The Open University

Innovating Pedagogy 2013

Exploring new forms of teaching, learning and assessment, to guide educators and policy makers

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Open University Innovation Report 2

A full-text PDF version of this report is available to download from
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Suggested citation:
Sharples, M., McAndrew, P., Weller, M., Ferguson, R., FitzGerald, E., Hirst, T., and Gaved, M. (2013). *Innovating Pedagogy 2013: Open University Innovation Report 2*. Milton Keynes: The Open University.

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ISBN 978-1-78007-937-0

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Executive summary

This series of reports explores new forms of teaching, learning and assessment for an interactive world, in order to guide teachers and policy makers in productive innovation. This second report proposes ten innovations that are already in currency but have not yet had a profound influence on education. To produce it, a group of academics at The Open University compiled a long list of new educational terms, theories, and practices. We then pared these down to ten that have the potential to provoke major shifts in educational practice, particularly in post-school education. Lastly, we drew on published and unpublished writings to compile ten sketches of new pedagogies that might transform education. These are summarised below, starting with four updates from last year's report, followed by six new entries, in an approximate order of immediacy and timescale to widespread implementation.

1 **MOOCs:** In the past year, massive open online courses (MOOCs) have attracted interest from universities and from venture capital investors. MOOC platforms have been announced from Australia to the UK, but the focus is still currently on North America. The US-based providers Coursera, Udacity and edX are exploring business models involving paid-for assessment, the award of recognised credit, and recruitment of students to campus courses. Typically, around 20,000 learners register for a MOOC, with 5-10 percent reaching the end point. In terms of pedagogy, the currently dominant approach is a transmission model involving video lectures, recommended readings and staged assessment. MOOCs are an evolving and expanding area with new developments likely to offer greater variety of courses and more innovative social learning pedagogies. They also offer the chance to run experiments that compare teaching methods.

2 **Badges to accredit learning:** Badging offers a flexible mechanism for recognising achievements as steps towards more substantial goals. Badging can also provide an informal alternative to accreditation. During 2012, the initial infrastructure and profile for badges became established. In 2013, there are encouraging signs that the tools and infrastructure are improving, with implementations appearing for mainstream learning environments. Educators are increasing their experience of using badging to help courses run successfully online and to motivate learners. Badging implementation requires further development, for example to offer more flexible ways to provide evidence. Lack of structures that can combine badges into a common accreditation framework currently limits their use. Greater awareness and presence of badging

through social networks is still required, but the core technology of a 'badge backpack' has already been refined.

3 **Learning analytics:** Learning analytics involve the collection, analysis and reporting of large datasets relating to learners and their contexts. Current developments are focused on three areas: understanding the scope and uses of learning analytics; integrating analytics into existing courses; and expansion of learning analytics to new areas, particularly MOOCs. A central challenge is to develop analytics that are driven by key questions, rather than just querying data collected from online systems. The relation of learning design to learning analytics is also being considered, so that new teaching methods and curricula are informed by analysis of previous experience. Methods of learning analytics not only examine past interactions but also support future outcomes for students and educators. Other key issues include secure data storage, appropriate levels of access, and providing the necessary infrastructure for storing and querying large data sets.

4 **Seamless learning:** Seamless learning (connecting learning experiences across the contexts of location, time, device and social setting) is moving from research to mainstream adoption. Mobile technologies enable learners of all ages to operate across contexts, for example schools allowing students to bring their own devices. Pedagogy is emerging, based on learners starting an investigation in class, then collecting data at home or outdoors, constructing new knowledge with assistance from the software, and sharing findings in the classroom. There is also a broader notion of seamless learning arising from connected experience. Our activities online are increasingly matched to our interests: search pages order responses based on previous queries; websites recommend content related to our past viewing. The benefits are that personally relevant information may be ready to hand, but the danger is that we may come to believe that our views, preferences and connections are not just the most relevant, but all there is.

5 **Crowd learning:** Crowd learning describes the process of learning from the expertise and opinions of others, shared through online social spaces, websites, and activities. Such learning is often informal and spontaneous, and may not be recognised by the participants as a learning activity. In this model virtually anybody can be a teacher or source of knowledge, learning occurs flexibly and sporadically, can be driven by chance or specific goals, and always has direct contextual relevance to the learner. It places responsibility on individual learners to find a path through sources of knowledge and to manage the objectives of their learning. Crowd learning encourages people to be active in setting personal objectives, seeking resources, and recording achievements. It can also develop the skills needed for lifelong learning, such as self-motivation and reflection on performance. The challenge is to provide learners with ways to manage their learning and offer valuable contributions to others.

6 **Digital scholarship:** Digital scholarship refers to those changes in scholarly practice made possible by digital and networked technologies: open access publishing, open science, digital humanities, the use of social media by academics, digital and citizen science. In the information and library sciences, a focus on digital curation reflects an interest in the ability of scholars to assemble, search across and publish annotated collections of interconnected multimedia artefacts. Digital scholarship demonstrates many elements of open and networked forms of scholarship. Open-access publishing and open peer review enable sharing of knowledge. Open publishing of research datasets supports reproducible research. Engagement in open educational practices has the potential to support moves towards a more free and collegiate teaching practice.

7 **Geo-learning:** Sensors built into mobile devices, such as smartphones and tablets, can determine a user's location and provide, or trigger, context-aware educational resources in the surrounding environment. These can enable both formal and informal

learning within physical 'real-world' settings. They may also enhance and frame the subject matter being studied. For example, learning about an historical event could be situated in the place where that event occurred, giving a rich sensory experience of being in the scene. Fieldwork activities have long encompassed 'geo-learning' as a way of providing information that exploits the surroundings and landscape. Geo-learning is not new, however technologies sensitive to location, or embedded in objects near the learner, now allow greater mixing of digital information with the physical world, to produce 'blended spaces'. We need to consider carefully how we employ these opportunities for learning. Current theories are somewhat limited, but several approaches, including research into learning spaces, provide ways to model the richness of these environments and our interactions within them.

8 **Learning from gaming:** There is increasing interest in the connections between games and education. When implemented as 'edutainment' or 'gamification' of learning, teaching practices can gain superficial elements of entertainment and reward. This may encourage learners to continue, however misses the power of digital games for engagement, reflection and self-regulation. New approaches of 'intrinsic integration' are linking the motivational elements of games with specific learning activities and outcomes, so that the game-play is both engaging and educationally effective. Game designers can achieve this by developing games with elements of challenge, personal control, fantasy, and curiosity that match the pedagogy. They can manipulate aspects of 'flow' (a player's feeling of absorption in the game) and strategy to produce a productive cycle of engagement and reflection. The shared endeavours, goals and practices in games also help build affinity groups gathering learners into productive and self-organising communities.

9 **Maker culture:** Maker culture encourages informal, shared social learning focused on the construction of artefacts ranging from robots and 3D-printed models to clothing and more traditional handicrafts. Maker culture emphasises experimentation, innovation, and the testing of theory through practical, self-directed tasks. It is characterised by playful learning and encourages both the acceptance of risk taking (learning by making mistakes) and rapid iterative development. Feedback is provided through immediate testing, personal reflection, and peer validation. Learning is supported via informal mentoring and progression through a community of practice. Its popularity has increased due to the recent proliferation of affordable computing hardware and 3D printers, and available open-source software. Critics argue it is simply a rebranding of traditional hobby pursuits. Proponents contend that recent evolutions in networking technologies and hardware have enabled wider dissemination and sharing of ideas for maker learning, underpinned by a powerful pedagogy that emphasises learning through social making.

10 **Citizen inquiry:** Citizen inquiry refers to mass participation of members of the public in structured investigations. It fuses the creative knowledge building of inquiry learning with the mass collaborative participation exemplified by citizen science, changing the consumer relationship that most people have with research to one of active engagement. The concept is that people who are not research professionals engage in collaborative, inquiry-based projects. For each investigation, they gather evidence of similar successful projects, create a plan of action, carry out a controlled intervention if appropriate, collect data using desktop and mobile technologies as research tools, and validate and share findings. Citizen inquiry not only engages people in personally meaningful inquiry, it can also offer the potential to examine complex dynamic problems, such as mapping the effects of climate change, by means of thousands of people collecting and sharing local data.

Introduction

Last year, we launched a series of reports on innovations in teaching, learning and assessment. The Innovating Pedagogy reports are intended for teachers, policy makers, academics and anyone interested in how education may change over the next ten years. In this 2013 report we revisit four themes from last year and introduce six new pedagogies that are garnering interest or appearing on the horizon.

We had no doubt last year that massive open online courses (MOOCs) should be included as a theme and we indicated that the MOOC was "gaining currency". That was an understatement. The New York Times dubbed 2012 "The Year of the MOOC" and the topic has attracted worldwide publicity. New MOOC providers and platforms have emerged, including FutureLearn in the UK, iversity in Germany, OpenLearning in Australia and Miríada X in Spain. The proposition of free online courses has spread to both high school education and workplace training.

MOOCs have entered the arena of venture capital and mass marketing. In relation to the Gartner Hype Cycle, they are climbing the "peak of inflated expectations". Previous educational innovations have followed a route of over-inflated expectations, followed by disillusionment and eventual small-scale productivity. These innovations included educational television in the 1960s, language labs in the 1970s, computer-based instruction in the 1980s, integrated learning systems in the 1990s and virtual worlds for learning in the 2000s. What characterises each of these innovations is an early focus on how the revolutionary technology will transform education, followed by frustration when trying to make the technology support learning and teaching and then a long period of embedding the system into conventional education.

