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Technological determinism in educational technology research: some alternative ways of thinking about the relationship between learning and technology

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Abstract

This paper argues that research on the educational uses of technology frequently overemphasizes the influence of technology. Research in the field is considered a form of critical perspective, and assumptions about technology are questioned. Technological determinism is introduced, and different positions on this concept are identified. These are used to discuss the ways in which work within the field might be described as technologically deterministic. Four theoretical perspectives (activity theory, communities of practice, actor–network theory, and the social construction of technology) are then briefly characterized, demonstrating that alternative positions are viable, and positioning each in relation to the earlier discussion of technological determinism. The paper concludes by arguing that research, building on such alternative conceptions of technology, is important in developing our understanding of the relationship between technology and learning, as well as identifying potential methodological implications.

Keywords affordance, educational technology, science and technology studies, technological determinism.

Introduction

This paper offers a theoretical critique of current ways of thinking about technology and learning in research. Firstly, the critical tradition that frames this work is briefly outlined. Then, conceptions of technology and its relationship to learning are reviewed. Four theoretical positions are then considered, each of which offers alternative ways of framing this relationship. The paper concludes by identifying implications for research in this field.

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Background

Developing a critical position on the use of technology in education

A growing body of work (e.g. Friesen 2008; Selwyn 2010) argues for the need for the development of a critical perspective on educational technology use, one that looks beyond the immediate context of learning gains or patterns of interaction to question the ways in which technology has been taken up in the first place.

> The academic study of educational technology needs to be pursued more vigorously along social scientific lines, with researchers and writers showing a keener interest in the social, political, economic, cultural and historical contexts within which educational technology use (and non-use) is located. (Selwyn 2010, p. 66)

Such work does not obviate the need for educational studies, of course; instead, it can be seen as complementing them, allowing their contribution to be questioned and judged. Friesen, for example, suggests that such work is

> . . . not seeking to reveal some claims and ideas in e-learning as being simply or positively 'false' or 'untruthful'. The purpose here, rather, is to undertake a kind of 'ground-clearing' exercise in order to call into question ways of talking about and justifying e-learning that obscure a more complicated reality (Friesen 2009, p. 181).

This paper seeks to contribute to such a tradition of work by focusing on one recurrent assumption in the literature – that technology causes particular effects – and exploring how this fits with theories of technology use. Firstly, reasons for focusing on this issue are provided.

Accounting for technology

Although plenty of research explores the use of technology in education, it has been questioned whether this actually constitutes a field of study. For example, Conole (2003) suggests that this work can be understood as a field, but that it is at an early stage of development. Czerniewicz (2008) goes further, assessing its fragmentation, whether it might be seen as scholarly or professional, asking how it aligns with other areas such as education, computer science or media studies, and so on.

This complex relationship with other areas means that perspectives from various disciplines have been brought to bear on a shared problem (Oliver *et al*. 2006). While this can be rich and generative in terms of producing explanations of phenomena, it has also given rise to concerns about the credibility of research work, for example, in terms of the research methods used (e.g. Mitchell 2000).

Various authors have attempted to respond to this situation by looking for commonalities that can unite work in the field. For example, Conole and Dyke (2004) identified the idea of 'affordance' as something that was widely invoked as an explanation of technological effects, and asked whether this could become a theoretical basis from which work in this area could build, for example, by mapping technologies in terms of their affordances as the basis for design decisions. This term has entered the literature about learning and technology via Norman's work on the design of technologies (Norman 1988), where he used the term to describe what actions the technology permitted or prevented, describing this in terms of the technology making 'natural' certain patters of actions for users. As has been argued (Oliver 2005), claiming that technology makes certain actions natural does not really explain design, but rather serves to hide how designers communicate their intentions and preferences to users. It does not explain how people learn to use technology, or how deviant uses develop. Analysing this issue further, however, requires the introduction of the concept of technological determinism.

Technological determinism

Affordance neatly illustrates the concept of technological determinism, which has been widely explored in the field of science and technology studies. This is the belief that technology shapes society in some way – which includes social practices such as learning (see, e.g. Jones 2001).

