JOURNAL OF INTERACTIVE MEDIA IN EDUCATION

Educational Technology Research: Contexts, Complexity and Challenges

SPECIAL COLLECTION: HISTORY OF EDUCATIONAL TECHNOLOGY

ARTICLE

EILEEN SCANLON

*Author affiliations can be found in the back matter of this article

ubiquity press

ABSTRACT

This paper explores the development of educational technology research over the last 50 years. This is done by considering what has influenced this development and what are current trends. The issue is further explored by considering what influence these trends have had on the development of distance learning pedagogy, especially for the education of adults.

Technology Enhanced Learning or educational technology research (TEL) is a relatively young area of research. The work of educational technologists and others involved in education research has indeed been interdisciplinary. So, part of the exploration of trends in this paper has been directed towards understanding the impact of other areas of research on progress in educational technology research.

A central focus of the paper is the understanding of how the "TEL Complex" (Scanlon et al. 2013) encapsulates some of these influences both from interdisciplinary perspectives and from an understanding of the complexity which has to be considered as part of the situatedness of the developments.

The paper discusses some key contemporary trends in educational technology research. These are identified as personalisation, social learning, learning design, machine learning, and data driven improvement. These are worthy of exploration, in part, because each has a basis in early work in the field and therefore illustrate some continuing concerns. The paper concludes by acknowledging the broader influences on the development of educational technology and the complexity of the challenges facing the field and its practical applications.

CORRESPONDING AUTHOR:
Eileen Scanlon
OU, GB
es51@hotmail.co.uk

KEYWORDS:
educational technology; theories; distance learning; complexity; technology enhanced learning

TO CITE THIS ARTICLE:
Scanlon, E. 2021. Educational Technology Research: Contexts, Complexity and Challenges. *Journal of Interactive Media in Education*, 2021(1): 2, pp. 1–12. DOI: *https://doi.org/10.5334/jime.580*

INTRODUCTION

Educational technology has a short history, but it is still a longer history than many people realise. This is partly because it is continually being discovered as a new field by refugees from other disciplinary silos. In addition, it is fertile ground for exploration by those searching solutions to practical problems they encounter while teaching and learning.

It is interesting to consider what influences the development of educational technology and its uptake. Various sources of influence have been proposed as making such an impact. One discussion considers that it is technology development that drives changes in educational technology. Or do societal changes make demands for new (technological) solutions to educational problems that drive change? (See e.g. Akron & Black 2005, and Janric & Hayes 2019, for other views on these questions.) Therefore, the main research question that this paper aims to address is, looking at the development of educational technology, what drives development and what changes can be detected?

DEFINITIONS AND CONTEXT

To answer such questions, it is important to consider what is meant by educational technology and how have such definitions evolved over the last 50 or so years. One location from which to consider such trends is the UK Open University. The need for expertise in educational technology at the UK Open University was recognised from the beginning of the institution. Its first Vice-Chancellor, Walter Perry, described a need for staff skilled in "*all the modern methods of educational technology*" (Perry 1969). David Hawkridge (1973), the founding Director of the Open University's Institute of Educational Technology (IET), was appointed to a chair in Applied Educational Sciences. Part of the Institute's role was to "*provide the Course Teams with continuous diagnostic feedback as a basis for remedial guidance, revision and recycling*". His early writing on the challenges he, and other colleagues, faced in developing distance learning for adults in 1969 and in the early 1970s, describes the foundations of instructional design as key to their finding solutions. In particular, he recognises the work of Briggs (1970) and others from the American Institute for Research, where he previously worked, as influential in this regard.

Rowntree, another contemporary of Hawkridge's at the OU, in 1979 defined educational technology as "*the design and evaluation of curricula and learning experiences with the problems of implementing and renovating them*" (cited in Issroff & Scanlon 2002). In a text from 1983 we are told "*An old joke is the only successful piece of educational technology is the school bus*" (O'Shea & Self 1983: 59). But the authors go on to make the serious point that the history of educational technology has moved from a position where devices and equipment are seen as defining educational technology to a more contemporary view that educational technology is best seen instead as "*a branch of behavioural science*."

Critiques of the view of educational technology as potentially being too narrowly defined as prescriptive, and limited only to influences from behavioural sciences, fail to recognise the development and influence of broader theoretical perspectives on teaching and learning. These theoretical perspectives do influence the practices developed to improve teaching and learning, as do new technological affordances. It is the interaction between these facets that makes educational technology research interesting.

Over the past thirty years, a variety of different terms have been used to refer to educational technology. The contemporary term which, in my view, best captures the essence of educational technology is technology enhanced learning (TEL). This term became popular thanks to a number of European Union funding streams such as the Horizon programme in the early 1990s. Two EU funded networks of excellence: *Kaleidoscope*, aimed at understanding learning with digital technologies, and *STELLAR* (Sustaining Technology Enhanced Learning in Large-Scale multi-disciplinary Research), which concentrated on bringing together different expertise, both adopted the term. In the UK the term (TEL) was popularised when the Joint Research Councils adopted it for their research programme in 2006 (the Teaching and Learning Research Programme on Technology Enhanced Learning) referring to work "*exploring the ways in which technologies can be used for learning*" (Conole et al. 2010: 4).

