The development of an implementation model for ICT in education: An example of the interaction of affordances and multimodality

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Abstract

This paper discusses the development of a model targeted at non-specialist practitioners implementing innovations that involve information and communication technology (ICT) in education. It is based on data from a national evaluation of ICT-based projects in initial teacher education (ITE), which included a large-scale questionnaire survey and six in-depth case studies. It draws on affordance and multimodality theory to address, and move beyond, considerations of the role played by the usability and utility of technology in any implementation. It argues that the perceived 'status' of technologies is a key factor in the success of an innovation.

Keywords: affordances; ICT implementation; initial teacher education; multimodality; technology

Introduction

This paper explores issues staff and students in initial teacher education (ITE) organisations faced in implementing a series of information and communication technology (ICT) projects. It is based on the findings from a national evaluation of

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ICT-related projects (*reference deleted*) funded by the Teacher Development Agency (TDA) in England between 2003 and 2008. The original evaluation was primarily concerned with assessing the impact of various types of projects at a number of levels from the organizational to the individual. In order to assess impact on tutors' and student teachers' learning and professional practices, the evaluation combined Kirkpatrick's (1994) model for evaluating professional development, supplemented by Shulman and Shulman's (2004) model of teachers' knowledge base, with Hooper and Reiber's (1995) framework for assessing e-maturity.

As the evaluation moved from a national survey of organisations that had received funding to in-depth case studies of six projects, it focused increasingly on the implementation issues participants had faced. The case studies revealed a complex set of interactions among the types of technology being adopted, the aims of the projects, and participants' attitudes towards the technology. To help those implementing ICT projects in education to unravel the nature of these interactions, we used our cross-case analysis to develop an implementation model. This model drew on affordance theory and the growing literature around multimodality to show how the perceived 'status' of a technology by participants in their professional and social lives varied considerably and was a key element in determining how, and to what degree, it was incorporated into their practice.

Theoretical background

'Affordance' has been used increasingly frequently in both education and ICT research, although definitions and applications have been various, problematic (John & Sutherland, 2005) and 'not well understood' (McGrenere & Ho, 2000, p. 1).

Gibson, who originated the theory and applied it to the natural world's potential to promote action and interaction, defined it in terms of the '*complementarity of the animal and the environment'* (Gibson, 1979). The development of the implementation model took this as a starting point, along with Gaver's (1991, p. 79) expansion which emphasised that '*affordances are properties of the world that are compatible with and relevant for people's interactions'*. It is the location of affordance theory in the interaction between perceiver and perceived that has made the concept so valuable, and adaptable, for research into ICT in education (see, for example, Laurillard, Stratfold, Luckin, Plowman, & Taylor, 2000).

Norman's (1988) application of affordance analysis to man-made objects, notably design technology and human computer interaction (HCI), has been influential, although his approach has been criticized for conflating the utility of an object and the way that utility is communicated to users (McGrenere & Ho, 2000; Boyle & Cook, 2004). McGrenere and Ho (2000, p. 6) addressed this by distinguishing between the usefulness (or utility) of an object: '*determined by what the design affords and whether these affordances match the goals of the user'* and its usability which they associated with '*clearly designing the perceptual information that specifies these affordances'*. They also claimed that the HCI community in general had followed Norman in concentrating on usability at the expense of usefulness (see also Kirschner, Strijbos, Kreijns, & Beers, 2004; Wang, 2008). We attempted to sidestep this issue by regarding usefulness and usability as interdependent, as another level of interaction, in our exploration of some of the factors that influence the implementation of ICT-based change in education.

The increasingly multimodal nature of ICT-based learning and communication has only heightened the interdependence of use and utility. Our use of multimodality

looks back to McGrenere and Ho's (2000) preference for Norman's (1998) plural notion of affordances (and de Souza's (2005) construction of affordance in terms of *communication* between designer and user) over Gibson's binary notion of affordance, in which it either exists or does not. It is also informed by Conole and Dyke's (2004) taxonomy of ICT-related affordances which extended Norman's plurality through the inclusion of elements such as diversity; uncertainty; immediacy; non-linearity and multimodality itself. Multimodality is a concept that has a complex relationship with theories of affordance and recent explorations of the area (Kress, 2000; Jewitt, 2009a, Kress, 2010) also informed our approach.