Gartner Hype Cycle

Formal education – whether at school, college or university level – is a super-stable system, with an interlocking set of conventions for teaching, curriculum development, recruitment, examination and accreditation that resist external change. Adding a major new innovation might disrupt the system and cause unpredictable changes, as happened with the innovation of automated trading in investment banking. More likely, it will just be absorbed. Will MOOCs cause major disruption to education? Probably not, based on past experience.

But the innovations described in this report are not technologies looking for an application in formal education. They are new ways of teaching, learning and assessment. If they are to succeed, they need to complement formal education, rather than trying to replace it.

Complementing education should not mean fossilising it. For the past 20 years, the UK Government has collected analytic data on attainment, progress and absence in England's schools. The league tables of schools, printed in national newspapers, influence decisions by parents about where to live and which schools to

choose for their children. School league tables are an example of the use of 'big data' analytics to preserve the systems of education – pushing affluent parents towards top-rated schools and traditional subjects. The analytics for learning described in this report serve a different purpose. By revealing the patterns of learning from individuals, groups and institutions, learning analytics provide continual opportunities for action, indicating ways to enhance learning and improve teaching. By bringing together MOOCs (as massive test beds for experiment outside traditional education) and learning analytics (as the means to provide dynamic evidence of the effectiveness of different teaching and learning methods) there is an opportunity for rapid, evidence-informed innovation on a grand scale.

The other innovations we describe do not have such immediate grand ambitions. They re-conceive and extend learning for an age of mobile connectivity or, in the case of maker learning, try to bring back the joy of craftwork with the help of new digital tools. They are all being explored in projects around the world, but have not yet found widespread application. None is likely to become an international media phenomenon, but together they indicate a new educational landscape that employs methods from computer gaming and social networking to support a flow of learning across locations, technologies, social interactions, and contexts. From children engaged in outdoor science explorations to engineers receiving training on the job, powerful learning comes from new ways in which activity in a particular physical and social context can be reflected upon, carried forward and shared, with the assistance of personal technologies.

As last year, this report has been written by a small group of academics in the Institute of Educational Technology and the Faculty of Mathematics, Computing and Technology at The Open University. It is based on our knowledge acquired from leading research projects, reading and writing educational research papers and blogs, holding conversations with colleagues worldwide, and surveying published and unpublished literature. We compiled the report by first producing a long list of new educational terms, theories, and practices, then paring these down to ten that have the potential to provoke major shifts in educational practice. Lastly, we drew on published and unpublished writings to compile ten sketches of new pedagogies that might transform education. We acknowledge inspiration from the NMC Horizon Report as well as other future-gazing reports on education. Those explore how innovations in technology might influence education; we examine how innovations in pedagogy might be enacted in an age of personal and networked technology.

One hundred years ago, in July 1913, Thomas Edison was quoted as saying, "Books will soon be obsolete in the public schools. … It is possible to teach every branch of human knowledge with the motion picture. Our school system will be completely changed inside of ten years." A century later, children continue to read books in school. Substitute the word 'tablet computer', 'netbook' or 'smartphone' for 'motion picture' and it would be hard to predict whether these technologies will completely change schools in five, ten, twenty years, or ever.

But, in the same newspaper article, Edison also referred to a new way of learning "through the eye", whereby children come to understand scientific concepts by viewing pictures in motion, "making the scientific truths, difficult to understand from text books, plain and clear to children." Learning from short animated movies is still a hot topic of research and is being integrated into game-based learning. New interactive software apps such as an animated periodic table and a virtual planetarium offer ways to learn "through the eye" that would have delighted Edison. The technologies may change, but the innovations in pedagogy bring lasting benefit.

> "technologies may change, but the innovations in pedagogy bring lasting benefit"

Resources

Description of the Gartner Hype Cycle:
http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp

Pappano, L. (2 Nov 2012), The year of the MOOC, The New York Times
http://www.nytimes.com/2012/11/04/education/edlife/massive-open-online-courses-are-multiplying-at-a-rapid-pace.html?pagewanted=all&_r=0

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Smith, F.J. (9 July 1913), The evolution of the motion picture: VI – looking into the future with Thomas A Edison, *The New York Dramatic Mirror*, p24, col 3, New York (Old Fulton).
http://bit.ly/15Ooux3

MOOCs

Massive open online courses

Potential impact: large

Timescale: short (1-2 years)

State of MOOCs

Availability, interest and expectations of massive open online courses (MOOCs) have all increased substantially over the last year. In this update we look at the range of MOOCs that is now emerging, the evolution that is taking place in MOOCs and those who are providing them, the meanings that they have for their learners, and the direction that we expect them to take in the coming year.

The description of MOOCs in our 2012 report as "open-access online courses that provide no constraints on class size" continues to apply, although examples have expanded to challenge more precise interpretation. We are now faced with MOOCs that you can pay for, MOOCs that are fairly small (niche MOOCs or NOOCs), and MOOCs that employ a range of different pedagogies. MOOCs can claim a special status at the moment in innovating pedagogy: they bring together other innovations such as badges, mobile learning and learning analytics. MOOCs can provide a laboratory for innovation and reflect a move away from the previously stable assumptions of education as paid-for direct contact tuition, towards adoption of free and online approaches. This could be education catching up with other sectors in which online activity has shown the power to transform (such as music, banking and gaming) or it could be a temporary evaluation and examination of the new approach, prior to a reinforcement of traditional higher education.

"MOOCs can claim a special status at the moment in innovating pedagogy: they bring together other innovations"

Pedagogy of MOOCs

While it is important to remember the more radical design ideas of connectivist MOOCs, the format of MOOCS for most users is represented by Udacity, edX, and especially Coursera. From these providers a typical course will: have a strong relationship with an originating course that could have been taken face-to-face, be organised around specific time periods that are usually a few weeks long, be adjusted for online access with short videos and quiz-type assessment, and have some peer support through online discussions focussed on question and answer. Assessment varies depending on the type of course and may include automated evaluation of programmes or peer assessment. The timing and the links to assessment reinforce the relationship to more formal courses and help to distinguish these online courses from open educational resources.

Pedagogically, this format offers both an assessment driver (which may be required by those who want to earn the reward of a certificate that confirms or validates their achievement) and an entertaining content driver, based on measured release and sequencing of content. Short high quality video and audio that can be played at double speed, with embedded reflective questions,

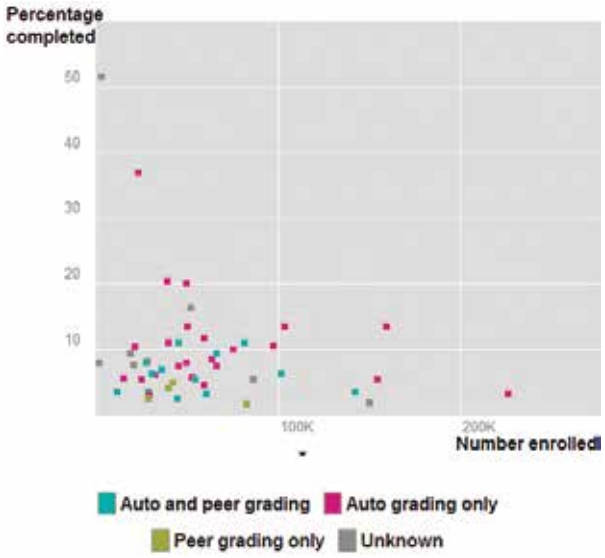
and pause and replay, offer an attractive alternative to the mainstream lecture. They fit with a 'flipped classroom' concept in which learners choose where and when to engage with teaching content provided online, and the course's human contact is focused on problems that need to be solved, and on building connections between people and knowledge.

Evidence from the demographics of those who take MOOCs indicates that the approach works for people who can cope with the challenge, but not necessarily for those who need support. Current MOOC design offers a good route for professional development, leisure learning and the study of courses alongside formal learning. These are all areas where there is both a need and a lack of funded provision for individuals, but ways need to be found to support less experienced students and those lacking confidence.

Pedagogies that could benefit such learners are missing from much of the first wave of massive courses. These pedagogies include materials designed to provide an integrated learning experience, feedback that is customised to meet learner needs, and direct mentoring of learners in difficulties. Some of these are hard to supply in a cost-free model. Social learning and peer support may provide alternative ways of generating some of the feedback that is needed. MOOCs are evolving. If that evolution is directed towards improving support for the less experienced, then new structures that enable support are likely to emerge. On the other hand, if business reasons make other elements of the market, such as professional development, a more attractive target for current providers, then alternative ways need to be found if the MOOC model is to meet the worldwide demand for education.

Retention and meeting learner needs

An area in which MOOCs have been challenged is retention. Collecting and combining the raw data shows that fewer than 10% of people who register on a MOOC complete the course. Measuring the fall-off from initial registration is simple but could be misleading. Similar trends for open educational resources show, not surprisingly, that viewing is far higher than engagement and that there are different types of participant, including the viewer, the volunteer student, and the social learner.



Graphic showing completion rates against enrolment rates for MOOCs with different types of grading method

What do MOOCs achieve?

