The social construction of educational technology through the use of proprietary software

Chris Bissell

Department of Communication and Systems, The Open University, UK, c.c.bissell@open.ac.uk

Abstract

Major strands of science and technology studies (STS) in recent decades have been the ‘social shaping of technology’ (SST) and ‘social construction of technology’ (SCOT) movements, whose adherents maintain that technological systems are determined just as much by social forces as by technological ones. Taking this ‘co-construction’ notion as a starting point, and putting a focus on the user, I look at some examples of the use of proprietary software in which the learner, instead of being constrained by a rather deterministic pedagogy of educational technology, can exploit the functionality of the software in ways far removed from the original design. For example, spreadsheets can be used to incorporate modelling assumptions directly to simulate digital signal transmission, or the workings of the binomial function. Audio editing software can be used to teach about the technology of music by allowing the student to explore waveform characteristics. The manipulation of images, if combined with a teaching of the principles behind data compression, can engender a deep understanding of the processes involved. And translation software can be used for language learning in a way very different from what was envisaged by the designers. Educational technology has tended to suffer from an emphasis on, and excessive claims for, technological innovation and novelty. Film, radio, television, programmed learning, interactive video discs, CD-ROMs, a ‘computer in every classroom’, ‘one laptop per child’, the web, computer-mediated communication, smartboards; and now mashups, Second Life, Facebook, YouTube and Twitter – all have all been seen as radical new technologies that would revolutionize learning. Here I make the case for the social construction of educational technology by users and teachers, based on exploiting to far better effect the possibilities of mature, often proprietary, software not originally designed for pedagogical purposes. The approach outlined here not only helps students gain experience with the sort of software they are likely to encounter in their professional life, but also fosters and sustains a healthy spirit of enquiry that too often is lacking in much educational software. Although the examples presented have been situated in the context of the individual learner, similar principles can be applied to a whole range of networked educational technologies.

Keywords

Social construction of technology; learner empowerment; spreadsheets; educational technology; proprietary software

Introduction

Over the last thirty years or so there has been much debate amongst historians and sociologists concerning the interplay of technology and society in the development and functioning of socio-technological systems. An extreme form of technological determinism – the view that technology is the major driving force in contemporary history or social progress – is still often found in the media and politics, but most historians and sociologists, and many technologists, would now take the view that technology and society are ‘co-constructed’, while differing in their analyses of the relative strength of the forces concerned.

An excellent review of the development of the general ‘social shaping of technology’ (SST) movement, with its origins in a number of centres in Britain and elsewhere from the 1970s onwards, can be found in the survey article by Williams & Edge (1996), which includes an extensive bibliography. Accounts of social construction of technology (SCOT) ideas often refer to a seminal meeting in Maastricht in 1983 (Bijker et al., 1987); see also Bijker & Law (1992), Bijker (1995) and MacKenzie & Wajcman (1999). The constructivist-determinist debate has been analyzed in some detail in Smith & Marx (1995). The historian David Edgerton made a significant contribution more recently in his examination of what precisely is meant by 'technological determinism' and his conclusion that the concentration on innovation and 'progressivist' accounts had led to a grave omission of studies of the *use* of technology. His thought-provoking paper directed at historians of technology (Edgerton, 1998, 1999) was followed by a well-received book for a popular audience (Edgerton, 2006).

Other work that has influenced the thinking behind this paper includes a set of studies by a group at the Institution of Education, London on the techno-mathematical knowledge required in a variety of work contexts, including bank employees, nurses, engineers, and others (Noss & Kent, 2000), focusing on the user in professional practice.

Educational technology has tended to suffer from an emphasis on, and excessive claims for, technological innovation and novelty. Film, radio, television, programmed learning, interactive video discs, CD-ROMs, a 'computer in every classroom', 'one laptop per child', the web, computer-mediated communication, smartboards; and now mashups, Second Life, Facebook, YouTube and Twitter – all have all been seen as radical new technologies that would revolutionize learning (or democracy and community). While not wishing to decry the undoubted opportunities offered by all these technologies, this paper will look at aspects of how learners and teachers can exploit the possibilities of mature ICTs, constructing in the process something rather different from what was originally intended by the software designers.