One recent definition of TEL which has been widely cited was provided by Bayne in 2014. She described Technology Enhanced Learning as "*a descriptive shorthand for what is in fact a complex*

and often problematic constellation of social, technological and educational change." (Bayne 2014: 5) This is a helpful definition as it highlights that the term is anything but simple. Another recent discussion of Technology Enhanced Learning echoes this complexity. "*Technology-enhanced learning consists of much more than a set of research-informed products. It is a complex system, which includes communities, technologies and practices that are informed by pedagogy (the theory and practice of teaching, learning and assessment).*" (Scanlon et al. 2013: 3). This definition emerged from the work of the *Beyond Prototypes* project (Scanlon et al. 2013) and this project provides the underlying theoretical framework for this paper. The project was an in-depth examination of the processes of research innovation in technology-enhanced learning. In the first phase, around 100 projects, products and programmes were considered. Desk research, leading to case study accounts constructed of educational technology projects and interviews were conducted with key participants. A selection of these projects were then examined in depth. In the second research phase, project team members, with a range of expertise in different fields, worked together to analyse the data and develop insights. Key findings were related to how educational technology projects could bring about change and improvement in education. The findings illustrated various aspects of what leads to significant and lasting change. A key finding was that TEL innovation and research requires long-term shifts in practice and therefore persistent intent from researchers, but, in particular, an understanding of the complexity of TEL research and innovation.

The concern that the complexity of TEL may be problematic is recognised in this *Beyond Prototypes* account which asserts that all the elements of the "*TEL Complex*" must be taken into account in order to design, develop and embed a TEL innovation successfully in an educational intervention. Nevertheless, the vision of how learning may be enhanced by the appropriate use of technology is considered to be at the centre of this "TEL Complex" (see ***Figure 1***).

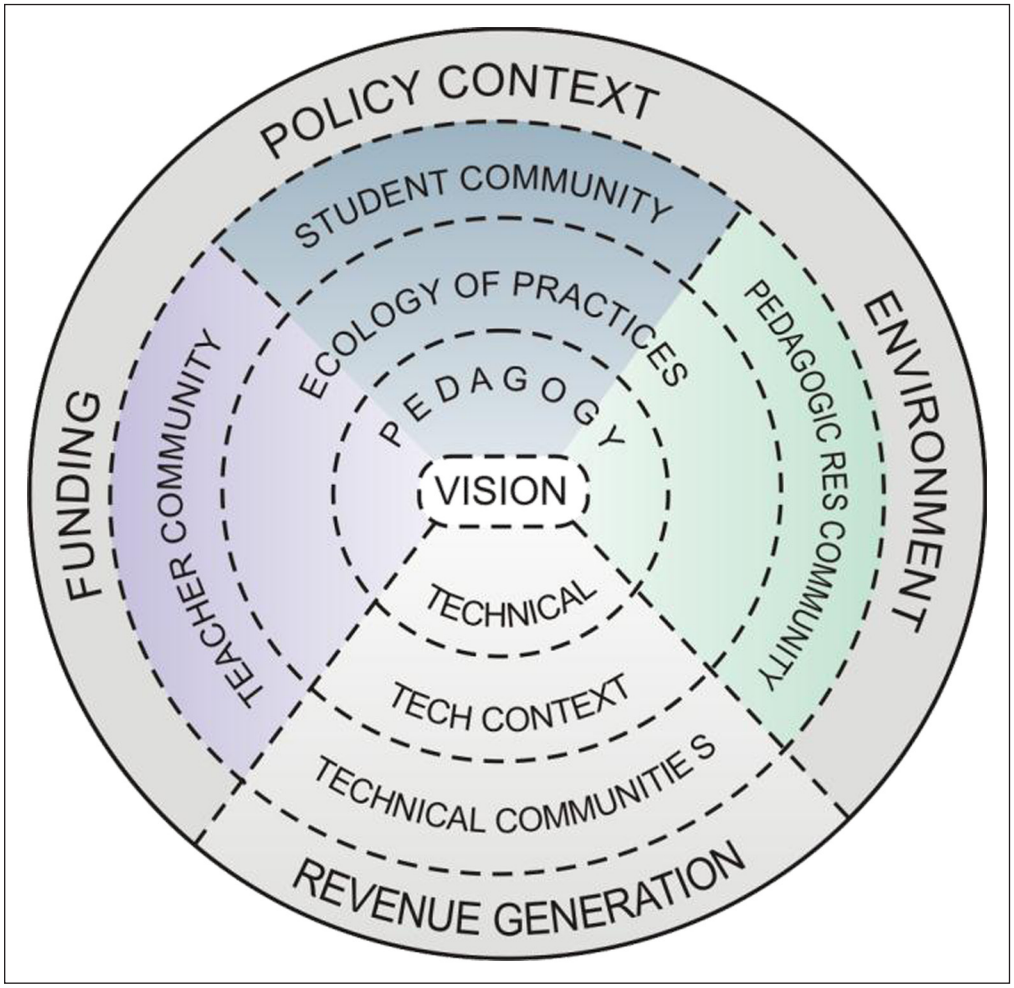

Figure 1 The TEL Complex: adapted with permission from Scanlon et al. 2013.

The "TEL Complex" is a way of representing the complexity of the ecosystem in which solutions to educational challenges involving technology are situated. This ecosystem has four main elements: pedagogy, technical components, ecology of practices and technical context communities.

Pedagogy is described as "a *theorised* approach to teaching and learning" (Ferguson et al. 2016). Noss (2013) describes pedagogy as "*an extremely complex and distinctive process which involves both student and teacher engagement, delivering a set of educational services by means of specific channels*." (Noss 2013: 28). In this view, the technical components support the pedagogy in order to achieve the aim of enhancing learning. Any example of TEL will be implemented in a specific context so practices and the communities such involved are important.

This *Beyond Prototypes* framework is used as the central theoretical framework in this paper. Consideration of this framework provides some suggestions about what factors need to be considered when looking at changes within educational technology. The framework elucidates the complexity and then allows us to consider what results in change in this "TEL Complex". The complex picture of influences revealed in the *Beyond Prototypes* project presents an account of all the aspects which need to be considered if change is to be effected. The pedagogic element, the technical context, the ecology of practices all have an influence. So, in terms of our central question related to how development and change have emerged over time in educational technology it suggests that a simplistic view of technology development leading to change is not sufficient.