This general definition seems, on the face of it, reasonable enough; it is certainly a familiar 'common sense' account of social change (Selwyn 2012). However, this general explanation is 'muddy and imprecise'; using it analytically requires greater precision about exactly what is being described (Bimber 1994). Bimber, for example, draws distinctions between nomological accounts, providing 'descriptions of an inevitable technological order based on laws of nature' (p. 81); normative accounts, in which technology is unquestioned because questions about efficiency and productivity replace political and ethical questions about use, and the unintended consequences account, which recognizes wilful, ethical, and social actors but suggests that they are simply unable to anticipate all of technology's effects.

These accounts are differentiated in relation to the causal power attributed to technology. Bimber suggests that only the nomological account is particularly problematic, because the other two allow additional (social) factors to influence outcomes. Grint and Woolgar (1997), however, disagree. They argue that very few would position themselves as 'hard' (nomological) determinists, but that these 'softer' accounts still attribute causal power to technology in a way that is inappropriate, even if it is moderated by other factors.

These positions still depend on essentialized accounts of the nature of technology – something they describe as 'residual technicism' (p. 37) – which, they argue, is unnecessary and unhelpful, because this assumed 'neutrality', which hides just how political and contested such understandings of technology are. In turn, their position has also been challenged – Winner (1985), for example, questions the credibility of such 'social determination of technology' on the grounds that it fails to account for the 'the things themselves', which are treated as if they 'do not matter at all' (p. 27). Grint & Woolgar's response, however, is that any such appeal to the 'true' nature of the things themselves presupposes some process of establishing that truth, a process that is social, contestable, and political. To illustrate this, they pose the question (p. 140) – what's social about being shot? Whether or not their argument is entirely convincing sociologically, it has a particular purchase when questions of education are at stake; because, they argue, to understand the 'effect' of a bullet on a person requires that we have learnt what a gun is, we have a process of establishing that a shot from this gun caused that wound, and that we understand what it means to die. For anyone committed to a constructivist – and particularly a social constructivist – account of learning, such steps are not trivial.

This leaves us with a range of possible interpretations of technological determinism. For the purposes of this analysis, these will be clustered into three positions: as simply causal of change, as technicist (it remains an essentialized cause of change, albeit not the only one), or as socially constructed.

Is research about learning and technology technologically deterministic?

If technology determines particular kinds of social effect, even if a 'soft' or a technicist form, this raises important questions of power and morality. Such questions are not often asked in relation to the study of technology and learning, yet they form an important part of critical theory (Friesen 2008; Selwyn 2010). In relation to technology, the very idea of agency is called into question, particularly when technology is assumed to have the power to determine choices.

> In this context agency itself appears as a central democratic value. No doubt this claim must be qualified by respect for the rights of others, however, it will not do to treat the agency of individuals under conditions of radical subordination as a merely instrumental value or a minor issue on the margins of democratic concern. The ability to intervene, to change and alter circumstances that affect one becomes a key issue [. . .]. What I have tried to do is to raise the alarm over the decline of agency for everyone, majority and minorities alike, and refocuses attention on its problematic status in an increasingly technocratic society. (Feenburg 2001, p. 186)

But to what extent does research in this field adopt such a position? While Grint and Woolgar (1997) argue that few people would adopt what is described here as a nomologically deterministic position, there are clear examples of this in research on learning and technology. Prensky (2001), for example, attributes generational changes in attention, learning, and even brain structure to the power of technology.

