

**Bridging the chasm – a study of the realities of
edtech use among trainee teachers**

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Abstract

This paper evaluates the findings of a small scale research project into how trainee teachers can use technology for educational purposes. The paper is inspired by an apparent disconnect between the availability of educational technology (abbreviated from here to edtech) and the frequency and impact of its use. Furthermore, the paper aims to assess the extent to which trainee teachers are developing the skills and behaviours that are deemed necessary for the digital world. This paper's focus is on the use of edtech with a cohort of trainee teachers. The first cohort is comprised of Secondary PGDE students, the second of PGCE trainee teachers specialising in Further Education and Training. A complementary element to the research reveals the disparities between individual trainees in their confidence towards using edtech and the barriers that are inhibiting the use of edtech. The work adheres to the principles of action research and was supported by two universities in the north of England. Through online questionnaires using Surveyhero.com, and focus groups, this paper raised some notable issues and areas for further study.

Keywords

Technology; technology enhanced learning, PGCE, edtech; eLearning; I.T.E, teaching; Secondary; schools; UK.

Background

This paper is concerned with the ways in which Secondary trainee teachers use educational technology (or edtech). The piece adheres to the conventions and guidelines of action research. Two universities in the United Kingdom backed the research.

Literature Review

This section will interrogate and contextualise the literature that underpins this study. Edtech describes the application of information and communication technologies to teaching and learning (Atherton, 2018b; Kirkwood and Price, 2013). An overarching challenge for any teacher who considers using edtech is whether it is likely to develop a teacher's pedagogy and, in doing so, deepen or accelerate their students' learning process (Atherton, 2018a; Higgins, Zhi Min Xiao & Katsipataki, 2011; Kirkwood, 2014).

The evidence that using edtech has an impact

One of the challenges in reviewing the literature has been that the way young people use technology is complex and its pace of change is outstripping that of education (Atherton, 2018a, Baker, Smith and Anissa, 2019). This can lead to a disconnect between the knowledge-base relating to edtech and the realities of cash-strapped schools. A further complication arises from how these compare to the outside world (Atherton, 2018a, Baker, Smith and Anissa, cited in NESTA, 2019). Though pedagogy itself changes slowly, the technologies that support it are elusive and, as in the Myth of Proteus, change their form just as teachers are able to understand them (Atherton, 2018a; Siemens 2005; Raffaghelli, Cucchiara, Persico, 2015). Furthermore, once the evidence of impact has been

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demonstrated, there is frequently a paucity of good quality advice to teachers, because of a lack of edtech infrastructure (Baker, Smith and Anissa, cited in NESTA 2019; Atherton, 2018a). An example of this is the use of artificial intelligence (AI) in schools. There may be clear evidence in the literature that AI can be deployed effectively to support humans making decisions about other humans. The adoption of AI, however, is retarded by fear, distrust and lack of clarity (Luckin and Kent, 2019, Selwyn, 2014). An additional set of issues arise from timing: development of edtech is often iterative and there can be a rush to disseminate evidence at the expense of robustness (King et al, 2014; Baker, Smith and Anissa, cited in NESTA 2019). When the research is disseminated, there are potential issues in terms of its usefulness. For example, if a testbed reports on an edtech platform and its pedagogical uses, it may be of limited value to teachers, who may find it hard to apply it to their own context (Baker, Smith and Anissa, cited in NESTA, 2019). In the words of Barlex and Carre (1985), *“We do not see things as they are, we see them as we are”* (p.4) (cited in McLain, Barlex, Bell and Hardy, 2015).

Some of the literature has reflected attempts to address this, sometimes by adopting structures and frameworks to help chart the impact of edtech platforms (King et al, 2016 pp22). In that sense, case studies of a smaller range of edtech tools could challenge the risk of the potential ‘echo chamber’ effect, where the sheer breadth of research becomes obfuscatory (Colleoni, Rozza, Arvidsson, 2014). A focus on the micro, not the macro, could be more likely to make a more meaningful contribution in a cluttered landscape (Fuchs, 2014). Even within those more focused case studies, however, there can be a risk of an excessive emphasis on how edtech can measure ‘likes’ or other forms of virtual affinity (Atherton, 2018a). There may be a need for a shift towards more qualitative analysis of how teachers can deploy edtech to scaffold or deepen learning (Atherton 2018a; Barber, 2016).

Edtech and theoretical models

This review has selected the theoretical models that are most closely related to the evidence-base. The digital natives debate, technological determinism, constructivism, digital positivism, connectivism, Education 4.0 are all critiqued in this section and in the Discussion.

