

Business as Usual or Digital Mechanisms for Change?

What Student DLOs Reveal About Doing Mathematics

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ABSTRACT

Mathematics classrooms have a long history of what has been termed ‘unidimensional’ character: a proclivity for student practice routines and teachers as experts and keepers of knowledge. This study investigates affordances of student-created digital learning objects (SC-DLOs) as transformative, design-for-learning practices in the hands of students. Historical distinctions are drawn between digital learning objects (DLOs) and digital learning artefacts (DLAs) primarily for teacher assessment of student learning. SC-DLOs are conceived as students’ design for learning for the peer learning community. Hence, SC-DLOs have additional and different learning potential that aligns with 21st century skill development. A corpus of mathematics SC-DLOs (n=155) were analysed from learner blogs (Year 7-8) in a 1:1 digital initiative in New Zealand. A mixed-methods approach was used to investigate features of students’ multimodal design for learning. A framework of implications informs and problematises understandings of transformative digital creation by students in mathematics.

KEYWORDS

1:1 Learning, Design-for-Learning, Digital Learning Object, Knowledge Building, Mathematics, Student Multimodal Artefacts, Student-Created DLO

INTRODUCTION

Creating, sustaining and scaling change in classroom pedagogy is a recognised and on-going challenge to learning innovation and outcomes improvement (Jesson, McNaughton & Wilson, 2015). In the subject area of mathematics, researchers and commentators continue to highlight barriers to change in mathematics teaching from prevailing attitudes and beliefs about active student participation in mathematical discourse (Boaler & Sengupta-Irving, 2016), problem solving investigation (Bailey, 2017) and collective knowledge building (Hunter, 2005, 2008). Mathematics classrooms have a long history of what Boaler (2008) terms ‘unidimensional’ character; where procedural routines dominate and the teacher is keeper and expert of knowledge (Soto, 2015). Digital learning environments (DLEs) may offer creative mechanisms for ‘disruption’ by providing opportunities for student design of conceptual digital objects and collaboration. Student-created digital learning objects (SC-DLOs) are conceived as going beyond skill-and-drill such as apps for practice and feedback because SC-DLO practices can position students as both designers and sharers of knowledge (Cope & Kalantzis, 2017).

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The reasons are at least two fold: (1) SC-DLOs are more than digital artefacts (or products) of the students' learning because they involve making *design-for-learning* decisions (Bezemer & Kress, 2008) by the student to enhance learning for others; (2) By adopting the role of 'instructor', student-designers potentially deepen learning by reflecting on how best to explicate knowledge for others by combining digital modalities (Kress & van Leeuwen, 2006). Design for learning by students is in line with developing desirable 21st century competencies and futures (Lai & Viering, 2012).

By analysing a corpus of students' mathematics SC-DLOs (n=155), we will argue for a qualitative difference between student-created digital learning artefacts (SC-DLAs) (e.g. worked example of an algorithm using mathematical notation) and digital learning objects (SC-DLOs) (e.g. screencast recording of a student explaining how to solve an algorithm for an online audience as a 'rewindable' resource). Therefore, a blogged screenshot of student *Mathletics*¹ progress, or photograph of groups using manipulatives to count are not considered SC-DLOs, as the artefacts represent no obvious instructional intent on the part of the designer. On the other hand, a screencast explanation of how to balance an equation is instructionally explicit in both the choice of medium (screencast demonstration) combined with verbal guidance.

Producing SC-DLOs requires access to media such as slide presentations, screencast, video, podcast and animation to afford design decisions with the full complement of multimodal resources (e.g. combinations of image, audio, writing, movement, gesture and spatial modes). Historically, DLO design by educational resource providers have been informed by taxonomies for enhancing learning potential (Churchill, 2007). Mayer's (2014) model of twelve principles of multimedia learning has had considerable impact on the field of multimedia design for learning by emphasising: (a) visual-verbal complementarity (b) human personalisation (e.g., use of voiceover), and (c) reducing extraneous cognitive load such as minimising distraction (e.g., unnecessary animation). Students in K-12 settings are unlikely to be aware of the formal principles of design for learning in everyday subject learning, but are likely to draw on age-related experiences of digital texts when design-for-learning awareness is emphasised.

BACKGROUND

There is a growing body of research featuring teachers' instructional use of DLOs (e.g. from educational resource providers), but only emerging research in SC-DLOs created by students. A search of peer-reviewed studies in prominent academic journals returned only four articles describing SC-DLOs in mathematics. Three involved use of screencasts (Croft, Duah & Loch, 2013; Shafer, 2010; Soto, 2015) with one use of podcast (Adams & Blair, 2014). The single primary school study included a large sample of SC-DLOs (n=47) (Soto, 2015) where students were asked to imagine creating screencasts for their peers. Therefore, the present study contributes further to SC-DLO scholarship by analysing the largest study sample to date, detailing the multimodal features and the implications of findings related to performative effects (where students positioned to teach others). This study is also situated within 1:1² school settings where students arguably have considerably more agency and day-to-day experience using digital devices for learning, including a potentially wider pool of SC-DLO forms they can create (e.g. podcast, animation, presentation). In the interests of exploring ways SC-DLOs may (or may not) contribute to 'change' practices advocated in mathematics research, we anticipate there will be particular interest in the findings by mathematics teachers, particularly in the potential affordance of capitalising on audience effects in the digital design for learning of peers.

THEORETICAL PERSPECTIVES

This study is informed by theories that conceptualise learning as a socially mediated process (Vygotsky, 1978) wherein SC-DLOs can be conceived as supporting active knowledge construction through both digitally mediated creation and interaction (Smith & Kennett, 2017). From a constructivist perspective

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