As argued earlier, accounts based on the idea of affordance can also be argued to fall into this camp. Authors continue to try to move from descriptions of practices (such as case studies, which might give the impression of focusing on social practice) to identifying general, decontextualized 'properties' of technology. However, this move is problematic; the idea of affordance has been argued to give insufficient recognition to the importance of social practice, meaning, and knowledge in this context, focusing unduly on the appearance of devices and underplaying the role of meaning and learning in the way that technology is taken up (Derry 2007). Moreover, this inductive step, which abstracts the properties of technologies from the specific historical contexts of their use, is at odds with Gibson's original use of the term, which was defined in terms of relationships between animal and environment (Gibson 1979). It is, arguably, a category error; observations are made of a social practice, and conclusions are then drawn about something else – specifically, some technology that was used as part of this practice. The rest of the elements of that practice – the people, their purposeful action, their values and concerns – are ignored, perhaps because so many of them are ephemeral, whereas the technology remains once the activity has finished. Even using Norman's weaker definition (1988), and working with the idea of perceived affordance, such claims only work if it is assumed that the people using technology, and the situations in which it is used, are more or less homogeneous – assumptions that are very hard to justify (Oliver 2005).

Such determinism is also visible in accounts of technological change. Friesen (2008), for example, discusses this in relation to models of technology diffusion. In this, he differentiates between 'optimistic' and 'pessimistic' determinism, the former characteristic of enthusiasts who focus on positive aspects of technical change and the latter associated with 'laggards' or 'luddites' who see it more negatively, or even as destructive. However, he argues that both groups have effectively conceded that technology is the cause of the change, and simply differ in terms of whether they believe the change to be desirable.

There is also a well-established body of work critiquing the deterministic commitments of cognitive psychology, which forms a foundation for much research in this field. Almost 25 years ago, for example, Woolgar (1987) argued that claims from cognitive science, and particularly from Artificial Intelligence researchers, depend on the proposition that terms such as reasoning, thinking, knowing, learning, and understanding can be explained in terms of cognition; that tasks can be construed as requiring intelligence for performance; and that behaviour can then be understood in terms of the outcome of changes in cognitive state as the result of computational procedures. He goes on to argue that appeals to technology to explain human behaviour misunderstand the relationship between technology, individuals, and society; successful designs may be better understood as a process of redefining concepts rather than as 'impact'.

> Tests of what count as intelligence appear to build in a facility for redefining intelligence. Instead of bringing research to a close, a 'successful' manifestation of intelligence occasions the re-definition of what, after all, is to count as intelligence. In the field of expert systems research, for example, the 'success' of any expert system ironically guarantees its own failure, in the sense that 'real expertise' then becomes the topic for future exploration. (Woolgar 1987, p. 319)

Such arguments have returned repeatedly over the years. Recently, Friesen (2009) explored the metaphors that have, historically, linked prominent technologies and ways of understanding the mind. For example, behaviourism's account of stimulus and response is argued to be analogous to the technology of the telephone, with messages relayed via brain as 'exchange', meaning that there was no need to explain internal states. Cognitivism's appeal to the computer as explanation is, on this account, simply a new attempt to understand an ongoing mystery. This risk here, however, is that its metaphorical status may be forgotten. If the mind is understood to be 'like' a computer, then computer-based tools are self-evidently well matched to supporting mental activities – forgetting the basis for the initial comparison results in tautological and trivial claims.

> The metaphorical comparison of mind and machine underlying cognitive psychology is literalized in the discourse of e-learning. This 'literalization' becomes especially problematic when computer technologies or mechanisms that earlier served a heuristic function for understanding the mind reappear as indispensable tools for teaching and learning. The result in some cases is a distorting and self-reinforcing circularity. (Friesen 2009, p. 87).

As Friesen argues, the issue here is not that cognitive psychology has failed to provide lasting contributions to the field of education (pp. 85–86); it is that an oversimplified account of their theoretical grounding results in a kind of determinism that appears nomological because it is, ultimately, self-referential.

Arguably, therefore, even the strongest form of technological determinism is evident in research about learning and technology. However, there are also accounts of technology and change that try and move beyond the simple, causal model. Cuban (2002), for example, has drawn a sharp contrast between the determinist assumptions represented in educational policies and the experiences of classroom teachers. He argues that technology has been bought – on a massive scale and over decades – on the assumption that it will *cause* improvements in learning outcomes and teaching efficiency. He then illustrates how, in practice, teachers struggle to integrate these resources into their practice, often marginalizing technology use so that any effect that it might have had is minimalized. This, he argues, is a perfectly sensible coping strategy on the part of teachers expected to use technology that they did not ask for. In Cuban's account, if there is causality, then it is extremely 'soft', a 'slow revolution', if there is a revolution at all.