Departing from the digital natives debate

In light of the emphasis on pedagogy, this piece is a departure from trends in the 2000s to categorise learners as naturally competent in digital technologies, or ‘digital natives’ as distinct from ‘digital immigrants’ (Prensky, 2001, 2012; Ingle and Duckworth, 2013). To categorise young students as in possession of fixed characteristics is something that belongs to an era before social media (Lanclos, 2016; Turvey and Pachler, 2018, cited in Luckin, 2018a); moreover, the theory lacks empirical evidence (Atherton, 2018b). Prensky, however later suggested that students would benefit from closer dialogue between students and educators on responsible and efficient use of edtech, an idea that he called ‘digital wisdom’ (Prensky, 2012, cited in Atherton, 2018b pp31).

Technological determinism: B.Y.O.D (bring your own device) and the flipped classroom

Another layer of complexity arises from a lack of momentum, continuity and coherence in the literature actually helping influence educational policy at Secondary level. In this respect, this paper shares the view of Kirkwood and Price (2014) in espousing a rejection of the notion of technological determinism, that is the idea that it is technology that drives change, not individuals. An example of this is the term, ‘flipped learning’ or ‘the flipped classroom’. These were buzzwords in the 2000s and 2010s but the adoption of these ideas has been variable (Chen et al, 2014). In the flipped classroom, students are encouraged to view online materials in preparation for a lesson. This is designed to help them develop their high order thinking and mastery (Sams and Bergmann, 2012; Hwang et al., 2015). Though the method is encouraged by universities, there is less of an incentive to adopt the method in schools and colleges. Flipping the classroom was and still is, inextricably linked to debates on the efficacy and ethics of asking students to bring their own devices to school. B.Y.O.D (abbreviated to B.Y.O.D) can promise significant savings on hardware, encourage students to take more care of their

tech and enable them to work on more up to date devices (Atherton, 2018a). Despite these potential advantages, many schools resist the temptation to allow B.Y.O.D, as they fear safeguarding concerns, the exposure of inequalities and even General Data Protection Regulation (G.D.P.R) infringements (Atherton, 2018a). These references to flipped learning reveal the limitations of technological determinism in explaining how edtech supports learning. This is explored further in the Discussion section.

Digital constructivism

Recent literature continues to recognise the ways in which edtech can present opportunities for constructivist teaching and learning. The notion of constructivism is indebted to the pioneering work of Piaget (1953), in which the learner constructs new knowledge based on their own experiences in a collaborative manner. This was further developed by Vygotsky, who made the link between a child's interactions with peers and adults and improvements in their learning (Crain, 2010; Allison and Kendrick, cited in Stabile and Erschler, 2016). This social constructivism, then, is sometimes aligned with new and emerging technologies. An example of this is through online games as a pedagogic tool. If used as learning tools, online games are a clear example of social constructivism: they are learner-centred, learners become active participants; game narratives are relatable to students' contexts and games can develop problem-solving skills (Keengwe, 2017).

The bigger picture - Education 4.0

This section will attempt to determine where education sits in relation to broader technological and educational developments. If the term 'Web 1.0' described a static, information-based internet, 'Web 4.0' reflects the ubiquity and pervasiveness of computer-based information (Almeida, 2017). If our learning culture can be described as 'Education 4.0', there is considerable evidence that many schools and colleges have not even entered Education 2.0 (Salmon, 2019). An example of a feature Education 2.0 is the effective use of VLEs, or virtual learning environments (Salmon, 2019). While Education 3.0 recognised the importance of collaborative learning, Education 4.0 is and will be supercharged by artificial intelligence and machine learning (Salmon 2019; Luckin, 2018a; Luckin and Kent 2019).

However we view the learning experiences of students, the literature is beginning to reflect the disparities and inequities between how educational institutions can equip their students for a digital future. Spending on edtech, is expected to grow from £45bn in 2015 to £129bn in 2020 (Moules, 2017; Atherton, 2018a). Given recent trends, it is likely that the literature will respond to the recognition by the DfE (the Department for Education) that edtech is important and also the drive towards evidence-based thinking on edtech (Luckin, 2018a; Atherton, 2018a).