The concept of multimodality used in the development of the model borrowed heavily from linguistics and semiotics (see Iedema, 2003; Kress & Van Leeuwen, 2001) in that it made a distinction between modes and media. Modes are the abstract, non-material resources of meaning making - obvious examples would be writing, speech and images; less obvious ones include gesture, facial expression, texture, size and shape, even colour. Media, on the other hand, are the specific material forms in which modes are realized including tools and materials (Dicks et al., 2006; Kress & Van Leeuwen, 2001). Thus, we conceptualised modalities as the abstract purposes for which information and communication technology are used, and technology as the specific processes, tools or products with which individuals and organisations engage.

From this perspective, individuals approach a piece of technology not simply as 'users', but as creators who reshape them to serve different purposes and aims. This is in line with both the technology's perceived affordances and its various modalities of use. These are culturally shaped modes of representation, meaning making, and communication from which a specific technology is approached. These modes contain different purposes, norms and expectations that mediate a participant's

engagement with a technology, an example of which would be the distinction commonly made between 'business' and 'pleasure' usages of the same technology. From this perspective the 'sense' made of a particular technology by those in a particular implementation project, and the 'status' they give it, differs depending on the potential modalities they associate with it.

The notion of multimodality used in this paper highlights the importance of the choices participants make and the assumptions they bring to an innovation. This more semiotic notion treats multimodality not as merely another affordance of the technology, but rather as a construct that relates more to users' social actions and intentions. It reinforces and extends Jewitt's observation that affordances are '*shaped by how a mode has been used, what it has been repeatedly used to mean and do, and the social conventions that inform its use in context' (*Jewitt, 2009b, p. 24). Echoing Greeno (1994) and Kennewell (2001), this use of multimodality treats technology as potential 'semiotic resources' (Kress, 2009, p. 55) that have both potentials *and* limitations that derive from both their utility *and* their use in social contexts over time. This challenged the research team to uncover and describe the key (interacting) modalities that shaped participants engagement. The model that was developed emphasised how the mix of modalities was likely to be different for tutors, students, pupils and leaders of ITE organisations and schools. The intention in developing the model was to make the insights generated by affordance and multimodal theory available to non-specialist practitioners involved in leading innovations.

Methodology

The evaluation focused on ICT-related projects funded by TDA between 2003 and 2008. Each year ITE organisations in England were invited to bid for funding for projects addressing themes identified by TDA. Crucially, TDA specified the technologies they funded and the need for organisations to submit an evaluation of their implementation but did not specify how the technologies were to be introduced. In the early years of the programme the themes related to the provision of laptops and/or interactive whiteboards. In later years, their scope was expanded to include areas such as videoconferencing, virtual learning environments (VLEs) and digital media.

The evaluation used three main sources of data. The first was content analysis of 241 programme documents – applications for funding and summative evaluations from ITE organisations. These were reviewed by pairs of researchers looking for evidence of impact and key implementation issues. This analysis informed the development of an online questionnaire survey, which was completed by 99 respondents from 70 ITE organisations, representing a response rate of 33% of ITE organisations. The questionnaire explored implementation issues and questions of impact in relation to different types of technology. Respondents were asked to assess students' and their organisations' overall use of a technology before and after their participation in the projects. Their assessments were analysed using an e-maturity scale derived from Hooper and Reiber (1995). The survey also asked respondents to assess impacts on students and tutors using four levels based on Kirkpatrick's (1994) evaluation model and Shulman and Shulman's (2004) model of teachers' professional knowledge. Finally, a purposive case study sample was built from survey respondents. The cases were selected to include the three main types of ITE providers

and different technologies. The final criterion was to include organisations at different levels of e-maturity but which had claimed at least a one-point improvement on this scale.

The data collection that underpinned the case studies was based on in-depth interviews undertaken with tutors, students and school mentors, generally over two one day visits by a minimum of two researchers. These interviews were supplemented by further documentary analysis and telephone interviews. The final stage of the data collection process was the creation of video case reports that focused on key individuals involved in the projects. They were filmed over a single day by a combination of project researchers and a professional video production company.

