Principles for consideration in the design of future learning environments: key issues from the education and technology research literature

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Aims of the paper

The Faraday Project brings multiple perspectives on science, education and technology together. Designing spaces for teaching and learning science will always be an interdisciplinary process. The heterogeneity of the Faraday teams and their partner schools is a valuable resource – it generates insight leading to innovation. However, interdisciplinarity brings with it challenges of its own. This review provides:

- A shared focus for discussion amongst the team members.
- An overview summary of the key ideas arising from research evidence to date.
- Directions to further reading (in reading lists following the main document).

The paper is intended primarily for the design teams and their school partners in the Faraday Project. As these teams are interdisciplinary in nature, and as this paper is intended to act as a resource for all of those working in the teams whatever their educational, research or design backgrounds, certain aspects of this paper may be more or less familiar to different readers.

In the limited space available, this paper cannot hope to be comprehensive or to avoid simplification. As such, it should be taken as a starting point for discussion rather than a 'last word' on the areas discussed. The sources that inform the paper are listed in the endnotes.

Overview

The paper addresses four key areas:

- Some challenges raised by digital technologies
- Teachers and learners and as 'users'
- Theories of learning
- The goals of science education

These areas are the focus for this paper as they address key issues that are likely to be faced by design teams in the Faraday Project.

Digital Technologies and future learning environments[i]

Tony Fisher and colleagues, in a recent review of the literature, categorised the affordances of networked digital technologies for learning into four clusters as outlined below:

Knowledge building	• adapting and developing ideas • modelling • representing understanding in multimodal and dynamic ways
Distributed cognition	• accessing resources • finding things out • writing, composing and presenting with mediating artefacts and tools
Community and communication	• exchanging and sharing communication • extending the context of activity • extending the participating community at local and global levels
Engagement	• exploring and playing • acknowledging risk and uncertainty • working with different dimensions of interactivity • responding to immediacy

These clusters represent the broad range of potential uses of digital technologies for learning, emphasising that they may be used to support a wide range of approaches to teaching and learning, and offering support for a wide range of models of 'science education'.

Another way of considering the implications of digital technologies for education is considering the ways in which they problematise 20th century assumptions about time, space and identity in education. Since the advent of mass schooling in the mid 20th Century, **time** in schools has been seen as a precious commodity which is parcelled out in 45-90 minute segments. The ways in which digital technologies are now being used, however, offers up the opportunity to challenge this organisation of time. The potential to communicate with others across the world opens up potential demand to work and learn in different time zones and over 24 hours; the potential to save work, revise it and transform it opens up the possibility of extended activities developed over days, weeks, months, years; the potential to access information, talk with others at all times of the day offers the opportunity of learning at times which suit learners and families.

Many schools are experimenting with time in complex and interesting ways: in one school, they are exploring the practice of '39 different Fridays' in which whole days are given over to a single subject; other schools are collapsing weeks into 'off-timetable' activity in which substantial projects are team taught; the longer temporal arcs of the school are also being challenged – three years teaching is being condensed into two; other schools are opening into evenings, while 'Notschool' is recruiting staff in New Zealand to cope with learners interested in learning at all times of day (see www.notschool.net).

The potential of digital technologies to create connections between people and places profoundly challenges our understanding of **space**. In the first instance, it raises the question of who we might work and learn with – if we can communicate via email, then why not learn with an expert or teach a novice in Russia or Africa? Second, they challenge the conception of 'where learning happens' – when information and resources can be accessed anywhere, from city streets to cafes, bedrooms to sports

centres – where does the 'classroom' begin or end? The emergence of personalised, mobile devices and of embedded ambient technologies begins to reawaken Socrates' ghost and reinvigorate the idea of the 'city classroom' – of conversation, collaboration and discussion interlaced with the spaces of the real world. There are schools today which are embedded in their cities and 'invisible', and universities which consist of 'no-space / no-place' communities of vibrant conversation and learning – we need, in fact, think only of the long history of the Open University to challenge the conception of learning as being tied necessarily to a classroom.