These notions reflect the broader technological culture, for example in relation to take up of Web 4.0. The paper will attempt to diagnose the extent to which edtech is starting to contribute to a new culture of learning (Donnelly, 2010; Siemens, 2005; Huang, Bhayani and Go, 2014). Conclusions will need to be conveyed with caution, to avoid a subjective stance. An example of this would be to view edtech in an overly positive, even evangelical manner (Lanclos, 2016, Selwyn, 2011). A less positive but maybe more reductionist stance is viewing technology from an instrumentalist perspective (Bayne, 2015). Here, technology is viewed as a neutral, pragmatic phenomenon, which is free from ideology (Bayne, 2015). Before these developments, critical theory had gone a step further by proposing that technology be viewed as an arena for dialectical struggle in pursuit of an understanding of the direction and impact of technologies (Kellner, 2003). Critical theory may be applicable to edtech but could be better suited to a critique of technology in its broadest sense.

Conclusion to literature review

To conclude the review, there is evidence that the discussion around edtech in education is in its infancy, both in terms of the range of literature and the application of this to the lived experience of

teachers (Denscombe, 2003). Much of the literature is out of date, from overseas, or relevant only to the context of teaching in HE. There is evidence, however, that more action research is being carried out in schools and colleges; University College London's (UCL) EDUCATE (their emphasis) programme provides guidance to edtech startups on conducting and disseminating research (Luckin, 2018b). In addition to this, there is a growing movement towards evidence-based approaches to edtech (Luckin, 2018b).

The 'Presentation of findings' section will reveal data that will be critiqued in the 'Analysis' section. In doing so, the paper will provide insights into the extent to which the real world of education mirrors theoretical notions and broader trends.

Research design

The research interrogates a small scale research project in terms of edtech's current context and recommended uses in an educational context. The study, therefore, follows the conventions of action research, which is hands-on research carried out as part of professional practice, to explore practitioner issues (Denscombe, 2003; Carr and Kemmis, 1986) and understand relevant phenomena (Burton & Bartlett (2009:15). Ideally, the study would show a connection between the research questions and the methods (Punch, 2014). The study necessitated mixed methods in order to ensure clarity and effective triangulation between quantitative and qualitative data and between subjective and objective statements by participants (Denzin, 1978, cited in Bassey, 2007; Punch, 2014).

The need for pre-empirical research (Punch, 2014) was met by a pilot study, which was conducted with twenty six trainee teachers on a one year PGCE course. They answered questions online via a Surveyhero questionnaire. The pilot study made it clear that there were no issues with the design of questions, though a pilot minimised the risk of damage to the overall outcomes (Denscombe, 2003). The pilot sample were selected using purposive sampling (Denscombe, 2003). The advantage of this type of sampling was that the sample was selected as a keen and engaged small sample. This allowed the researcher seven months to scrutinise the questionnaire design and the results, then look at the positives and negatives of using convenience sampling (Denscombe, 2003). Though the study used a single questionnaire, it did generate a significant range of data. The largely qualitative data was approached by the researcher with an open mind, to illustrate patterns and with little desire to anticipate future trends (Dolowitz, Buckler and Sweeney, 2008). Also, the evidence could be interrogated in a way that was exploratory, not confirmatory (Gruzd, Paulin and Haythornthwaite, 2016). That being said, the study did generate a great deal of useful quantitative data. This 'hard data' (Punch, 2014) worked very much in harmony with the qualitative data. The quantitative data helped signpost lines of inquiry, that could be explored through asking qualitative questions to help clarify patterns and make generalisations (Dolowitz, Buckler and Sweeney, 2008; Punch, 2014; Gruzd, Paulin and Haythornthwaite, 2016). The use of convenience sampling, therefore, precipitated a broader range of responses that could represent an entire cohort. Further research could use a comparative study, to establish patterns among and between Initial Teacher Education providers (Denscombe, 2003).

The advantages of this strategy were that the sample was increased to the entire cohort. In addition to this, analysis of the results of the pilot survey helped clarify the research design and strategy (Punch, 2014). Participants' data was anonymous and this helped them express themselves more freely. Furthermore, the participants had attended a lecture earlier that day, the seminar of which the survey was a part explored the issues arising from the survey. In that respect, the process was collaborative and intended to address a series of issues (Carr & Kemmis 1986, Denscombe, 2003). Potential limitations of the research were the relatively small sample and, perhaps more tellingly, the contradictory nature of some of the data. These will be examined in the 'research findings' chapter. In addition to this, the researcher employed is already familiar with the participants and this could

lead to polite responses from participants or the researcher overlooking important data trends (Denscombe, 2003).