Spreadsheets

The late 1980s and 1990s saw a rash of papers in the science and engineering education literature on using spreadsheets as a teaching tool. Originally designed for financial planning and analysis, the early spreadsheets were soon extended by the inclusion of a full range of mathematical functions and even a high-level programming language such as Visual Basic. The vast majority of the scientific and engineering educational applications reported in the literature used spreadsheets simply to set up and solve standard mathematical models as part of simulations of processes or systems. Many examples used in practice, including some developed by the UK Open University, deliberately excluded the user from exploring the model behind the simulation by hiding cell contents or making them read only. Comparatively few published papers took the line of asking students to construct the spreadsheets themselves by building the modelling assumptions directly into the spreadsheet formulas, rather than simply using them to solve standard equations (Bissell, 1994). The following two examples are illustrative of the latter approach, adopting an orthodox constructivist pedagogy in which students – either individually or working as a group – build the simulations from scratch.

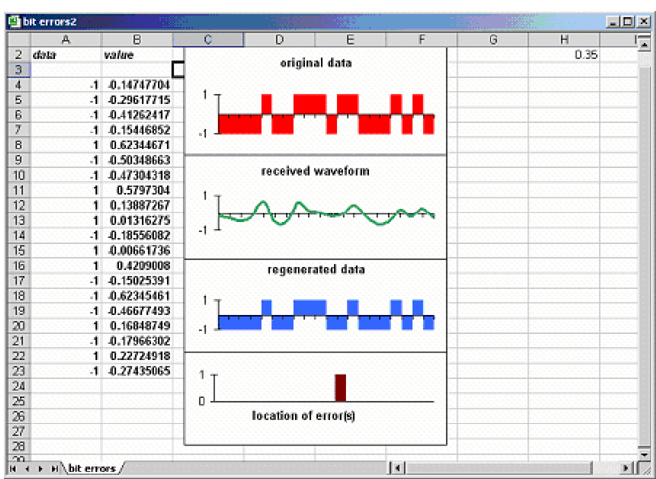


Figure 1: How a digital signal can be regenerated with or without errors

The first is an illustration of how a digital signal can be regenerated either without error or with a small number of errors. The technical spreadsheet knowledge required is fairly elementary, essentially being able to use the random and integer rounding functions and to plot bar and line charts. Column A holds a random sequence of ±1, while column two adds random 'noise' to represent the received waveform after attenuation and distortion.

ISBN 978-1-86220-225-2

The two waveforms plus the ‘cleaned up’ or regenerated digital signal are shown in the charts. Students can experiment with varying the amount of added noise and view the corresponding error(s).

The second example shows a spreadsheet equivalent of a physical model used to demonstrate the binomial function. In the physical model, ball bearings fall through a set of partitions, building up the classic binomial distribution, an approximation to the Gaussian or ‘normal’ bell-curve. In the spreadsheet, 1’s trickle in from the left, taking a random path through the tree, finally being summed in the ‘total’ column and plotted as a chart.

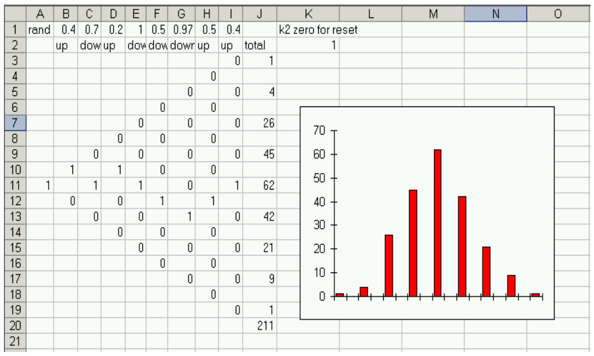


Figure 2: Spreadsheet and physical models of binomial function

So far, this is a classic example of a constructivist / situated learning approach (Abbey, 2000; Lave, 1998). What I want to emphasise here (as in the remainder of the examples presented in this paper) is that:

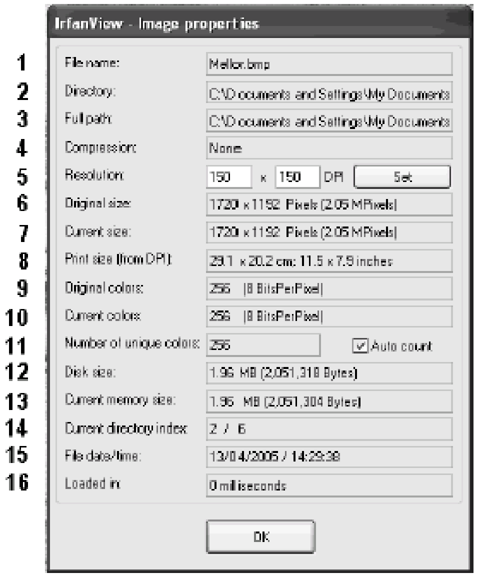
- by building such spreadsheets for themselves, students become more competent users of the software, as well as improve their understanding of (in this case) digital signal transmission and the binomial distribution
- in their use of the spreadsheet software the teacher and students have turned the package into something quite different from what was originally envisaged by the developers, and also something very different from a simple mechanical solution of an underlying mathematical model; the model assumptions are built *directly* into the spreadsheet without intervening mathematical formalism