Friesen (2009) similarly writes briefly about the adoption of WebCT (Blackboard Inc., Washington, DC) in universities. He argues that the rapid emergence of the Internet 'did not mean that it simply washed over the educational landscape, doing away with existing institutional and business models'; instead, the Internet was refashioned through virtual learning environments that were often developed by universities and which reinforced the traditional functions and identities of university personnel. There are clear resonances here with Cornford's analysis that 'the virtual university is . . . the university made concrete' (2000).

Clearly, more social accounts of technology and learning exist, and serve to illustrate the kinds of critical approach that may allow the field 'to move beyond the deterministic assumption that technologies possess inherent qualities, and are therefore capable of having particular "impacts" or "effects" on learners, teachers and educational institutions if used in a correct manner' (Selwyn 2010, p. 68). Various positions can be identified that explicitly seek to adopt more social accounts of technology. In the next section, four of these will be introduced and will be considered as alternatives to the 'hard' deterministic position.

Social and cultural perspectives on the educational use of technology

In order to identify alternative ways of framing the relationship between learning and technology, four different traditions of work are considered here. Of necessity, each is introduced briefly and considered selectively, focusing on the way in which technology is conceived of and analysed; this inevitably risks oversimplifying each. However, the purpose of this is not to write off nor even to develop particular approaches, but to characterize them in relation to the three positions identified earlier.

Activity theory

As suggested above, not all work within the field of educational technology adopts the 'common-sense' model of technology as determinant. This can be illustrated with reference to work that makes use of activity theory.

Activity theory builds on the work of Vygotsky; it is known more precisely as cultural–historical activity theory, which illustrates its commitment to understanding learning in terms of peoples' intentional actions within social settings (Kuutti 1996). At its core is the proposition that actions are mediated – the unit of analysis is of a subject (a person) working towards an object (an objective) using a tool. Later generations of the theory contextualized this in terms of the community, rules, and division of labour in which this action takes place. Technology is then understood in terms of its ability to mediate action.

The central role of tools in this theory is one reason for its appeal to researchers interested in learning and technology. Another is the way in which these concepts can be used to develop detailed understanding of specific cases; this is particularly valuable given the high volume of case-based research in the field (Issroff & Scanlon 2002). As Issroff & Scanlon demonstrated, this theory can be very useful in exploring cases of technology use in a systematic way. The precision and attention to contextual detail that it requires means that it has strong explanatory power, even if its ability to predict the outcomes of use in other contexts is weak.

There are two considerations arising from this perspective that are particularly relevant here. Firstly, according to this approach, all human experience is shaped by the tools and sign systems that we use (Nardi 1996, p. 5). This is significant for the discussion here, because the unit of analysis within activity theory is neither the individual nor a technology, but the purposeful use of technology within a cultural and historical context (Barab *et al*. 2004). It is not clear what sociocultural researchers should take as their unit of analysis, although the tendency has been to move towards increasingly holistic analyses; Vygotsky, in particular, argued that the whole of the phenomenon should be studied, not its disaggregated elements (Matusov 2007). The implication of this is that claims must then be made in relation to the whole phenomenon, and not to elements – such as technology – taken out of context.

> It is impossible to understand mediation and its different modes if one does not take into consideration the connection between definite modes of mediation (e.g. definite signs and sign systems) and the corresponding activity, as only this activity gives meaning to the means of mediation. The same thing that is used as a means of mediation has different meanings and mediates different processes if it is used in different kinds of activity. (Lektorsky 2009)

This is a problem for people interested in the design of technology, because the thing they want to focus on – the technology – is not the unit of analysis. Conclusions cannot be drawn about the technology *per se*. This avoids the problem of nomological technological determinism described earlier, but only by ruling any decontextualized discussion of technology, deterministic or not, out of scope. This does not prevent researchers from studying technology – arguably, Krange & Ludvigsen's historical and situated design experiments (Krange & Ludvigsen 2009) show how technology can still be studied in context – but it does emphasize the need to consider elements alongside the technology as part of the analysis. Arguably, this places it most clearly in the technicist camp, with technology's inherent properties contributing to but not determining the outcome of activity.

