

# Affordance, opportunity and the pedagogical implications of ICT

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This paper provides a brief overview of the InterActive Education project and an introduction to this special issue. At the heart of the project was a unique partnership between university researchers, teacher educators and teachers, who worked together to find out how ICT can be used in schools to enhance learning. Within this paper we argue that it is the relationship between the pedagogy within a subject area (the practice in the setting), the subject domain and its culture (the ecology of the setting) and the technology (the tool within the setting) that is crucial to engendering quality learning.

## Introduction

This paper provides a brief overview of the InterActive Education project and an introduction to this special issue. Within this framework we develop our thinking around the idea of affordances, arguing that it is the relationship between the pedagogy within a subject area (the practice in the setting), the subject domain and its culture (the ecology of the setting) and the technology (the tool within the setting) that is crucial to engendering quality learning.

The overall aim of the InterActive Education project was to examine the ways in which ICT can be used in educational settings to enhance teaching and learning. We took a holistic approach, examining learning with ICT at both the level of learner and classroom, and the learner in outside school settings, being careful to take into account the institutional and societal factors which structure learning (Sutherland *et al.*, 2004). The project centred around developing research partnerships between teachers, teacher educators and researchers in order to design researchable learning environments which were supported by research on teaching and learning. From the outset partnerships were established with ten institutions (one further education college, five secondary schools and four primary schools).

The project focused upon a multi-level set of overlapping communities of practice. At the meso-level, the project was organised around Subject Design Teams (SDTs)

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in the areas of English, mathematics, science, modern foreign languages, music, history and geography. Within these teams teachers, teacher educators, researchers and research students worked together to develop learning initiatives, designated as Subject Design Initiatives (SDIs). Whereas the meso-level was the starting point for the Subject Design Initiative, much of the working through of the initiative took place at a micro-level where a teacher and researcher worked intensively together on the design, realisation and evaluation of the Subject Design Initiative (Triggs & John, 2004). Design was informed by theory, research-based evidence on the use of ICT for learning, teachers' craft knowledge, curriculum knowledge, policy and management constraints and possibilities. These classroom-specific, collaboratively designed and progressively adapted initiatives gave the project theoretical and methodological versatility. The aim was to develop understanding and change practice through a long-term shift in conceptions. At the macro-level the core University team worked together to develop the theoretical and methodological coherence of the project. Overall 59 teachers, 7 researchers, 6 teacher educators and 3 research students worked together within the project.

The InterActive Education project was framed broadly by socio-cultural theory which emphasises the notion that human action is interactive and is fundamentally connected to 'social and cognitive tools' (Wertsch, 1991; Cole & Engestrom, 1993). The idea of the 'cognitive tool' includes a wide range of cultural artefacts and semiotic systems. These cultural artefacts are both material and symbolic, as well as being instrumental in regulating interactions with one's environment and oneself. In this respect they are 'tools broadly conceived and the master tool is language' (Cole & Engestrom, 1993, p. 9). Such 'tools' might be digital, such as a word-processor, dynamic geometry software, music composition software, email or an interactive whiteboard. They could be non-digital tools, such as paper and pencil or a dictionary. The idea of a 'social tool', on the other hand, includes people who are currently involved with the action, individuals who interact at a distance, and those who interact through another medium or socially constructed artefact, a textbook or an online information system, for instance. Wertsch (1991, 1998) suggests that successful students incorporate the pattern of teacher-student (inter-mental) interaction into their own (intra-mental) functioning.

In recent years the emergence of new digital technologies has offered up the possibility of extending and deepening classroom learning in ways hitherto unimagined. Much of this optimism is predicated on the idea that digital tools will extend children's capabilities as their affordances are used to transform learning outcomes. However, we need to be cautious when we speak of the affordances of new technologies and even more cautious about assuming that a given medium or technology will automatically afford particular learning outcomes. In reality, learning is always distributed in some form between the technology, the learner and the context and there is nothing inherent in technology that automatically guarantees learning. This introductory paper will offer some reflections on these issues as they emerged in the Economic and Social Research Council's (ESRC) InterActive Education project.<sup>1</sup>

## Affordance

Throughout the InterActive Education project the idea of affordance as it relates to particular learning tools and situations has been central. Although the term has become ubiquitous in the ICT literature definitional and deployment problems persist and a number of conceptions or perspectives have emerged within the literature. Some of these are summarised accordingly.