The issue of where MOOCs are going is perhaps less important in the short term than how they are shaping expectations from individuals, organisations and governments that they should meet the growing need for education and learning. In that case they clearly do have a role. MOOCs can be considered in terms of the challenges that they help to address:

1. Deliver development needs for lifelong learning amongst those already educated but in need of additional professional development.
2. Enable current education providers to improve quality, collaboration and price for their students.
3. Attract into education those who are already considering it and introduce them to particular approaches and providers.
4. Extend public awareness of education through fun and enjoyment and help shape rewarding experiences for those who remain outside formal education.
5. Build a path into education for those who are currently unable to meet requirements or who lack confidence.

On current evidence, challenge 1 is being addressed, 2 and 3 partly but not directly, 4 is a possibility and 5 is a major challenge that may require a different approach.

Resources

Coursera:
https://www.coursera.org

EdX:
https://www.edx.org

FutureLearn:
http://futurelearn.com

Udacity:
https://www.udacity.com

Glance, D.G., Forsey, M. and Riley, M. (2013). The pedagogical foundations of massive open online courses, *First Monday* [online]. http://firstmonday.org/ojs/index.php/fm/article/view/4350/3673

Godwin, S. & McAndrew, P. (2008). Exploring user types and what users seek in an open content based educational resource. In J. Luca & E. Weippl (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2008*, pp. 3711-3718. Chesapeake, VA: AACE. http://oro.open.ac.uk/27399/

Koller, D.; Ng, A.; Do, C. and Chen, Z. (2013). Retention and intention in massive open online courses: in depth, *Educause Review* [online]. http://www.educause.edu/ero/article/retention-and-intention-massive-open-online-courses-depth-0

Badges to accredit learning

Open framework for gaining recognition of skills and achievements

Potential impact: high

Timescale: medium (2-5 years)

From consumer protection schemes to trade associations, badges are used as quality marks that can demonstrate the provenance of a particular item, reward success, or indicate membership of a professional body or approved trade association. In education, badges reward a learner for achieving a set level of knowledge of a topic or a standard of behaviour. Badges may also be used to show that a learner has participated in, or successfully completed, a course or has demonstrated a particular level of competency in an activity or skill.

In 2013, there are encouraging signs that the tools and infrastructure for awarding badges in online environments are improving, with implementations appearing for mainstream learning environments such as Moodle. The emergence of a possible standard, in the form of the Mozilla Open Badge framework, provides a system in which secure individual 'backpacks' display badges from known issuers on sites or accounts that are under the control of learners. With a model in place that guarantees a learner the legitimate right to display a badge awarded by a particular provider, the focus of attention shifts to the quality processes adopted by the badge issuers, and the conditions under which they award badges. Currently, issuers are free to award badges as they see fit. Learners' own willingness to display badges may also affect the perceived value of badges as micro-credentials. Indiscriminately displaying badges for insignificant achievements from low quality issuers reduces the value of the badge backpack as a statement of achievement, much as including meaningless achievements would reduce the value of a curriculum vitae (CV).

Using appropriate metadata associated with a badge to describe its subject and topic, provides potential to customise the delivery of learning content based on the learner's disclosed achievements. In automated learning systems, this could also unlock courses or learning activities that have pre-requisites mapped onto particular badges.

Badges from the Open Learning Design Studio MOOC indicating progress through the course and status within the community

Informal education providers are making increasing use of badges. For example, museums such as the Dallas Museum of Art use badges to allow visitors to keep track of their engagement with special exhibitions, as well as to cross-promote physical and online visits.

Badges are also used by informal learning websites to drive engagement by unlocking increased privileges based on increasing reputation and badge attainment. The Stack Exchange question-and-answer site uses its system of tracking the involvement and reputation of users both to drive the award of badges and to unlock privileges associated with the operation of the site. Privileges include the ability to edit other people's questions in order to improve them, to create new metadata tags to label questions and answers, or to act as a moderator.

> "badges provide a way to recognise achievement within MOOCs as well as driving engagement with them"

As a lightweight and trusted mechanism, badges provide a way of recognising achievement within MOOCs as well as driving engagement with them. They may indicate the expertise of a student in a particular role or topic and so assist other students to find relevant and reputable helpers. They can also indicate a student's profile of skills to colleagues and employers.

Resources

Mozilla OpenBadges, 'Get recognition for skills you learn anywhere':
http://openbadges.org/

Open Learning Design Studio badges
http://www.olds.ac.uk/badges

Stack Exchange:
http://stackexchange.com/

Rodley, E. (2012). Museums and digital badging (18 Dec 2012). *Center for the Future of Museums Blog*.
http://futureofmuseums.blogspot.co.uk/2012/12/museums-and-digital-badging.html.

Learning analytics

Data-driven analysis of learning activities and environments

Potential impact: medium/high

Timescale: medium (2-5 years)

Learning analytics involve the collection, analysis and reporting of large datasets relating to learners and their contexts. The purpose is to improve learning and the environments in which learning takes place. Analytics enable visualisations and recommendations designed to influence student behaviour while a course is in progress. Current developments are focused on three areas: understanding the scope and uses of learning analytics; integrating analytics into existing courses; and expansion of learning analytics to new areas, particularly MOOCs.

Scope and uses

Virtual learning environments (VLEs), learning management systems (LMSs) and MOOCs make it increasingly easy to collect data about learners and their activities. It is now relatively straightforward to develop data-driven analytics, based on activities that can easily be quantified and counted, such as the distribution of scores for each piece of online assessment. The challenge is to develop analytics that start with questions, not data. What problems could analytics help to solve? What will learners and educators gain? How will the analytics support positive change? These fundamental questions do not emerge from the data. Instead, they stem from models of teaching and learning, from conceptions of knowledge, of how learning takes place and what can be counted as success.

Today, the links between learning design and learning analytics are increasingly evident. In order to understand how students are progressing, it is necessary to be aware of their learning outcomes and objectives. Educators at Carnegie Mellon University in the USA are currently using a learning dashboard to identify where students are struggling, which skills they are practising, and which misconceptions they have displayed. The dashboard is underpinned by a design that identifies the skills and knowledge covered by the course, allowing the use of analytics that can provide students with feedback, recommendations and material for reflection.

A recent review by Dyckhoff and her colleagues provides a summary of the rationales behind key learning analytics tools. These possible uses provide a basis for discussion about analytics and the questions they can help answer.

Educators can use learning analytics to:

- monitor the learning process
- explore student data
- identify problems
- discover patterns
- find early indicators for success, poor marks or drop-out
- assess usefulness of learning materials
- increase awareness, reflect and self-reflect
- increase understanding of learning environments
- intervene, supervise, advise and assist, and
- improve teaching, resources and the environment.

Learners can use learning analytics to:

- monitor their own activities, interactions and learning process
- compare their activity with that of others
- increase awareness, reflect and self-reflect
- improve discussion participation, learning behaviour and performance
- become better learners, and
- learn.

An important element when developing analytics is timescale. Most current analytics focus on data about the past, reporting what has happened. Other analytics link the present situation with a predicted future; using forecasts and predictive modelling to identify indicators of success, failure or student drop out. A preferable approach, linking learning analytics and learning design, will be the use of analytics to support educators and learners to produce a desired future result.

Integration into existing courses

Putting the infrastructure and frameworks in place for learning analytics is increasingly important because institutions are currently beginning to implement analytics at a large scale. Carnegie Mellon, as noted above, is one example of this shift. In New Zealand, the University of Canterbury is developing institution-wide accountability for the recruitment, admission, retention and success of students. Lecturers are encouraged to become familiar with the LearnTrak software at the university, so that they can become part of an early intervention process. Meanwhile, at The Open University in the UK, 'data wranglers' are working with each faculty of the university to present analytics in clear and actionable ways, and to understand the needs and context of both educators and learners.

Currently under development are social learning analytics, including tools to help people develop ideas together through discussion and writing. There is increasing interest in the collection of data from the physical environment, including gestures and both eye tracking and sensor data. This information can be used to monitor attention, engagement and emotional state. There is also a growth of research into the development of learner and teacher dashboards capable of fostering awareness of, and reflection on, learning processes. This is linked with work produced in collaboration with teachers, focused specifically on support for educators.

Expansion to new areas

In order to use analytics in support of learning, institutions need to collect and curate large amounts of data. Such data stores are potentially huge, covering multiple institutions. The inBloom project, funded by the Gates Foundation, aims to personalise school education in the USA by providing tools and services to visualise and aggregate student data. The project already stores data from Student Information Systems, testing vendors, and other sources in nine States.

Also in the USA, the STEMscopes online science curriculum is currently producing visualisations that reflect the activity of 50,000 teachers and over a million students. The aim is to produce analytics that are not only grounded in pedagogy but that can also incorporate experiences such as student inquiry and hands-on experiences that are not currently captured in the digital record. Work on the project so far has underlined the importance of understanding context, and of involving teachers in the process of developing and deploying analytics.

Visualisation of student data from inBloom

Large-scale stores like this will require institutions to protect data against unauthorised access and to develop a comprehensive data governance structure. In the past, university data policies have presented students as recipients of data services. Future data policies will need to involve learners in the processes of developing and acting on analytics, will need to allow them a say in how they are labelled, and will need to make clear the responsibilities everyone involved has for providing accurate data and for acting on recommendations. It may be necessary to set up learning and teaching ethics committees alongside pre-existing research ethics committees, in order to safeguard educators and learners from issues such as mislabelling, misleading analytics and pressure to share sensitive data.