Now, there is nothing particularly innovative in the final results of these activities. Similar simulations abound on the web or in classrooms. The key difference in this approach – in contrast, say, to using java applets or other programming tool – is that not only is there pedagogical constructivism in the student activity, but there is also the social construction of a new educational technology through the use of an existing, stable, generic platform.

Graphics and audio software packages

My second example concerns the use of graphics and audio processing software in two UK Open University courses: the level 1 introductory course *Networked Living* and the level 2 *Technology of Music*. Both these courses make considerable use of proprietary software much more specialised than a spreadsheet package (Jones, 2007).

Irvanview is a freeware graphics editing and manipulation package, offering functions very similar to those of numerous other graphics editors. In *Networked Living*, however, the package is used to explore the fundamentals of image compression rather than simply to manipulate a file to some desired end of the user. Again, the key to the teaching use of this software is to engage the learner with the software in a novel way.



One particularly useful feature is the 'image properties' window (left), included in the package to enable the user to quickly observe the characteristics of the image in terms of the resolution, the file size, the colour palette involved, and so on. Part of the course *Networked Living* includes teaching about various compression algorithms, and asking students to explore the suitability of them for particular types of image. In the example shown, line 6 gives the number of pixels, line 12 the compressed size and line 13 the uncompressed size. Line 10 shows the number of colours used. With the aid of this information the learner can explore the result of compressing various types of image – full colour, charcoal sketch, pen-and-ink drawing – and come to sensible conclusions about the appropriateness or otherwise of particular techniques. For example, there is little point in using 256 colours (8 bits per pixel) for a pen-and-ink drawing where each pixel is either black or white. Simply compressing an image and observing the subjective quality and file size (something a naive user might do) involves little learning.

Figure 3: Image properties window of Irvanview

In the *Technology of Music* course students use Adobe Audition in a similar way. They generate audio waveforms, manipulate them, and relate the results to their theoretical understanding of the principles taught in the course as well as their perception of the sounds created or analysed. Audition is a (moderately expensive) professional audio editor well-established in areas such as local radio, and not designed for teaching purposes. As was the case with Irfanview, however, the course exploits various facilities of the software for a detailed exploration of the subject area – in this case the study of elements of acoustics and psychoacoustics over a week-long study period. The following figure shows just one example from these activities, to illustrate the differences in the waveform amplitudes of a chord tuned to pure ratios and the same chord using equal temperament tuning.

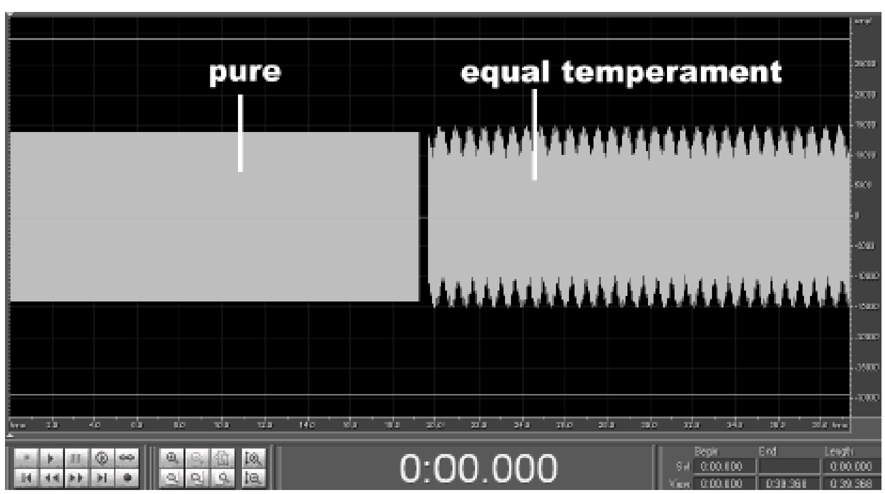


Figure 4: Differences in waveform amplitudes

In the past the UK Open University might well have produced its own in-house computer-aided learning material to teach such matters, with significant constraints on, and more explicit direction of, the learner (and probably exploiting the latest programming tools – all based on sound pedagogical principles, of course!). The point I wish to stress here, as in the spreadsheet examples, is not only the constructivist educational approach, but the (re-)creation of the learning environment itself.