- *Affordances are about effectivity.* Gibson's (1979) original conception defined affordances as actionable properties that existed between the world and the actor. These ecological properties were fundamentally naturalistic and offered the 'animal what it provides or furnishes, either for good or ill'. The key link between the object and the individual is direct perception, which Gibson claimed is mediated by the level of mediums, surfaces and substances rather than deeper levels of atoms, particles and processes. This level of perception then informs individual affordances, and action transforms these into *effectivities* (Allen & Otto, 1995) which extend human capabilities. Affordances are therefore about relationships or properties of relationships that afford opportunities for action. In this sense natural and constructed affordances merge into *effectivities* through conscious activity. This emphasis on action or potentials for action (Gaver, 1991) blurs the distinction between the importance of perception and the existence of an affordance that is independent of the actor's ability to perceive it. [1]
- *Affordances are about perceptions.* 'The perceived properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. A chair affords (is for) support and, therefore, affords sitting. A chair can also be carried' (Norman, 1988). This conception has become so widespread that perceptibility is now taken as the *sine qua non* of affordance. Norman (1988) also saw a close relationship between the actor's past knowledge and experience and the ways in which the cognitive and perceptual capacities of the actors influenced that knowledge and experience. Alternatively Gibson (1979) believed that affordances were primarily independent of the actor's culture and experience. Later in his analysis Norman (1993) went on to distinguish between real and perceived affordances claiming that the former were more crucial to the design process; however, such a change of focus is resisted by ecological researchers who claim that Norman (1988, 1993) confused the affordances of an object with the information that specifies the affordances (Flach, 1995). [2]
- *Affordances are about cognitive constructs.* A third conception sees affordances as a set of cognitive constructs that are deeply subjective in nature. Vera and Simon (1993), for instance, see affordances as 'internal representations of complex configurations of external objects'. This connects to Gibson's (1979) original ideas in that affordances are seen as objective, measurable properties in an external world, but, as Newell and Simon (1972) point out, for regularities in the world to be perceptible by an actor, some change in mental representation must occur, and that it is the resulting mental structure that deserves to be called an affordance. These cognitive constructs are the internal encodings of particular [3]

symbols denoting relationships, rather the external situations that evoke symbols (Vera & Simon, 1993).

The papers in this special edition variously apprehend the concept of affordance within the parameters described above by focusing on the ways in which ICT tools can enhance classroom learning. In this sense the work presented is collectively concerned with cultural and pedagogic processes rather than with the descriptive category that ICT has come to represent. Given this caveat, it should be pointed out that the authors are all committed to theorising the practical by beginning with a range of tangibly and clearly understandable questions, the purpose being to create a considered relation between the analytic and the concrete; and between the theoretical and the empirical aspects of practice. The concept of affordance is the conceptual glue that binds this variety of perspectives and practices together.

Gall and Breeze in their paper on musical composition and the multimodal affordances of specialised technologies provide an account of the processes and outcomes of music activity in typical classrooms. Using an integrated theory of affordance, drawing on the work of Gibson (1979), Norman (1988) and the less well known ideas of Verillon and Rabardel (1995), they posit that learners adapt to classroom tasks using an amalgam of their direct experience and their perceptions of what possibilities the tool presents. They go on to use this theoretical frame to guide their exploration of the multi-modal affordances of composition software. Taylor, Lazarus and Cole focus on more practical issues but in an equally compelling way. Drawing more closely on the literature associated with the learning of modern foreign languages, they investigate the ways in which drop down menus can facilitate and extend students' writing in German. Using the idea of a writing frame, derived from dialogically based theories of learning, the authors describe in detail a novel and highly replicable approach to writing in a target language; an approach that conjoins attention to detail and improved accuracy with greater imagination and fluency. The affordances of the technology highlighted in this piece of research appear to support Wenger's (1990) conjecture, that for technology to be used effectively in any learning process it must be highly visible as a learning tool but at the same time highly invisible as a mediating technology.

