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Actant affordances: a brief history of affordance theory and a Latourian extension for education technology research

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Abstract
Affordance theory provides a useful lens to explore the action opportunities that arise between users and technology, especially in education. However developments in the theory have resulted both in confusion and misapplication, due partly to issues related to affordance theory's ontology. This paper outlines two competing perspectives on affordances by Gibson and Norman, before arguing that Latour's theory of 'actants' provides a useful middle way between these competing positions. This 'actant affordance' provides new opportunities for undertaking educational technology research that focuses on the network of negotiations taking place *between* actants (student, teacher, technology, pedagogy, etc.) rather than studying causality or simple binaries.

Keywords: actants, affordances, Actor Network Theory, educational technology

Introduction

It is theory, as Einstein once said, 'which decides what can be observed'. Within social sciences, and particularly education research, shifts are taking place in how theoretical perspectives are used to approach research.

One of the key shifts, Fenwick, Edwards, and Sawchuk (2015: vi) argue, is towards a sociomaterial perspective. A shift that eschews positions that 'assume the social/cultural and the personal to be the defining parameters of what it means to learn' but rather foregrounds materiality in learning, where 'the material world is treated as continuous with, and in fact embedded in, immaterial energies, such as certain social relations and human intensities'.

There are several lenses that embody the sociomaterial paradigm, where these lenses serve 'as a sensitizing device to recognize and theorize the intertwining of the material and the social' (Mueller et al., 2012). One of these sociomaterial lenses is affordance theory. However, while affordance theory, within the greater sociomaterial perspective, provides a useful lens to explore educational research, like most theories it is far from uncontested. Developments within affordance theory, while extending our understanding of its use as a research perspective, have also resulted in heated debates with some even arguing for its abandonment.

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This paper explores firstly, the development of affordance theory from Gibson's initial conceptualisation of an affordance, through Norman's extension of affordances, to the resultant bewilderment on how to use affordance analytically. The paper then attempts to bring structure to the development of the theory by proposing a Three Movements framing of affordances. This framing attempts to bring clarity to the ontological issues that are at the heart of the debate. The framing then elaborates on the third movement of actant affordances by applying more recent developments in social theory, developed by Latour, to affordance theory. Finally the discussion considers how applications of affordance theory in technology-based research can be seen to fit the three movements framework.

History of affordances

Affordances have been used extensively over the years as a theoretical lens in education research, and in particular education technology research. Researchers have used affordance theory for studying 3-D Virtual Environments (Dalgarno & Lee, 2010), online social networks (Veletsianos & Navarrete, 2012), scaffolded social learning (Zywica, Richards, & Gomez, 2011), blogs and learning (Robertson, 2011), science learning (Webb, 2005), literacy (Hawkins, 2004), and much more. However, while there is extensive usage of affordance theory as a lens, the use of the theory in often disparate ways, necessitates re-examining the history and changing meaning of affordances.

The term affordance was introduced by James Gibson in 1977 in his article 'The Theory of Affordances' (J. Gibson, 1977) and then expounded in more detail in his later work where he framed it as an 'ecological approach' to perception (J. J. Gibson, 1979) and later in his wife, Eleanor Gibson's work (E. J. Gibson, 1982, 1988). Developed out of his desire to understand visual perception, Gibson theorised the concept of an affordance. For Gibson (1977) affordances were the action possibilities existing in an environment. 'The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either good or ill. The verb to *afford* is found in the dictionary, but the noun *affordance* is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment' (emphasis in original) (J. J. Gibson, 1979: 127). For example a surface that is horizontal, flat, extended and rigid has a support affordance as animals can walk, stand or run on it.

However, affordances offered do not necessarily equate to affordances acted upon, or even affordances perceived. This is firstly a factor of the physical characteristics of the animal/person. For example, while a stepladder affords climbing and hence reaching something up high, this is not an affordance for a baby. Equally a leafy thorn tree may afford food for a giraffe equipped with both a long neck and dexterous tongue, but not so for many smaller antelope. Secondly, affordances are, according to Norman (1988), also a factor of a person's culture, social setting and experience (Gaver, 1991). This is classically displayed in the movie 'The God's must be crazy' (Uys, 1984) where a Coke bottle discarded from a light aircraft is discovered by a Ju/'hoansi-San nomad. For the Ju/'hoansi-San, the affordances of the bottle are not related to holding liquid for drinking, but for curing snake skin, making music, creating circular stamps, crushing corn, etc.

