THE UNIVERSITY OF
WARWICK

University of Warwick institutional repository: http://go.warwick.ac.uk/wrap

This paper is made available online in accordance with
publisher policies. Please scroll down to view the document
itself. Please refer to the repository record for this item and our
policy information available from the repository home page for
further information.

To see the final version of this paper please visit the publisher's website.
Access to the published version may require a subscription.

Author(s): Michael Hammond

Article Title: What is an affordance and can it help us understand the
use of ICT in education?
Year of publication: 2010
Link to published article: http://dx.doi.org/10.1007/s10639-009-9106-z

Publisher statement: The original publication is available at
www.springerlink.com

What is an affordance and can it help us understand the use of ICT in education?

Abstract

This paper revisits the concept of affordance and explores its contribution to an understanding of the use of ICT for teaching and learning. It looks at Gibson's original idea of affordance and at some of the difficulties long associated with the use of the word. It goes on to describe the translation of the concept of affordance into the field of design through the work, in particular, of Norman. The concept has since been translated into research concerning ICT and further opportunities and difficulties emerge. The paper locates key points of divergence within the usage of 'affordance', as involving direct perception, invariant properties and complementarity. It concludes by arguing that affordance offers a distinctive perspective on the use of ICT in education because of its focus on possibilities for action.

What is an affordance?

The term affordance was introduced by Gibson to describe what an environment:

> offers the animal, what it provides or furnishes, either for 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." (p 127 Gibson 1986)

An affordance, then, is a relation between an organism and an object with the object perceived in relation to the needs of the organism. For example, a tree might afford sheltering from the rain; hiding from a pursuer; or even eating and sustenance if the tree is a source of food. The properties of the tree remain the same, or invariant, but the opportunities provided the tree differ according to need. Further, the same tree might afford different things at the same time to different organisms.

The essence of an affordance is that it 'points both ways' to the object and to the organism. An affordance is an emergent property of an object. The affordance is

there, it has always been there, but it needs to be perceived to be realised. A subsidiary idea is that affordances provide both opportunity and constraint. These are not opposites rather they are complementary, so, for example, a sledgehammer affords the breaking of rocks but the user is constrained by its weight – the very thing that provides the opportunity for rock breaking.

The strength of the idea of affordance, and perhaps accounting for its popularity, is that it offers an alternative to the now unfashionable realist perspective (that the world exists independently of the perceiver), but rejects the radical nominalist position that properties are perceptual and exist only so far as they identified. As Turvey puts it, the concept of affordance avoids the idea that there are "thingless properties" or "propertyless things." (p176 Turvey, 1992). To be sure, Gibson is a realist in that he sees objects as having invariant properties; he believes that affordances are real and that the environment is governed by physical laws. However, affordances are always described in relation to the perceiver. This concept of affordance can of course be attacked, in turn, by realists, who might see affordances as metaphysical, while, on the other hand, radical social constructivists, and more extreme versions of Actor Network Theory (ANT) would question whether there are inherent properties outside of our interpretations of them. Hutchby (2001), amongst others, addresses this problem head on. He argues that while uses and definitions of tools are socially constructed they do nonetheless have material properties. The more extreme example he discusses is that of a gun which can be put to different uses and perceived in different ways, but, if fired, can have quite devastating physical effects, just as physical laws predict, which it would be perverse not to recognise.

As with many important theorists, Gibson's work is capable of, or, it can be said without irony, affords different interpretations. However, its central and distinctive contribution is that it suggests a way of seeing the world as a meaning laden environment offering countless opportunities for actions and countless constraints on actions. The world is full of potential, not of things.

Difficulties with affordances

The concept of affordance has become very popular across a great many fields but, leaving aside the ontological tensions raised above, its application raises some

difficulties: in particular how do organisms perceive (or become attuned to) affordances? The key in Gibson's work is that affordances are perceived directly. This is a difficult idea which is described at length by Michaels and Carrello (1981). They argue that in both cognitive and behaviourist theories, perception is indirect, that is the *data* we pick up in the world are inadequate or impoverished, they need to be processed, or reordered internally for the perceiver to make sense of them. In contrast the direct view of perception suggests that we perceive rich *information* about our environment directly and this is because we perceive events, rather than discrete objects in snapshots of time, relative to our niche within it. Direct perception need not rule out the importance of past experience, memory and context, for these will certainly affect the ways in which the organism knows the environment, but they do not undermine the idea of direct perception. We are able to perceive directly because we know our environment already and are, in a sense, primed to find out more about it. Knowing is an active process; we are constantly seeking to know more about our environment. Constructivists, of course, share a view of knowing through active engagement but their focus is much more on internal sense making.