The paper by Armstrong *et al.* considers a number of parallel ideas related to the use of interactive whiteboard technology (IWB). Using an innovative collaborative methodology involving the co-construction of meaning from the use of multi-focused video, the authors explored the potential affordances of IWB technologies and the ways in which specific affordances define the pedagogic interaction. Beginning with a clear definition of interaction, their case studies highlight the fact that teachers should be 'critical agents' in mediating the software so that subversion by some of the deeper affordances might be avoided. John's quite different study is an attempt to get to grips with the often problematic relationship between school subject culture, pedagogy and new technologies. Using extensive interview data and Bernstein's concepts of the sacred and the profane, his analysis highlights the ways in which both consonance and dissonance develop within school subject cultures when ICT is introduced into the pedagogic equation. He argues that school subject

cultures are built on deep traditions and that these need to be addressed if ICT is to become more embedded in the curriculum of schools. In particular, policy-makers and innovators need to think in more evolutionary terms where the pragmatism of teachers has to merge with a 'pedagogical cultural agenda' (Watson, 2001) so that the affordances and constraints of new technologies can be understood and integrated more smoothly into practice.

### **Pedagogic opportunity**

Across the contributions to this special edition, the pedagogic opportunities provided by the affordances of particular technologies are elaborated on both empirically and theoretically. In order to understand the development and consequences of these opportunities Woolgar (1991) proposes that primarily we interpret the tool itself (its material and structural elements) more in terms of the assumptions it makes about the user, the activities it encourages, and the way it constrains and enables particular activities. This conception suggests that the range of potentialities offered by ICT tools shapes, urges, and constrains particular uses. Moreover, this regulation of social practice is not random or idiosyncratic, rather it is systematic in that the activities encouraged tend to envision the world in a certain way. To consider ICT in this way means focusing on the design of the application, the sorts of choices offered and those which are not. It also means exploring the relationship between the software, the hardware, and the learning process as well as uncovering the sorts of pedagogical implications attendant upon that relationship. We also need to know how the tool anticipates who the users are and what they are likely to do as well as taking into account the character of the ontological assumptions represented in the software. These valences are likely to be hidden from view or might even appear neutral as obvious elements of the technology; they might even be presented seductively offering engagement, empowerment and efficiency while being interpreted and used differently.

The paper by Armstrong *et al.* highlights these issues. In the case study of 'Sarah Curran', for instance, the ways in which Sarah and her pupils engaged with the software—*Virtualfishtank*—appeared to be at odds with Sarah's intended lesson objectives. This was related to the affordances of the software which was originally designed to be used as a museum-based interactive exhibit to teach about emergent animal behaviour. In the particular classroom context in which pupils were asked to design a fish which lived for the longest possible time, they used the software as a 'gaming' tool since the visual interface resembled the commercial gaming packages which are part of their out-of-school culture of computer use. Consequently, claim Armstrong *et al.*, the viewers were 'placed in a certain position by the maker of the image and viewers make meanings around their interpretation and engagement with the image'. Similarly, in John's contribution, there is evidence that science teachers were concerned that too often simulation software resembled the 'genre of gaming' and as a result they felt that 'students might miss the deeper subject significances preferring to see the simulation as an end in itself'. This is reminiscent of what

Rabardel calls catachresis, ‘a concept that designates the difference between the planned and actual use of artefacts’ (Rabardel, 2001, p. 92). Importantly, theoretical work in this area points to the crucial role of the teacher in ‘directing the students toward the construction of the appropriate instruments starting from the same artefact’ (Olivero, 2002, p. 50).

The papers by both John and Gall and Breeze also highlight the ways in which teachers appeared willing to concede a number of trade-offs between the technology and their pedagogy. Such trade-offs were a reaction to the affordances of particular technological tools that appeared to make it easier to achieve particular learning objectives. This, in part, matches our intuitions about physical artefacts in general, for instance, the same property (heaviness) that gives a sledgehammer its primary affordance (a powerful swing) simultaneously makes it inappropriate for more delicate tasks. In the paper by Gall and Breeze we see music teachers experiencing a number of these pedagogical trade-offs. For example, while *Dance eJay* was beneficial for what might be termed the ‘democratisation’ of the subject, its pre-programmed structure did appear to constrain some pupils. Similarly, the teacher, being unable to hear the sounds produced by *Cubasis*, had to decide whether to intervene in order to understand the dialogues that were taking place and thereby interrupt the flow of the process of composing.