> *Xi tried the thing out to cure thongs. It had the right shape and weight. It was also beautifully smooth and ideal for curing snakeskin. And Pabo discovered you could make music on it. And every day they discovered a new use for the thing. It was harder and heavier and smoother than anything they'd ever known. It was the most useful thing the gods had ever given them. A real labour-saving device* (Uys, 1984).

Developing on this, the next major development of the term was when Donald Norman (1988) appropriated the term into the context of human-computer interaction (HCI). Norman (2002: 9) defined an affordance as 'the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used'. Norman (1999) was concerned with what people saw rather than simply what an environment afforded. So while affordances, according to Gibson (1977), were latent within the environment, Norman (1999) argued that if these were not perceived they could not be classed as an affordance because they could not be acted upon. So while Gibson's original concept of affordances emerged out of visual perception, Norman's affordances were grounded in HCI and particularly design elements of online spaces.

Initially it seemed as though the concept was the same as that of Norman with just minor adjustments being made, but it soon became apparent that Gibson and Norman's conceptualisations of affordances were different. A Gibsonian affordance is one of *action possibilities*, while Norman's affordance is more about users' *perceptions* of action possibilities. A Gibsonian affordance is an action possibility partly independent of the actor - the actor's experience and culture intersect, but do not determine, the affordance. A Normanian affordance, however, is linked to the actor's past experience, knowledge, culture, etc. 'The frame of reference for Gibson is the action capabilities of the actor, whereas for Norman it is the mental and perceptual capabilities of the actor' (McGrenere & Ho, 2000: 2).

For Norman, emphasis in on perception, and this perception creates affordances that become real, whether they were objective/actual affordances of the object/design or not. 'It's very important to distinguish real from perceived affordances. Design is about both, but the perceived affordances are what determine usability. I didn't make this point sufficiently clear in my book and I have spent much time trying to clarify the now widespread misuse of the term' (Norman, 1999: 124).

This move by Norman, and others, resulted in a wide range of uses in the term affordance, ranging from what might be considered Normanian affordances, to Gibsonian affordances, to something else, as depicted by the following selection of phrases from various authors.

Gibsonian affordances

- 'The affordances of the environment are what it offers…provides…furnishes' (J. J. Gibson, 1979: 127)
- 'we define affordances as the potential for behaviours' (Volkoff & Strong, 2013: 823)
- 'Gibson intended an affordance to mean an action possibility available' (McGrenere & Ho, 2000: 1)
- 'Potentials for action' (Gaver, 1991: 1)

- ‘affordances are properties of the world that make possible some action’ (Gaver, 1991: 2)
- ‘Affordances are behavioural meanings, they are signs to an organism that actions are possible’ (Pickering, 2007: 72)

Normanian Affordances

- ‘the perceived and actual properties of the thing’ (Norman, 2002: 9)
- ‘fundamental properties that determine just how the thing could possibly be used’ (Norman, 2002: 9)
- ‘both actual and perceived properties ‘ (Soegaard, 2003)
- ‘primarily those functional properties that determine just how the thing could possibly be used’ (Pea, 1993: 51)
- ‘a perceived suggestion’ (McGrenere & Ho, 2000: 4)

Something else

- ‘An affordance is a property of the relationship, and was defined as an opportunity for action’ (Volkoff & Strong, 2013: 822)
- ‘Affordances imply the complementarity of the acting organism and the acted-upon environment’ (Gaver, 1991: 2)
- ‘ all of this functionality is mapped onto a single affordance on the dashboard’ (Mohageg et al., 1996, as cited in McGrenere & Ho, 2000: 5)
- ‘We are currently evaluating the affordance and socialness of this system through its actual use in our office’ (Tamura & Bannai, 1996: 132)

While there appear to be two major views, even within these two views there is a range of understandings represented by the multiplicity of phrases used to define affordances. For example Gibsonian affordances are referred to with terms such as ‘offers’, ‘opportunities for action’, ‘potential for behaviours’, ‘action possibility’, ‘properties of the world’ and so on. Normanian affordances are referred to with terms such as ‘fundamental properties’, ‘perceived suggestion’, ‘perceived properties’ and so on. In addition to the two main understandings of affordances, there are also a plethora of other definitions that add more confusion to the issue. However, as will be discussed later, it is within this grouping that a new direction for understanding and using affordances exists.

This diverse range of definitions of affordances has lead to critiques, such as that levelled by Oliver (2005), who feels affordances should not be used. It has also led to debates around the use of the term such as the three papers appearing in the journal ALT-J (Boyle & Cook, 2004; Conole & Dyke, 2004a, 2004b). However despite this, affordances are still widely used because they provide a useful way to describe the ‘complex and dynamic co-evolving relationship between technologies and users’ (Conole, 2012: 98), and in particular as it applies to education technology.