In terms of research paradigms, constructivism appeared the most appropriate for this study. As a helpful way of looking at issues (Babbie, 2014), constructivism is a paradigm that is concerned with ways in which specific societies and experiences explain reality (Punch, 2014). To an extent, it appears as a natural starting point for a study such as this. The social constructivist classroom sees the teacher as facilitating group activities (Chen, 2012) and using creativity to construct learning (Piaget, cited in Muller, 2009). In this respect, this paradigm could be seen as a departure point, as this study is more concerned with more collaborative and dialogic learning (Donnelly, 2010). The process of coding was facilitated by Surveyhero's paid features - for example pie charts, data tables, range charts, word clouds and so on (Dolowitz, Buckler and Sweeney, 2008).

All participants provided Informed Consent and were given full disclosure of the research project and likely dissemination (Brooks et al., 2014). They were, therefore, treated with respect, in accordance with BERA guidelines (2011). The anonymity was guaranteed by the absence of names, schools or subject areas from the data.

The findings will be presented in the next section.

Research findings

These findings are derived from responses to online questionnaires on Surveyhero.com. All are with 166 trainee teachers from two universities.

Questionnaires

The questionnaires were conducted as part of a seminar on edtech and pedagogy. The seminar followed a keynote lecture, entitled, 'Digital Pedagogy'.

As indicated by Figure 1. Youtube, Kahoot!, Padlet, Doodle and Google Classroom were the easiest for participants to recall having used. If the data is presented in tabular form (as in Table 2.), this reveals some useful lists and narrative detail. Table 2. summarises individual participants' commonly used edtech tools. Fig D selects some specific or knowledgeable comments. There are more comments that are similar to those expressed in Tables 3 and 4 in response to Questions 3 and 4.

Table 2. Question 2 - list of commonly used edtech tools.

List 1 Google Classroom Canva Storyboard That Kahoot! Quizlet Padlet Goose Chase Virtual classroom/Moodle Facebook Twitter Tumblr Google docs and sidoshows	List 2 Kahoot! Memrise Quizlet Live Powerpoint Youtube	List 3 Youtube Cameras Photoshop Powerpoint Pinterest	List 4 Personally: Duo lingo, Youtube, Coursera, Khan academy. In school we use Doodle
List 5 PowerPoint, smartboard and projector. Online resources such as Show My Homework and Edulink.	List 6 Photoshop, PowerPoint, Youtube, Instagram, Pinterest	List 7 Garageband Sibelius Firefly Powerpoint Youtube	List 8 Youtube, Boardworks, Powerpoint, Twitter, Instagram
List 9 Kahoot! Prezi, Youtube, Pinterest, Stop motion	List 10 Kahoot! Poll everywhere Pinterest Powerpoint Prezi	List 11 Padlet Kahoot! Animal Behaviour pro on iPad PowerPoint iPads/phones for recording video	

Q3: Do you feel that your use of edtech been creative and innovative? If so, how?

Table 3. Edtech has helped my teaching.

Can make games/ fun	Kahoot! is an exciting and engaging platform that students really like
Using interactive white board to draw accurate shapes, graphs, tables etc. helps learning as pupils can visualise problems more easily	Using PowerPoint to show exam style questions, then to annotate and withdraw information by highlighting the relevant parts
Animations on slides, drawing shapes on PowerPoint, Drawing tables and graphs, making interactive games	Colourful, fun, timers, etc
The interactive whiteboard technology is good. It allows for creative lesson planning and means I can deliver lessons in an innovative manner. I feel technology could be incorporated more frequently into lessons though	It gives me a lot more freedom to draw shapes and show solutions to worksheets, which would otherwise be difficult to do. I can interpret graphs much easier than if I did not have it.
It enables me to cover topics like polygons with pre-drawn shapes in different colours to help make it easier for them to recognise the shapes	I think it was creative because the pupils were engaged in the lesson it was different ways of presenting information.
ActivInspire has allowed me to be more creative in the classroom using an interactive whiteboard pen. I can get my students involved and engaged in the class by asking them to come up to the board and write the answers on the whiteboards	Quickly drawing shapes accurately with use of autoshapes on SMART Notebook. Revealing answers with a click.
I make my own PowerPoint slides Using own data and Excel for Stats	Yes I do because it has allowed for different strategies to be used to engage and relate to a technological generation
Rewards can be used when tracking accelerated reader progress	Creating an online class with resources to help develop students and monitor their progress
I created my own quiz on Kahoot. I've also worked with Quizlet and PowerPoint. My power points aren't always just read and write, they have been interactive like I used the PowerPoint animation to create a game.	I feel like I can engage the class more with interactive tasks and activities.
I've used interactive games to demo concepts, eg a reaction tapping game to demo reaction times	Gives students the opportunity to reflect on performance within PE.