The second consideration is the way that technology is understood historically. Cultural–historical activity theory, as the name implies, involves locating analyses temporally as well as culturally. However, many studies that focus on learning and technology interpret the historical context very narrowly, often presenting more of a snapshot than an evolution. Within work on activity theory, more generally, a focus on development is more common but still modest in scale. For example, Engeström (2001) has outlined an analytic, interventionist use of activity theory that uses a change laboratory process to engineer 'expanded' systems that are able to cope with problems identified in existing practices. This process of 'expansion' implies development over time, albeit for a relatively short period; it is concerned with the intricacies of development during a discrete period of time.

Rückriem (2009) argues that this focus leaves Engeström with a narrow view of history as 'just the trajectory of developmental expansive cycles of activity systems' (p. 110), and unable to account for wider developments such as social transformation. Similarly, Langemeier and Roth (2006) suggest that activity theory oversimplifies the complexities of social and societal action, and that the way in which Engeström constitutes examples of practice fails to account for the historically situated way in which the constituent parts (the subject, tool, object) have been constituted. They are taken as 'given'.

> The figures represent them as actors without subjective reasons to act, separated from their own interpretive horizons, biographies, and social positions or status. (Langemeier & Roth 2006, pp. 32–33)

Langemeier and Roth go on to suggest that the reason for this is Engeström's interest in systems; they argue that individual perspectives are only of interest in, so far as they explain, systemic structures. In other words, it is Engeström's focus on normative systems that enables particular elements of systems (people, technologies, and so on) to be taken as 'given' in an unproblematic way, rather than considered as socially produced and hence problematic in their own right. Again, this cannot be understood as nomological determinism, but would be consistent with technicist accounts; tools may not inevitably lead to particular actions but, when taken for granted, they can be treated as reconfiguring systems of activity in particular ways.

Communities of practice

Wenger's work on communities of practice (1998) offers an alternative perspective on the relationship between technology and practice. This account of learning in terms of participation builds from anthropological studies, often in work settings, to provide an account that links learning to identity and competent performance within a community.

Again, this is a theory that features frequently within research on learning and technology. However, the term has been understood in several different ways, so that ideas of both 'community' and 'practice' are ambiguous (Cox 2005). Studies of learning and technology that draw on this idea may also draw selectively from the theory, neglecting some concepts so as to focus on others (or simply adopting the phrase).

In relation to the discussion of technology, determinism and practice, one particular pairing of ideas from Wenger's 1998 book is particularly relevant. Within this text, Wenger argues that two complementary elements need to be considered alongside each other in order to explain practice – participation and reification. Participation involves active involvement in social processes. Reification, on the other hand, involves the formalization and abstraction of practice so that it can be shared. Reification can include any kind of representation of practice, from words and terminology to rules and to tools.

For example, Wenger (1998) presents a case study of claims processors working in an insurance company. Within this case study, he describes how a spreadsheet was produced that codified how claims processors should calculate claims. This reified their practice – abstracting it from moment to moment, personal judgments, making it available to others in a form that could be inspected and critiqued. It also served to marginalize the claims processors, making it clear that their professional judgment was less important than the standard routine laid out by analysts elsewhere in the organization. They did not fully understand this routine, and could not explain it – making it hard to defend decisions when challenged by clients. However, the reification served to guide and standardize their practices.

This account offers a useful response to the problem of explaining how technology and practice are related without resorting to deterministic models. The technology in question here – a simple, paper-based form – did not, in itself, determine how an individual claims processor would act. It did, however, establish how they *should* act, according to rules drawn up by others. In other words, the technology was *normative*, understood in terms of a social intervention in practice rather than as a natural, nomological 'impact'. In Wenger's terms, it was intended to align the practices of claims processors so as to standardize their work and to serve the needs of others (e.g. people working in the finance department).