Various attempts have been made to bring clarity to affordance theory because of the usefulness of this framework for understanding interactions between users and technology. McGrenere and Ho (2000: 3) attempted to illustrate the differences between the two major views as is depicted in figure 1 below.

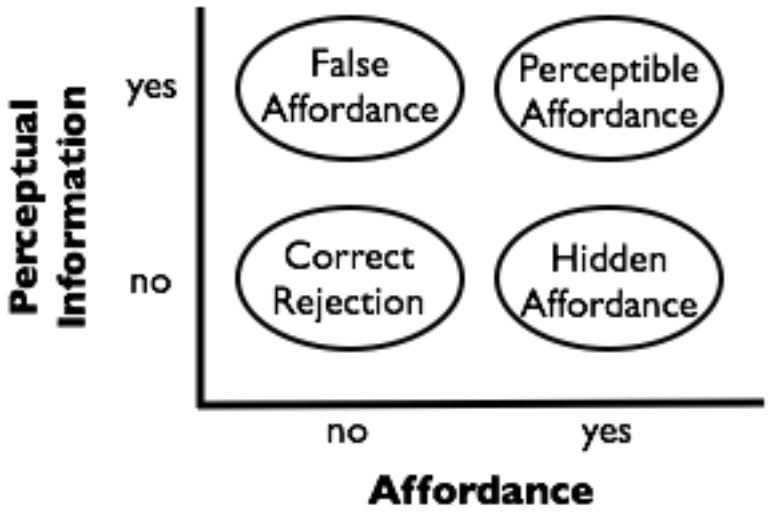
Figure 1: Gibson-Norman Affordance Comparison (McGrenere & Ho, 2000)

Gibson's Affordances • Offerings or action possibilities in the environment in relation to the action capabilities of an actor • Independent of the actor's experience, knowledge, culture, or ability to perceive • Existence is binary – an affordance exists or it does not exist
Norman's Affordances • Perceived properties that may or may not actually exist • Suggestions or clues as to how to use the properties • Can be dependent on the experience, knowledge, or culture of the actor • Can make an action difficult or easy

Soegaard (2003) suggested a simpler understanding, that Gibson's affordances are more about the utility/usefulness of an object whereas Norman's affordances are more about the usability of the object. This is not surprising in that Gibson's point of departure was visual perception and what objects communicate, whereas Norman's point of departure was HCI and what users perceive when they use objects.

However this still does not really make clear what an affordance actually is and how it should be determined. One of the most useful attempts to date to bring clarity was presented by Gaver (1991). He combined affordances and perceptual information in a simple matrix, as shown in figure 2 below.

Figure 2: Affordance categorisation (Gaver, 1991)



The matrix is useful in at least two ways. Firstly it makes clear the possibility of a Hidden Affordance that could be useable but is not perceived as useful. This resonates

strongly with the Gibsonian line. Secondly it shows up cases of False Affordances that appear to be useful but actually are not – helping to stop a relativist perceptual slide into whatever is perceived as an affordance being an affordance. Helpful as this categorisation is, it still does not sufficiently explain the so-called 'Perceptible Affordance'. Nor does it explain how one can correctly distinguish between a 'hidden affordance' and a 'correct rejection' when both do not offer perceptual information. It provides a very useful first clarification, but the 'over-simplified black boxes' of affordances (Wright & Parchoma, 2011: 256) need to be elaborated on. The next section considers such a reframing.

Reframing affordances: the Three Movements

The somewhat confusing history of affordances has led some such as Oliver (2005) to suggest abandoning the theory because of the apparent confusion and lack of clarity in its use. However as Sanders (1997) argues, just because there are ontological issues about whether the colour blue exists or does not exist, this has not caused us to abandon colours; so too the usefulness of affordance theory should not be abandoned simply because we have not yet clearly framed it within an appropriate ontological understanding. In response to this need we seek to develop a framing that provides a lens to both explore the developments in affordance theory and point towards potential future directions for its use in education research.

In developing this framing we begin by following what several researchers have suggested (Parchoma, 2013; Sanders, 1997; Turvey, 1992) as the best place to unravel the confusing and often-conflicting definitions and uses of affordances – the ontology of affordances. This has formed the base of the preceding discussion regarding the difference between Gibson's affordance, that actually exists in the environment (realist), and Norman's emphasis on perception of a property that might or might not exist (relativist).