On-line translation: a personal anecdote

My third example is admittedly a little idiosyncratic, yet further reinforces, I hope, my general argument. I am including it as an example of the use of the web as an interactive resource that goes beyond the simple search for information, as well as another example of user re-construction of the resource.

It concerns the Internet as a resource for foreign language learning. When I gave my first paper in French, a few years ago, I realised while preparing the text that I was unsure about certain technical terms or expressions. Available dictionaries, printed or on-line, were not very helpful or sufficiently up to date. However, by searching for my proposed French terms I could find out whether they appeared in WWW documents, and how often.

For example, should the technical term "time domain" be translated into French as "*domaine de temps*" or "*domaine temporel*"? At the time of writing a Google search returns:

	pages from .fr sites	total pages in French
domaine temporel	34 600	63 600
domaine de temps	30 600 000	30 700 000

Now, this technique cannot indicate correctness or otherwise with certainty, although it can certainly provide strong evidence in favour of an alternative. Care is always needed concerning quality and authority – and there are plenty of web pages with poor grammar, spelling and vocabulary, or written by non-native speakers. In the case of French, too, there may be significant differences if the site originates in France, Canada, Belgium, Switzerland, or the former French colonies, even when produced by a competent native speaker.

Even translation software can be useful. Such tools are often either claimed to be far superior than they really are, or dismissed out of hand as completely inadequate. The truth is somewhere in between. The following screen shot shows the apparently straightforward example of using translation software to translate a Russian sentence into English.

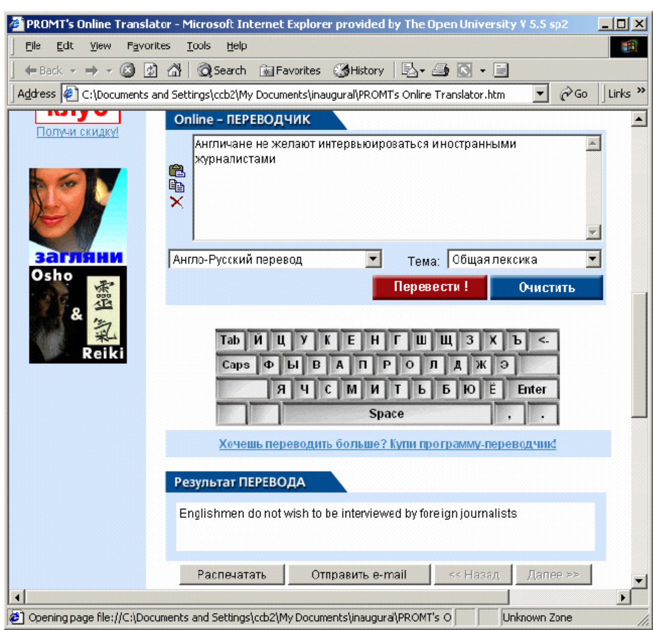


Figure 5: Screenshot of translation software

ISBN 978-1-86220-225-2

What it does not show, however, is that this is the final result of an interactive session in which I ran some of a draft Russian text written by me for an evening class through a translation page back into English (back translation). The stages not shown enabled me to correct some spellings and erroneous word endings. Again, the result cannot guarantee correctness, but it can indicate certain errors. So I was pleased when my final version returned almost exactly what I was trying to translate ("The English don't like being interviewed by foreign journalists.")[*]. Ironically, the better such translation software becomes in coping with spelling and grammatical errors, the less useful this approach will be.

I include this personal anecdote as another example of constructing a new use for a mature technology (as users have always done), again with a distinct learning purpose very different from the expectations of its designers. It is, I believe, an example of the educational use of non-educational tools in a way often invisible to educational technologists, and rarely studied.

Conclusion

This paper has articulated a very simple claim, prompted by recent research into the sociology and history of technology (particularly the dangers of privileging innovation over use), and the observation that much educational technology appears to be fixated with novelty. There is, admittedly, increasing research into the *use* of educational technology. For example, Smith *et al* (2005) give a review of the literature on the use of interactive whiteboards in the (predominantly British, school) classroom; Creanor *et al* (2008) report the findings of the LEX (Learner EXperience of e-learning) project in UK post-16 education; while Kear (2004) is amongst those who have examined the details of learning in an asynchronous networked environment.