The most striking difficulty when applying the idea of direct perception to human behaviour is one of translating a theory of 'animal' behaviour, to understanding human societies with access to sophisticated tools including complex symbolic systems (Scarantino 2003). This is the point made by Baerentsen and Trettvik (2002) who argue that Gibson's work underplays the distinction between natural and cultural objects and that direct perception might contribute much more to understanding how we meet our immediate needs. For example, in the wild, a path may be created naturally by humans as a means of getting from A to B but a road needs to be understood as a planned connection, a culturally and historically modified environment. Cultural tools are made with intended or specified affordances, nested in systems of societal praxis. In a further example both Baerentsen and Trettvik (2002) and Greeno (1994) amongst others, raise the idea of a mail box as an example of social praxis, or at least engagement in a symbolic system, which cannot be understood in terms of physical properties of the mail box. The example was one offered, of course, by Gibson himself, but not, Baerentsen and Trettvik and Greeno argue, adequately dealt with. In a similar vein Chemero (2003) makes the distinction, borrowing from Strawson, between *recognising features* and *feature placing.* In other words there are different types of perception some of which are more immediate (e.g. *it is raining*) and some requiring knowledge of properties. In

a further critical comment Derry (2007 p 508) agues that what is distinctive about human contact with the world is that “perception has a conceptual dimension”; we do not merely respond to the world but know what follows from a response.

The idea of direct perception is, then, a difficult one and becomes muddied by examination of experimental work. A classic study (Warren 1984) considers the affordance of stair climbing (i.e. what height stairs have to be to be seen as climbable). Through much empirical testing the affordance of climbable is seen as strongly associated with body scale. (A point to add here is that ecological psychologists usually see this kind of association between property and affordance as dispositional rather than as a search for natural laws). However in a further examination Greeno (1994) suggests that ‘ability’ (in the sense of effectivity and aptitude) affects the perception of climbability, so that perception of physical properties is more complicated than might be supposed. It can further be argued that perception is influenced by context in a way in which experimental psychology tends to underplay. For example what is perceived as climbable will alter if one is being chased - context, aptitudes and effectivities are all important.

Affordances and technology

From the above brief account it can be seen that Gibson does not provide an answer to problems of perception but raises intriguing questions as to what we perceive and how we come to perceive it. Not surprisingly, affordances became a very influential concept in range of diverse fields including, of most relevance for this paper, that of design and human computer interfacing. One key moment in this was the popularisation of affordance by Norman (1998) However, Norman (1998) offered a modified view of affordance focusing on an association with suggestibility:

> …the term *affordance* refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. (p.9)

There are subtle differences between Gibson and Norman (which Norman has been happy to acknowledge). Norman was, firstly, interested much more in how the environment could be both symbolically and physically designed; secondly, in perception of the user (rather than the invariant properties of the tool); and, thirdly,

how goals, culture and past experience influence perception (see McGrenere and Ho 2000 and Brown, Stillman, and Herbert 2004). Norman was, however, asking the key question for a designer: 'how can I make this thing so that it is feels natural to use'. However, Gaver (1991, 1996) amongst others, suggested there was value in going back to Gibson's concern with material properties. He gives the example of hierarchical placing within an office block, the higher the floor on which an office is located, the greater the prestige. While assigning prestige might be a social construct it tracks back to a material property, the higher the floor, the more one is afforded privacy. Look behind many conventions, including those in human computer interfacing (HCI) and there may be affordances based on material properties. Gaver further reminds us of the importance of nested affordances, ones that are grouped in time and space, and offered further insight by adding that affordances are not just seen (Gibson's focus) but may, also be felt or heard.

Affordances and ICT

The concept of affordance crossed over from HCI into the application of ICT in education and became increasingly used in connection with the opportunities for action which various technologies provided. However, predictably, the concept is used in different ways for different purposes. One divergence is between its use in learning design research (how should we design, or at least highlight, affordances to support learning?) and more naturalistic research (how can we describe and explain the different ways in which a tool might be perceived?). These categories are 'fuzzy' (design work often takes place in natural settings and naturalist enquiry takes place in order to illuminate implications for practice) but are useful and lie at the heart of differences in the ways in which we conceive of educational research. The distinction is illustrated by looking at some examples in which interest in the concept of affordance has been clearly signalled.