In the sections which follow, discussing the themes identified for examination, the approach taken will consider the influence of the theoretical underpinnings on developments. First, the findings of a research study asking educational technologists to discuss theoretical influences are discussed. Secondly, a more detailed description of key themes identified for consideration in this paper is offered.

RESEARCHERS' VIEWS ON THE ROLE OF THEORY IN EDUCATIONAL TECHNOLOGY

As part of the aforementioned UK Joint Research Councils' programme on Technology Enhanced Learning, Scanlon and Conole conducted a study of people working on the funded TEL research projects (Scanlon & Conole 2018). They conducted interviews which included some probing questions as to the views of participants on what they regarded as their most important theoretical influences. The work of Dewey (1916) and Laurillard (2002) was mentioned by some. The work of Vygotsky (1980), Engeström (1987) and others on Activity Theory were cited by many as an important influence. The interviews illustrated the way in which in TEL research work a broad literature is being drawn on, literature coming from across different disciplines in addition to a broad range of theories. These texts in the literature they cited are drawn from a wide number of disciplines. How can theories be integrated or developed to produce a distinctive educational technology perspective?

ACTIVITY THEORY

The influential work on Activity Theory by Engström (1987) has produced a more nuanced interpretation of the world view described as the "TEL Complex" in the *Beyond Prototypes* report and of what it implies for impacting work on educational technology research. Waycott et al. (2005) have demonstrated that the emphasis Activity Theory places on tools as mediators of activity leads to a refreshing concern for paying attention to the activity itself, not simply to the technology used in it. This emphasis focuses attention on the activity itself, on its purpose. In addition, this approach leads to analysis of an interactive dynamic process of users or learners and their tools rather than simply the focussing on the technology alone.

Waycott writes that her work on mobile tools for learning: "*[...] revealed a two-way process in which the user adapts the tools they use according to their everyday practice and preferences in order to carry out their activities; and how, in turn, the tools themselves also modify the activities that the user is engaged in*." (Waycott 2005: 107)

Scanlon et al. (2005) have built on this work to describe how, with the introduction of technology to an educational activity, the activity itself is changed. They used the example of mobile technology introduced to science learning settings, and the extent to which developments in mobile technology offered new possibilities to be exploited in teaching settings. This work reveals the complexity of the question being addressed in this paper. Technological developments lead to new possibilities and working on activities can provide changes to tools.

INTERDISCIPLINARITY

In an earlier study Issroff and Scanlon (2002) also wrote about the different influences on theories of educational technology citing Artificial Intelligence (AI), Human Computer Interaction (HCI) and Education as main sources for these influences. They were inspired by the writing of Rogers (2000) about the ways in which HCI had changed over time by its incorporation of a wider set of influences, from many fields including anthropology. Issroff and Scanlon recognised the influence of changing theoretical perspectives over time in the formation of relatively new disciplines such as educational technology, in line with those who have studied the development of disciplines (see e.g. Nowotny 1994). Further investigation of interdisciplinary working in TEL research (Herodotou et al. 2020) confirms the requirements identified for work on educational technology projects to be open to a wide variety of influences.

EDUCATIONAL TECHNOLOGY IS WHAT EDUCATIONAL TECHNOLOGISTS DO

Updating Hawkridge's description of educational technology at the Open University in the Institute of Educational Technology (IET), Ferguson et al. (2019) wrote about the forty-year development of an Open University research group based in the Institute of Educational Technology which has specialised in the study of Computers and Learning (CALRG). In the introduction, four insights from the work of the group are outlined. The book reports on the group's experiences in using technology to support the learners working at a distance in the university. The authors report the experiences of researchers in the group to explain the insights that developed with the use of educational technology approaches to research, design, development and research: teams can successfully teach any number of students at a distance; learning at a distance is accessible for everyone; teaching at a distance is adapted to meet learners' needs; and learners engage enthusiastically with Science, Technology Engineering and Mathematics (STEM) learning. Each of these items is based on the findings of a coordinated programme of research within the group. The first objective of the group was "*to carry out a coordinated programme of research into ways computers can be used to improve the quality of education*" (Jones & Scanlon 1981). In their edited book Jones, Scanlon and O'Shea (1987) explained that all the work described within the book "*had a distance education (or training) setting in mind*" (Preface: x). Hence

> "*there was not only a strong commitment to researching teaching, but also a desire to understand how technology could improve teaching and learning within the distance learning context of the OU.*" (Jones et al. 1987: 4)

More recently in pursuit of this understanding the researchers based in the IET have produced a series of reports in the series "*Innovating Pedagogy*." Herodotou et al. (2019) report on this collaborative activity conducted with colleagues over the past few years to assess the opportunities presented by contemporary examples of the interaction of technology and pedagogy. The series of reports explores new forms of teaching, learning and assessment for a digital world, and aims to guide teachers and policy makers in productive innovation. In the 2019 summary paper reviewing that work, the impetus behind it is described as working towards "*reducing the distance between aspirations or vision for the future of education and current educational practice*" (Herodotou et al. 2019: 12). Our research and horizon scanning over the years have offered us a useful perspective on what has changed in educational technology research and what has stayed the same, together with a sense of what the implications of this research are for distance learning pedagogy and technology.

KEY ISSUES

I have used these experiences to choose a few areas to discuss in this paper in order to consider the consequences of changes in educational technology and the trajectories within that work. The areas chosen are personalisation and adaptive instruction, societal influences and social learning, artificial intelligence and machine learning and learning analytics, learning design and data driven approaches.

An alternative approach to identifying trends in educational technology research can be aligned with systematic review methods and is widely used (see e.g. Delgado Kloos et al. 2014).