Conclusions

A year ago, Innovating Pedagogy 2012 predicted that time to impact for learning analytics would be two to five years. This still seems a reasonable estimate, as institutions in many countries gear up to collect, store and process data, and researchers work on ways of analysing that data. The timescale seems set to be longer in areas where students do not have reliable and regular access to online resources. The importance of involving educators and learners in the learning analytics process is becoming increasingly clear. Their involvement is key to understanding local context and to the development of analytics that can make use of data to support learners, rather than using learners to provide data. The potential is emerging for a virtuous circle, where inquiry into the learning process feeds into learning design, which motivates learning analytics, which motivate future inquiry and thus the refinement of the design and analytics.

> “a virtuous circle, where inquiry into the learning process feeds into learning design, which motivates learning analytics”

Resources

inBloom:
https://www.inbloom.org/

Learning Analytics Summer Institutes (LASI Local) – links to a week of online and face-to-face events around the world:
http://www.solaresearch.org/events/lasi/lasi-local

MOOC analytics at Stanford:
http://news.stanford.edu/news/2013/april/online-learning-analytics-041113

SoLAR Community Evidence Hub, set up for the learning analytics community to pool issues and ideas, debate different kinds of evidence, and map people, projects and organisations:
http://solar.evidence-hub.net

Southern SoLAR Flare learning analytics event held in Sydney, Australia – overview:
http://salexanderlak.blogspot.co.uk/

STEMscopes:
http://stemscopes.com/

UK SoLAR Flare learning analytics event – an overview of work presented:
http://dougclow.org/2012/11/19/solar-flare-uk-morning-presentations/

Slides and presentations from the event
http://www.solaresearch.org/flare/solar-flare-uk/

Relevant papers from the Third International Learning Analytics & Knowledge Conference (LAK13) include the following:

- Dyckhoff, A. L., Lukarov, V., Muslim, A., Chatti, M. A., & Schroeder, U. Supporting Action Research with Learning Analytics.
- Prinsloo, P. & Slade, S. An Evaluation of Policy Frameworks for Addressing Ethical Considerations in Learning Analytics.
- Suthers, D., & Verbert, K. Learning Analytics as a ‘Middle Space’

Access to LAK conference proceedings is restricted. Conference liveblogs:
http://dougclow.org/lak13-liveblogs/

Tull, S. (2012). On Trak: first steps in learning analytics, *Educause Review* (online)
http://www.educause.edu/ero/article/trak-first-steps-learning-analytics

Seamless learning

Connecting learning across settings, technologies and activities

Potential impact: medium/high

Timescale: medium (2-5 years)

Seamless learning (connecting learning experiences across locations, times, technologies or social settings) is emerging from research projects and moving towards mainstream adoption. Mobile technologies are enabling learning to continue across contexts, so a piece of work started in the classroom can be continued at home; and ideas that occur on the move can be shared with colleagues online, then followed up in person.

In Innovating Pedagogy 2012, we suggested that institutions can encourage students to see themselves as continuous learners. For the learner, there are clear benefits to maintaining a flow of learning. Topics can be continued from place to another, notes can be made whenever a thought occurs, ideas can be shared with people wherever they are. Seamless learning can also make good use of learners' environments, with the rich world outside the classroom providing a resource for exploration and meaning making, and the classroom offering a space for reflection and the synthesis of knowledge. Connecting these provides a driver for learning, so that learners explore themes from the classroom in their homes or outdoors and use their life experiences to enrich classroom lessons.

Pedagogy of seamless learning

Some schools now allow pupils to 'bring your own device' (BYOD), or to take home tablets or laptops provided by the institution. Pedagogy is emerging whereby the teacher discusses a problem or challenge in class, then sets pupils to collect data or build understanding at home, discuss their data in a classroom group, and present shared findings to the class. For example, as part of a project on healthy eating, a teacher might ask each child to take photos of meals over two days. The children use an application on a smartphone or tablet to log the contents of each meal (e.g. 'pepperoni pizza', 'apple juice') and the software produces a bar chart showing their nutritional intake for the day, compared to the recommended nutrients for children of their age. Back in class, the children can compare data and create group presentations of their shared results. Building on this approach, the SEAMLESS study in Singapore and its successor WE Learn have developed a 'mobilised curriculum' for seamless learning with mobile devices.

There is now greater potential to incorporate the surrounding environment within seamless learning, employing mobile devices as scientific toolkits to collect environmental data, record interviews, conduct surveys, take measurements, and log findings. As an example, a smartphone can be used as a sighting device, with its tilt sensor recording the angle from the ground to the top of a tree or building in order to measure its height through the application of basic trigonometry. Just as some people create social networks through Twitter feeds or Facebook postings, so they can create human-computer networks of their interactions with the surrounding world.

> "learners explore themes from the classroom in their homes or outdoors and use their life experiences to enrich classroom lessons"

Lifelogging

Human memory has an episodic component that captures a sequence of events, and a semantic component that is used to build abstract knowledge. Wearable 'lifelogging' devices such as Google Glass (miniature cameras and sound recorders) can make these aspects of human memory external, by allowing people to capture the flow of everyday life as they see or hear it and link these experiences to resources such as web pages or information sources. How, then, do we create 'teachable moments' from this technology-supported flow of experience, so that incidents in daily life become resources for learning, and people can create links not only to external resources but also to other related and personally meaningful moments?

An educational technology challenge is to support learners in a process of situated meaning making, by providing appropriate resources and tools whenever they are needed, allowing a learning activity to be suspended and resumed, enabling learning activities to be interwoven, harnessing the power of everyday social interaction so that people can create composite lifelogs of shared events, and learners are able to 'scroll back' in time to recall previous activities and outcomes.

Google Glass lifelogging technology

Alongside the challenges of developing personalised technology for seamless learning, there are ethical and social issues concerning which experiences should be shared and whether we should move towards a world where we record the entire flow of experience. A broader notion of seamless learning is emerging, involving implicit shaping by experience. Our activities online are increasingly matched to our interests, so search pages order their responses based on previous queries and websites recommend content that relates to our past choices. This personalised 'me-shaped world' is a form of seamless learning by induction: we come to see the world as constructed around our interactions with it. The benefit is that relevant information may always be ready to hand, but the danger is that this prevents us from seeing alternative perspectives. We may come to believe that our experiences, views, preferences and connections are not just the most relevant, but all there is. Alongside the challenge of creating seamless learning is the related challenge of creating seams in the flow of learning experience, spaces to stop and reflect, spot the gaps in our understanding, take into account the perspectives of others, and gain genuinely new experience.

Conclusions

One indication of the success of seamless learning is that it is no longer regarded as a topic for discussion – children and adults continue to extend their personal technologies for learning across times and locations, until the learning blends with everyday life. The more powerful and pervasive such learning becomes, the more it needs to be integrated with formal education in schools, colleges and workplaces, and the greater the danger of it only reinforcing familiar ways of thinking and acting. Seamless learning could become a highly efficient method of information storage and retrieval. What is needed is a means of interpreting that information as useful knowledge, and exploiting it as wise and purposeful action.

Resources

Lee, M. L., & Dey, A. K. (2008). Wearable experience capture for episodic memory support. In *Wearable Computers, 2008. ISWC 2008. 12th IEEE International Symposium on Wearable Computers* (pp. 107-108). http://www.cs.cmu.edu/~mllee/docs/iswc142-Lee.pdf

Rawassizadeh, R. (2012). Towards sharing life-log information with society. *Behaviour and Information Technology*. 31(11), 1057-1067.

Toh, Y., So, H-Y., Seow, P., Chen, W., & Looi, C-K. (2012). Seamless learning in the mobile age: a theoretical and methodological discussion on using cooperative inquiry to study digital kids on-the-move. *Learning, Media and Technology*. Published online. DOI:10.1080/17439884.2012.666250.

Crowd learning

Harnessing the knowledge of many people

Potential impact: high

Timescale: medium

Crowd learning involves harnessing the knowledge and expertise of many people in order to answer questions or address immediate problems. When carried out successfully, it enables learners to gain information related to what they want to know, at the time when they want to know it. In a world where learning occurs around the clock, involving a wide diversity of places and devices, the facility to find timely, appropriate information is not only convenient, but also taken for granted. We expect to be able to view the profile of someone we are about to meet for the first time, locate the instruction manual for equipment we are using, identify music that is playing nearby, and learn about the art and buildings at a heritage site we are visiting.

Crowd control

As people gain more opportunities to learn when and where they wish, it becomes more complex for them to manage that learning. Making learners independent and able to control their learning paths has the potential to bring major benefits. The first is scale; many people can share and contribute to the learning, blurring the distinctions between teachers and learners.

The Stack Exchange website is a network of communities, each supporting experts in a specific field. It started as a site for expert computer programmers, but has now expanded to include people with expertise that ranges from mathematics to bicycles, from science fiction to photography. The culture of Stack Exchange sites is based on people asking questions, indicating the kind of answer they expect, and giving a summary of what they have already tried in order to address the problem. This invites respondents to provide an answer in a way that is sympathetic to the learning needs of the questioner. By allowing experts and more knowledgeable participants to provide multiple answers to questions, different ways of addressing a problem can be explored. This invites further critique and discussion of which answer is most appropriate and why. Sometimes, answers take the form of coaching, with long tutorials around the question being answered.