Affordances for learning design

Here the focus is on how *should* we perceive or design a tool so that it supports activities which are seen as desirable or necessary for learning. This implies a top down interest in affordance in that the focus is on what is there in the technology to support a previously articulated pedagogy. For example, Pea (1993), one of the early adopters of the term affordance in the field of technology and learning, wanted to

focus on those affordances that supported distributed intelligence. He proposed research in how we can:

> get a learner to attend to the pertinent properties of the environment, or the designed object, or the inscriptional notations, such that the learner can join in to contribute to distributed intelligence in activity (Pea 51-52)"

While Pea references the contribution of Gibson, his interest is much more in the tradition of Norman; how can we design, in this case, learning tools so that their use is as transparent as possible to the user? Like Norman he is much more interested in the role of culture and context, than the 'direct perceptual pick up' of an affordance.

This view of affordance is consistent with that of Laurillard et al (2000) who explored the use of a multi media CD-ROM in school. The researchers developed what is described as a conversational framework for understanding learning but found that pupils were not engaging in such a framework in their use of CD-ROM material. Rather, analysis of talk between pupils showed that they tended to focus on how to operate the software and talk remained at a low level of reflection. Their aim was to make the affordances for supporting the semantic task become clearer. This could be undertaken by the teacher, through paper based support, task setting and through re-designing the learning material.

In a similar vein Webb (2005) is interested in affordances in the context of supporting productive learning activities, in particular support for conceptual change, in science education. Her paper relates affordances for student learning (eg making predictions, comparing predictions and note taking) to elements that provide the affordance (eg microworlds and teacher worksheets). Further, it looks at elements that increase, or decrease, the degree of affordance and elements that provide information about the affordance. The idea of complementarity is downplayed in both Laurillard's work cited above and Webb so that the focus is on the opportunities which technology provides. Neither contains an explicit discussion of direct perception.

A final example in using affordance tailored to pedagogical design is offered by Conole (2004). This is a more speculative paper which relates affordances in technology to features of 'our late modern age'. Through this lens taxonomy of ICT affordances is created including accessibility, speed of change, diversity, communication, reflection and multi modality.

Affordances and a more naturalistic approach

Here there is a more open ended exploration of how users *do* perceive tools rather than, at least in the first instance, how might affordances be best made transparent. Downes (2002), for example, presents a mixed methods study, drawing on ecological psychology, cultural studies and childhood studies, to explore children's use of computers in the home and school. Children, it is suggested, see 'playability' as a compelling affordance of the computer but this may conflict with the perception of schools and teachers. The tension between the tool / toy perception explains some of the difficulties experienced in using ICT for learning, and for example, makes it quite explicable that children may focus on using word processors for improving the 'look of' the text (toy), rather than editing (tool). Downes looks at how perception is shaped by culture and context but does not address head-on the notion of direct perception. The paper does not directly refer to complementarity but shows that the same property of a programme, for example the provisionality of text, affords both opportunity and constraint.

Kennewell (2001) is interested in observing the use of technology but does so in the wider focus of supporting students as they cross the learning gap between what they know and what is in their capability to know. In the tradition of ecological psychology he sees opportunities and constraints as complementary, and sees constraint as a necessary part of supporting learning, for example in reducing the cognitive complexity of the task. This work has been helpfully extended in discussing interactive whiteboards (IWBs) (Kennewell et al 2008) but earlier work focused on trainee teachers using the WWW to support learning. It was argued that quite subtle differences in how these teachers perceived the opportunities associated with a technology led to changes in planning which resulted in noticeably different learning outcomes. However, it is not clear why teachers should perceive affordances as they do, nor is direct perception discussed.

A sustained attempt to develop the notion of affordance in ICT was offered by an ESRC project in the UK (Sutherland 2004, John and Sutherland 2004). One aim of the project was to support small teams of teachers in exploring their perception of technology and develop their practice in using ICT. Not surprisingly, given the breadth of the work, a consistent view of affordance is not carried through in each of