The decision not to follow a systematic literature review method was taken after a consideration of the purpose of this paper. An issue of concern was to settle on an appropriate method that would best capture the historical flow of trends and capture influences on a developing field. This is because the intention here is not to review evidence on a particular topic or answer the question of effectiveness of a particular educational technology solution but to highlight areas of interest which have been studied by educational technologists over the period. Instead a synoptic view is produced, describing some interesting research work in its historical context, an approach which can offer some commentary about the development of educational practices (see e.g. Cohen et al. 2007).

It is interesting to note, however that Lai and Bower (2019) in their recent systematic review of systematic reviews of educational technology (73 in number) also identify some themes which have been considered in one or more of these reviews. It emerged that themes they identified include learning outcomes and design, affective and social elements, technological innovation, and teaching techniques (including personalisation). These categories map well on to the areas selected for consideration in this paper. They also feature in the *Innovating Pedagogy* series of reports described earlier, but added to them is a section of this paper on the Artificial Intelligence approaches which are becoming highlighted in educational technology research, added in response to the recent flurry of activity in this area.

PERSONALISATION AND ADAPTIVE INSTRUCTION

Personalisation is a contemporary concern in current approaches to teaching and learning but it also has roots in the history of educational technology. The importance of feedback and of adaptive instruction was recognised in the early years of educational technology research (see for example, Reiser and Dempsey, (2012), and Tomei (2013)). It turned out to be surprisingly difficult to deliver the potential benefits of this feedback. McAndrew (2019) writes "*In Hattie's analysis* (Hattie 2008) *of effects of educational innovations, feedback is ranked as one of the areas having highest likely impact, and yet this is a factor that often is either ill-defined or side-lined*." (p. 25)

A wider view of personalisation has been developed in recent years. For example, Jones et al. (2013) review approaches to personalisation coming from both a sociological and technical perspective. They approach this consideration in terms of a project focussing on requirements for personalised inquiry in a school context, interpreting personal inquiry as having three aspects: choice, personal relevance, and learner responsibility. Fitzgerald et al. (2018) conducted more recently a literature review of personalised technology-enhanced learning highlighting the renewed interest in this topic among researchers. Holmes et al. (2018) also comment in their extensive literature review on personalisation in TEL that the term has many meanings. All these commentators point out that there has been a significant shift from considering the importance of individualised or adaptive instruction, to a contemporary concern for motivational factors such as the introduction of personally relevant issues or concerns for study as a way of selecting examples which help to drive student interest and commitment. The interest in personalisation in many settings has been combined with realism in understanding the constraints of fully achieving personalisation within the limits of curriculum and assessment regimes.

SOCIETAL INFLUENCES AND SOCIAL LEARNING

Jones (2010) discussed the importance of affective issues in learning technologies. She described how emotional responses to technology impact learning and the potential role for technology in supporting socio-emotional skills. She writes: "*Learners' perceptions of technology and attitudes towards it are clearly important factors in affecting whether they are likely to make use of such technologies*." (Jones 2010: 12)

Dystopian visions of educational technology have often included images of learners trapped in individual conversations with teaching machines. A very important development in the history of educational technology was the turn towards more social visions of learning. In the 1980s there began to be the realisation of the benefits of collaborative learning and ways in which this could be enhanced by technology particularly for learners studying at a distance from each other. Sharples (2019) highlights this development as not only due to a realisation of the potential positive impact of learning with others, but a realisation that developments

in our understanding of the theories of learning were recognising that knowledge is not just in an individual's head but in some way stored in the network of learners. This "learning as network" view also has become important in understanding the pedagogy of MOOCs. Sharples and Ferguson (2019) remind us that "*Learning as conversation [...] is a comprehensive theory of the cognitive and social processes of learning*" drawing on Laurillard's framework, one of the influential theories often cited by TEL researchers. Meltzoff et al. (2009) discuss what makes social interaction such a powerful catalyst for learning "*A key component is the role of "the social" in learning. What makes social interaction such a powerful catalyst for learning? Can key elements be embodied in technology to improve learning?*" (Meltzoff et al. 2009: 288)

This issue, the social aspect of learning, has gained in importance over time in the development of educational technology research. An initial emphasis on individualised instruction has changed over time into a wider perspective on the range of collaboration and co-creation opportunities which can be provided by judicious use of technologies and, in tandem, a developing understanding of the importance of working with others. A key question which is of continuing interest is considering how to develop effective social networks for learning.

LEARNING DESIGN, ANALYTICS AND DATA DRIVEN IMPROVEMENT

For educational technologists, the lure of evidence to enable principled improvements in the design of learning is strong. Much progress has been made in finding representations to describe these learning designs. For example, Cross et al. (2008, 2012) have experimented during this renaissance of instructional design and developed work investigating various representations of learner activity and established what works to support teachers developing their learning designs. The investigation of how learners respond to teaching materials designed in a particular way with a range of types of activity is one part of this work. Linking this investigation with the outcomes learners achieve studying different courses has been a quite recent development. As Rienties and Jones (2019) write: "*Learning design by itself is just a useful approach to depict how teachers design a particular learning activity or a complete course. Only when learning design is combined with how students are actually engaging with these learning designs do we start to make real progress*." (Rienties & Jones 2019: 128)

This new development of linking learning analytics with learning design has exhibited huge growth of research recently. This is interesting for two reasons. First, there is the belief in the potential of connecting learning design activity with information from learning analytics to enable teachers to better support their students' success. There is also, secondly, increasing pressure on teachers to make use of data to allow them to act on what it implies for improving student outcomes. Rienties and Jones (2019) review this work to assert: "*While there is widespread evidence that learning analytics tools and predictive engines could accurately identify which students might need some additional support, there is mixed evidence* (*Ferguson et al. 2016; Ferguson & Clow 2017; Herodotou et al. 2017; Rienties et al. 2018*) *as to whether universities and teachers in particular are ready to engage with these tools and approaches*" (p. 119). Developments of this work at the OU linking particular designs with better student outcomes are interesting. Also interesting are the experiments with learning analytics dashboards for students and tutors and the use of predictive analytics to identify students in need of real-time help.

