Visualising the Field: Reviewing Trends in Educational Design Research in Mathematics

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Abstract: This paper will use methods drawn from the digital humanities and social sciences to undertake a meta-study of recent EDR research in the domain of mathematics education. The findings suggest that much of the work presented as EDR might be better characterised as implementation studies as they contain only limited commitment to theoretical development capable of supporting the scaling of innovation.

Keywords: Educational Design Research, meta-study, theory development, mathematics education, Design based research

Introduction

Emerging in the 1990s the approach to taking educational research out of the lab and into the "real world" that has been known variously as design based research, design experiments, and educational design research (EDR) is the "signature" approach of the Learning Sciences (LS, Yoon & Hmelo-Silver, 2017). EDR is increasingly being taken seriously beyond LS, and its potential to scaffold changes in teacher professional practice is being recognised in places such as the policy world of the OECD (Paniagua & Istance, 2018). As the EDR framework is adopted beyond the confines of the LS community it seems more important than ever to interrogate the gaps and blind spots that are still evident its implementation. This paper contributes to such an interrogation through a meta-study of recent EDR studies in mathematics education. It does so making use of tools emerging from the digital humanities and social sciences to visualise trends in the literature.

Method

This paper provides findings from a meta-study of EDR in the domain of mathematics education published in outlets indexed in the ERIC database. The full method and inclusion criteria are set out in the technical paper (see Fowler, Leonard, & Fiedler, 2020). The 174 papers used in the study were investigated using automated content analysis with reference to the categories of theory development offered by diSessa and Cobb (2004). diSessa and Cobb's five categories included *Grand Theories (*abstract drivers of action), *Orientating frameworks* (unspecific meta-theories that form the basis of instructional design), *Frameworks for action* (unfalsifiable prescriptions of pedagogical practice), *Domain Specific Instructional Theories* (action based testable theories often based on formulating, testing and revising learning trajectories) and *Ontological innovation* (the development of theoretical constructs that help us view learning differently and recategorize out current understandings).

Results

The content analysis shown in figure 1 shows some instructive gaps when the goals of EDR are considered. Context for instance is present as a theme, but context of the mathematical problems to be solved rather than the context of the learning. Theory development is notable as it is entirely absent as a concept. On the whole, the studies are focussed on improving the effectiveness of interventions, how students use the interventions, and how teachers can learn from being involved in the research. Where theory development has been prioritised the interest is almost entirely on domain specific instructional theories and the work remains focused on evaluating the usability of a new design within its own context (see Fowler et al., 2020 for further detail). Notable in its absence is theory development on how the results of the studies can be scaled or applied to other contexts

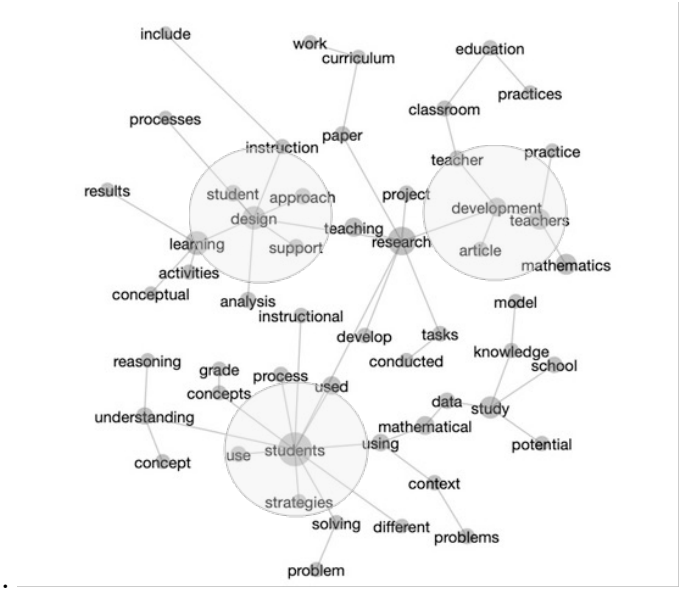

Figure 1. Concept map of paper abstracts generated by *Leximancer*.

Discussion

DiSessa & Cobb (2004) suggested that most early EDR studies actually stem from one main theoretical category, that is domain specific learning theories. Our findings show that this focus has continued and that the focus of most EDR studies remains on refinements within the current educational system, with little attention being given to intellectual or organisational milieu in which the studies sit. It seems that what is often described as "theory development" in the Educational Design Research literature might be better labelled as framework generation with the intent to orient action and practise. Supporting the widespread adoption of innovation, however, would seem to require more. If EDR is to have a significant impact on the development of the learning sciences, researchers need to heed diSessa and Cobb's (2004) call for ontological innovation and Biesta's (2019) repurposing of educational research as a method of problematising the unseen. EDR offers a path for the scaling of innovative pedagogies but a policy emphasis on a limited vision of "evidence based" educational practice at the start of the millennia, and the continual neo-liberal focus on easily assessable standards, seem to have diverted EDR from its early ambition of being a stimulus for effective educational intervention while also refining and developing theory . The learning sciences are facing a technocratic model focused on finding "what works" while rarely asking the question of "who it should work for" (Biesta et al., 2019).

The kind of EDR that is most likely to support scalable change will be multi-disciplinary in order to truly understand the messy context of learning. It will seek to understand the phronetic as well as the technic. At this time, however, very little of the research being published under the EDR banner, at least in mathematics education, looks like this. As such, caution is needed as policy makers look to approaches such as EDR as a path to educational change. EDR does have promise but realising this promise will require the development of deep research cultures.

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