the sub projects but ideas of effectivity; perception; and cognitive construct are seen as important elements (John and Sutherland, 2005). However, the project, arguably, sits more to the tradition of Norman than of Gibson both in the concern for user perception as formed by memory and context and in the focus on symbolic presentation. A paper on music composition (Gall and Breeze, 2005) for example, looks at how the use of 'contemporary signage', i.e. controls which look familiar to users of video recording machines, enabled the use of music composition software to be transparent to the children. However, the paper does also look at physical attributes, such as storage of 'samples' of music, within the software. There is a discussion of 'trade offs' in affordance which carry a sense of complementarity, for example pre-programmed samples of music encouraged the composition process by acting as stimulus and a facilitation for composition but were a constraint on creativity by limiting the range of composition, particularly for more able students. There is no explicit reference to ideas of direct perception. A further paper on Interactive Whiteboads (IWBs) (Armstrong et al, 2005) looks at affordances within the tradition established by both Gibson and Norman. There is a strong focus on understanding teachers' use of IWBs in terms of choices over resources used and how those resources are perceived (for example a presentation to be used in a science class was perceived as having game like elements which detracted from conveying the teacher's learning goals). In this, and in the use of IWBs in general, it is suggested that the perception of technologies needs to be understood through past use of similar technologies. This is taken up in a further paper (John, 2005) which stresses the importance of context and internal construct. A helpful discussion between arena and setting is made and 'psychological access' is seen as important in explaining how beliefs about the nature of subject knowledge affect perception.

A further example of work on IWBs is offered by Mercer (2007) in considering what are valuable affordances of the IWBs, relative to supporting productive talk in the classroom. The approach is a 'bottom up' one, i.e. looking at how IWBs are used, albeit working with teachers who might be more likely to model desirable use. Changes in practice are seen as shaped by technology and imply a complementarity of, or at least a trade off between, opportunity and constraint. For example, storing presentations allows teachers to make more coherent and more varied presentations for pupils, but may constrain teachers from developing more spontaneous classroom talk.

Discussion

Table 1 pulls together the different ways in which affordance has been conceived and shows the key consistency is that it refers to the interaction between user and tool. This is its major value as a concept: it is not the tool, it is not the person, it is the interaction of tool and person. Affordance serves as a particularly useful translation of a concept (a cognitive metaphor, if you like, Valenzuela and Soriano, 2005) from one domain to another in order to explain a complex idea. There are however, tensions in the use of the term; these are historical and have been revisited in the context of research into ICT. These tensions concern direct perception, the nature of properties; the idea of complementarity.

Direct perception

Part of the difficulty here is that Gibson sought to create a physiological basis for affordance, with early work taking place in an experimental psychology tradition. He wanted to stress that affordances were real. In today's intellectual environment, the appeal to direct perception is more likely to rest on intuition and introspection than experimental psychology. For example, Latour (2002), with characteristic bravura, suggests "those who believe that tools are simple utensils have never held a hammer in their hand, have never allowed themselves to recognise the flux of possibilities that they are suddenly able to envisage" (p. 250). However, the fact remains that direct perception is unfashionable in discussion of affordances and ICT - Dillon (2002) is rare in taking it up, though drawing on the work of Dewey rather than Gibson. However, even if the idea of direct perception is problematic it is worth taking seriously. This is, firstly, because the concept is more sophisticated than its detractors argue; secondly, it helps us understand how we see possibilities for action within a technology which precede the reordering of sensory input; thirdly, it has simply been ignored, rather than critiqued. Without an idea of direct perception it would not, as Latour adds, be possible to understand our own development as a species. More prosaically there are many examples, both in the research cited above and in the general literature, in which teachers or pupils see opportunities for action more or less 'directly' even if what they are attuned to perceive is explicable in terms of past history. Indeed Armstrong et al (2005) suggest this in the example of a teacher changing his practice when using an IWB. The teacher explained that he was:

> normally reluctant to let pupils come up to the board but he stated that with the IWB 'it seemed like the natural thing to do and that helped to break down those barriers between pupils and normal teacher space' (Armstrong et al 12)

Teachers' accounts of their first experiences of computers often provide further examples of this kind of perception of opportunity (Hammond et al 2008). For example, one participant explains that on seeing a spreadsheet he could:

> immediately see as a mathematician what a great tool it was. For things that previously you'd had to hack out on the back of an envelope for hours, the machine would immediately show you the answer. (p32)

In these, and many other examples, direct perception is, at the least, a useful metaphor to describe sudden realisations of possibilities within a tool and provide a way of understanding how teachers' practices change, for better or worse, when using computers. It might help explain the template for the habits (or routines) which teachers develop in their further use of the technology. We need to know more about what the user 'sees immediately' or finds the 'natural thing' to do. It might well be that if a teacher is unable to directly perceive the affordances of ICT, relative to well rehearsed goals such as creativity, analysis, authentic learning and so on, then he or she is unlikely to be an enthusiastic adopter of ICT.