However ontology does not stand alone in its role within the development (and confusion) of affordance theory. Key to the debate are the related issues of object-subject perspective, and object-subject causality (Parchoma, 2013). Gibson (1979) argued that affordances 'cut across the dichotomy of subjective-objective' yet this does not appear true: neither in his object emphasis nor later in subject-oriented affordance responses. Gibson's affordance perspective emphasises the 'object' side whilst Norman's affordance perspective emphasises the 'subject' side.

In addition to object-subject perspectives are issues of agency or causality. As Parchoma (2013) points out in her analysis of the development of affordance theory, there are also key differences in direction of agency. Some theorists argue for agency taking place unilaterally from the subject to the object, where the subject causes the affordances of the object to be revealed. Whereas other theorists argue for agency taking place unilaterally from the object to the subject, where objects produce effects in subjects. So, for example, Turvey's exclusive pairing of affordances with the effectiveness of humans and animals denies agency to artefacts. Reed can be read as arguing strongly for the opposite pole with an evolutionary analogy that pushes resource-based affordances as having agency to produce effects in human and animal behaviours (Parchoma, 2013). The issues of object/subject perspective and the agency direction are therefore both key to developing a framework for understanding affordances (Parchoma, 2013).

Once we had the three basic categories of perspective, causality and ontology, we felt it was important to align these more broadly within philosophical paradigms as a locating device– so we used a fourth category of 'philosophical paradigm'. This element is important, as it has been argued that theories of affordances are not always true to specific paradigms. For example Oliver (2005) argued that Norman straddled both Positivist and Interpretivist positions. This 'ring fencing' of perspective, causality and ontology within paradigms also opens the opportunity to both 'test' the affordance theory's definitions against other defining elements of the paradigm, as well as opening opportunities to explore other paradigms that may offer new insights into affordance theory.

As such it is possible to frame the various movements of affordance theory in terms of the following four dimensions (see Table 1).

Table 1: Affordance Movement Dimensions

Perspective	Object	Subject
Causality	Object->Subject	Subject->Object
Ontology	Realist	Relativist
Philisophical Paradigm	Positivist	Interpretivist

These four dimensions will be used to position affordance theory within two existing and one emerging movement. The concept of 'movements' is used to reflect the moves that have taken place between the ends of paradigmatic continuums, bounded largely by object-subject extremes.

Affordance Movement 1 - Object Affordances

The first movement is named Object Affordances, because of its object perspective and causality. This movement, as described originally by Gibson (1977) is grounded in a positivist ontology (Parchoma, 2013) that suggests the objective and inherent affordances offered by an environment to the actor (Oliver, 2005). In this sense the affordances are more about the objective environment than the subjective perceptions of the individual and the predominant causality is that of the object to the subject. Ontologically, affordances are real possibilities for action that reside in objects or the environment. Interestingly, it is this realist ontology that remains as the single unchanging dimension across the three movements, and also the axial point of contention and confusion.

The first affordance movement, as depicted in Table 2 below, is therefore defined by an object-centric perspective, an object→subject causality, a realist ontology, and a positivist paradigm.

Table 2: Affordance Movement 1

	Movement 1	
Perspective	Object	Subject
Causality	Object->Subject	Subject->Object
Ontology	Realist	Relativist
Philisophical Paradigm	Positivist	Interpretivist

Movement 1, Object Affordances, can therefore be defined as latent cues in the environments and other real objects that offer action possibilities to actors. As such Object Affordances are defined as action possibilities, represented by verbal nouns, arising as offers, existing in the environment, and are independent of the actor (see Table 3).

Table 3: Object affordance characteristics

1 - Object Affordance
Action possibilities
Verbal Noun
Offers
Environmental
Independent

Affordance Movement 2 - Subject Affordances

The second movement is named Subject Affordances, because of its subject perspective and causality. The second movement, as primarily conceptualised by Norman (1988), saw an attempt to remain ontologically aligned with the first movement's realist perspective but at the same time frame affordances within an interpretivist paradigm, thereby creating an interpretivist-realist dilemma (Oliver, 2005). Chemero (2003: 182) argued that this 'makes affordances seem like impossible, ghostly entities, entities that no respectable scientist (or science-worshipping analytic philosopher) could have as part of their ontology'.

While acknowledging real affordances, Norman (1988) introduced the notion of perceived affordances which initiated a movement towards a separation of real and perceived affordances and the associated tensions (Parchoma, 2013). Unlike the first movement, this second movement is more concerned with the properties of affordances (due to the interpretivist perspective) than the affordance per se. This overlaying of property on the affordance attempts to acknowledge the realist ontology but at the same time imbue it with an interpretivist perspective (Chemero, 2003). This uncomfortable interpretivist-realist tension has caused various researchers (Reed, 1996; Turvey, 1992) to try and clarify the position in terms of subject-object agency.

