 274 initially identified articles within Scopus - after excluding articles-in-press (AiP), there were 239 articles, of which 162 were downloadable. Removing duplicates brought about by the three search terms resulted in 80 articles. After qualitative synthesis, 18 papers were flagged for further scrutiny and analysis.

Trustworthiness

To reduce the risk of bias among the selected papers for inclusion or exclusion, Fleiss kappa was used to evaluate the inter-rater agreement among those carrying out the systematic review. Fleiss et al. (1981) explain that Fleiss kappa values over .75 indicate excellent value for agreement, .40 ~ .75 suggests fair to good, and below .40 indicates a poor level of agreement. In our case, two authors scanned all filtered papers and identified papers for inclusions and exclusions. The IRR value at this stage was ($\kappa = 0.368$, $p < 0.005$). To resolve differences, all authors undertook further discussion and resolved contradictions. The final IRR kappa value indicated an excellent reliability level of agreement ($\kappa = 0.774$, $p < 0.005$).

Ethical considerations

Though ethical considerations in "conducting systematic reviews in educational research are not typically discussed explicitly" (Suri, 2020; p.41), we acknowledge that every step has ethical implications, whether searching and selecting literature, evaluating, interpreting and distilling evidence, making connections, and choosing an "audience-

appropriate transparency" (Suri, 2020; p.41). In addition to following the guidelines offered by PRISMA, it is also important to acknowledge interpretivism as our own epistemological orientation.

Limitations

In line with prescriptions for quality in systematic reviews (Alexander, 2020; Moher et al., 2009) we have acknowledged the criteria for inclusions and exclusions, and also the complexities and the implications of these. Limitations to this systematic review are recognised as using only the Scopus database and not excluding "learning analytics" from the corpus of search terms.

Analysis and findings

The final list of 18 articles was then deductively analysed to identify the relationship between "learning analytics" and the three different variations of terms for the pandemic. The analysis was concerned with what the literature reveals about learning analytics during the pandemic (so far). Table 1 presents an overview of research foci into learning analytics. The focus was not to document the findings of these different studies, but rather to map the use of types of learning analytics or claims regarding opportunities offered by learning analytics to understand and improve student learning and support, and teaching during the pandemic.

Table 1:   An overview of the selected articles' reference to learning analytics

Reference	Learning analytics in a time of pandemic
Cornide-Reyes et al. (2020)	The potential of multimodal LA (1)
Rosenberg & Willet (2020)	Preserving students' privacy while enhancing learning using LA (2)
Villegas-Ch et al. (2020a)	Adaptive learning and LA (3)
Dias et al. (2020)	Predictive analytics (4)
Choi and McClenen (2020)	Adaptive learning and LA (3)
Huang et al. (2020)	Predictive analytics (4)
Abou-Khalil et al. (2021)	Student behaviour and engagement (5)
Villegas-Ch et al. (2020b)	Big Data and Artificial Intelligence (6)
Gonzalez et al. (2020)	Student behaviour and engagement (5)
Choi and Cho (2020)	Student behaviour and engagement (5)
Carter Jr et al. (2020)	Artificial Intelligence (Support of SRL) (6)
García-Peñalvo et al. (2020)	Artificial Intelligence (6)
Raffaghelli et al. (2020)	Data literacy (7); ethics and privacy (2); datafication (6)
del Carmen Olmos-Gómez et al. (2020)	Teacher development and improving the quality of learning (8)
Yilmaz et al. (2020)	Teacher development (8)
Jost et al. (2021)	Student behaviour (Support of SRL) (5)
Rasmitadila et al. (2020)	Teacher development (8)
Beerwinkle (2020)	Ethics and privacy (2)

Discussion: Thematic analysis

A total of eight themes were identified and are discussed below, in no particular order:

1. Multimodal – While research and practices involving multimodal learning analytics are on the increase (Blikstein & Worsley, 2016), only one paper covered multimodality and learning analytics in the context of the pandemic. Cornide-Reyes et al. (2020) reviewed the usefulness of a multimodal approach called NAIRA to provide real time feedback to the students to foster collaboration.

2. Student perceptions and student privacy – Under this category, two papers referred to ethics, privacy and student perceptions of their data collection. Rosenberg and Willet (2020) and Beerwinkle (2020) suggested that there should be more focus on the ethical considerations and the data collected during the pandemic in the light of the haste institutions, educators and students responded in the move to EROT.

3. Adaptive learning – Two papers focused on adaptive learning. Choi and McClenen (2020) claimed that adaptive learning is important to provide correct information and personalized data to students in the time of COVID-19, and Villegas-Ch et al. (2020a) refer to Learning Analytics as a driver to analyse large volumes of data to offer adaptive educational models.

