Mapping AI and Education debates: revisiting acquisition and participation metaphors for learning

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Abstract

The role of artificial intelligence for learning is again attracting attention in policy and academic fields; a renaissance fuelled in part by the proliferation and availability of big data, alongside advances in computational techniques and the need for a new 'technical fix' for Education (Robins and Webster, 1989). In the public domain, dramatic headlines abound proclaiming the end of education as we know it in utopian and dystopian terms. Yet, in the academic sphere important advances are being made that educators need to pay attention to in order to have a more nuanced and 'responsible response' (Biesta, 2013) to the role that artificial intelligence can and should play in Education.

This presentation aims to contribute to that goal through reporting findings from an ongoing study that aims to identify and explore academic studies that are concerned with artificial intelligence and Education. Through the use of a number of machine learning techniques we aim to map and visualise the current areas of research in this area and identify the underlying philosophies of learning and education embedded within these activities, drawing on Anna Sfard's acquisition and participation metaphors for learning (Sfard, 1998).

Through primarily computational analysis (including network analysis and natural language processing) of the citations, titles and abstracts (where available) of around 8500 books, chapters, papers and conference presentations alongside small scale qualitative coding of a sample of papers we highlight the different ways that people define and talk about AI in Education and demonstrate how the vast majority of work in this area is primarily promoting an 'acquisition' based view of learning, promoting individual cognition over collaborative, networked forms of participation. We argue that while this is not necessarily a problem as acquisition is an important aspect of learning; discussions of the use of artificial intelligence in Education would be significantly advanced if far more attention was placed on ways of thinking about learning and Education that promote a broader social-cultural view. This would enable more discussion of if, and how, the use of artificial intelligence in Education could advance knowledge in a Network Society alongside the use of artificial intelligence to make knowledge transfer more efficient; and further advance theoretical debates in Networked Learning.

Keywords

Artificial Intelligence, Machine Learning, Topic Modelling, Acquisition, Participation, Education.

Research Context

AI in Education as a field of study has gone through periods of significant attention, followed by periods of relative indifference, mirroring "summers" and "winters" in AI research generally since almost the beginning of the field in the 1960s. It is again very much in vogue, fuelled in part by popular debates in the media about the role of AI in society generally. One prominent figure crossing research, practice, and education has even deemed AI to be in an "eternal spring" (Ng, 2017) in which the hype and hope of past interest cycles are coming into being with a sustainable forward momentum, making the area deserving of academic attention. However, although in academic circles the availability of large scale data sets and computational power have supported advances of work in this area, much of this research expertise comes from outside education, with many projects being led by experts in computer science, engineering and related fields.

In order for the Education and especially the Networked Learning community to be a significant part of these debates there needs to be greater awareness of the kinds of work that are being undertaken. The aim of this research is to support this process through the analysis of the current research outputs in AI and Education. In doing so, we hope not only to provide information about the kinds of topics and techniques being used, but perhaps more importantly, the ways that people are defining and thinking about AI and Education and the kinds of philosophies or working theories that experts in this area hold about learning.

To achieve this goal, we draw on Sfard's 'acquisition' and 'participation' metaphors for learning (Sfard, 1998). As in wider discussions about learning theory, AI in Education can be understood and/or positioned to promote individual cognition, as in the case of many personalised intelligent tutors (e.g. Graesser et al., 2004), or potentially distributed cognition (e.g. Pea, 1998) in a manner more akin with the work of Networked Learning researchers. Both acquisition and participation metaphors and philosophies are important when thinking about learning (Sfard, 1998), particularly in a Network Society.

Aims and Objectives

In order to assist in framing and developing debates about the future of AI in Education, a better understanding of the ideas and debates being put forward would be valuable for the wider education community. This presentation aims to support that goal via the use of bibliometric and natural language processing techniques to:

1   Map and visualise current areas of research in AI and Education
2   Examine ways that experts define and talk about AI and Education
3   Identify underlying philosophies of learning and education embedded within this body of work

And make these efforts available to the wider academic community to encourage further debate in this area. This work forms part of a wider project that will use in-depth ethnographic methods to explore the use of AI for lifelong learning, utilising a critical perspective.

Design

We reviewed scholarly databases including Scopus, Web of Science, and (using Harzing's Publish or Perish 5) Google Scholar, using variations on the following Boolean search target: ("machine learning" OR "artificial intelligence") AND (teach* OR education OR "lifelong learning" OR "personalized learning"). Data collected encompassed (where possible) article title, author, date of publication, journal, abstract, keywords, and cited references. By merging and de-duplicating all results into a common BibTeX database (using JabRef), as well as using web data extraction techniques to clean and complete missing data, we identified around 8500 unique articles, book chapters, and conference proceedings.

We then visualized available citation network data and keyword co-occurrences using VOSviewer; conducted topic modelling using latent Dirichlet allocation (LDA) and non-negative matrix factorization (NMF) algorithms in the Python, varying the number of topics across multiple iterations of modelling; experimented with training a classifier to determine "acquisition" versus "participation" disposition, also using Python; and overall, navigated and extended each of these steps with qualitative coding of a small proportion of academic outputs as well as topic model visualization using t-distributed stochastic neighbour embedding (t-SNE).

Preliminary Findings and Conclusion

While our unsupervised learning approach was not designed to identify any single number of topic modelling topics as "best", our process yet indicated a number of different areas of focus within the area of AI in Education. This manifested, for example, in the persistence of qualitative topic cluster contents across multiple number-of-topic values, or the emergence of distinct new clusters at higher topic number values. These areas included: classification techniques in educational data mining, the future of AI and Education, learning companions and agents, ways to teach AI to students, use of AI in gaming and robotics, student modelling, and a significant literature on the use of AI specifically in medical education. Within each of these areas the ways in which experts talk about and define AI varied, thus in the presentation of results we will examine what different groups are really talking about when they talk about AI.

Finally, it appeared from our analysis to date that a very high proportion of studies on the use of AI in Education are primarily acquisition based, that is, they prioritise the support of individual cognition as opposed to more participative forms of learning that could potentially be seen as knowledge building (Bereiter, 2005). Too strong an emphasis on a more individual and information processing-based approach to learning is problematic, as it is important but not the only approach to learning and Education necessary within Network Societies, and risks reducing and narrowing the experience of learning and the purpose of education. Further work will be carried out to develop and add to the existing data base to enhance and refine the results, and make these results visible and usable to the wider Network Learning Community.

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