In addition to the perceived potential benefits of this work in terms of efficacy, it is also not without controversy on other grounds. Researchers have raised ethical issues including privacy and surveillance concerns. It is a large undertaking for an educational institution to embark on: "*such collection of data and its use faces a number of ethical challenges, including issues of the location and interpretation of data; informed consent, privacy and the de-identification of data; and the classification and management of data.*" (Slade & Prinsloo 2013: 1)

These concerns on data use on ethical grounds include intrusion and privacy. Some concerns address the ethics of collecting such data (which has become easier), and the ethics of collecting data which is not then used or collecting data which is incomplete. Pedagogical decisions could potentially be made on insufficient or misleading data. For example, Coughlan writes: "*While the increase of interactions with technology creates the potential for ever more data to be collected and analysed, this does not necessarily lead to greater understanding of the needs of learners*." (Coughlan et al. 2019: 79)

Nonetheless, opportunities and interest from educational researchers to make use of learning design and analytics are growing fast. There is the opportunity to use these approaches to improve student success and to inform teachers on the impact of learning design decisions. The learning design and learning analytics developments are one example of the increasing role of data collection and interpretation on teaching decisions. Data plays a significant role too in the next trend discussed.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Nafea (2017) describes machine learning as "*a subset of artificial intelligence (AI) that helps computers or teaching machines learn from all previous data and make intelligent decisions*." A contemporary view of Al is that it is a combination of algorithms, machine learning and big data. A set of procedures for solving a problem is the original definition of an algorithm i.e. a list of steps for solving a problem, usually using a computer, and, in that view, a computer program can be viewed as an elaborate algorithm. However, machine learning is where a computer system learns from data rather than being dependent on a programmer's intervention and consequently performs better on such tasks as prediction and is data driven.

The original applications of artificial intelligence methods to education (AIED) resulted in work on intelligent tutoring systems that were built on models of the learning and teaching process (see for example Ritter et al. 2007). The revived interest in Artificial Intelligence in Education (see Holmes et al. 2018, 2019; Luckin et al. 2016; Baker et al. 2019) is therefore an example of the return to a key component of early work in educational technology in the 70s and 80s. In the history of AI work there were several periods when funding dried up (termed by some as *the AI winter*) but in fact work continued and developed. There are several contemporary suggestions for useful applications of AI in educational settings. Examples include repetitious activities that students and staff engage in which could be automated and assumed to provide cost-savings by responding automatically to frequently asked questions. The assumption is that current technology which, for example, allows the construction of chatbots, could be developed to learn to effectively support learners. One example of this is the current *Assistants for the Disclosure and Management of Information about Needs and Support* project (ADMINS). This project is taking an artificial intelligence (AI) approach to the design of a virtual assistant (VA), to reduce the administrative burden on students to disclose any disabilities, and allow accessible support to be offered (Iniesto et al. 2020).

A key feature of work on AI and Education has been its use as an approach to understanding how learning takes place, often producing models of learning which can be tested. The new work in this area while recognising some successes of the past, identifies these successes as often siloed examples and it is suggested that what is required is a holistic approach to the work in the education system, recognising the role of teacher, technology solution, learner needs and an understanding of the setting in which the AIED solution is employed. Luckin et al. (2016) offer this contemporary perspective and write: "*AIED offers the possibility of learning that is more personalised, flexible, inclusive, and engaging. It can provide teachers and learners with the tools that allow us to respond not only to what is being learnt, but also to how it is being learnt, and how the student feels. It can help learners develop the knowledge and skills that employers are seeking, and it can help teachers create more sophisticated learning environments than would otherwise be possible*" (p. 11). It is interesting that their concern is both for better learning environments but also the focus on knowledge and skills for employment. "[...] *we should harness the power and strength of AI itself. In that way we can help teachers to equip learners – whatever their age – with the knowledge and flexible skills that will allow them to unleash their human intelligence and thrive in this re-shaped workplace*." (ibid: 11)

Yu et al. (2017) apply ideas from emerging AI techniques to current MOOC teaching which they assert is still more focused on standardisation, not personalisation and has the potential to use tools for learning at scale. They suggest that knowledge representation tools could be used by students to design their own learning paths. Another suggestion is that "*optimization techniques can efficiently match community teaching assistants to MOOC mediation tasks to offer personal attention to learners*" (Yu et al. 2017: 12). More speculatively they consider the prospects for the construction of virtual learning companions with human capabilities such as emotion and curiosity.

Luckin et al. (2016) reiterate the importance of involving teachers, students, and parents to ensure that future AIED systems meet their needs. Adopting the methods of participatory design which have become popular in constituent disciplines such as HCI they propose that this would lead to better AIED products, with the result that teachers would become more knowledgeable about the processes of learning, and students become more successful learners. All of these processes are also linked to the development of data standards with attention to ethical uses of data and standards underlying data use.

Some of these visions of future opportunities for educational researchers from making use of AI are enticing. The opportunity to use data from students' experiences of learning at scale, to help develop more knowledge about the most effective learning paths for students to provide more suitable help could be very attractive to organisations aiming to maximise retention of students and improve their progression through courses.