Yes gives another dimension to lessons makes students feel more involved	To show movement within P.E I have used edtech , this has helped show a visual demonstration.
I have used interactive activities that have allowed the whole class to engage more in the lesson.	I realised you can learn any skill from Youtube when I was a teenager and that was the thing (over school) that inspired my interest in learning. I would like to pass this inspiration on to my students and constantly look for new educational Youtube channels, we I see as somewhat innovative.
It was creative in that pupils are used to basic Powerpoints and I made use of transitions and better designs . Autocad was used in a STEM trip it was creative in that it allowed freedom to do what I wanted to explain to pupils what to do	Plickers is a fun formative assessment that can be completed quickly
Kahoot! for formative assessment	Kahoot!' for starters and plenaries are out of the norm, so the classes enjoy them.
Provokes thought when answering exam questions. The exam responses incorporated well developed answers.	Edpuzzle for learning on video
Encouraging students to work without groups and use each other's existing knowledge to expand knowledge	Use of Kahoot! to replace paper based Q and A. Padlet for gathering ideas from the group.
Showing demonstrations visual aids and music use	I am able to see which students understand what and they can offer explanations for the correct answer
Good, used for assessment and feedback, recapping and to play games	Students uploaded their ideas onto Poll everywhere which encouraged class discussions.
Learners created their own Pinterest boards in order to create a mood board.	Encourage me to think of alternative activity deliveries. Attempt to get learns more engaged. Get learners involved more. Not chalk and talk
More interactive with the learners Used for fitness testing, creates motivation	

The presentation of the data in the form of a word cloud did not reveal anything of significance. The data table, however, provided some narrative detail that will be summarised in Table 3. and analysed in the 'Discussion' section. Before summarising the data table, it is important to state that 81 out of a total of 166 participants (49%) felt that their use of edtech was not creative or innovative.

Table 4. reveals polarised experiences of using edtech.

Table 4. There are barriers to using edtech in my school.

It's difficult with the resources in my school	No; I am limited by the quality of equipment (the interactive whiteboard is terrible) and the school is vastly underfunded in terms of technology
the school is not very technological	I struggle to use technology in school due to no signal
It's been bang average	The Wi-Fi connection is poor and it would be frowned upon to use social media platforms in school
I've tried to use the interactive whiteboard but they don't work properly in my school.	No because I'm limited by the facilities in my school
I don't feel I've had the opportunity/ training to do so.	In my placement school there is little provision, encouragement or infrastructure to use tech.
Not encouraged to experiment	not much chance to use any tech in my school
Student behaviour is so poor that use of technologies is shunned by the school in favour of paper based activities.	I feel like it is quite basic but in line with the routines of the school.

Table 5. I have my own barriers.

I stick to videos etc. I don't know many edtech platforms to use	I don't feel that my use of technology at all has been innovative. I rely largely on PowerPoint and physical resources for the students.
I only use videos and animations so far	Time constraints limit this
I rarely use the technology. I much prefer pen and paper	I would use edtech however I do not feel I currently have the skill set to do so
No due to lack of skills	I have not gained very much experience of it so far and I am limited in my ability to be creative with it.
Not particularly. I don't know where to look to find a suitable platform. They often require purchase. Don't know how to integrate it into a lesson.	

Tables 4. and 5. indicate that there are significant and enduring barriers to participation in edtech-

experiences of one practitioner (Denzin and Lincoln, 2011).

One of the benefits of both the sampling methodology and the emphasis on qualitative data was that the researcher was able to approach the data with an open mind (Dolowitz, Buckler and Sweeney, 2008). Also, the evidence could be interrogated in a way that avoided confirmation bias (Gruzd, Paulin and Haythornthwaite, 2016).

The main limitation of the study has been the relatively narrow sample for the action research. In addition to this, there are likely to be ongoing barriers for the researcher of edtech and pedagogy, most notably in relation to taxonomies of edtech and clarity of language to describe it (Bayne, 2015; Salmon, 2019). Furthermore, the researcher needed to treat the sometimes emotive statements from participants with caution (Stake, 1995).

Some of the data reveals that schools may be using edtech but persist in using teacher-centred methods (Blin and Munro, 2008, cited in Kirkwood, 2013). Further research could categorise participants into subject areas and follow the study with in- depth interviews. It would be logical to pursue a line of inquiry into how specific schools are using edtech but there may be inhibitors in terms of ethics and anonymity (Punch, 2014; Denscombe, 2003).