### Effects of ICT

The InterActive project was also interested in the ways in which pupils and teachers appropriated tools and continued to use their affordances even when the tool was removed. This is particularly interesting when we move from using a digital to a non-digital tool (or vice versa) for a similar activity. For example, Mogetta (2003) has shown convincingly that students are influenced by their dynamic exploration of geometry with a digital geometry tool when they return to paper-based geometry problems.

Salomon (1993) argues that it is important to consider both the effects-with and the effects-of technology, where the effects-of can be considered to be the residue which is left behind when a technology is no longer present. This need to ‘internalise’ a tool can be an explicit aim within education, where tools are often introduced for the particular pedagogic purpose of ‘scaffolding’ learning. This process of ‘scaffolding’ is emphasised in the paper by Taylor, Lazarus and Cole where we see the idea of a writing frame being adapted and customised so that the linguistic structure of German might be better understood and used in more transactional tasks. The use of drop down menus behind words and phrases gave pupils alternative lexical and grammatical choice within a structured environment. The affordances of the tool were therefore being used to help students personalise their work as well as reflect on its on-going form and content by using the text box beneath. From the evidence presented, the writing frames appear to have been fundamental in helping the pupils internalise the correct word order for past tense constructions thus improving their assessment using standard pencil and paper tests.

In his interviews with teachers, John further discovered that many were concerned that there should be a dynamic relationship between digital and non-digital activities so that disciplinary-based knowledge and skills would not fall into desuetude. In particular, mathematics teachers expressed concern about the potential loss of basic mathematical skills and process; in English some teachers were anxious about new technologies 'speeding up' the subject and thus derogating the need for rumination, reflection and 'slow engagement'. And finally in science, some were worried that the over use of simulations might 'cleanse the subject' of practical laboratory-based activities. We have argued (Sutherland *et al.*, 2004) that within particular knowledge domains it may be important for young people to be able to work with both digital and non-digital tools, and that digital tools do not necessarily replace non-digital tools. However, it should be borne in mind that some artefacts can only be produced by a person-plus-digital-tool. This is the case when the use of an ICT tool makes the production of something possible which would have been impossible without the use of such a tool.

### **Teacher as mediator**

Finally, all four papers point to the importance of the teacher and the ways in which technology is incorporated into their pedagogy. This emphasises the importance of the ecological setting of classrooms and how a mixture of teachers' subject and pedagogical understandings act as filters during planning, practice and reflection. The papers also emphasise the value of pedagogical alignment. This relates to what Wood (1999) terms 'psychological access' where the internal referentiality of a range of personal theories becomes aligned with the perceived needs of both the learning situation and the technology. In the three papers dealing directly with this issue (Armstrong *et al.*; Taylor *et al.*; Gall and Breeze) we see teachers actively integrating a range of technologies into their pedagogy using their own and their pupils' agency to mediate its affordances. This sometimes resulted in teachers using more constructivist approaches to learning while at the same time being drawn to more didactic strategies through the use of Interactive Whiteboards (IWBs). The power of the IWB and its range of affordances clearly helped teachers improve the quality of their presentations, create more purposeful interactions, and increase the efficiency of knowledge transfer, all within a multi-modal environment. In fact, IWBs offered an adaptive solution to the tension between individual and common knowledge in a classroom and where they could counteract the emergence of too much 'idiosyncratic knowledge' (Godwin & Sutherland, 2004, p. 150). Nevertheless, as Armstrong *et al.* (following Glover & Miller, 2001) point out, we should be wary of this easy assimilation where IWBs enhance interest rather than encourage a new approach to pedagogy and learning.

### **Digital video as a tool for developing understanding**

We suggest that an elaborated concept of affordance can help researchers, and teachers begin to understand the learning potential of a new technology. This

learning potential will emerge in the classroom as a complex interrelationship of the designer's and teacher's intentions, the teacher's and students' perceptions and constructions of how the technology can be used, and the cultural context into which the new technology has been placed (including the subject domain and its culture). As Armstrong *et al.* argue, teachers bring a much-needed perspective to the process of understanding this complexity. But more importantly we suggest that unless teachers are offered theoretical tools to support their use of ICT in the classroom, they are unlikely to develop approaches to teaching and learning which harness the potential of ICT for enhancing learning.

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### Note

1. For further information see [www.interactiveducation.ac.uk](http://www.interactiveducation.ac.uk).

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