DISCUSSION

This consideration of the history of the development of educational technology as a field of study recognises that it is deeply rooted in the experiences of practitioners. Educational technology is also oriented towards the solution of problems or challenges in improving the learning experiences of students. This desire to solve practical problems and improve the outcomes for learners helps to remind us of the complexity of all the aspects we need to consider in developing educational technology-based approaches to problems in teaching and learning but also demonstrates the potential impact of such approaches. The perspective of educational technology as a field which draws on the influences of the prior training of its practitioners, whether from the behavioural sciences, the humanities or even economics, is a helpful reminder of the contributions which can be made by the 'birth' disciplines of its researchers. It allows us to consider the ways in which interdisciplinary working is shaping the field.

In terms of the focus of attention displayed by current education technologists, I have discussed some key trends which can be seen to have been developing from early years of this work but also given a second wind by recent technological developments. Of these trends, personalisation, AIED, and data driven approaches such as learning analytics are currently the subject of much commentary. A welcome corrective to considering only these trends is the horizon scanning conducted at the OU, but also by other organisations which encourages consideration of a wider range of new technologies which are being developed. For example, the *Innovating Pedagogy* report for 2020 from the Open University highlights 10 pedagogies influenced by technology to watch in the future. Only one of these is based on AI techniques.

One challenge in our contemporary concerns arises from the essential contradiction between a move towards personalisation and a move to the social approaches to instruction. The challenge is whether individualisation of instruction or adaptive or prescribed individual learning pathways can be combined with the benefits of social and group approaches to participation Perhaps most pleasing is the continuing insistence in distance teaching and learning on evidence-based pedagogies. This continues a long tradition of recognising the importance that has been placed within the field on developing good evidence in the evaluation of innovations. Despite the challenging vision of the "TEL Complex" as the truly complex world in which we sometimes struggle to make progress, the better understanding of this complexity enriches current approaches to the meaningful conduct of evaluations of learning. In addition, this vision highlights the complex relationship between developments in technology and the related changes in activity.

CONCLUSIONS

In this paper I have argued that educational technology is a field with a rich history with influences from a wide variety of disciplinary sources. It is not without theoretical influences arising from many different fields in which such advances are being made. Educational technologists work on devising innovative ways of supporting learners and teachers in complex settings. The paper has argued that a simplistic view that educational technology research is a form of technology evangelism, or that it is impoverished as to the theories of learning it draws on to develop good quality learning experiences, does not stand up to scrutiny.

To return to our main research question, in this paper reflecting on the development of educational technology, the interest has been in considering what drives development and in examining what changes have taken place. The consideration of whether technology development drives changes in educational technology or that societal changes make demands for new (technological) solutions to educational problems has illustrated that these two influences on the development of educational technology research (technology development and changes in society) are both influencing practice. What remains in educational technology research and practice is an increased and nuanced understanding of the complexity of teaching and learning supported by technology.

ACKNOWLEDGEMENTS

My thanks are due to colleagues with whom I have worked in the various projects mentioned throughout this paper. In particular, Simon Cross, Ann Jones, Kim Issroff, Rebecca Ferguson and Mike Sharples. My thanks are also due to Tim O'Shea for commenting on the drafts.

COMPETING INTERESTS

The author has no competing interests to declare.

AUTHOR AFFILIATION


Eileen Scanlon *orcid.org/0000-0003-1180-682X*
OU, GB

REFERENCES

Akron, M and **Black, P.** 2005. *Changing the subject*, OECD.

Baker, T, Smith, L and **Anissa, N.** 2019. *Educ-AI-tion Rebooted? Exploring the future of artificial intelligence in schools and colleges*. Available at *https://media.nesta.org.uk/documents/Future_of_AI_and_education_v5_WEB.pdf.*

Bayne, S. 2014. What's the matter with 'technology enhanced learning'? *Learning, Media and Technology*, 40(1), 5–20. DOI: *https://doi.org/10.1080/17439884.2014.915851*

Briggs, LJ. 1970. *Handbook of procedures for the design of instruction*. Pittsburgh, PA: American Institutes for Research.

Cohen, L, Manion, L and **Morrison, K.** 2007. *Research methods in education* (6th edition). London: Routledge.

Conole, G, Scanlon, E, Mundin, P and **Farrow, R.** 2010. Interdisciplinary research: Findings from the TEL research programme. *TEL Programme*. Available at *http://oro.open.ac.uk/25107/.*

Coughlan, T, Lister, K, Seale, J, Scanlon, E and **Weller, M.** 2019. Accessible inclusive learning: Futures. In: Ferguson, R, Jones, A and Scanlon, E (eds.), *Educational visions: The lessons from 40 years of innovation*. London: Ubiquity press, pp. 75–91. DOI: *https://doi.org/10.5334/bcg.e*

Cross, S, Conole, G, Clark, P, Brasher, A and **Weller, M.** 2008. Mapping a landscape of learning design: Identifying key trends in current practice at the Open University. In: *2008 European LAMS Conference*, 25–27 Jun 2008, Cadiz, Spain.

Cross, S, Galley, R, Brasher, A and **Weller, M.** 2012. *Final project report of the OULDI-JISC project: Challenge and change in curriculum design process, communities, visualisation, and practice*. Available at *http://www.jisc.ac.uk/media/documents/programmes/curriculumdesign/OULDI_Final_Report_instit%20story.pdf.*

Delgado Kloos, C, Ibáñez-Espiga, M, Fernández-Panadero, C, Muñoz-Merino, P, Estévez-Ayres, I, Crespo-García, RM and **Alario-Hoyos, C.** 2014. A Multidimensional analysis of trends in educational technology. *2014 IEEE Frontiers in Education Conference*, 395–398. DOI: *https://doi.org/10.1109/FIE.2014.7044053*

Dewey, J. 1916. *Democracy and education: An introduction to the philosophy of education*. New York, NY: The Free Press.