The properties of computers and the idea of complementarity

Following from the tradition of Gibson and his interpreters we can think of computer tools as having both physical (such as size, material, composition of component parts) and symbolic properties (such as interface and texts). Of course any description of even the physical properties is 'socially constructed' so, for example, teachers and pupils, let alone accountants and politicians, might offer very different descriptions of what a computer is. Nonetheless the physical properties are real, for example data is processed at a certain rate, depending on the data and the processor, according to predictable, natural laws. The physical properties are often implicit in the literature on ICT and only brought to the forefront when particularly significant. For example, in the case of music composition software (Gall and Breeze 2005) given earlier, the number of stored 'samples' of music is noted as limited as this has a constraint on learning; this may be due to cost considerations or design shortcomings but whatever the case it is a physical constraint. The fixing of an IWB to the wall (Mercer 2007) is physical constraint on use and may affect range of

teaching style at the board. Again, the need for data to be in electronic form so that it can be presented within the IWB (Armstrong et al 2005 and Mercer, 2007) or accessed via the WWW (Kennewell 2001) represents a fundamental constraint on practice, though one that is often taken for granted. In contrast, the very fact that data are in electronic form makes them open to random access and easy storage and opens up the often reported opportunities, say, for more authentic learning.

Symbolic properties are not the same as physical properties but they are real in the sense they exist, as with affordances, irrespective of whether they are perceived or not. For example, an interface may be game-like even if this would not be recognised by someone who has not played a game. Here it might be helpful to think of a distinction between a property (game like) rather than an affordance (game-playable), though the relationship between properties and affordances is a difficult one and rarely addressed explicitly. One well known, imaginative, but ultimately flawed, attempt to discuss properties in relation to IT was offered to teacher trainers in England, Northern Ireland and Wales (TTA 1998). The 'features' of computers were described as:

- speed, capacity and range of access to information;
- automatic processing of data;
- ease of amendment of work carried out;
- immediate feedback to the learner (Teacher Training Agency,1998)

There is a clear ambiguity here as to whether features are properties or affordances. In fact they might better be seen as affordances, enabled by physical properties such as memory cards which store electronic data; processor units which process data; and devices for handling volatile data. The relationship between properties and affordances is implicit rather than spelt out in the literature. Figures 1, 2 and 3 represent an attempt to do this. The examples, adapted from some of the research described earlier, show how affordances can be understood in the context of, firstly, teachers using the IWB; secondly, learners (including teachers as learners) using game like interfaces; and, thirdly, learners using processing software such as the word processor or desk top publisher.

They suggest that affordance is a coming together of perception and property of hardware and software, and has a basis in physical properties. The arrows in the diagram are double headed, indicating that affordance points back to both perceiver

and object. In these examples the opportunities and constraints are always in relation to something, in this case learning goals, and can be seen as sequential (again, but not shown, these point back to property and perception). Complementarity (opportunity and constraint) is inherent in the make up of the affordance.

Insert figures 1, 2 and 3 about here

Conclusion

There is a strong case for using the term affordance in discussing ICT. Firstly, Gibson gives a distinctive insight into the relationship of tool and user and points us to the right question: how do user and tool come together? This helps us to focus on perception though, as a shortcoming, it may constrain us from, but does not rule out, viewing the wider arena or setting in which learning takes place. Secondly, Gibson, makes a distinctive contribution by suggesting that perception is direct, this remains an intriguing and helpful idea, even though it is not entirely satisfactory. However, if the concept of affordance is to be helpful, and if it is going to continue to be used, there must be greater agreement as to its meaning; the suggestion given here is that an affordance:

> is the perception of a possibility of action (in the broad sense of thought as well as physical activity) provided by properties of, in this case, the computer plus software. These possibilities are shaped by past experience and context, may be conceptually sophisticated and may need to be signposted by peers and teachers. However, they may, drawing on intuition and deduction from user accounts, be 'perceived directly', and perception of actions can precede internal mental ordering. Perceptions of affordances can, and do, become habitual. Affordances arise because of real physical and symbolic properties of objects. Affordances provide both opportunities and constraints. Affordances are always relative to something and, in the context of ICT, relative to desirable goals or strategies for teaching and learning. Affordances are often sequential and nested in time.

Armstrong,V., Barnes,S., Sutherland, R., Curran,S., Mills,S. and Thompson,I. (2005) Collaborative research methodology for investigating teaching and learning: the use of interactive whiteboard technology, *Educational Review*, 57, 4, 457- 469.