4. (and 6.) AI, machine learning and predictive analytics – Five papers were found to specifically address the potential, challenges and implications of AI, machine learning and predictive analytics. An editorial by García-Peñalvo et al. (2020) points to the potential of AI to support learning during the pandemic (also Carter Jr, Rice et al., 2020). Villegas-Ch et al. (2020b) propose improvement to an online model that prioritises an individual student's learning (based on progress and other known information), provides prompts to the student, and notifications to a teacher. The paper proposes student-centred educational models by using AI and big data to improve engagement and reduce drop out with a mention of COVID as a life changer for education. The Dias et al. (2020) paper looks at analysing student interaction with online platforms and generating predictive analytics. The last article by Huang et al. (2020) reviewed the response of the Chinese government to put in place online and distance learning during the pandemic, highlighting the promise of Learning Analytics to identify students at risk in the Chinese context.

5. Student behaviour and engagement – Four papers were identified. Abou-Khalil et al. (2021) explored student perceptions of engagement strategies during emergency online learning and concluded that students prefer engagement with content over engagement with teachers or other students. Social network analysis was used to build a Learning Analytics framework for systems of assessments as a means of understanding learners' paths during the pandemic (Choi & Cho, 2020). Gonzalez

et al. (2020) drew on the potential of Learning Analytics for improving and evaluating the assessment in higher education during pandemics. In a different context, Jost et al., (2021) used Learning Analytics methods to highlight the importance of Self-Regulated Learning during pandemics.

7. Data literacy – The editorial by Raffaghelli et al. (2020) for a special issue on data literacy, highlights the importance of data literacy in the context of the increased collection, analysis and use of learning analytics during the pandemic. The authors point to the emergence of "pandemic pedagogies" and foreground concerns around ways that educators make sense of student data and the broader datafication of education and the emergent practices and concerns. Raffaghelli et al. (2020) express concerns that educators' data literacies have not received the necessary attention.

8. Teacher development – There are three articles that themed "Teacher development". Learning analytics was suggested as a means of comparing teacher performance for development purposes (Yilmaz et al., 2020), to support teacher development through smart learning environments (del Carmen Olmos-Gómez et al., 2020), and to foster teacher use of ICT (Rasmitadila et al., 2020).

Reflections on learning analytics in a time of a pandemic and beyond

Student data is always an invitation to a conversation (Prinsloo, 2019), and considering the huge impact of the pandemic on our students' lives – personal, professional and in their learning – their data could potentially tell many stories and invite many conversations.

Looking at findings from this systematic review, both in terms of quantity and depth of consideration in the nexus between learning analytics and the pandemic, one should be careful not to conclude that learning analytics may have missed an opportunity to appropriately and ethically engage with student data during the pandemic. We may yet see more findings and more detailed analyses of how learning analytics responded during the pandemic going forward. Having said that, based on this review, the following might be considered with regard to learning analytics post-pandemic.

Firstly, as students and educators found ways to communicate and engage in different ways, using multiple devices and platforms, synchronously and asynchronously outside of the institutional LMS, questions can be raised as to the capacity of data limited to the LMS to provide institutions with a detailed view of how students are progressing and learning. Secondly, the pandemic illustrated how unequal access to the internet is, and this inequality of access is gendered, raced and geo-political. While reference to the digital divide prior to the pandemic often called forth images of internet connectivity in the Global South, the pandemic starkly illuminated disparities in access and use of the internet also in the Global North. With learning analytics dependent on internet access, this raises

concerns of the generalisability and representativeness of our data sets, as well and introduces a question as to the contribution of learning analytics in "data-poor" contexts, where not all students have access to and/or use the LMS regularly or where the majority of students' engagement happens outside of the LMS.

A third point worthy of consideration is whether the haste in responding to the emergency resulted in institutions, educators and students choosing technologies and applications without due consideration of privacy and ethical issues and concerns. While this lapse of institutional oversight could be rationalised on utilitarian grounds given the urgency to reach out to students, it may be hard to disentangle these practices and arrangements from teaching and learning practices once the pandemic has eased.

The fourth and final point for reflection is how nimble and responsive both the policy environment (both on national, regional and institutional) and digital infrastructure were in terms of responding to the increasing digitalisation and datafication of education.

Conclusion

The pandemic, and institutional responses to it, provide huge scope for reflection. In many ways the pandemic revealed and destabilised many assumptions and beliefs that have become naturalised and gone unquestioned, such as student and staff access to the internet, the affordability and sustainability of access, and so forth. The pandemic may also have led us to realise that we may not yet fully understand student learning and therefore that our support initiatives may be inappropriate or ineffective.

Learning analytics has promised, since its emergence in 2011, to help us understand student learning better, in order to teach and support students more effectively, and to help students to make more informed decisions. If there ever was a time when we needed to better understand what students were experiencing and how they were coping, the pandemic and the move to EROT have provided us with such an opportunity.

As such we were curious to look at research published during the pandemic (to date) and to get a sense of how learning analytics had responded. This systematic review provides us with an initial glimpse of how scholars and researchers have researched and reflected on the potential of learning analytics during the pandemic.

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