The open nature of Stack Exchange sites, and the mixed vocabulary they employ (everyday language in a question statement; expert terminology in the answers), combine to provide a powerful recipe not only for answering an immediate question, but also for supporting others in their search for knowledge and answers. The reward scheme provided by Stack Exchange uses reputation and badges to support personal development based on particular patterns of activity by the site user, both as asker and as responder.

At a less expert level, Lingobee is a project designed to engage international students in the process of improving their language vocabulary by encouraging learners or native speakers to add a word, a definition and a picture of a colloquial or unusual word (such as the English phrase ‘modesty board’: “a board fixed to the front of desk to hide a person’s legs and feet from view”).

iSpot mobile app

The iSpot service combines novice and expert crowd learning, by enabling anyone to take a photograph of a living organism, such as a flower or insect, and upload it with relevant information and a provisional identification. Others on the site either confirm and extend the identification or propose an alternative. A sophisticated method of reputation management promotes people who have contributed agreed identifications, rewarding them with virtual badges.

Other crowd-sourced learning sites include the Forvo online guide to pronouncing words and phrases in 306 languages, powered by recorded contributions from users, and the PeerWise free online learning tool that allows students to design multiple-choice questions related to their course for their classmates.

Personal Ownership

A second benefit of crowd learning is that it can transfer ownership of the learning process to the learner. If this is achieved in a manageable way, then setting personal objectives and judging one's own learning outcomes help to shape and integrate learning and reflection.

Learning in a formal setting has in recent times been designed on an assumption of compliance: learners have a curriculum set out for them, a set of tasks to undertake, materials to support those tasks, and assessment to check and validate that they learned what was intended. The internet provides many resources that can provide a distraction from formal education and a challenge to any scheme of compliance. Adopting a more independent approach has the potential to liberate learning, but will also require tools and mechanisms to guide learners towards valuable and appropriate materials, recognise their progress, and reward valued contributions. Crowd-sourced information sites such as Wikipedia and Trip Advisor have been criticised for lacking the authority and scholarly provenance of traditional encyclopaedias and reference guides. But that misses the point. These sites rely on the 'wisdom of the crowd' to produce continual updates and revisions, and they may offer a more personal and local perspective than centrally published media.

As learners engage with a variety of media with different structures and formats, the onus is on them to filter, record and reflect on their personal learning journeys. Online learning records, also known as eportfolios, have had a more limited impact on learning than was expected, despite some success in large organisations such as the UK's National Health Service. Eportfolio systems are designed to blend learner-owned content with institutional endorsement, in order to provide a system that can meet the needs of both individuals and institutions. In practice, many learners have found the systems too time consuming and employers have struggled to wade through the online documents and validate the information.

PebblePad is described as a "Personal Learning Space" that is "much more than an eportfolio". It helps learners to create records of achievement as well as providing them with ways to reflect on performance and achievement. Extending the record of achievement, degreed.com offers a flexible way to record formal education alongside informal experiences ranging from studying with MOOCs to watching YouTube videos. Degreed encourages learners to set personal goals, such as 'read at least five articles a day, watch three learning videos and read one book', following the powerful pedagogic approach of encouraging learners to propose and exceed their individual goals.

Just-in-time

With a wealth of material and multiple ways in which to progress, a central issue for the learner is how to find what is important, just when it is needed. This could either involve searching previously seen material, or finding new information in order to solve an immediate problem. To do this, the learner needs to recognise a need, articulate it in a way that will help the search, search for appropriate recollections or resources, interpret these in the context of the immediate need, and perhaps store or share them to reflect on or discuss later. All these higher-level skills need to be learned.

Educator's role

The role for the educator in a system of crowd-sourced and self-directed learning is to indicate what resources are available, help learners to diagnose their needs, and support a variety of study methods. The learners may then need tools – such as notepads, bookmarks, timelines and concept maps – to manage their own learning as they set goals and track what they have achieved.

The paths that learners take are becoming more complex in both formal and informal settings. For formal qualifications there has been a move from the classic model, which involves learners attending a single institution for a fixed period of time, towards a more part time and blended approach. Data from the US show more than 70% of post-secondary students do not fit this model. Crowd learning may be an important way of supplementing their studies.

Conclusions

Crowd learning provides a way to learn easily, at little personal cost. We can quickly find answers to immediate needs. These answers will generally be reasonably accurate, due to the collective effort of many people to produce and improve materials. But this requires a smaller group of people to be active contributors; not all resources are equally reliable, particularly in new and rapidly developing areas, and some questions cannot be formulated as simple queries.

Resources

Degreed:
http://degreed.com

Forvo:
http://www.forvo.com/

iSpot:
http://www.ispot.org.uk/

Lingobee:
http://itrg.brighton.ac.uk/simola.org/#lingobee

PebblePad:
http://www.pebblepad.co.uk/

PeerWise:
http://peerwise.cs.auckland.ac.nz/

E-portfolios overview:
http://www.jisc.ac.uk/whatwedo/programmes/elearning/eportfolios.aspx

Influences on learning outcomes, an overview that includes personal goal setting ("There is strong evidence that challenging, achievable goals influence achievement, provided the individual is involved in setting them"):
http://growthmindseteaz.org/files/Visible_Learning_Collingwood_23.11.09.ppt

Goodyear, P. & Ellis, R.A. (2008). University students' approaches to learning: rethinking the place of technology, *Distance Education*, 29(2), 141–152.

Pepicello, W. (2012). University of Phoenix. In D.G. Oblinger (ed.), *Game Changers: Education and Information Technologies*. Educause, pp. 133–144.

Preece, J. and Shneiderman, B. (2009). The Reader-to-Leader Framework: Motivating Technology-Mediated Social Participation. *AIS Transactions on Human Computer Interaction*, 1(1), 13-32.

Digital scholarship

Scholarly practice through networked technologies

Potential impact: medium/high

Timescale: short

Digital scholarship can be defined in its broadest sense as changes in scholarly practice brought about by the use of digital and networked technologies. There are, however, alternative interpretations of the term. For instance, in information and library sciences, the emphasis is more on digital curation. Taking a broad perspective, digital scholarship can be viewed as an umbrella term for many online educational practices. Open access publishing, open science, digital humanities, use of social media by academics, and online conferences and courses can all be considered to be aspects of digital scholarship.

Digital scholarship can be viewed as synonymous with open scholarship, if we take the definition by Veletsianos and Kimmons of open scholarship as being based on three forms: (1) open access and open publishing, (2) open education, including open educational resources and open teaching, and (3) networked participation. The Open Educational Resources (OER) movement is broadening its focus on resources to include associated practices that are related to the production, use and reuse of high quality open educational resources.

Another related term is 'digital literacies', particularly literacies of academics related to online research and open publishing. This term can include developing such skills in school and college learners.

There is thus a set of converging groups and areas of interest around digital scholarship. It is now a term that is used increasingly frequently; the British Library recently appointed a Head of Digital Scholarship.

Current work

It is possible to include almost any use of technology for academic practice under 'current work', given the broad definition of the term. However, there are four inter-related areas that can be seen to represent major aspects of digital scholarship. These are: open access publishing, scholarly use of social networks and digital media, open resources and MOOCs, and network research and pedagogy.

Open-access publishing is the free and wide dissemination of scholarly publications, whether through the 'green route' that involves self archiving, the 'gold route' whereby the author pays the publisher for open access, or through other means such as free journals, institutional repositories, and pre-publication repositories. If one views scholarly publication as a core activity undertaken by researchers, then open access publishing represents a fundamental shift in access to that knowledge.

However, open access has its problems. The UK Finch report advocating gold route fees has been widely criticised for subsidising existing publishers rather than exploring new routes to disseminating knowledge. By contrast, the American Historical Association (AHA) has proposed that new PhD graduates should be given the choice to withhold their dissertations from being posted online by the university library, for up to six years after their completion, to allow these early-career historians time to revise their dissertations and submit them in

book form to publishers. The argument by the AHA is that history is a book-based discipline, so open publication of theses makes it difficult for scholars to persuade publishers to produce printed books when the source material is already available online. This draft policy has sparked a lively debate among historians on the AHA Today blog.

In scholarly use of social networks and digital media, academics extend their peer networks through social networking. This also helps them establish reputations that stand apart from their institution. The use of digital media such as podcasts and video allows alternative forms of dissemination and teaching that bypass traditional media. Open resources and MOOCs extend the sharing of educational resources.

Open resources and MOOCs extend the sharing of educational resources. MOOCs were also covered in Innovating Pedagogy 2012 and their description has been updated in this report.

While the previous three areas represent opportunities afforded by new technologies, there are also new methods of scholarship available. These include using crowd-sourcing and social network analysis methods in research, incorporating analytics into learning design, and adopting networked pedagogies such as connectivism and rhizomatic learning. Approaches such as these, which are available for scholars to use in teaching and research, can be viewed as 'internet-native'. Rhizomatic learning was addressed in Innovating Pedagogy 2012.

> "increased adoption and experimentation with digital scholarship by teachers and researchers help to increase the legitimacy of these approaches"

Future development

Future progress may be closely linked to the development of related topics such as MOOCs. Viewed from a broad perspective of digital scholarship, development can be seen largely in terms of increased legitimacy. For institutions, this may include promotion and tenure practices rewarding profiles of digital scholarship or research agencies including digital scholarship practices within their calls for proposals, insisting upon open access publications and the extension of 'research impact' beyond traditional academic publication. Increased adoption and experimentation with digital scholarship by teachers and researchers help to increase the legitimacy of these approaches, and make reliance on existing practices seem anachronistic. So far, uptake of digital scholarship has been cautious, often held back by conservative practices within institutions and reward structures. It is this area that is likely to see the most significant changes over the next five years, as more individuals adopt digital scholarship practices.