Baerentsen, K. and Trettvik, J. (2002) An activity theory approach to affordance, in *ACM International Conference Proceeding Series;* University of Aarhus, Denmark, 31, 51 - 60

Brown, J., Stillman, G. and Herbert, S. (2004) Can the notion of affordances be of use in the design of a technology enriched Mathematics curriculum? In I. Putt, R, Faragher and M. McLean (Eds) *Proceedings of the 27th Annual Conference of the Mathematics Education Research Group of Australasia*, Sydney, MERGA, 1, 119-126.

Chemero, A. (2003) An outline theory of affordances, *Ecological Psychology,* 15, 2, 181 – 195.

Conole, G. and Dyke, M. (2004) What are the affordances of information and communication and technologies, *ALT-J Research in Learning Technology*, 12, 2, 113 – 124.

Derry, J. (2007) Epistemology and conceptual resources for the development of learning technologies, *Journal of Computer Assisted Learning*, 23, 503-510.

Dillon, P. (2004) Trajectories and tensions in the theory of information and communication technology in education, *British Journal of Educational Studies*, 52, 2, 138 – 150

Downes, T. (2002) Blending play, practice and performance: children's use of the computer at home, *Journal of Educational Enquiry, 3, 2,* 21.

Gall, M and Breeze, N. (2005) Music composition lessons: the multimodal affordances of technology, *Educational Review*, 57, 4, 415 – 433.

Gaver, W. (1996) Situating Action II: affordances for interaction: the social is material for design, *Ecological Psychology*, 8, 2, 111 – 129.

Gaver, W. (1991) Technology affordances, *Proceedings of the SIGCHI conference on Human factors in computing systems*: New Orleans, Louisiana, United States, pp 79 - 84

Gibson, J. (1986) *The Ecological Approach to Visual Perception*, Lawrence Erlbaum Associates, New York.

Greeno, J. (1994) Gibson's affordances, *Psychological Review*, 101, 2, 336 - 342.

Hammond, M., Younie, S., Woollard, J., Cartwright, V., Benzie, D. (2009) *What does out past involvement with computers in education tell us*?, The Association for Information Technology in Teacher Education.

Hutchby, I. (2001) Technologies, texts and affordances, *Sociology* 35, 441-456

John, P. and Sutherland, R. (2004) Teaching and learning with ICT: new technology, new pedagogy, *Education, Communication and In Information, 4, 1, 101-107.*

John, P. (2005) The sacred and the profane: subject sub culture, pedaogogical practice and teachers' perception of the classroom uses of ICT, *Educational Review*, 57, 4, 471-490.

John. P. and Sutherland, R. (2005) Affordance, opportunity and the pedagogical implications of ICT, *Educational Review*, 57, 4, 405 – 423.

Kennewell, S. (2001) Using affordances and constraints to evaluate the use of information and communications technology in teaching and learning, *Journal of Information Technology for Teacher Education,* 10, 1&2, 101 - 116.

Kennewell, S.; Tanner, H.; Jones, S.; Beauchamp, G. (2008) Analysing the use of interactive technology to implement interactive teaching, *Journal of Computer Assisted Learning*, 24, 1, 61-73.

Latour, B. Morality and technology, the end of the means, *Theory, Culture and Society*, 19, 5/6, 247 -260 (translated by Couze Venn).

Laurillard, D., Stratfold, M., Luckin, R., Plowman, L. & Taylor, J. (2000) Affordances for learning in a non-linear narrative medium, *Journal of Interactive Media in Education*, 2000 (2) accessed at [www-jime.open.ac.uk/00/2]

Mercer, N. (2007) *Interactive whiteboards as pedagogic tools in primary schools. Full research report, ESRC End of Award report RES – 000- 22- 1269*, ESRC, Swindon.

Michaels, C. and Carello, C., (1981) *Direct Perception*, Prentice-Hall, Englewood Cliffs, NJ.

McGrenere, J. and Ho, W. (2000). Affordances: Clarifying and evolving a concept. *Proceedings of Graphic Interface 2000*. Montreal, Canada, May. Pp. 179-186

Norman, D. (1998) *The Psychology of Everyday Things*, New York, Basic Books.

Pea, R. (1993) Practices of distributed intelligence and designs for education in Pea, R. (ed) *Distributed Cognitions, Psychological and educational considerations*, Cambridge university Press, Cambridge.

Scarantino, A. (2003) Affordance explained, *Philosophy of Science,* 70, 949-961.

Sutherland, R. (2004) *Interactive Education: Teaching and Learning in the Information Age, Full Report, L139251060*, ESRC, Swindon and accessed http://www.esrcsocietytoday.ac.uk/ESRCInfoCentre/ViewFullAwardPage.aspx?data=lWEC7sNY9jm1ZHivC4z6rQ%3D%3D&xu=0&isAwardHolder=&isProfiled=&AwardHolderID=&Sector=&Awardnumber=L139251060

Teacher Training Agency (1998) *The Use of ICT in Subject Teaching: Expected outcomes for teachers,* Teacher Training Agency, London.