Individual written and video case reports were created for each case, which then underwent cross-case analysis informed by Jensen and Allen's (1996) notion of a 'meta-synthesis'. The synthesis was designed to create a composite analytical framework based on the key themes identified in the initial documentary analysis, the questionnaire survey and the reports from each case. The construct validity of this composite framework was cross-checked by all four researchers involved in the case studies. Each researcher also validated the final set of key themes identified in the cross-case analysis against their own case reports. The implementation model was then developed to present these themes in a more cohesive and accessible format for practitioners and was published as part of the final report (*reference deleted*).

An implementation model for ICT in education

The implementation model was based on three sets of overlapping, interdependent factors that our cross-case analysis indicated were key in determining the success of ICT-based curriculum innovations. The factors were:

- Capacity for innovation
- Alignment with needs and aims
- Status of the technology

The development of the first two sets of factors was based on organisational change theory. The third set of factors, which addressed the 'status' of the technology being implemented, drew on notions of affordance and multimodality. Before discussing in detail how these constructs supported the development of this third factor, the first two factors are briefly introduced.

Capacity for innovation

An ITE organisation's capacity for innovation is dependent on behaviour, skills and attitudes at different levels of the organisation which include: the skills and understanding of individual staff and students; the dispositions, norms and levels of teams and groups; and the commitment of leaders across the organisation (Fullan, 2001; Hargreaves & Fink, 2006). The cross-case analysis revealed the importance of having sufficient capacity at each of these levels, or at least some strategy for developing them, and the ability to coordinate them.

Developing individual capacity was highly problematic because of the relatively short time span of many of the projects. Three broad strategies were

adopted to overcome this. Firstly, organisations implemented or extended the use of a technology that was already relatively familiar to at least some of the stakeholders involved. This allowed them to provide informal learning and support to those for whom it was less familiar. Secondly, support was focused on relatively small numbers of individual. This created a group of internal experts (or early adopters), which could include staff or students, who mentored and coached colleagues informally using the technology being implemented. Finally, the technology was embedded in existing practices and made available in a range of contexts. This allowed colleagues to model its use and encouraged those with limited experience to experiment.

In a number of the HEIs the innovations were based on the team responsible for ICT across the curriculum. These teams took the lead in developing other teams' capacities, focusing on establishing key dispositions and norms that supported innovation and practice sharing. Developing such norms was not just a question of encouraging staff but also setting up processes and structures to facilitate collaboration. For example, the lead developer of one VLE adopted a strategy of giving staff 'enrolment keys', that controlled access to the materials they had developed. They could then decide which colleagues to give these keys, giving them a degree of control over what they disclosed while at the same time creating an expectation that emergent practice would be shared.

At the organisational level, securing commitment from leaders was crucial in driving forward a successful innovation. Where additional leadership capacity was required, it was often provided by people outside formal leadership and management structures. A number of project leaders recognised the need for additional leadership at those points where they felt their innovation was most likely to falter. Particularly

problematic was the point at which it transferred into the school setting, and here many aspired for their students to take on a leadership role, acting as 'champions' or even 'ambassadors'.

Aligning the project with the needs and concerns of individuals and teams

This factor appeared to have the greatest influence on whether an implementation developed or stalled in its early stages. The technology being implemented needed to meet a significant number of individuals' needs in their contexts in order to add substantively to the quality of the core activities of key groups and teams to be adopted. This was key in mobilising individuals and teams to engage with the technology at a basic level and later develop a critical mass of individuals with a 'personal investment' (Granger, Morbey, Lotherington, Owston & Wideman, 2002) in it becoming an established way working in the organisation.

Major stumbling blocks occurred when projects were designed to meet needs which were already being met quite adequately by non-technological means; when the benefits of using a technology were so marginal that only those disposed to a technical 'solution' became engaged; or when there was insufficient consultation at the beginning of the project. A consultation process of some form was important not only in defining needs but also in developing an understanding of how potential participants viewed the technology on offer. Mobilising the efforts of individuals and the resources of teams meant not only designing an implementation process around their needs and specific enhancements, but also challenging and developing how participants thought the technology could be used.