Engstrom, Y. 1987. *Learning by expanding: An activity-theoretical approach to developmental research*. New York, NY: Cambridge University Press.

Ferguson, R, Brasher, A, Clow, D, Cooper, A, Hillaire, G, Mittelmeier, J, Rienties, B, Ullmann, T and **Vuorikari, R.** 2016. Research evidence on the use of learning analytics – implications for education policy. In Vuorikari, R and Castaño Muñoz, J (eds.), *Joint Research Centre Science for Policy Report; EUR 28294 EN*. DOI: *https://doi.org/10.2791/955210*

Ferguson, R and **Clow, D.** 2017. Where is the evidence? A call to action for learning analytics. In: *LAK '17 Proceedings of the Seventh International Learning Analytics & Knowledge Conference, ACM International Conference Proceeding Series, ACM*, New York, USA, pp. 56–65. DOI: https://doi.org/10.1145/3027385.3027396

Ferguson, R, Jones, A and **Scanlon, E.** 2019. *Educational visions: The lessons from 40 years of innovation*. London: Ubiquity Press. DOI: https://doi.org/10.5334/bcg

FitzGerald, E, Jones, A, Kucirkova, N and **Scanlon, E.** 2018. A literature synthesis of personalised technology-enhanced learning: What works and why. *Research in Learning Technology*, 26: article no. 2095. DOI: https://doi.org/10.25304/rlt.v26.2095

Hattie, J. 2008. *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Abingdon, Oxon: Routledge. DOI: https://doi.org/10.4324/9780203887332

Hawkridge, D. 1973. *Media taxonomies and media selection. ERIC*. Available at https://eric.ed.gov/?id=ED092067 (last accessed 4 Sept 2020).

Herodotou, C, Rienties, B, Boroowa, A, Zdrahal, Z, Hlosta, M and **Naydenova, G.** 2017. Implementing predictive learning analytics on a large scale: The teacher's perspective. In: *Proceedings of the Seventh International Learning Analytics & Knowledge Conference, ACM*, NY, pp. 267–271. DOI: https://doi.org/10.1145/3027385.3027397

Herodotou, C, Sharples, M, Gaved, M, Kukulska-Hulme, A, Rienties, B, Scanlon, E and **Whitelock, D.** 2019. Innovative pedagogies of the future: An evidence-based selection. *Frontiers in Education*, 4: article no. 113. DOI: https://doi.org/10.3389/feduc.2019.00113

Herodotou, C, Papathoma, T, Davies, G, Gaved, M and **Scanlon, E.** 2020. Interdisciplinary research in technology-enhanced learning: Strategies for effective working. In: *International Conference of the Learning Sciences (ICLS 2020)*, 19–23 Jun 2020, Nashville, TN, USA.

Herodotou, C, Rienties, B, Boroowa, A, Zdrahal, Z and **Hlosta, M.** 2019. A large-scale implementation of predictive learning analytics in higher education: The teachers' role and perspective. *Educational Technology Research and Development*, 67(5): 273–1306. DOI: https://doi.org/10.1007/s11423-019-09685-0

Holmes, W, Anastopoulou, S, Schaumburg, H and **Mavrikis, M.** 2018. *Technology-enhanced personalised learning: Untangling the evidence*. Stuttgart: Robert Bosch Stiftung GmbH.

Holmes, W, Bialik, M and **Fadel, C.** 2019. *Artificial Intelligence in education. Promise and implications for teaching and learning*. Boston: Centre for Curriculum Design.

Issroff, K and **Scanlon, E.** 2002. Educational technology: The influence of theory. *Journal of Interactive Media in Education*, 2002 (6). ISSN: 1365-893X [www-jime.open.ac.uk/ 2002/6]. DOI: https://doi.org/10.5334/2002-6

Janric, J and **Hayes, S.** 2019. Who drives the drivers? In: Saltman, KJ and Means, AJ (eds.), *The Wiley handbook of global educational reform*. © 2019 John Wiley & Sons, Inc. DOI: https://doi.org/10.1002/9781119082316.ch15

Jones, A. 2010. Affective issues in learning technologies: Emotional responses to technology and technology's role in supporting socio-emotional skills. *Journal of Interactive Media in Education*, 2010(2): Art 9. DOI: https://doi.org/10.5334/2010-9

Jones, A and **Scanlon, E.** 1981. A review of research in the CAL group: A report of the first annual conference, November, CALRG Technical Report No. 27, Open University, Milton Keynes.

Jones, A, Scanlon, E, Gaved, M, Blake, C, Collins, T, Clough, G, Kerawalla, L, Littleton, K, Mulholland, P, Petrou, M and **Twiner, A.** 2013. Challenges in personalisation: Supporting mobile science inquiry learning across contexts. *Research and Practice in Technology Enhanced Learning*, 8(1): 21–42.

Jones, A, Scanlon, E and **O'Shea, T.** (eds.) 1987. *The computer revolution: New technologies for distance teaching*. Brighton: Harvester Press.

Iniesto, F, Coughlan, T, Lister, K and **Holmes, W.** 2020. Designing an assistant for the disclosure and management of information about needs and support: The ADMINS project. In: *22nd International ACM SIGACCESS Conference on Computers and Accessibility*, 26–28 Oct 2020, Athens, Greece (Online). DOI: https://doi.org/10.1145/3373625.3418017

Lai, J and **Bower, M.** 2019. Evaluation of technology use in education: Findings from a critical analysis of systematic literature reviews. *Journal of Computer Assisted Learning*, 36(3): 241–259. DOI: https://doi.org/10.1111/jcal.12412

Laurillard, D. 2002. *Rethinking university teaching: A conversational framework for the effective use of learning technologies* (2nd ed.) London: Routledge. DOI: https://doi.org/10.4324/9780203304846

Luckin, R, Holmes, W, Forcier, L and **Griffiths, M.** 2016. *Intelligence unleashed. An argument for AI in education*. London: Pearson.