Finally, and fundamentally, digital technologies raise questions about the fundamental 'unit of education' – the learner. As we access information in diverse locations, use tools to present our ideas, model our thinking, share our understanding, as we work together with people online, through email, through social software, we are increasingly seeing the boundaries of identity stretched to include these other people, objects, tools and resources. Young people entering the secondary classroom in 2007 have never known life without the internet, have never known leisure without computer games, and have never known sociability without instant messenger. Life, knowledge and play are intimately 'connected' activities – not to use these tools is to ask young people to 'power down' when they enter the school.

The implications of such transformations in understandings of time, space and identity raise the question of whether future learning environments should or could be considered 'classrooms' of the future. In the meantime, however, they foreground the importance of considering any future 'classroom' as a space that is intimately and constantly *connected*: with the wider world, with the local community, with other learners and advisors.

Theories of users[ii]

Another key issue that design teams have to address in developing future learning environments is the question of who will be using the space and what we know about those users.

Theorising childhood

Just as it would be inappropriate to present one overarching theory of learning, so, since the 1970s, do researchers urge us to be cautious about using a uniform picture of 'children'. Most 19th and 20th century research presented an idea of childhood as a time of uniformity and shared experience, in which children progressed at the same time and in the same way through shared biologically defined developmental stages (for instance, both Freud and Piaget identified distinct and universal stages of development). However, the late 20th century research endeavour has challenged this view of childhood – both from sociological and psychological perspectives. From a psychological perspective, for example, Howard Gardner's work on multiple intelligences challenges the idea of a unitary form of intelligence and development. This work has led to the sometimes over-used concept of children having different 'learning styles'. It has also led to experiments with different age classes working together and a new exploration of children developing according to 'stage' not 'age'.

In sociology and youth studies an increased attention to children's own accounts of the world has made visible young people's capacities to act as experts, advisors and teachers in the non-school setting. This research has also identified the achievements young people are able to make when engaged in self-directed and authentic learning

experiences outside school. At the same time, the 1989 UN Convention on the Rights of the Child accords to all children the right to be consulted in matters which concern them – education being a prime candidate for such consultation. We are increasingly, as a result, seeing the development of 'Learner Voice' programmes and as a whole, a need for educational environments which are designed to:

- Recognise and cater for differences between children, of their different needs, experiences, concerns and resources.
- Build upon children's agency and capacity to act as advisors and mentors, as well as learners, and to bring knowledge from outside the school into the classroom.
- Acknowledge children's rights to be consulted in the educational domain.

Teachers' needs?

Teachers' needs, independent of their role in interacting with children, are sometimes overlooked in the design of learning environments such as classrooms. Where they are considered, it is often in terms of their role in orchestrating and facilitating learning interactions, managing resources and so forth. What is often ignored, however, is their own identity as learners and professionals and humans (to the extent, in the extreme, that teachers often suffer from bladder and bowel conditions as they are unable to find time to go to lavatories that are located a long way from their teaching rooms). What is clear is that in designing future learning environments it may be necessary to consider the role of the 'future teacher' in the context of ongoing workforce reform. Future learning environments, for example, might need to be considered as spaces in which a teacher can also act as:

- A learner, engaged in personal development and progression
- A collaborator, participating in co-development teams with colleagues inside and outside the school
- A facilitator and connector, making connections for children with the outside world and with resources which extend beyond the classroom
- A manager, directing other adults and children in the educational process

Changing demographics

Learning institutions are already having to deal with huge uncertainties related to their viability and sustainability and will face a range of other significant demographic changes over the next few decades, including changing age profiles within local communities, fewer numbers of school age children, and the transience and mobility of local communities. This, combined with a drive to create closer links between schools and communities through concepts such as the 'extended schools' programme, and the Every Child Matters agenda, which sees schools increasingly acting as community hubs for a range of services, significantly increases the likelihood of learning spaces acting as sites for adult learners. At the same time a drive towards lifelong learning, the emergence of the idea of learners progressing by 'stage' not 'age', raises the possibility of mixed age group learning communities. Future learning environments might therefore need to be considered as spaces in which:

- Different groups of adults and children use the space at different times of the day.
- Mixed age groups are a key feature of the use of the space.
- The environment may be repurposed for other community based activities.