The status of the technology being introduced

An affordance analysis has been said to offer '*a methodology which concentrates directly on the critical aspects of the selection process: the underlying features of tools and the cognitive and collaborative requirements of learning tasks* (Bower, 2008, p. 15). In developing this section of the model, rather than focusing on the kinds of implementation barriers that have been explored in detail elsewhere (e.g. Bingimlas, 2009), we combined the affordance analysis with multimodality theory to develop the construct of the 'status' of the technology being implemented. Drawing on both its normative meaning as social or professional standing and more hierarchical connotations of high ranking, the term 'status' was chosen to describe the key modalities that affected how individuals and groups react to specific technologies. Status therefore refers to the key social and cultural perspectives, or modalities, from which individuals made sense of, and with, a new technology. It is broader than underlying features of tools or the cognitive requirement of the tasks that any particular technology 'medium' required participants to engage with. In this instance the status of the technology was affected by its 'fit' with individuals' existing pedagogic practices, their notions of curriculum, social and professional identities and established learning habits. This notion of 'fit' echoes Norman's (1993, p. 232) distinction between hard and soft technologies, particularly his association of soft technologies with user-led systems that '*acknowledge the initiative and flexibility of the person'*. It is our contention that users' perceptions of a technology's status also play a key role in whether, and how, they adopt it.

Refocusing Kirschner et als. (2004, p. 50) recognition of the interplay of technological, social and educational contexts and affordances in education, the analysis showed that the new technologies were constructed from within three key modalities:

- Technological status
- Learning status
- Social status

Technological status

The technological status of an innovation related to the participants' self-constructions of themselves as users of technology and the extent to which the adoption of any new innovation sat within, or challenged, these constructions. These constructions were related to issues of individual's expertise and familiarity with a specific technology and their overall level of ICT skills. They were also related to broader constructs such as a technology's perceived malleability (Norman's flexibility) - the extent to which it can be customized and adapted - and its robustness - the extent to which it requires maintenance or supervision. This modality was therefore based on the extent to which participants felt they could express themselves and make meaning via technology and their perceptions of the costs and benefits of such activities.

In some instances, students' and tutors' differential constructs of a technology led to a reversal of traditional training hierarchies. More technologically literate students who engaged with certain innovations influenced not only the practice of

their tutors and the school staff with whom they worked, but also the culture of their training organisations and placement schools:

> *The confidence and competence of students in using IWB technology, developed through use of their laptops, helped those tutors/teachers working with students who lacked confidence in using ICT and in some cases the teachers certainly learnt from the students' practice.* (Tutor)

The perceived technological status of a specific innovation was key in terms of participants' resilience when encountering issues or problems. The technological status of an innovation therefore interacted with design affordances related to its ease of use; its degree of compatibility with other forms of technology and existing ICT infrastructure; and its overall reliability and functionality. Instances of technical problems preventing an effective implementation were relatively rare in the case studies. This in part reflected the extent to which staff and teams with existing expertise in ICT training and support were involved in leading projects. It had a significant impact on the level of technical support that needed to be offered if a particular piece of technology had 'low' status, in that it did not fit with participant's view of themselves as ICT users, or appeared rigid, constraining or not robust. Similarly, the degree, sophistication and intensity of the formal professional development that was on offer needed to be greater than for those technologies that were perceived to have higher status.

Social status

As Jewitt has asserted (2009b, p. 15), all modes of a technology '*have been shaped through their cultural, historical and social us*es *to realize social functions'*. In this study the social status of a technology was based on how different social cultural groups constructed the cultural significance and relevance of a particular technology. These groupings might be as specific as the organisational culture of a college or school where a project was located or as broad as a technology's popular image in youth culture and the media. The existing social status of a technology was particularly important in determining its initial acceptability and the ease with which a small project could be scaled up. In some instances, take-up of a technology varied widely across different professional and social groups which held divergent perspectives on whether certain technologies was 'good' or 'bad', aspirant or otherwise, as they judged them against very different norms and values.