Resources

AHA Today blog entry on embargoing of history PhD dissertations: http://blog.historians.org/2013/07/american-historical-association-statement-on-policies-regarding-the-embargoing-of-completed-history-phd-dissertations/

Digital libraries – see for example: http://cnx.org/content/m14163/latest/

Finch Report: http://www.researchinfonet.org/publish/finch/

Borgman, C. L. (2007). *Scholarship in the Digital Age: Information, Infrastructure, and the Internet*. MIT Press.

Harley D., Acord S., Earl-Novell S., Lawrence S. & King C. (2010). *Assessing the Future Landscape of Scholarly Communication: An Exploration of Faculty Values and Needs in Seven Disciplines*. Center for Studies in Higher Education, UC Berkeley. http://escholarship.org/uc/cshe_fsc

Pearce, N., Weller, M., Scanlon, E., & Kinsley, S. (2010). Digital scholarship considered: How new technologies could transform academic work in education. *In Education*, 16(1). http://www.ineducation.ca/index.php/ineducation/article/view/44

Proctor, R., Williams R and Stewart J. (2010) If you build it, will they come? How researchers perceive and use Web 2.0. *Research Information Network*. http://www.rin.ac.uk/our-work/communicating-and-disseminating-research/use-and-relevance-web-20-researchers

Veletsianos, G., & Kimmons, R. (2012). Assumptions and challenges of open scholarship. *The International Review of Research in Open and Distance Learning*, 13(4), 166-189. http://www.irrodl.org/index.php/irrodl/article/view/1313/2304

Weller, M. (2011). *The Digital Scholar: How Technology Is Transforming Scholarly Practice*. London, UK: Bloomsbury Academic. http://www.bloomsburyacademic.com/view/DigitalScholar_9781849666275/book-ba-9781849666275.xml

Geo-learning

Learning in and about locations

Potential impact: medium

Timescale: medium

Ubiquitous computing is now commonplace in many parts of the world, involving a wide variety of mobile devices including smartphones, netbooks and tablet computers. Many smartphones and tablets can detect a user's location, and software applications that provide context-aware resources and content for both formal and informal learning within physical 'real world' environments are commonly referred to as 'geo-learning apps'.

Blended spaces consist of a physical space, such as the exhibits in a museum, and a digital information space, such as an online museum guide, that together create opportunities for learning. As a visitor walks around the museum, this physical movement creates a path through the associated digital information space, offering opportunities to view and interact with information about the exhibits.

The environment may be natural or artificial, although it can be argued that humans may have heavily shaped even 'natural' environments. It may be as rich in visual aesthetics as a grand building or as relatively poor as an area of seemingly desolate grassland. Locations may be indoors, outdoors or a combination of the two. Nearby resources, including shops, cafés and leisure venues, as well as people in the vicinity and local information such as signposts, street names and tourist information points are also part of this potentially very rich space in which learning can take place.

While geo-learning has long been a core component of field trips, increasing access to networked mobile devices provides more opportunities to mix digital information with the physical world. Combining the two needs careful consideration in order to exploit these opportunities for effective, place-based learning.

Current work

Location-based technology, such as quick response (QR) codes, augmented reality (AR) and global positioning systems (GPS) can provide 'touch points' that link the physical to the digital. QR codes, GPS and other technologies, including ultrasonic positioning, have been used to provide location-based information for tourists and for visitors to museums and zoos. The mScape (mediaScape) platform offered a way of delivering location-based multimedia, via handheld devices that were triggered by the user's GPS position. Although development of this platform has been discontinued, the vision of overlaying digital information on the physical world has been realised in the Situ8 project that allows users to browse geo-located information and upload their own location-tagged data.

Within higher education, the 'Out There, In Here' project supported geo-learning through distributed collaboration. A group of students took part in field-work outdoors and communicated in real time with other students working indoors in a distant laboratory, via a range of technologies including interactive tabletops, large screen displays, tablet computers, and mobile phones. The outdoor students had the advantage of 'being there', while those located indoors had easy access to a variety of information, research, and visualisation tools.

Related pedagogies

To date, there is no unifying theory that explains how we combine the physicality of the environment (including buildings, architectural details, landscapes, viewpoints, visibility of objects and landmarks, and other available resources) with electronic information. However, approaches borrowed from psychology, education, the built environment, geography and human-computer interaction (HCI) can help us understand how it is possible to interact with our surroundings in ways that help us learn effectively.

Situated cognition suggests that knowledge is situated within physical, social and cultural contexts and cannot be separated from these. This theory can help to explain learning in social and cultural environments, although the physical location is often reduced to a single term such as 'classroom', 'lab' or 'field trip'.

The Zapp application identifying a distant landmark

Embodied cognition proposes that movements of the body have a direct influence on the mind and related mental constructs, so that to gain skills in, for example, geology or medicine requires an inseparable blend of physical and mental learning. This perspective emphasises the person as a physical and mental being and does not focus on aspects of learning in the external environment.

Challenges in implementing geo-learning

However rich and compelling our interactions in this environment may be, there are still some potential pitfalls associated with the ways in which we learn with technology in blended spaces. These can be broadly sub-divided into technical, pedagogical and social challenges.

Technical challenges include inaccuracy in detecting or displaying a learner's location, lack or failure of data and phone networks (many technologies require internet access in order to function), and issues relating to cost, maintenance (e.g. flat batteries) and use in adverse weather conditions (bright sunlight or rain make it difficult to see the screen of a handheld device). The novelty effect and limitations of the technology, rather than the teacher or the lesson objectives, may shape what is learned. Learners may also be overwhelmed by a wealth of digital information that is not presented appropriately, resulting in cognitive overload. Social issues include intruding on a person's privacy by knowing their location or tracking their movements.

Future development

We expect blended spaces to become more pervasive, especially given current worldwide investment in 'smart cities'. These large urban areas are becoming more networked and integrated with digital resources, with embedded sensors providing data about utility supply and usage, parking availability, and local facilities. Together with personal human augmentation, achieved through accessories such as smart watches or visual displays like Google Glass as well as wearable sensors that can be incorporated within clothing, our interactions with the physical world are likely to involve navigating through an increasing amount of location-based data in the near future.

Conclusions

Current digital location-based information, relevant to our immediate surroundings, is already abundant, and is mainly used for commerce and tourism. A few projects have used digital handheld devices to support geo-learning effectively. We consider the real challenge to be the effective use of such information to support both formal and informal learning. Effective curation of digital resources, delivered in a contextually appropriate way, is vital in order to provide an engaging and insightful educational experience in blended spaces.

> “increasing access to mobile, networked devices provides more opportunities to mix digital information with the physical world”

Resources

BBC (2013). Mosaic QR codes boost tourism in Rio de Janeiro:
http://www.bbc.co.uk/news/technology-21274863

Google Glass:
http://www.google.com/glass/start/

JISC project on learning spaces:
http://www.jisc.ac.uk/whatwedo/projects/learningspaces08.aspx

mScape website:
http://www.pmstudio.co.uk/project/mscapes

Out There In Here:
http://www.open.ac.uk/blogs/otih

QR codes in museums:
http://www.themobilists.com/2011/08/30/qr-codes-in-museums

Situ8 project:
www.situ8.org

Benyon, D., Mival, O. & Ayan, S. (2012). Designing Blended Spaces. *Proceedings of the 26th BCS Conference on Human Computer Interaction: People & Computers XXVI*, Birmingham, UK, BCS/EWiC.

Sharples, M., Meek, S. & Priestnall, G. (2012) Zapp: Learning about the Distant Landscape. In M. Specht, J. Multisilta & M. Sharples (eds.), *Proceedings of 11th World Conference on Mobile and Contextual Learning (mLearn 2012)*, Helsinki, October 2012, pp. 126-133.
http://oro.open.ac.uk/35303/1/Preprint_Sharples_et_al_mLearn_2012.pdf

Learning from gaming

Exploiting the power of digital games for learning

Potential impact: high

Timescale: medium

During the past decade, interest has developed in the ways in which digital games can be linked with education. With digital games and consoles aimed at every age group, half of all European gamers are now aged over 35, and 25% of Europeans play games every week.

Several factors have combined to increase interest in the connections between games and education. Some of these have well-established roots. The classical notion of 'a healthy mind in a healthy body' has traditionally linked physical games with education, and by the 18th century intellectual games such as chess were also being presented as a means of self-improvement. In the early 20th century, influential educational theorists such as Vygotsky and Piaget drew attention to links between play and learning.

More recently, there have been efforts by gaming companies to move into the lucrative educational market. At the same time, widely reported challenges – for example, the notion that videogames can change children's brains and cause attention and behaviour problems – have provoked the industry to respond by emphasising educational benefits of gaming. The website of the US Entertainment Software Association currently promotes research showing that "surgeons who played video games three hours a week made 37 percent fewer errors than non-players in laparoscopic surgery simulations, which involves joystick controls".