Rather than simply settling down in a new ontological and epistemological space, this second movement vacillates with subject-object agency issues (Oliver, 2005). The result is an uncomfortable tension in the ontological umbilical cord tethering realism to the interpretivist paradigmatic perspective. The interpretivist paradigm takes the starting point to be human

interpretation (Subject→Object). It is a 'position that argues against the positivistic notion of a passive, mechanistic and reactive human being' (Chen, Shek, & Bu, 2011: 129). Interpretivism's heritage is Kant's (1896) work and the concept that ontological reality cannot be independent of what is known inside the head. As Chen et al. (2011: 130) point out, the goal of interpretivism 'is to understand the "lived experience" (Erklaren) from the standpoint of the research participant'. Interpretivists claim that objective reality is not possible and do not agree with the positivist view that perceptions are determined by the outside world. Rather they claim that the focus should be on participants' subjective interpretations of the outside world. This does not necessarily mean a rejection of ontological realism, and as Chen et al. (2011: 133) suggest, 'a number of interpretivists tend to stand close to the realist side'.

The second movement, as depicted in Table 4 below, is therefore defined by a subject-centric perspective, a subject→object causality, a realist ontology, and a interpretivist paradigm.

Table 4: Affordance Movement 2

	Movement 2	
Perspective	Object	Subject
Causality	Object->Subject	Subject->Object
Ontology	Realist	Relativist
Philisophical Paradigm	Positivist	Interpretivist

Movement 2, Subject Affordances, can therefore be defined as the perceived and actual properties of things that can be acted upon. As such Subject Affordances are defined as perceived properties, represented by verbal nouns, arising from perceptions of offers, seen in the properties of the environment, and are dependent on the actor (see Table 5).

Table 5: Subject affordance characteristics

1 - Object Affordance	**2 - Subject Affordance**
Action possibilities	Perceived properties
Verbal Noun	Verbal Noun
Offers	Perceptions
Environmental	Properties
Independent	Dependent

Affordance Movement 3 - Actant Affordances

Much of the current debate around the use of affordances relates to Movement 1 and Movement 2. While various attempts have been made to unravel the causal and ontological differences between these two movements, they have often resulted in more confusion. What is required, in order to articulate a third movement, is not simply a reaction to the first two

movements but a theoretical basis around which Movement 3 affordances can be conceptualised. It is this goal that the following conceptualisation of Movement 3 – Actant Affordances -- attempts to achieve.

For some time there have been calls for a shift away from subject-object and agency debates that have defined both the first and second movements of affordances (Sanders, 1997; Williams & Edge, 1996). In a broader theoretical sense this is part of the response to move away from simple discrete binaries to what Barad (2007) refers to as entanglements and the need for 'individuals to emerge through and as part of their entangled intra-relating'. Barad (2007) argues that there needs to be a move away from inter-action perspectives, caused by binary or stratified arguments, towards 'intra-action' that considers entangled agencies.

> The notion of intra-action recognizes that distinct agencies do not precede, but rather emerge through, their intra-action. It is important to note that the 'distinct' agencies are only distinct in a relational, not an absolute, sense, that is, agencies are only distinct in relation to their mutual entanglement; they don't exist as individual elements (Barad, 2007: 33).

Fenwick et al. (2015: ix) in their discussion of sociomaterial, call for a move away from 'problematic binaries such as theory/practice, knower/known, subject/object, doing/reflecting, meaning/matter, informal and formal learning human/non-human and so forth'. However, only recently have developments in social theory provided potentially appropriate framings to make this next move.

Both Movement 1 and 2 are based on 'straightforward accounts of an otherwise complex socio-technological age' (Selwyn, 2012: 83) which obscures the messy manifestations of what is taking place in practice, and the inherent issues with cause and effect or subject-object idealisations. Rather than oscillating between these extremes, the third affordance movement argues for an approach that opens up the extremes by providing a new position between them. This 'in between' approach, as Williams and Edge (1996) called for, is neither simple uni-directional causality nor the black boxing of binaries such as technology and actors.

One of the first steps towards the third movement of affordances was made by Schmidt (2007). He conceptualised the notion of social affordances, meaning that the social nature of objects affords particular social uses. By this he suggested that social relationships create additional environmental properties for objects. For example, a cup that affords graspability due to having a handle, might not be grasped by me because it is not mine, or might not be grasped by me because it is a sentimental ornament not meant to be used.