Differences in perceived social status were particularly important in the implementation of ubiquitous technologies, rather than those with more specialised educational uses. A positive shared cultural perception could make a piece of technology 'aspirant' (or highly ranked) in the mind of potential users and so encourage uptake. The evidence from this research was that teacher students had increasingly come to regard having a laptop and using it in their everyday activities as part of their emergent professional identities as teachers, and had therefore become both ubiquitous and aspirant from their perspective:

> *It's like having a pen nowadays. Anyone who does any sort of work really, especially those in a managerial position (like teaching) where you are paid to get the job done rather than for the hours that you work, needs a laptop to do it. Otherwise you're stuck to one place and one desk.* (Student)

The selection of a technology that was aspirant or perceived positively by different stakeholders generally made implementation easier. In some instances, technologies with divergent social status made implementation more complex, a good example being VLEs which many ITE organisations had had for some time. The case studies of VLE's showed how their recent rapid take-up by students, and to a lesser extent staff, was supported by the widespread use and acceptance of social networking sites. This made uploading and downloading documents and participation in online discussion forums commonplace among students, but less so among tutors. Those responsible for implementing VLEs therefore encountered widespread difference in the status as well as levels of familiarity with this technology.

> *At first I thought it was going to be fantastic but then I just found myself duplicating everything, one copy for the VLE then one for mentor and assessor. My tutor prefers to have a hard copy that he can mark - he's not completely computer literate.* (Student)

This contrasted with students working with tutors more familiar with Facebook and other networking sites, for whom regularly posting materials on the VLE was synonymous with effective tutor-student interaction:

> The fact that you know that someone is going to look at it almost immediately really focuses you on it. I'd normally do it later but because I know my tutor's going to check and my mentor's going to check, I make sure it's up there. If I put something up I normally get feedback by the following day. (Student)

The social status of a technology was closely related to the social and professional identities of participants and the role technology played in the construction and maintenance of these identities.

Learning status

Learning status relates to a technology's perceived utility and applicability to individuals' learning and its potential to support the learning of others. This modality is based on an individual's views of what constitutes 'learning', the curriculum, and effective teaching and learning processes. These views attune the individual to the affordances of each specific technology to support learning. For tutors the starting point for this process of attunement was their initial perception of how well a certain technology 'fitted' with their existing pedagogical approach and curricula, before going on to consider how it might support changes and improvements. One tutor, who later became an advocate, initially expressed misgivings about video-conferencing because its perceived passivity clashed with their views of effective learning and teaching:

> As primary scientists we are very aware that science should be as hands-on and interactive as possible. We weren't sure if we could use [video-conferencing] to enhance or enrich sessions and we weren't going to use it if it wasn't. My first impression, knowing nothing about it, was that you got a person quite distant at the end of a screen and a whole classroom of excited kids. (Tutor)

Those using ICT to innovate had to respond to and challenge widely different perceptions of the learning potential of some of the technologies. For example,

students' closeness to pupils often gave them insights into their digital habits and a recognition of the role they played in their out of school learning. This helped many to recognise the role that technology could play in supporting their pupils' learning and how technology could make the curriculum more relevant. However, in other cases, students felt frustrated by others' failure to recognise the learning potential of new technologies and this undermined their attempts to develop their use in their own practice.

Conclusion

Although this study was limited to only six case studies, they were selected on the evidence from a national survey that supported the idea that successful projects were characterized by a recognition, and occasionally exploitation, of the differences between groups in the 'status' they gave to a technology. Effective project leaders challenged negative perceptions of the specific technology and considered how differential prior engagement would affect initial take-up and the overall training and support needed.

The model that has been created was developed to make accessible the insights generated by theories of modalities and affordances to non-specialist practitioners involved in ICT implementation projects in higher education. The model set out to help them to understand how individuals' engagement with a technology depends on social and cultural constructs that define its 'status' in their contexts. However, it should be emphasised that we have downplayed the extent to which the three sets of factors operate interdependently, resembling dynamic and mutually influencing elements of a complex adaptive system, and capturing how this

interdependence functions more fully would be a potential area for further research. However, because the 'status' of a technology is likely to be different for the various groups or stakeholders involved in any innovation, the study showed how failing to recognise, or make use of, this phenomenon during the implementation stages of a project was a major factor in determining whether the technology would ultimately have an impact on practice.

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