The rise of 'gamification'

This combination of factors has produced widespread interest in 'edutainment', or the 'gamification' of learning. This can take several forms. One is the 'chocolate-covered broccoli' approach where a game provides a veneer of fun covering a mundane educational task. The game may offer a stimulus or reward, but the underlying exercise does not change. A related approach is to use the trappings of games – including badges, scores and timed challenges – to make drill-and-practice work appear more appealing. Popular examples of this approach have included Dr Kawashima's Brain Training and Junior Brain Trainer for the Nintendo DS.

A more radical approach is to situate learning within a game environment or virtual world. Virtual worlds such as Minecraft offer learners and educators environments in which they can engage in activities that would be too difficult, dangerous or impossible in the physical world. When used effectively, such settings can promote creativity and the development of '21st-century skills' such as collaboration and problem solving.

However, use of a gaming environment is not necessarily linked with new approaches to learning and teaching. Lessons in these worlds can be designed to support a behaviourist approach to the transfer of skills and information; they do not automatically promote the construction and development of knowledge. At the simplest level, they may offer nothing more than gamification of maths and spelling tests within a virtual world, with participants receiving small rewards in return for sessions of drill and repetition.

As O'Neil and his colleagues found, when carrying out a meta-analysis of research relating to learning outcomes and computer games in 2005: "The evidence of potential is striking, but the empirical evidence for effectiveness of games as learning environments is scant."

Gaming and learning

Gamification jumbles elements of play, gaming and incentive-centred design in an unstable mixture that has no clear association with learning gains. Nevertheless, there are clear links between games and learning, and these can be used to inform pedagogy.

Jesper Juul defines a game as "a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable." Replace the word 'player' with the word 'learner', and any section of this definition could also be applied to education.

Game play is seen to be engaging and intrinsically motivating, acting as its own reward. These qualities are sought after in educational contexts. They are associated with flow, a concept developed by the psychologist Mihaly Csikszentmihályi. Individuals who experience flow encounter a balance between the challenge and their skill level, the merging of action and awareness, the existence of clear goals, clear feedback, focused concentration, a sense of control, a loss of self-consciousness, a reduced awareness of time and a sense that the activity is intrinsically rewarding. Once again, there is an overlap between gaming and education, as an experience of flow is desirable in both settings, though effective learning also requires learners to break the flow in order reflect on their activity.

Affinity groups

Complex video games require their players to develop new skills and to build detailed understanding of the gaming environment, its characters, capabilities and stories. This learning is key to success within the game – but these skills and knowledge need to be developed in an engaging way, or players will simply switch off and give up. The methods used by video game designers to motivate, train, inform, support and reward gamers, both individually and in teams, might usefully be applied to other areas of online and distance learning. When James Paul Gee investigated what video games have to teach us about learning and literacy, he drew on this understanding as he identified 36 principles of learning in these environments. These include:

- Self-knowledge principle: the virtual world is constructed in such a way that learners learn not only about the domain but also about themselves and their current and potential capacities.
- Achievement principle: for learners of all levels of skill there are intrinsic rewards from the outset, customised to each learner's level, effort and growing mastery, and signalling the learner's on-going achievements.
- Discovery principle: overt telling is kept to a well-thought-out minimum, allowing ample opportunity for the learner to experiment and make discoveries.
- Affinity group principle: learners constitute an 'affinity group', that is, a group that is bonded primarily through shared endeavours, goals and practices and not shared race, gender, nation, ethnicity or culture.

Gee went on to expand the concept of affinity groups as environments in which learning takes place. In doing so, he combined findings from the science of learning and from gaming. The affinity group is a pedagogically informed way of organising both learners and learning environments. It can be applied not only in gaming, but also in other online settings and in face-to-face environments. Affinity groups are organised around a passion. Within them, people use 'smart tools' such as interactive maps to be productive, they do not simply consume. The groups are not age graded; they bring beginners and experts together. Within these groups people both mentor and are mentored, knowledge is both distributed and dispersed, learning is proactive but aided and everyone is still a learner.

> "the affinity group is a pedagogically informed way of organising both learners and learning environments"

The principles of the affinity group can be seen in action in the work of MIT's Lifelong Kindergarten. This section of the MIT Media Lab takes a constructionist approach to learning, on the basis that "people learn a great deal when they are actively engaged in designing, creating, and inventing things." The group's work with the Lego toy company led to the development of the internationally successful Lego Mindstorms robotics kits that can be used for both play and learning. They also developed the Scratch programming language and community – an international learning community that has all the characteristics of an affinity group.

Another example of an affinity group successfully supporting learning is the Massively@Jokaydia community in the virtual world of Minecraft. This international community brings together children from across the world who are interested in developing digital media skills, exploring their creativity and developing online social skills. Badges and awards are used to empower children to 'level-up' and become game-makers and community moderators as well as players and learners.

Conclusions

Games and gaming environments support the development of knowledge and skills that are relevant within the game, but these may have little use within the wider world. Game-informed pedagogy draws on study of games to increase engagement and a sense of 'flow' within learning settings. Adding the trappings of games – colourful avatars, bright badges and staged challenges – is not enough. The organisation and environment of the 'affinity group' allows the practices of gaming to be effectively applied within learning contexts.

Mediaeval town researched and built by children from three continents learning together informally in Massively@Jokaydia Minecraft community

Resources

Entertainment Software Association: http://www.theesa.com/

James Paul Gee talks about gaming, learning and affinity groups at the Handheld Learning 2009 conference: http://blip.tv/handheld-learning/james-paul-gee-handheld-learning-2009-2738062

Jokaydia Minecrafts, "Jokaydia Minecrafts spaces are designed to support players to develop critical 21st-century skills and explore a range of concepts": http://minecraft.jokaydia.com/

Lifelong Kindergarten at MIT, "Our ultimate goal is a world full of playfully creative people who are constantly inventing new opportunities for themselves and their communities": http://llk.media.mit.edu/

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Maker culture

Learning by making

Potential impact: medium

Timescale: medium

There has been a recent renewed interest in learning through making, focused on the social construction of artefacts. While this might appear to echo earlier formal apprenticeship models of learning, the emerging 'maker culture' emphasises informal, networked, peer-led, and shared learning motivated by fun and self-fulfilment.

Maker culture has grown up outside formal learning structures, and encompasses not only the process of creating specific objects, but also the social and learning cultures surrounding their construction. It embraces a wide range of domains from the high-tech (electronics, programming, computer-aided design) to craft skills such as sewing, woodworking and soldering. Maker culture encourages novel applications of technologies, and the exploration of intersections between traditionally separate domains and ways of working including metal-working, calligraphy, knitting, and computer programming. New technologies, such as the Raspberry Pi computer on a single printed circuit board and the Arduino open-source electronics prototyping device, offer tools for practical experimentation.

Experimentation

This has its roots in traditional hobby pursuits and in computer hacking, and inherits their approach to learning principles such as self-directed goals, learning through constructing, valuing the understanding of processes as much the creation of the final object, and learning supported by a community of peers. Experimentation is highly regarded, with playful engagement and risk taking (learning through making mistakes, trying novel approaches) very much encouraged. Social interaction is seen as central, with local groups and larger meetings providing a locus for activities. Community interaction and knowledge sharing are often mediated through networked technologies, with websites and social media tools forming the basis of knowledge repositories and a central channel for information sharing and exchange of ideas.

Proponents argue that the networked aspect is a key distinction between this and earlier construction-centred affinity groups, such as a local woodwork or sewing club: giving far wider spheres of communication and enabling a critical mass to be achieved globally rather than necessarily locally. It doesn't matter if you are the only hacker in town interested in building air pollution monitors on your Raspberry Pi: somebody elsewhere in the world will be interested in sharing their hardware hacks with you.

Community creation of artefacts

Maker culture has attracted the interest of educators concerned about students' disengagement from STEM subjects (science, technology, engineering and mathematics) in formal educational settings. Maker culture is seen as having the potential to contribute to a more participatory approach to learning and create new pathways into topics that will make them more alive and relevant to learners. It is seen as drawing on successful models of learning present in the workplace and everyday life. Maker culture emphasises the production of tangible artefacts that solve a need in their makers' everyday lives – and this explicitly includes playful or aesthetic 'needs'. It emphasises experimentation, innovation, and the testing of theory through practical, self-directed tasks.

Artefacts are formed through a creative process that emphasises immediate feedback, through the production activities themselves: rapid iterative development involving the immediate testing and building of multiple prototypes. Continuing and informal peer feedback is sought, and shared creation is seen as highly valuable. Risk taking is actively encouraged in the form of pushing one's skills to their limits and exploring novel solutions and production methods, with mistakes and failures celebrated as positive learning outcomes, identified as offering opportunities for personal reflection and skills progression.

Social learning and participation as part of a community are seen as keystones of maker culture, either face to face or mediated via networked technologies. 'Maker spaces' (workshop spaces equipped for maker groups), informal gathering of friends, organised events ('Maker Fayres') and online spaces enable cooperative construction, peer feedback, and validation. These recognise that learning can occur through the gradual introduction of a learner into a community of peers. Learning is initially achieved through watching and undertaking simple tasks ('legitimate peripheral participation'), progressing to more complicated challenges, supported through informal mentoring by more expert members.

Exploring how wavelength affects pitch with a home-made theremin at Electromagnetic Field, a hacker camp / maker fayre in the UK

Understanding is recognised as being socially constructed, through conversations with peers about specific practical problems or actions to enable all participants to move towards shared comprehension. Learners can ask questions about problems, improve their grasp of skills through peer responses and, most powerfully, begin to teach others as they increase their expertise. Maker culture resonates with current interests in life-long learning and in cross-generational learning, with skills transmitted not only from old to young but also from young to old.