Conclusions

The purpose of this paper was to examine how a cohort of trainee teachers are using educational technologies (or edtech). Other ways in which the research could be developed could be by creating case studies of how a small range of edtech platforms can contribute towards improving select aspects of pedagogy. When the emphasis is on the *impact* of edtech, there could be a risk of losing sight of the job of the teacher and their subjective experiences (Luckin and Kent, 2019, Denscombe, 2003). In that sense, this paper echoes Fuchs' call for a move away from the tyranny of increasingly *big data* and a culture of digital positivism (Fuchs, 2017, Atherton, 2018a). This is one of the reasons that multiple autoethnographies from teachers may be a fruitful way to build bridges between edtech and education (Atherton, 2018a). Furthermore, the aforementioned inequalities could be addressed in a way that builds a political culture of resistance and possibility (Denzin and Lincoln, 2011).

Perhaps the design of edtech platforms could place more emphasis on teachers sharing ideas (Baume and Scanlon, 2018, cited in Luckin, 2018a), though not to the extent that those teachers become unpaid brand advocates (Atherton, 2018a).

One way of providing a more coherent structure to participants' subjective statements might be through the use of Q Methodology (McLain, 2017; Watts, 2005). One of the limitations of this study is that the dataset is essentially a *concourse*, which reflects the full range of opinions and experiences (McLain, 2017; Watts, 2005). Developing a Q set could help rationalise the data and refine and review future questions (Fischer, 2018).

Since the research began in 2018, the government has announced a significant increase in funding, both broadly and in terms of edtech. What remains to be seen is how these will have an impact on the role of edtech and pedagogy. Furthermore, it may be preferable to conduct a longitudinal study of a small group of trainee teachers, to interrogate their edtech journey.

References

- Almeida, F. (2017). Concept and Dimensions of Web 4.0. INTERNATIONAL JOURNAL OF COMPUTERS & TECHNOLOGY. 16. 7040-7046. DOI: 10.24297/ijct.v16i7.6446.
- Atherton, P. (2018a). *50 ways to use technology enhanced learning in the classroom*. 1st ed. London: Sage Publications Ltd.
- Atherton, P. (2018b) More than just a quiz: how Kahoot! can help trainee teachers understand the

- learning process. *Teacher Education Advancement Network Journal*, 10 (2). pp. 29-39. [ONLINE] Available at: <http://insight.cumbria.ac.uk/id/eprint/3926/> [Accessed 27 August 2019].
- Babbie, E.R. (2014). *The Basics of Social Research*. 6 Edition. Boston, MA: Cengage Learning.
- Barber, D. (2016). Ucl.ac.uk. (2017). *Why we should take artificial intelligence in education more seriously*. [online] Available at: <http://www.ucl.ac.uk/ioe/news-events/news-pub/april-2016/New-paper-published-by-pearson-makes-the-case-for-why-we-must-take-artificial-intelligence-in-education-more-seriously> [Accessed 22 Oct. 2019].
- Bassey, M. (2007) 'Case Studies' In Briggs, A. and Coleman, M. *Research Methods in Educational Leadership and Management*, London: Sage Publications Ltd 142-155
- Bayne, S. (2014) *What is the matter with Technology Enhanced Learning?* Learning, Media and Technology, DOI: 10.1080/17439884.2014.9158511.
- BERA (2011) Revised Ethical Guidelines for Educational Research. Macclesfield: British Educational Research Association.
- Burton, D and Bartlett, S. (2009). *Key Issues for Education Researchers (Education Studies: Key Issues)*. Edition. Sage Publications Ltd.
- Carr, W. and Kemmis, S. (1986). *Becoming critical*. London: Routledge.
- Carter, A. (2015). *Carter review of initial teacher training (ITT)*. [ONLINE] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/399957/Carter_Review.pdf. [Accessed 27 Aug. 2019].
- Chen, B (2012) *Investigating instructional strategies for using social media in formal and informal learning | Chen | The International Review of Research in Open and Distributed Learning*. [ONLINE] Available at: <http://www.irrodl.org/index.php/irrodl/article/view/1027/2073>. [Accessed 20 Aug 2019].
- Chen, Y., Wang, Y., Kinshuk and Chen, N. (2014). Is FLIP enough? Or should we use the FLIPPED model instead?. *Computers & Education*, [online] 79, pp.16-27. Available at: <https://www.sciencedirect.com/science/article/pii/S0360131514001559> [Accessed 27 Aug. 2019].
- Colleoni, E., Rozza, A., & Arvidsson, A. (2014). Echo chamber or public sphere? Predicting political orientation and measuring political homophily in Twitter using big data. *Journal of Communication*, 64(2), 317-332.
- Crain, W. (2010) *Theories of development: Concepts and applications*, 6th ed. Upper Saddle River, NJ: Prentice Hall.
- Denscombe, M. (2003). *The good research guide*. Maidenhead: Open Univ. Press
- Denzin, N. (1978) *The Research Act: A Theoretical Orientation to Sociological Methods*. New York: McGraw -Hill.
- Denzin, N and Lincoln, Y. (2011). *The Sage Handbook of Qualitative Research*. London: Sage.
- Dolowitz, D, Buckler, S. and Sweeney, F. (2008). *Researching Online*. London. Palgrave Macmillan
- Donnelly. (2010). *Critical Design and Effective Tools for E-Learning in Higher Education: Theory into Practice (Premier Reference Source)*. First Edition. Information Science Reference.
- Fischer, 2018 National Annual Advance HE surveys conference 2018, Leeds: Using Q-methodology to understand the perceptions and opinions of students or staff
- Fuchs C (2014) *OccupyMedia! The Occupy Movement and Social Media in Crisis Capitalism*. Winchester: Zero Books.
- Fuchs, C. (2017). From digital positivism and administrative big data analytics towards critical digital and social media research!. *European Journal of Communication*, 32(1), pp.37-49. DOI: 10.1177/0267323116682804
- Gruzd, A., Paulin, D., & Haythornthwaite, C. (2016). Analyzing Social Media And Learning Through Content And Social Network Analysis: A Faceted Methodological Approach. *Journal of Learning Analytics*, 3(3), 46-71. DOI: 10.18608/jla.2016.33.4.
- Higgins, S, ZhiMin Xiao and Katsipataki, M. (2011). *The Impact of Digital Technology on Learning: A*