Such an account leaves room for individual agency; indeed, it is required because making a reification meaningful, in this account, involves interpreting in relation to existing practice. Returning to Wenger's example, the claims processors who read and used the form understood it as a guide to acceptable kinds of action. They could, of course, have chosen to act differently – to reject the form, to try and subvert it, to pay lip service to its use – but it is easy to imagine how others could then hold them to account, using the rules represented in the spreadsheet as a point of reference.

Arguably, from this perspective, technology can be understood as a reification. If technology has been designed through the reification of particular kinds of practice, then it will be easiest to reinterpret and adopt in situations where similar kinds of practice already exist. This can be seen in the examples offered earlier where virtual learning environments are designed around abstracted versions of existing institutional roles, and with the spread of these tools, come to reinforce those particular forms of practice and make others harder to sustain (Cornford 2000; Friesen 2009). There are also interesting parallels with recent work on design patterns – for example, in Goodyear *et al.*'s (2006) discussion of the way in which such patterns can serve as mediation between theories and praxis, serving to promote actions that accord with the deliberate application of theory or which are entailed by a particular theoretical structure.

In other words, the reification has no deterministic power – if a community chooses to ignore a particular technology, for example, then the technology cannot force a change in their practice. Instead, practice is changed through wider social activity (within what Wenger describes as a constellation of practice), using the technology as a reification of a particular kind of practice to which communities can be asked to conform. Arguably, then, this provides a socially constructivist account, most consistent with the explanations offered by Grint and Woolgar (1997). Practice is reshaped in reference to technology but through the exercises of power within social contexts.

Actor–network theory

Actor–network theory (ANT) developed within Science and Technology Studies (see, e.g. Callon 1987). It explores how people work with things in order to sustain (or fail to sustain) social processes. Several things distinguish ANT from other perspectives, but perhaps most relevant to the discussion here are its material semiotic approach, and the ideas of heterogeneous networks, actants and punctualization (or 'black-boxing').

Unlike many other theories, ANT assumes that social practice involves networks that consist of things working together, and argues that successful social practice is the result of 'a process of "heterogeneous engineering" in which bits and pieces from the social, the technical, the conceptual, and the textual are fitted together' (Law 1992, p. 380). The idea of heterogeneity refers to the 'bits and pieces', which might include people, technologies, materials, processes, and so on. Like activity theory, it aspires to a holistic unit of analysis, considering the network as a social achievement, rather than making claims about decontextualized parts. Within this, it focuses on *how* networks are formed and sustained rather than why (Law 1997). On the face of it, this neatly sidesteps the whole issues of technological determinism; there is no attempt to ask for a cause, only a description of what happened. This in itself is a cause, enough for some to question the worth and even the morality of this approach (e.g. Winner 1993). The question of whether technology caused a network simply cannot be asked – only what role it played in the success (or failure) of some social process.

However, this matter is complicated by the idea of actants. In order to remain equally open to different kinds of 'things' within networks, no initial distinction is drawn between people, technology, resources, and so on. All are treated as able to act, and all are treated as produced. They are all 'actants'.

> In actor-network webs the distinction between human and non-human is of little initial analytical importance: people are relational effects that include both the human and the non-human (think, for instance, of 'Pasteur') while object-webs conversely include people (ephemeredes). Particular networks may end up being labelled 'human' or 'non-human' but this is a secondary matter. (Law 2008, p. 147)

Just as in activity theory, almost all social activity is seen as mediated – however, within this tradition, the means of mediate are always material rather than allowing things such as concepts (in the abstract, rather than in a particular material form) to be included.

While a particular technology might not 'cause' a social process, it can be blamed for its failure. Callon (1987), for example, talks of how contaminating catalysts resisted the efforts of Renault's engineers to develop an electric car. The catalysts have agency, were able to resist, and the engineers were unable to co-opt them into the smooth-running vehicles that they were trying to create.