Maker culture has been driven in part by the availability of affordable tools that have enabled participants to engage with production methods, hardware and software previously only accessible to commercial or academic organisations. Freely available web tools have enabled easy communication, and open source software, cheap single-board computers and sensors have encouraged widespread experimentation with computing projects that interact with the real world: air pollution monitors, footballing robots, and clothing with embedded sensors. Affordable 3D printers and online sharing of designs have encouraged the creation of custom-made components, models and jewellery; the latter hinting at more recent interest not only from STEM educators but also from the arts.

Maker culture offers an example of self-organised social learning that has been widely taken up across the world, and can offer principles that might be put into practice not only in formal learning contexts but also in informal learning environments such as museums, libraries, and community based-settings.

> "maker culture emphasises informal, networked, peer led, and shared learning motivated by fun and self-fulfilment"

Resources

Air Pi: an environmental sensor kit based on the Raspberry Pi, devised by UK school children: http://airpi.es/

Arduino: an open source electronics prototyping platform aimed at artists, designers and hobbyists: http://www.arduino.cc/

Design-Make-Play: *Growing the Next Generation of Science Innovators* (2012). New York: New York Hall of Science. http://www.nysci.org/media/file/DMP-Report-2012.pdf

The Restart Project: a recycling group encouraging people to have fun and learn skills fixing their broken electronic equipment rather than throwing them away: http://therestartproject.org/

Make: an online magazine and blog for maker culture (US focussed): http://makezine.com/

Maker Faire 2012: Nerdy Derby as Inspirational Pedagogy: http://empathetics.org/2012/10/03/maker-faire-2012-nerdy-derby-as-inspirational-pedagogy/

Makerspace Playbook (2013): a practical guide to setting up a maker space, including discussion of the pedagogical underpinnings of maker culture. Focuses on school-aged students, US based. http://makerspace.com/wp-content/uploads/2013/02/MakerspacePlaybook-Feb2013.pdf

Raspberry Pi: a single board computer designed to encourage children to explore programming: http://www.raspberrypi.org/

Sarah Griffiths – The amateur at play: how FabLabs nuture sociable expertise. http://www.re-public.gr/en/?p=5403

Kuznetsov, S., Paulos, E. (2010). Rise of the expert amateur: DIY projects, communities, and cultures. *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*, pp. 295–304. http://www.staceyk.org/hci/KuznetsovDIY.pdf

The Economist (3 Dec, 2011). *More than just digital quilting*. The Economist Newspaper Limited. http://www.economist.com/node/21540392

Citizen inquiry

Fusing inquiry-based learning and citizen activism

Potential impact: medium

Timescale: long

There is growing interest in involving people without scientific training in practical science investigations. An editorial in Science magazine argues that wider personal engagement in "carefully designed, hands-on, inquiry-based exploration of the world" will inform public debate and may lead to scientific breakthroughs.

Inquiry-based learning is a powerful generalised method for coming to understand the natural and social world through a process of guided investigation. How can we enable many people who are not professional natural or social scientists to engage in the challenge of innovative inquiry? The transformative idea is to open up to citizens of all ages the process of proposing, commissioning, conducting and reporting inquiry-led scientific projects.

Citizen inquiry fuses the creative knowledge building of inquiry-based learning with the mass civic engagement of volunteer activism. This goes a step beyond most current citizen science projects, in which professional scientists determine the agenda, to one in which ordinary citizens are enabled to do this. Current citizen science projects such as Galaxy Zoo, Foldit and iSpot involve citizens in classifying objects, solving puzzles or observing wildlife, but scientists set the research questions and methods. Platforms such as Kickstarter and Wefund provide a means for funding and organising creative projects, but are not underpinned by a model of scientific inquiry.

> "a powerful generalised method for coming to understand the natural and social world through a process of guided investigation"

In citizen inquiry, citizens of all ages participate in the entire process of proposing topics for investigation, developing research questions, selecting appropriate methods, conducting investigations, sharing findings, and presenting results.

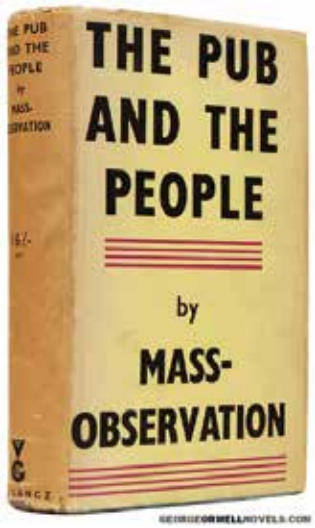
Most projects are likely to be small scale and for mutual interest, involving people freely sharing a range of expertise. Some may be larger scale, involving mass participation in observation and experiment. The challenge is to enable this process through a process of personally meaningful inquiry learning, supported by carefully designed, appropriate and ethical methods of web-based creativity, collaboration and dissemination, within a robust and sustainable organisational structure.

Current work

Some of these elements are present in existing citizen science projects. The Foldit online game involves members of the public in solving the hard scientific problem of protein folding. Players are set tasks that use their visual problem-solving skills to find the best structures for proteins. People play competitively and researchers examine their techniques in order to devise new computer-based methods for analysing the folding of proteins.

Techniques from computer gaming are used to motivate players and to encourage collaboration and competition. These include immediate rewards from game scores, longer-term rewards through player status and rank, social praise from forums, the ability to work in a team or individually, and a clear indication of the scientific benefits associated with taking part. As groups compete for higher rankings and discover new structures, this motivates other groups to form and out-perform them. Similar methods of reputation management and reward have been built into other citizen science platforms such as iSpot.

Investigations can also be carried out in the human and social sciences. The Family and Community Historical Research Society (FACHRS) carries out collective research into life within local communities. In a FACHRS research project, a group of people commit to carrying out a study around a central theme, exploring local and regional differences. Examples include exploring how seasons affect marriage in a community, how a community copes with crime, and how local newspapers influence a community.



The Pub and the People, by Mass Observation, 1943

The longest-running citizen inquiry project has been Mass Observation. Started in 1937 by three young men to create an "anthropology of ourselves", it blossomed into a citizen study of the everyday lives of ordinary people in Britain. Volunteer observers went into public situations, ranging from pubs to churches, and recorded people's behaviour and conversations. The material they produced is a rich and varied documentary account of life during the Second World War. Mass Observation still continues, with a panel of citizens writing their observations on topics such as the local High Street or the 2012 Olympic Games.

Future development

Citizen inquiry could be developed as a layer of current citizen science projects, offering the additional opportunity to devise new individual or group investigations, and guiding people through the process of creating and running a study. But the area of interest has to be one that members of the public can devise. For example, in Foldit the game of folding may be accessible to members of the public, but creating new protein models is not.

Local wildlife and nature form one starting point for citizen inquiry. For example, a group of gardeners could decide to find out which kinds of plants attract the most butterflies, design their own investigation, and communicate their results. The initial motivation comes from personal curiosity about a topic, which is then maintained by forming or joining a group of investigators with similar interests and a diversity of contexts.

Although the concept seems straightforward – helping groups of like-minded people to join together in order to carry out careful investigations of scientific value – there are substantial barriers to success. Devising a scientific question is a challenging task. It may not be the 'big science' of medical advances or scientific breakthroughs, but it should be personally relevant to the participants and also have wider meaning and validity, adopting methods recognised by the scientific community. For that to happen, there needs to be guidance on choosing relevant topics, setting questions that can be answered through collective inquiry, and collecting and analysing data by rigorous and sharable methods. It is unclear whether non-scientists in ad hoc teams can plan or adopt inquiry processes that follow the good practices of professional science.

Conclusions

Creating an online community for citizen inquiry requires difficult design decisions. Should it be a place for scientific investigation (like iSpot), or community involvement (like FACHRS), or online serious gaming (like Foldit)? One solution may be to create an overarching challenge that offers opportunity for open investigation. For example, Big Garden Birdwatch is the world's largest wildlife survey, involving over half a million people in counting bird species in their gardens. It has been successful in identifying threatened bird species and changes in bird population over time. Data from this and similar surveys could form the basis for local investigations into threatened species or changes in habitat, which would involve support for creating teams, maintaining interest and rewarding success.

A salutary lesson about the power of mass participation has come through citizen investigations into crimes such as the Boston bombings of April 2013. On that occasion, amateur investigators analysed photos and video that had been uploaded to public websites and posted accusations of suspects. These were repeated by the mass media. A consequence was that innocent people had their lives disrupted by false accusations. Citizen inquiry can be a powerful form of learning through citizen collaboration in scientific practices; it can also be a rallying point for mutual delusion.

Resources

Big Garden Birdwatch:
http://www.rspb.org.uk/birdwatch/

Family and Community Historical Research Society:
http://www.fachrs.com/

Foldit:
http://fold.it/portal/

Galaxy Zoo:
http://www.galaxyzoo.org/

iSpot:
http://www.ispot.org.uk/

Kickstarter:
http://www.kickstarter.com/

Mass Observation:
http://www.massobs.org.uk

A brief history of Mass Observation:
http://www.massobs.org.uk/a_brief_history.htm

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http://wefund.com/

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Innovating Pedagogy 2013

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ISBN 978-1-78007-937-0