Turvey, M, (1992) Affordances and prospective control: an outline of the ontology, *Ecological Psychology*, 4, 3, 173 – 187.

Valenzuela, J. and Soriano, C. (2005) Cognitive metaphor and empirical methods, *Barcelona Language and Literature Studies*, 14, online journal access at *www.publicacions.ub.es/revistes/bells14/PDF/metaphor_02.pdf*

Warren, W. H. (1984). Perceiving affordances: visual guidance of stair climbing,*Journal of Experimental, Psychology: Human Perception and Performance*, 10, 683–703.

Webb, M. (2005) Affordances of ICT in science learning: implications for an integrated pedagogy, *International Journal of Science Education*, 27, 6, 705 – 735.

	antecendents		stronger focus on how opportunities for learning *should be* perceived			stronger focus on how opportunities for learning *are* perceived				
example	Gibson	Norman	Laurillard	Webb	Conole	Gall	Armstrong	Downes	Mercer	Kennewell
affordances points to tool and person	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
directly perceived	Yes	No	Not explicit	Not explicit	Not explicit	Not explicit	Not explicit	Not explicit	Not explicit	Yes
opportunity and constraint as complementary	Yes	No	No	No	No	As trade offs	Implicit case is strong	Implicit case is strong	Implicit	Yes
there are inherent physical and symbolic properties	Yes	No	Implicit	Implicit	Implicit	Not implied	Not implied	Not explicit	Implicit	Implicit