'The existence of social affordances depends upon the relationships between perceiver and environmental properties at this social scale' (Schmidt, 2007: 142) and as such it is important to understand how social processes 'property' the environment with real properties. Schmidt (2007: 149 e.a.),) concludes by saying that 'social affordances of objects emerge from the relationship *between* these abstract, functionally defined properties of the perceiver and the environment' hence signalling the move to 'between'.

In much the same way as the second movement was a reaction to the first movement, this third movement can become a reaction to the second movement resulting in a return to

first movement affordances once again. As Volkoff and Strong (2013: 819) say, there is a 'renewed focus on the concept of affordances that returns us to its roots in Gibson'. This leads him to later define affordances as that which 'is offered, provided or furnished to someone or something by an object' (Volkoff & Strong, 2013: 819) thereby invoking the first movement definition. However, the middle ground, a ground that this third movement of affordances is attempting to claim, has real opportunities to extend the use of affordances in new ways (Wright & Parchoma, 2011) that are neither first movement object affordances or second movement subject affordances, but third movement 'actant' affordances.

Latour (2005) introduces the concept of actants into the object-actor discussion. He does this in order to remove the dichotomy and illustrate the equal import of the role played by both the 'object' and the 'actor' where both operate together to construct activity. Latour's (2005) actant perspective argues against the object/subject dichotomic end points in favour of a construction that takes place *between* equally active objects and actors, termed actants (Alvesson & Sköldberg, 2009).

This Latourian perspective provides a framing that finds itself (un)comfortably between the interpretivist and positivist extremes. As Alvesson and Sköldberg (2009: 32) say, 'Latour (who) describes himself as a social constructionist…later developed in a (more) realist direction. He describes himself as being in permanent change and transformation, and provocatively refers to himself as a realist and a positivist'. Hence for Latour, technical artefacts play as much of a role in constructing activity as do the actors. In a sense the co-construction speaks neither to an object or subject but rather to the relationship created by the interaction of the various actants in the network.

This shifts the focus to the 'space between' rather than the dichotomic end points, potentially providing a response to Gaver's (1991) suggestion of positioning affordances around the complementarity of the acting organism and the acted upon environment Williams and Edge (1996: 866) refer to this middle ground as 'a "garden of forking paths" (where) different routes are available, potentially leading to different technological outcomes'. Theorising this messy, forking, middle ground requires approaches that speak to a multi-directional construction created and being created by multiple actants.

This third movement seeks to escape 'the strict form of social constructionism…(by acknowledging that) real inanimate objects are responsible for constructing facts no less than are power-hungry humans…(so moving to occupy) a strange middle ground' (Harman, 2009: 11). This is the ground where both real social practices and real properties of objects interact to create affordances (Parchoma, 2013). The third movement is therefore a framing of affordances in terms of the 'in between' rather than one or other side. While carrying over elements from the second movement's interpretivist/constructivist approach, this third movement extends the framing to embrace the environment as an equal actor in the construction of the affordance, as espoused by the first movement. Hence this third movement elevates the role of connection in affordances between equally real and enabled actants.

Thus while the first movement espoused an object→subject causality and the second movement responded with a subject→object causality, the third movement steps out of these uni-directional causalities and frames itself within an actant↔actant relationship. This movement seeks to instantiate actionability to both object and subject in the Latourian sense

of the actant. This therefore removes uni-directional causality that plagues Movements 1 and 2 by replacing it with multi-directional, networked relationships between actants, whether inter-object, actor-object, object-actor, or inter-actor. The actant is both the subject and the object and neither the subject nor the object, but the network.

Like both Movement 1 and 2, Movement 3 remains true to the realist ontology. However whereas the marriage of a realist ontology with interpretivist paradigm in Movement 2 creates an 'inconsistency' (Oliver, 2005), Movement 3 could be said to adopt a stratified ontology as conceived in Bhaskar's (2008) Critical Realist paradigm. While accepting the realist ontology, Critical Realism argues for a stratified ontology where the real world is ontologically stratified into real, actual and empirical domains. While ontologically Critical Realism has positivist roots, epistemologically it is anti-positivist (Koponen, 2009) thus providing useful framing for the third movement of affordance theory. Volkoff and Strong (2013: 819) demonstrate how 'affordances arise in the real domain from the relation between the complex assemblages of organisations and of IT artefacts, how affordances are actualised over time by organisational actors, and how these actualisations lead to the various effects we observe in the empirical domain'. Additionally, as Fenwick et al. (2015: x) argue in their discussion of the case for sociomaterial perspectives, 'critical realism appears to offer interesting potential for educational analyses…(however) there is yet little published educational research exploring this potential'.