Meltzoff, N, Kuhl, PK, Movellan, J and **Sejnowski, TJ.** 2009. Foundations for a new science of learning. *Science*, 325(5938): 284. DOI: https://doi.org/10.1126/science.1175626

McAndrew, P. 2019. Teaching and learning: Foundations. In: Ferguson, R, Jones, A and Scanlon, E (eds.) *Educational visions: The lessons from 40 years of innovation*. London: Ubiquity press, pp. 75–91.

Nafea, I. 2017. Machine learning in educational technology. In: Farhadi, H (ed.), *Machine learning – advanced techniques and emerging applications*. InTechOpen. DOI: *https://doi.org/10.5772/intechopen.72906*

Nowotny, H. 1994. *The new production of knowledge: The dynamics of science and research in contemporary societies*. London Thousand Oaks, California: SAGE Publications. ISBN 9780803977945.

Noss, R. 2013. Does technology enhance learning? Some findings from the UK's technology enhanced learning (TEL) research programme. Available at: *http://www.tlrp.org/docs/enhance.pdf* (Last accessed 25 September 2020).

O'Shea, T and **Self, J.** 1983. *Learning and teaching with computers*. Brighton: Harvester Press.

Perry, W. 1969. *Establishment of an applied educational science unit*. Council Paper C/II/3. Milton Keynes: Open University.

Reiser, R and **Dempsey, J.** 2012. *Trends and issues in instructional design and technology*. 3rd edition. Saddle River, NJ: Pearson Publishing.

Rienties, B, Herodotou, C, Olney, T, Schencks, M, and **Boroowa, A.** 2018. Making sense of learning analytics dashboards: A technology acceptance perspective of 95 teachers. *International Review of Research in Open and Distributed Learning*, 19(5):186–202. DOI: *https://doi.org/10.19173/irrodl.v19i5.3493*

Rienties, B and **Jones, A.** 2019. Evidence-based learning: Futures. Using learning design and learning analytics to empower teachers to meet students' diverse needs. In: Ferguson, R, Jones, A and Scanlon, E (eds.), *Educational Visions: The lessons from 40 years of innovation*. London: Ubiquity Press, pp. 109–125. DOI: *https://doi.org/10.5334/bcg.g*

Ritter, S, Anderson, J, Koedinger, K and **Corbett, A.** 2007. Tutor: Applied research in mathematics education. *Psychonomic Bulletin & Review*, 14(2): 249–255. DOI: *https://doi.org/10.3758/BF03194060*

Rogers, Y. 2000. *Recent theoretical developments in HCI; Their value for informing systems design*. Available at *http://www.cogs.sussex.ac.uk/users/yvonner/.*

Rowntree, D. 1979. *Educational technology in curriculum development*. London: Harper and Row.

Scanlon, E and **Conole, G.** 2018. Interdisciplinarity in technology enhanced learning: An interview study. *Journal of Interactive Media in Education*, 2018(1): 11. DOI: *https://doi.org/10.5334/jime.476*

Scanlon, E, Jones, A and **Waycott, J.** 2005. Mobile technologies: Prospects for their use in learning in informal science settings/*Journal of Interactive Media in Education*, 21(5): 2005/25. ISSN:1365-893X [*jime.open.ac.uk/* 2005/25]. DOI: *https://doi.org/10.5334/2005-25*

Scanlon, E, Sharples, M, Fenton-O'Creevy, M, Fleck, J, Cooban, C, Ferguson, R, Cross, S and **Waterhouse, P.** 2013. *Beyond prototypes: Enabling innovation in technology-enhanced learning*. DOI: *http://doi.org/10.13140/2.1.1026.8163*

Sharples, M. 2019. *Practical pedagogy*. London: Routledge.

Sharples, M and **Ferguson, R.** 2019. Pedagogy-informed design of conversational learning at scale. In: *CEUR Workshop Proceedings*, 2437. DOI: *https://doi.org/10.1145/3330430.3333642*

Slade, S and **Prinsloo, P.** 2013. Learning analytics: Ethical issues and dilemmas. *American Behavioral Scientist*, 57(10): 1509–1528. DOI: *https://doi.org/10.1177/0002764213479366*

Tomei, LA. 2013. *Learning tools and teaching approaches through ICT advancements*. Hershey, PA: Information Science Reference. DOI: *https://doi.org/10.4018/978-1-4666-2017-9*

Vygotsky, L. 1980. *Mind and society*: *The development of higher psychological processes*. Cambridge, MA: Harvard University Press. DOI: *https://doi.org/10.2307/j.ctvjf9vz4*

Waycott, J, Jones, A and **Scanlon, E.** 2005. PDAs as lifelong learning tools: An activity-theory based analysis. *Learning, Media and Technology*, 30(2): 107–130. DOI: *https://doi.org/10.1080/17439880500093513*

Yu, H, Miao, C, Leung, C and **White, TJ.** 2017. Towards AI-powered personalization in MOOC learning. *NPJ Science Learn*, 2: 15(2017). DOI: *https://doi.org/10.1038/s41539-017-0016-3*

TO CITE THIS ARTICLE:
Scanlon, E. 2021. Educational Technology Research: Contexts, Complexity and Challenges. *Journal of Interactive Media in Education*, 2021(1): 2, pp. 1–12. DOI: *https://doi.org/10.5334/jime.580*

Submitted: 02 March 2020
Accepted: 29 September 2020
Published: 26 February 2021

Journal of Interactive Media in Education is a peer-reviewed open access journal published by Ubiquity Press.