Table 1: affordances and ICT relative to learning

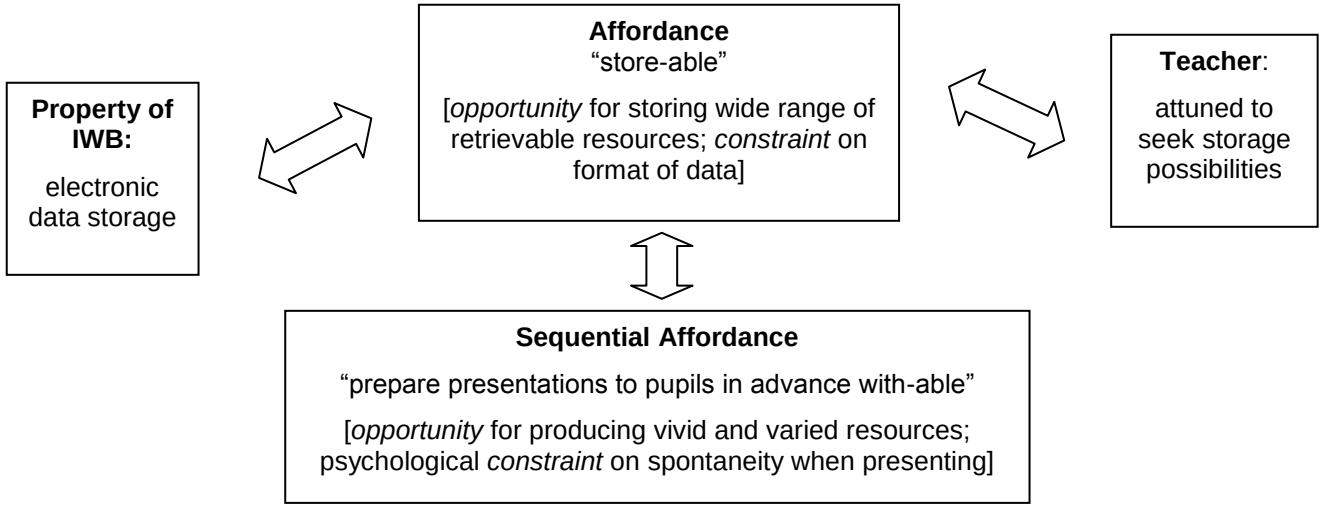

Figure 1: affordance and the preparation of presentations

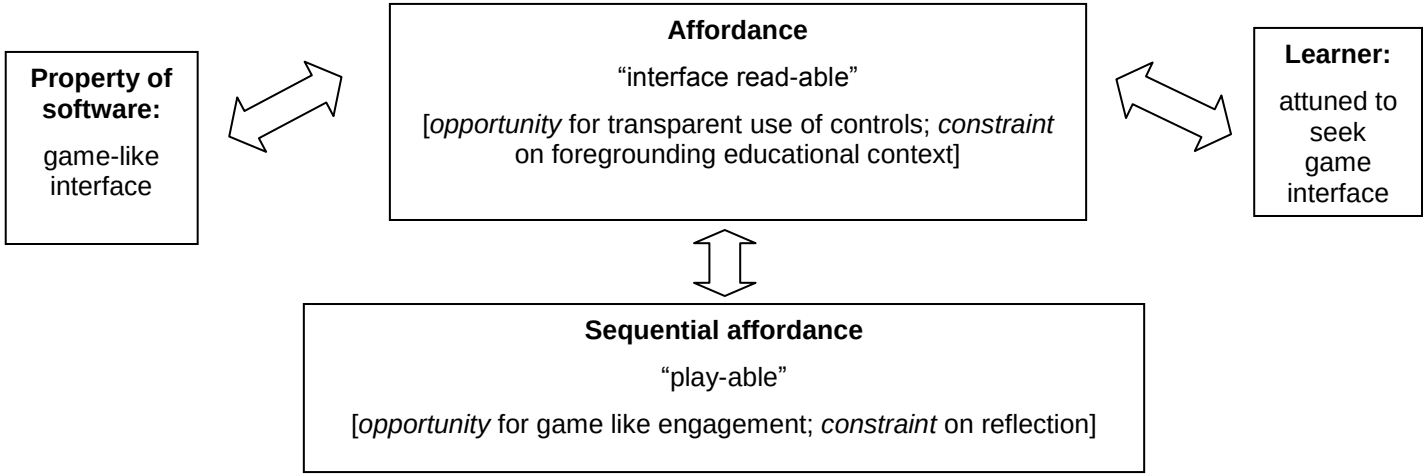

Figure 2: a game-like interface affords playing

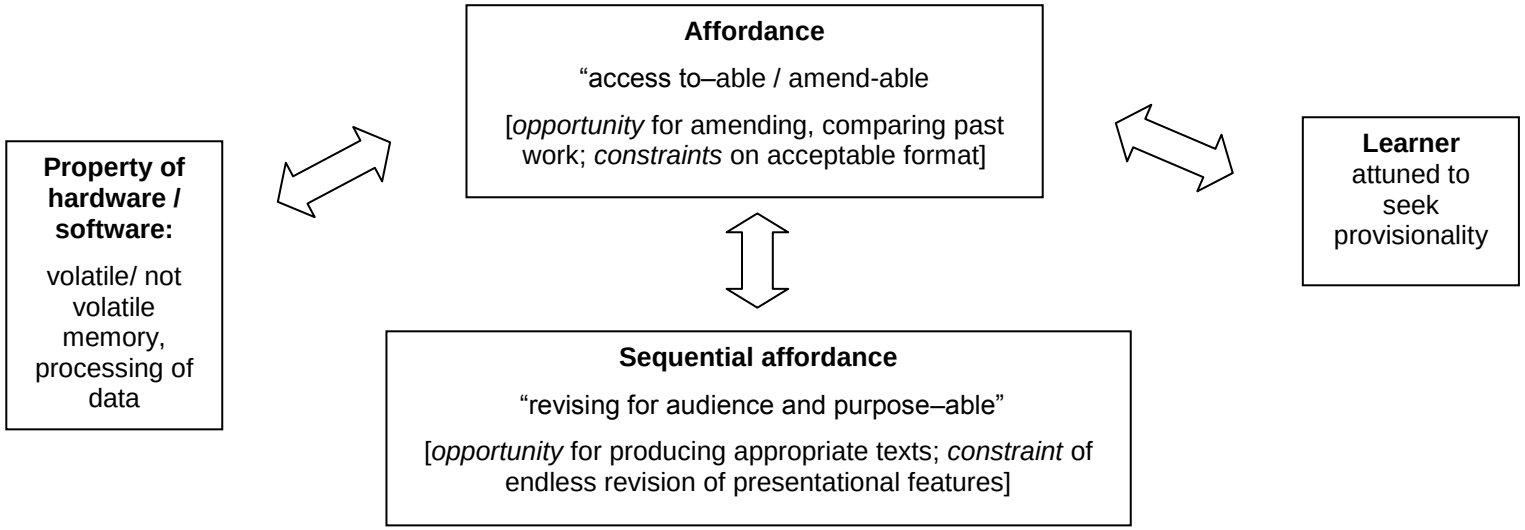

Figure 3: the processor affords revising of texts