Can agent-based modelling serve education in understanding user experience based on autopoietic technology?

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Abstract

Today's educational technology and technology-enhanced learning systems and affordances (possibilities) have a key role to play in the transformative potential of educational practice. Educational technology allows for learning to occur practically anywhere in collaboration with anyone, while promoting innovative, inclusive and transformative types of learning, thereby challenging traditional pedagogical approaches. Yet such processes are embedded within an inherent complexity, not only in the design and development of technology-enhanced learning systems, experiences and affordances, but also in the socio-cultural contexts where users reside. One key characteristic of complex phenomena is that emergence of new properties is spontaneous and unpredictable, challenging the resilience of educational technology in socio-cultural settings over time. This call for the creation and nurturing of adaptable and self-organising technology-enhanced learning systems where the interaction with users enables the emergence of facilitated meaningful learning experiences over time. How can this be achieved? The solution may lie in the concept of autopoiesis coming from systems biology, literally meaning 'self-maintenance'. By conferring such organic properties found on living systems, i.e. adaptability and self-organisation, during the design and development of technology-enhanced learning systems, the emergence of meaningful learning processes could be enabled and self-maintained while adapting to the ongoing dynamic changes of socio-technological systems. Leaving the challenges of achieving such type of organic technology-enhanced learning systems aside, the focus here is on asking the agent-based modelling (ABM) community to consider how ABM could assist in understanding human experience based on autopoietic educational technology.

Introduction

Educational technology facilitates new forms of interconnected social learning around the transformative possibilities offered by digital tools (Cook & Santos, 2016). For example, mobile devices today allow learning processes to occur virtually anywhere, anytime and in collaboration with anyone; promoting learning types that are innovative, inclusive and transformative, therefore continually challenging traditional pedagogical approaches. Contents can also be designed in such a way that they adjust to the characteristics and needs of users. In turn, what users can do and create through digital tools will depend on the affordances offered by the technology, and on the understanding of such affordances by the users themselves. Both factors – the affordances offered by technology and the understanding of them by users, are in turn influenced by the socio-cultural characteristics of learning contexts (Knight, Gunawardena & Aydin, 2009).

The socio-cultural learner

The use of technology in education has not been exempt from a need for rapid adaptation by educators and designers in creating favourable conditions for the efficient and relevant use of educational technology across contexts. Educational processes in individuals, groups and communities not only require an adequate integration with technological possibilities and tools, but also with other key dimensions such as the cultural, social and emotional dimensions, and the dispersive cognitive frameworks of given users. This calls for a need to satisfy the unique characteristics and needs of each individual and communities of users, when generating new innovative ways to educate through the range of possibilities offered by emerging digital technologies.

This panorama of socio-technological complexity in the culturally situated use of digital technology in education presents a myriad of barriers and unknowns that are increasingly unpredictable and almost uncontrollable. But also offers opportunities to those who, as educators and designers of digital educational experiences, deal with meeting users' socio-cultural and emotional characteristics and needs in order to promote ongoing and meaningful technology-enhanced learning (Aguayo, 2016).

Autopoiesis in technology-enhanced learning

Within this context there is an important and significant potential in conceptualising educational technology and technology-enhanced learning (TEL) systems from the complexity sciences, and in particular, from the concept of autopoiesis coming from systems biology. Autopoiesis, literally meaning self-making, defines living organisms as intelligent self-organising units capable of adapting to unpredictable changes in their environments, while maintaining internal coherence over time (Maturana & Varela, 1980).

Transferring the notion of autopoiesis into TEL systems (to the best of my knowledge) has only been recently attempted at a theoretical and speculative level (see Aguayo, 2018; Aguayo, Veloz & Razeto-Barry, 2019), with much research and applied work still to be done. For the purpose of this workshop on ABM modelling of human behaviour, TEL

systems created on autopoiesis principles can be defined as follows. If we consider the most basic and key underlying principles of an autopoietical unit being (1) the capacity of self-organising itself, (2) by maintaining internal coherence at all times (i.e. therefore implying the existence of some sort of 'boundary' defining the unit), and (3) by following a set of own rules (Maturana & Varela, 1980); we can then extrapolate the idea into TEL systems in the following way – note until here only a definition of a sole autopoietic unit has been given, without considering its relation with its medium. In theory, autopoietical TEL systems are to be capable of continuously re-arranging their internal structure, organisation and processes on their own (implying a 'unit', and therefore a 'boundary'), and following their own rules, i.e. guidelines or 'mandate'.

Living systems exist in a thermodynamic world, and to maintain coherence they must comply with thermodynamic rules, involving the process of adaptation. This view of autopoiesis, involving adaptability and self-organisation, is what has been branded molecular autopoiesis (Razeto-Barry, 2012). Yet TEL systems, as with the use of the concept of autopoiesis in social sciences, the arts and the humanities to mention some examples, do not need to comply with thermodynamic restrictions, this being known as qualitative autopoiesis. So if maintaining coherence for a biologically living system means to comply with thermodynamic restrictions at all times over time (with reproduction being one of the strategies for transcendence over thermodynamic restrictions), for a TEL system in education (involving a boundary defined by the process of designing and developing a digital interface), it simply involves to promote the facilitation of the emergence of meaningful learning on learners – which now brings the notion of the relationship with the medium and/or another unit/agent, i.e. the socio-cultural learner.

The Santiago School of Cognition (Rudrauf et al., 2003), founded on the concept of autopoiesis, establishes that human experience and cognition are unique to every individual and context (Thompson, 2007). This has profound epistemological consequences when designing digital technology and TEL systems in education, as the dominant 'one solution fits all' paradigm becomes invalid. On the contrary, TEL systems ought to provide as many intelligent solutions as individuals, contexts and situations there are. The underlying hypothesis is that educational technology can be embedded with autopoietical properties found in living systems during its design, creating 'intelligent' TEL systems that can respond to socio-culturally and emotionally different learners over-time (Aguayo, 2018).

Being able to develop technology-enhanced learning systems presenting autopoietic coherence is one thing (addressed elsewhere). Yet the understanding of the impact on human experience requires attention on the interactions and relationships existing between (alleged) autopoietical TEL systems and users themselves, especially when users can bring almost infinite socio-cultural and emotional backpacks into the learning experience.

Can agent-based modelling serve education in understanding user experience based on autopoietic technology?

This is an open question to the agent-based modelling (ABM) community. If educational technology could follow design principles informing the development of technology-enhanced learning systems presenting autopoietical coherence, could ABM provide an analytical framework to understand and predict user experience occurring across socio-culturally diverse settings and on users presenting divergent cognitive framework dynamics? This in an invitation to the participants of the 2019 International Workshop on Agent-Based Modelling of Human Behaviour (ABMHuB) side event of the ALIFE2019 Conference to consider *if* and *how* ABM can serve education by understanding user experience within autopoietically intelligent educational technology solutions.

The relevance of this challenge lies in that an understanding of user experience within such given environment, could assist in making digital learning design, development and implementation more efficient, cost-effective, and most importantly, meaningful on end-users.

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