Gibson (1979: 127) said that he made up the noun 'affordance' from the verb 'afford'; 'The verb to afford is found in the dictionary, but the noun affordance is not. I have made it up'. Gibson's (1979) notion of what is called a verbal noun (Trask, 2006) created a structure (noun): agency (verb) tension with Gibson foregrounding the precedence of the noun (object/environment) and what it offers (verb) and Norman responding with a subject (noun) and what it perceives (verb). However, the third movement seeks to preference neither the object nor the subject, or reductive uni-direction cause-and-effect relationships. The concept of actants, arising from Actor Network Theory (ANT) provides a conceptualisation of affordances that is both networked and multi-directional, that presents affordances as actant action possibilities residing in the realm of the verbal nouns (plural). 'It is this relational materiality that is often overlooked in educational research' (Fenwick et al., 2015: 3) with its focus not on individual objects' agency but rather on the effect of sociomaterial assemblages.

The third movement, as depicted in Table 6 below, is therefore defined by an actant perspective, a networked actant↔actant causality, a stratified ontology, and a critical realist paradigm.

Table 6: Affordance Movement 3

		Movement 3	
Perspective	Object	Actant	Subject
Causality	Object->Subject	Actant<->Actant	Subject->Object
Ontology	Realist	Stratified	Relativist
Philisophical Paradigm	Positivist	Critical Realist	Interpretivist

In Movement 3, Actant Affordances are therefore defined as the actant opportunities that exist for action. They are the opportunities negotiated at the intersection of actants, both

environmental and human. As such Actant Affordances are defined as actant action opportunities, represented by verbal nouns, arising out of interactions, existing in the network of relations, and are co-dependent on the environment and actor (see Table 7).

Table 7: Actant affordance characteristics

1 - Object Affordance	**2 - Subject Affordance**	**3 - Actant Affordance**
Action possibilities	Perceived properties	Actant action opportunities
Verbal Noun	Verbal Noun	Verbal Nouns (plural)
Offers	Perceptions	Interactions
Environmental	Properties	Network
Independent	Dependent	Co-Dependent

This implies that in addition to objects affording opportunities to actors (Movement 1) or actors perceiving opportunities in objects (Movement 2), there also exists the possibility of objects affording action opportunities to objects and actors to actors (see Figure 3). This extended range of actant action opportunities indicates the widening range of opportunities through which technological affordances can be explored.

Figure 3: Range of Actant Affordances

Object	Inter-Object	Real Affordance
Actor	Perceived Affordance	Inter-Actor
	Object	**Actor**

As such, the Actant Affordance focuses on the assemblage of micro-connections, where the networks 'produce force and other effects: knowledge, identities, rules, routines, behaviours, new technologies and instruments, regulatory regimes, reforms, illnesses and so forth…(where) learning and knowing are performed in the processes of assembling and maintaining these networks, as well as in the negotiations that occur at various nodes comprising a network' (Fenwick et al., 2015: 10).

'One way to visualize an affordance is thus as an ongoing strand of action potential, which is interwoven with other strands in patterns that can be explored to understand how information technology might be implicated in…(learning) as those affordance strands are actualized' (Volkoff & Strong, 2013: 824). Movement 3 affordances are an interwoven strand of actant action opportunities, that while existing in the domain of the real, will only be actualised, brought into the domain of the actual, if a user acts upon the affordance.

> An affordance arises from the relation between a structure or object and a goal-directed actor or actors. It needs to be triggered or actualized by that actor. Generative mechanisms may arise from structures alone, and their causal powers triggered

without the intervention of an actor. Thus, affordances are a type or subset of generative mechanisms' (Volkoff & Strong, 2013: 823).

Mapping technological affordances to the three movements

Technological affordances focus specifically on the use of affordance theory to understand the relationship between humans and technology, and especially as it is increasingly being applied to educational technology. It is unsurprising that when examining the usage of affordances as applied to technology, evidence is found of positioning within all three movements.

While affordances, as originally conceived by Gibson (1977) were about human perception, and ecologically based, Norman (1988) applied them to technology, instituting a move away from Gibson's conceptualisation by focusing on the link between perception and action, and as so initiating the second movement. However this was soon followed by a call to return to the original Gibsonian concept, arguing that 'as the concept of affordances is used currently, it has marginal value because it lacks specific meaning' (Boyle & Cook, 2004: 298). Therefore 'returning to a definition close to that of Gibson's would solidify the concept' (McGrenere & Ho, 2000: 7) and so precipitated a swing back to the first movement.