Nevertheless, much of the research in this area relies heavily on eliciting the views of teachers and learners, and there is little convincing analysis of learner achievement and the rôle of the technology in this all-important aspect. In fact, Smith *et al* (2005) conclude their study of interactive whiteboards (IWB) as follows:

> In order for us to understand the best way for practitioners to use IWB technology in the future as transformational devices, research is needed in order to collect empirical evidence so that the processes of teaching and learning with this new technology are more fully understood and more coherently conceptualised. An interesting starting point for this research would be to ask what the intersection between technical and pedagogic interactivity looks like in reality.

The same could be said for many other educational technologies, new or well-established.

I have made the case for the social construction of educational technology by users and teachers, based on exploiting to far better effect the possibilities of mature, often proprietary, software not originally designed for pedagogical purposes. The approach outlined here not only helps students gain experience with the sort of software they are likely to encounter in their professional life, but also fosters and sustains a healthy spirit of enquiry that too often is lacking in much educational software. Although the examples presented have been situated in the context of the individual learner, similar principles can be applied to a whole range of networked educational technologies.

It is likely that considerable unreported activities of this nature are taking place in many educational institutions or by users in isolation. Indeed, the whole area of the practical use of ICT-supported learning technologies appears to be under-researched, whether the exploitation of generic technologies as described here, or the way teachers and learners *really* engage with purpose-designed educational software once it leaves the research, development or pilot-project phase.

[*] Unfortunately, when my tutor read it, she uttered that phrase so hated by language learners ... "I'm sorry, we just don't say that in Russian". Like the computer program behind the translation page, I had mastered (some of) the rules – but I was still a novice in the culture.

ISBN 978-1-86220-225-2

References

Abbey, B (ed) (2000), *Instructional and cognitive aspects of web-based education*, Hershey, PA: Idea Group Publishing

Bijker, W E (1995), *Of bicycles, bakelites, and bulbs : toward a theory of sociotechnical change*, Cambridge, MA: MIT Press

Bijker, W E; Hughes, T P & Pinch, T J (eds) (1987), *The social construction of technological systems*, Cambridge: MIT Press

Bijker, W E & Law, J (eds) (1995), *Shaping technology/building society : studies in sociotechnical change*, Cambridge: MIT Press

Bissell, C (1994), 'Spreadsheets in the teaching of information engineering', *Eng. Sci. & Ed. J.*, April, pp. 89-96

Cohen, Y & Pestre, D (eds) (1998), 'Histoire des Techniques', *Annales Histoire, Sciences Sociales*, Vol. 53, No. 4-5 (special issue). Paris: Armand Colin

Creanor, L, Trinder, K, Gowan, D & Howells, C (2008), 'Life, learning and technology : views from the learners', *Learning and Teaching in Higher Education*, Issue 2, pp. 26-41

Edgerton, D (1998), 'De l'innovation aux usages. Dix thèses éclectiques sur l'historie des techniques', *Annales Histoire, Sciences Sociales*, Vol. 53, No. 4-5, pp. 815-835

Edgerton, D (1999), 'From innovation to use: ten (eclectic) theses on the history of technology', *History and Technology*, Vol. 16, pp. 1-26

Edgerton, D (2006), *The shock of the old: technology and global history since 1900*, London: Profile

Jones, A (2007), 'Proprietary software tools as learning aids.' Presented at: *AACE Ed-Media 2007*, Vancouver, Canada, 25-29 June, 2007

Kear, K (2004) 'Peer learning using asynchronous discussion systems in distance education', *Open Learning*, Vol. 19, No. 2, pp. 151-164

Lave, J (1998), *Cognition in practice*, Cambridge: Cambridge University Press

MacKenzie, D & Wajcman, J (1999), *Social Shaping of Technology*, Milton Keynes: Open University Press, (2nd ed)

Noss, R & Kent, P (2000), 'The visibility of models: using technology as a bridge between mathematics and engineering', *International Journal of Mathematics Education in Science and Technology*, Vol. 31, No. 1, pp. 61-69

Smith, H L, Higgins, S, Wall, K & Miller, J (2005), 'Interactive whiteboards: boon or bandwagon? A critical review of the literature', *Journal of Computer Assisted Learning*, Vol. 21, No. 2, pp. 91-101

Smith, M R & Marx, L (1995), *Does Technology Drive History?*, Cambridge, MA: MIT Press

Williams, R & Edge, D (1996), 'The social shaping of technology', *Research Policy* Vol. 25, pp. 856-899