The process through which actants gain this agency is not usually examined because it is assumed to be stable and treated as 'a matter of indifference' (Callon & Latour 1981). When it is examined, the idea of punctualization becomes important. This suggests that actants can be understood as 'black boxes' – when they work, there is simply no need to understand them; but when they fail, they can be opened up to see how they should have worked and what went wrong. An actant is thus understood as a heterogeneous network of other actants, albeit one that can normally be treated as a single entity. Callon and Latour (1981) note, for example, how researchers, 'black box', complicated the issues in order to make 'macro' claims about social processes.

Thus, it is possible within this tradition to ask questions about technology, and there are ways of exploring how it affects the actions of others, emphasizing how it has been socially constituted, and how it involves delegated or translated actions (e.g. Waltz 2006). For example, Enriquez (2009) has studied how Blackboard 'enacts multiple ways of working'. Such a study is concerned not with whether Blackboard 'works' or what its 'impact' is but how it comes to work properly in specific institutions as part of successful practices.

> Blackboard is articulated as something less bounded and, perhaps, as something 'soft' within which agency *flows*. (Enriquez 2009, p. 386)

This reframes Blackboard not as some bounded thing that causes an impact but as multiple variants. In this account, there is no single 'thing' that is Blackboard but various ways in which it can be framed: as a 'closed' product (as produced by its designers), as an open and extensible system (as it is taken up by institutions), as a course site, as a communication medium.

> Could it be more than one thing, and instead, many things simultaneously: a driver of change, a virtual environment, a tool, an approach? [. . .] What it is is always in relation to other people and things, and it always tells where it is working. (Enriquez 2009, p. 397)

Thus, two kinds of alternative account of technology are made possible with actor–network theory and other such relational approaches. The first of these focuses on the *how* of success (or failure), focusing on the ways in which social processes are engineered and describing technology in terms of the way that it is constituted in, and helps to constitute, practice. This tradition of work deliberately positions itself against nomological accounts of technological determinism but arguably remains technicist (Grint & Woolgar 1997). The second of these involves opening the 'black box' of technology to see how it has in itself been produced and why it plays the roles that it does. In many ways, this second kind of account resembles a second tradition from within Science and Technology Studies, which will be considered next.

Social construction of technology

The Social Construction of Technology (SCOT) provides a second perspective from the field of Science and Technology Studies. Whilst the 'common sense' views positioned technology as a determinant of practice, and Community of Practice theory places reifications like technology in a dialectic relationship with participation, Science and Technology Studies has led to the development of perspectives in which technology is positioned as the *consequence* of practice.

This perspective originated in enquiries into the process of scientific and industrial innovation, and initially focused on explaining the development of things such as the bicycle or Bakelite (Pinch & Bijker 1987). This particular tradition of work emphasized the social and political processes that took place around technological development. It focuses on the interpretative flexibility of technological artefacts (the idea that it means for different things to different people), that this can give rise to both technological problems and social conflicts, but that these differences can be 'closed' over time (either rhetorically by persuading people to think differently about them or by inventing a new problem to which this is a solution), and asking how these developments relate to the wider sociopolitical milieu.

Clearly, there have been differences of opinion within Science and Technology Studies about the extent to which social, as opposed to material, factors should be understood as shaping the evolution of technology or social processes. For example, a chapter by Law in Bijker *et al*. 1987 collection focused on weather systems and ocean currents in relation to the design of trading vessels, whereas the chapter by Pinch and Bijker focused on the development of bicycles primarily in terms of the preferences of thrill-seeking young men, modest women, or anti-cyclists.

Again, this position has been criticized as avoiding technical determinism simply by substituting social determinism. Instead of technical causes leading to social change, society is seen as the root cause of technological change. It is interesting to note that responses to this have included attempts to link this approach with elements visible in the 'common sense' formulation, such as the use of affordance (e.g. Hutchby 2001). Here and elsewhere, he attempts to steer the discussion away from 'what technology is' to how people engage with artefacts in their everyday experiences (Rappert 2003). However, as Rappert goes on to point out, these attempts are problematic and rely on taking for granted the very processes that SCOT wishes to explore, namely, how people come to make particular statements about technology. Pinch (2010), moreover, suggests simply that such criticisms miss the point; SCOT does not ignore the way that technology influences people and their actions but rather emphasizes the intentionality of technology and draws attention to the politics and processes that led to the engineering of particular kinds of 'forcing' of action by technology.