At the same time Laurillard, Stratfold, Luckin, Plowman, and Taylor (2000) introduced the conversational framework for designing educational environments. This educational framework sees affordances as designed features and activities within technological environments, as such reflecting a potential move towards some middle ground. Conole and Dyke (2004b) in their application of affordances to educational technology suggested that affordances are functional properties of ICT environments, signalling a movement back towards the Normanian concept of perceived affordances and the underlying tenets of the second movement. However almost immediately there was a push back against this as Boyle and Cook (2004: 297) in their critique of Conole and Dyke (2004b) suggest a move towards a 'new habitat' that combines Gibson's concept of affordances (Movement 1) with the social constructivist approach (Movement 2), which they suggest will produce an 'uncomfortably productive' theoretical tension (a vision of Movement 3).

Suthers (2005), in work published at a conference and later in a journal (Suthers, 2006), looked at technological affordances in terms of inter-subjectivity. While defining her use of the term affordances in terms of Norman's perceived affordances, Parchoma (2013) argues that Suthers (2006) adopts Latourian concepts that empower technologies to be constraints or regulators. As such he signals the beginning of an alignment with the third movement of affordances seeing 'technological affordances as enablers, restrictors, and regulators within human-computer interactions' (Parchoma, 2013: 22), a move Wright and Parchoma (2011) suggest is necessary in the evolution of affordance theory.

Educational technology affordance research is now entering the third movement, where research seeks to focus on the 'between' or the relational view of artefacts and actors, between technology and human. 'Technological affordances are descriptive of temporal relationships *between* human and technological actors within networked social environments' (Parchoma, 2013: 23). Using an actant perspective allows for a focus on the sociomaterial, on the interconnections between human and non-human entities.

By decentering human intention and action, the objective shifts to understanding '*how* these things come together—and manage to *hold* together—to assemble collectives or 'networks' that produce force and other effects: knowledge, identities, routines, behaviours, policies, curricula, innovations, oppressions, reforms, illnesses and on and on' (Fenwick & Edwards, 2011: 7).

Conclusion

Researchers have brought a range of theoretical lenses to bear on research related to technology and how it is impacting education, such as Activity Theory (Rambe & Ng'ambi, 2011), Communities of Practice (Williams, Karousou, & Mackness, 2011), and Affinity Spaces (Lammers, Curwood, & Magnifico, 2012). While all of these theories provide useful perspectives into interaction and design issues, affordance theory provides a lens to explore the network of actant opportunities that exist between actants in e-learning environments. These intended and unintended actant opportunities can exist between users and technology, between users and users and between technology and technology.

Shifting paradigmatic perspectives has been key both to the use of, and views of affordances. Just as there is still much debate, and confusion amongst the range of philosophical paradigms on offer, so too debate and confusion continues to exist in affordance theory. However, by aligning the movements in affordances with broader movements in ontology, causality, and philosophy it is possible to not only reframe affordances but also enrich affordance theory with a new range of socio-technical perspectives that offer exciting new perspectives for exploring e-learning environments.

These new sociomaterial perspectives of affordances encourage a focus on the minute negotiations taking place *between* actants and thereby offer educational researchers the 'resources to consider systematically both the patterns and the unpredictability that make educational activity possible' (Fenwick et al., 2015: 2). By taking what is here termed as an actant affordance perspective, educational researchers are not simply seeking simple causalities, but able to explore the rich interplay between all factors matter and meaning (Barad, 2007), human and non-human, environment and pedagogy. By exploring the affordances that lie at these junctions, educational researchers are offered a myriad of potential new insights into teaching and learning.

Theorising a new middle ground is not for the faint hearted as Latour (2005) has endured critique from both ends where he is accused of returning to realist ontologies and at the same time accused of abandoning relativist perspectives (Harman, 2009). However, as Harman (2009: 12) says, this middle ground is not 'an eclectic compromise mixing elements of both, but marks a position of basically greater philosophical depth'. It is this middle ground that the next movement of actant affordances seeks to boldly claim, and thereby continue to enrich its value as a lens for researching the nexus of education and technology.

Post Script

If theorising this new middle ground is not for the faint-hearted, then attempting a massive research project that embodies these principles involves a strong stomach as well. Such a project, conceived by Latour, is currently in play, although the jury is still out on its success. It is called AIME – An Inquiry into Modes of Existence. 'Modes of existence' is a 'middle

ground' concept that explores how different networks working in this middle ground construct connections and affordances that enable specific types of change. Latour is specifically interested in our modern 'modes of existence' and has set up the research project in such a way that the technological aspects of the research afford specific types of relationships and possibilities. He has made the research freely available on the net.
See http://modesofexistence.org

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