Theories of learning[iii]

Theories of 'how learning happens' always inform school design. Sometimes the influence of a theoretical approach will be explicit throughout the design process. However, there is a real danger for interdisciplinary design teams that they remain oblivious to their own assumptions and the constraints these impose on the design process. Education research offers a wealth of models of learning many of which offer different, sometimes complementary, sometimes conflicting, perspectives. Amongst others, these theories include:

- Constructivist theories (which emphasise the importance of individual exploration and creation of representations and simulations)
- Socio-cultural theories (which emphasise social learning through participation in communities of practice)
- Connectionist theories (which emphasise the importance of play and pattern matching activities)
- Expert practice theories (which emphasise skills and content acquisition, repetition, practice, reflection upon practice)

These different theorisations of learning arise both from different research traditions and interests, and also, one might conjecture, from the possibility that there are many different ways of learning in different circumstances. Jey Lemke, for example, argues for the importance of reflecting upon our own lives in order to identify the diverse range of ways in which we may learn at different times:

- *read a book or surf the web for information*
- *ask a friend or an expert to explain something*
- *tinker with things and try to figure them out*
- *get a group together to find an answer or make something happen*
- *watch other people doing something and try it for yourself*
- *explore a new territory, alone or in company*
- *talk to people*
- *write and make diagrams, drawings, movies, music, multimedia*
- *invent new things or ideas of your own*
- *compare different ideas and experiences*
- *ask why? and how? and how else?*
- *all of the above, in some combination.*

Learning, from this perspective, is a process of rich and diverse encounters and experiences; it suggests that "it takes a village to educate a child" (Lemke 2002).

This perspective on learning challenges the idea of single 'learning method' or 'teaching and learning approach', and instead suggests that future learning environments might therefore need to create learning environments and interactions that support a diverse range of such activities – from silent reflection on nature, to practising expert techniques, from collaborative problem solving, to the creation of models to experiment and try things out.

The goals of science education[iv]

The most contested issue this in this overview for Faraday teams is the question, 'what is science education for?' There are four common rationales for science education: the utilitarian (science will be helpful to everyone); the economic (we need trained scientists to compete); the cultural (science is a human achievement we need to understand); the democratic (science raises moral dilemmas which we need everyone to be able to debate). These rationales lead to different models of science education and encourage a focus on different elements of science – from engaging with scientific *process*, to relating scientific *narratives*, to *debating* scientific and social dilemmas, to *memorising* scientific facts.

Interestingly, the same four rationales are applied to public engagement with science, but in subtly different ways. The 'science communication' agenda and the science education agenda are only superficially similar – which means roles for museums and scientific institutions in school science are less straightforward than they might at first appear.

Three major changes have emerged in the last 20 or so years which inform debates in both science education and science communication. First, scientific practice and scientists are no longer seen as separate from society, but as part of it and shaped by its values, as such, 'science itself' (its institutions and assumptions) has been identified as a legitimate subject of inquiry and investigation. Second, the perception of what constitutes 'real science' is becoming less homogenous (For instance, there is increased awareness of the differences between disciplines such as physics and chemistry which attempt to generate explanatory models of the world and disciplines such as evolutionary biology, cosmology and such like which attempt to historically reconstruct the past.) Third, the technologisation of the scientific workplace (as with many other workplaces) has changed the ways in which scientists work – both in terms of what they are able to work on, the questions and challenges they are able to explore, and in terms of how they work with others both locally and internationally.

Future learning environments might therefore need to be considered as spaces in which these multiple models of science and science education can be supported.

Reading Lists

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