Of the approaches considered here, SCOT is the least visible in literature in the field of learning and technology. Selwyn (2007, 2012) has argued for its potential value in understanding the competing interests, agendas, and power formations that underlie uses of technology in education, but such analyses remain conspicuously absent, visible only in passing in one or two pieces of published work (e.g. Cook 2007).

Conclusions

The argument in this paper focuses on the way in which technology is discussed in studies of technology and learning. By adopting a critical position, it has been argued that technology should not be understood to operate on a causal model; it does not have straightforward 'impact' in some simple, mechanical way on the practices that it encounters. Through this, the analysis seeks

> to participate in the pressing need to reconsider our research practices, methodologies, methods and metaphors in doing educational research by drawing attention to a different way of conceptualizing the technologies we apply, evaluate and study. (Enriquez 2009, p. 386)

Essentialized and deterministic explanations of technology's role remain widespread in studies of technology. Arguably, this is a problem for researchers who wish to draw conclusions about technology, where their educational commitments are social and constructivist but their research conclusions are couched in materialistic and causal terms.

Four alternative positions have been outlined briefly here, each of which offers a different way of thinking about the relationship between technology and action. Such alternatives can offer explanations of how social practices make use of technologies (activity theory, ANT), what societal considerations influenced design and use (SCOT), and what practices (at a micro level) led to their creation or assimilation (communities of practice). Each perspective, however, only offers a partial account – for example, activity theory focuses on systems rather than elements such as technology; SCOT foregrounds intentionality but downplays the way that technologies might shape practice. Communities of practice focus on the actions of groups operating in narrowly circumscribed ways, and ANT describes social practice at the expense of offering reasons for it. Each offers a helpful way of moving beyond 'hard' technologically deterministic accounts and finding some way to recapture a sense of agency and, in some cases, moral and political sensitivity. As Enriquez suggests, such alternatives are needed.

However, these positions differ in the degree to which they move beyond nomological accounts. Which kind of alternative is most appropriate, however, remains open to debate. The position described here as technicist certainly has much in common with a considerable body of work in the field, not least with work that draws on traditions of activity theory. Selwyn (2012), for example, has argued that this incorporation of technical and social accounts is productive, particularly where it draws on theories of the social shaping of technology or political economies of technology; he also discusses the rehabilitation of 'affordance' as perceived possibilities for action, which is consistent with positions taken by authors such as Conole and Dyke (2004).

By contrast, the more radical social constructivist account is rarely seen nor argued for, at least explicitly; yet it is, arguably, consistent with work that draws on communities of practice (at least where that work makes use of the concept of reification). Moreover, there may also be methodological reasons to consider this position. Social, constructivist accounts of learning have come to dominate work in the field (Thorpe 2002). Adopting a reflexive position, because researchers can reasonably be described as learning about their object of study, it follows that their accounts of technology must also be constructed and socially negotiated. We cannot claim unproblematic, direct access to the 'true nature' of technology. Arguably, this is where accounts of learning and technology that appeal to concepts such as affordance in unreconstructed ways become problematic, and it has implications for the kinds of claims we make on the basis of studies. It suggests the importance of avoiding simplistic claims about impact, effect and technical causation, and concentrating instead on descriptions of practice, accounts of purposeful action and negotiated meanings.

This does not mean that technology has no properties, nor that any claim about technology is equally credible. To suggest this would be to ignore the processes of research through which knowledge claims are judged as warranted, are negotiated and peer reviewed, and may be refuted or supported; in other words, to ignore the 'social' part of social constructivism. It simply means that if we propose a socially constructivist account of learning, then our explanations of this should also be understood as socially grounded accounts.

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