- Summary for the Education Endowment Foundation*. [ONLINE] Available at: https://v1.educationendowmentfoundation.org.uk/uploads/pdf/The_Impact_of_Digital_Technologies_on_Learning_FULL_REPORT_%282012%29.pdf. [Accessed 30 August 2019].
- Huang, Bhayani and Go, (2014). *ICT in Education in Global Context: Emerging Trends Report 2013-2014 (Lecture Notes in Educational Technology)*. 2014 Edition. New York: Springer.
- Hwang, G.J., Lai, CL. & Wang, SY. J. *Comput. Educ.* (2015) 2: 449. [ONLINE] Available at: DOI: [10.1007/s40692-015-0043-0](https://doi.org/10.1007/s40692-015-0043-0).
- Ingle, S. and Duckworth, V. (2013) *Enhancing learning through technology in lifelong learning*. Maidenhead, UK & New York: Open University Press (McGraw-Hill).
- Keengwe, J. (2017). *Handbook of research on digital content, mobile learning, and technology integration models in teacher education*. Open Library: Information Science Reference.
- Kellner, D. (2003). *Toward a Critical Theory of Education*. *Democracy & Nature*. 9. 51-64. DOI: [10.1080/1085566032000074940](https://doi.org/10.1080/1085566032000074940). [Accessed 28 Aug. 2019].
- King, M., Dawson, R., Batmaz, F. and Rothberg, S. (2014), "The need for evidence innovation in educational technology evaluation", in Uhomoibi, J. (Ed.), *Proceedings of INSPIRE XIX: Global Issues in IT Education*, British Computer Society, Southampton, pp. 9-23.
- King, M., Rothberg, S. Dawson, R. and Batmaz, F. (2016 "Bridging the edtech evidence gap", *Journal of Systems and Information Technology*, Vol. 18 No. 1, pp. 18-40. DOI: [10.1108/JSIT-06-2015-0059](https://doi.org/10.1108/JSIT-06-2015-0059).
- Kirkwood, A. & Price, L. (2014) *Technology-enhanced learning and teaching in higher education: what is 'enhanced' and how do we know? A critical literature review*, *Learning, Media and Technology*, 39:1, 6-36, DOI: [10.1080/17439884.2013.770404](https://doi.org/10.1080/17439884.2013.770404)
- Lanclos, D. (2016). *The death of the digital native: four provocations from Digifest speaker, Dr Donna Lanclos*. [online] Jisc. Available at: <https://www.jisc.ac.uk/news/the-death-of-the-digital-native-23-feb-2016> [Accessed 16 Aug. 2019].
- Luckin, R. (2018a) *Enhancing Learning and Teaching with Technology*. London: UCL Institute of Education Press
- Luckin, R. (2018b). *Machine Learning and Human Intelligence*. London: Ucl Ioe Press. Marshall, Catherine; Rossman, Gretchen B. (2011). *Designing Qualitative Research, Fifth Edition*. Thousand Oaks, CA: Sage Publications Ltd.
- Luckin, R. and Kent, C. (2019). *Why teachers must learn to interrogate AI's algorithms*. TES. [online] Available at: <https://www.tes.com/news/why-teachers-must-learn-interrogate-ai-algorithms> [Accessed 28 Aug. 2019].
- McLain, M., Barlex, D., Bell, D. and Hardy, A. (2015). *Teacher perspectives on pedagogical modelling and explaining in design & technology: a Q Methodology study*. In: Marjolaine Chatoney. *Plurality and Complementarity of Approaches in Design and Technology Education*. April 2015, Marseille, France. 2015 [available at: <https://hal.archivesouvertes.fr/hal-01161553>]. [Accessed 22 Aug. 2019].
- McLain, M. (2017). *Emerging perspectives on the demonstration as a signature pedagogy in design and technology education*. *International Journal of Technology and Design Education*, [online] 28(4), pp.985-1000. Available at: <https://link.springer.com/article/10.1007/s10798-017-9425-0> [Accessed 28 Aug. 2019].
- Moules, J. (2017). *UK start-ups take slice of £130bn educational technology market*. *Financial Times*. [online] Available at: <https://www.ft.com/content/6e73096a-7675-11e5-933d-efcdc3c11c89?mhq5j=e3> [Accessed 28 August. 2019].
- Muller, U, (2009). *The Cambridge Companion to Piaget (Cambridge Companions to Philosophy)*. 1 Edition. Cambridge University Press.
- NESTA (2019). *Educ-AI-tion Rebooted? Exploring the future of artificial intelligence in schools and colleges*. [online] Buckingham: NESTA. Available at:

- https://media.nesta.org.uk/documents/Future_of_AI_and_education_v5_WEB.pdf
[Accessed 22 Oct. 2019].
- Piaget, J. (1953). *The origin of intelligence in the child*. New Fetter Lane, New York: Routledge & Kegan Paul.
- Prensky, M. (2001). *Digital Natives, Digital Immigrants*. On the Horizon, Vol. 9 No. 5, October 2001. (MCB University Press)
- Prensky, M. (2010). *Teaching Digital Natives*. London: Sage Publications
- Prensky, M. (2012). *From Digital Natives to Digital Wisdom*. London: Sage Publications
- Punch, K. (2014). *Introduction to Research Methods in Education*. 2nd ed. London: Sage Publications.
- Raffaghelli, J., Cucchiara, S. and Persico, D. (2015). Methodological approaches in MOOC research: Retracing the myth of Proteus. *British Journal of Educational Technology*, [online] 46(3), pp.488-509. Available at: <https://telearn.archives-ouvertes.fr/hal-01156416/document> [Accessed 23 Aug. 2019].
- Salmon, G. (2019). May the Fourth Be with you: Creating Education 4.0. *Journal of Learning for Development - JL4D*, [S.l.], v. 6, n. 2, jul. 2019. ISSN 2311-1550. Available at: <https://jl4d.org/index.php/ejl4d/article/view/352/404>. Date accessed: 27 Aug. 2019.
- Sams, A. and Bergmann, J. (2012). *Flip Your Classroom: Reach Every Student in Every Class Every Day*. Washington: International Society for Technology in Education / ISTE.
- Scales, P. (2013). *Teaching in the Lifelong Learning Sector*. 3rd edition. Maidenhead: Open University Press.
- Selwyn, N. (2014). *Digital Technology and the Contemporary University*. London: Routledge
- Siemens, G. 2005. *A Learning Theory for the Digital Age*. Available at: <http://devrijeruiimte.org/content/artikelen/Connectivism.pdf>. [Accessed 27 Aug 2019].
- Stabile, C. and Ershler, J. (2015). *Constructivism reconsidered in the age of social media*. 1st ed. San Francisco: Jossey Bass.
- Stake R E (1995) *The Art of Case Study Research*, London: Sage Publications
- Watts, S. and Stenner, P. (2005). Doing Q methodology: theory, method and interpretation. *Qualitative Research in Psychology*, 2(1), pp.67-91.
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