Innovating Pedagogy 2016

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

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Open University Innovation Report 5

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Executive summary

This series of reports explores new forms of teaching, learning and assessment for an interactive world, to guide teachers and policy makers in productive innovation. This fifth 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 Institute of Educational Technology in The Open University collaborated with researchers from the Learning Sciences Lab in the National Institute of Education, Singapore. We proposed 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 Lastly, we drew on published and unpublished writings to compile the ten sketches of new pedagogies that might transform education. These are summarised below in an approximate order of immediacy and timescale to widespread implementation.

1 **Learning through social media:** Outside schools and colleges, people learn less formally. Some use social media such as Twitter and Facebook to share ideas and engage in conversations. These sites can offer a range of learning opportunities, to access expert advice, encounter challenges, defend opinions and amend ideas in the face of criticism. Unfortunately, the same sites may present learners with inaccurate information, biased comments and hostile responses. Some organisations have set up social media specifically to offer learning opportunities. Learners are helped to share experiences, make connections, and link these with teaching resources. Other educational sites are based on projects, such as 'RealTimeWorldWarII', 'The Diary of Samuel Pepys' and NASA's 'MarsCuriosity' Twitter account. Educators on these sites have multiple roles that differ from those of a classroom teacher. These projects require expertise, as well as the time and ability to take on different roles. Anyone can engage and leave at any time, but a skilled facilitator who takes on the tasks of filtering resources and engaging people can keep a social media project running for many years.

2 **Productive failure:** Productive failure is a method of teaching that gives students complex problems to solve and attempt to form their own solutions before receiving direct instruction. The aim is for students, working together, to use their prior knowledge to consider possible solutions, then evaluate and explain the best answer. By struggling and sometimes failing to find a solution, the students gain a deeper understanding of the structure of the problem and its elements. After this process, their teacher explains the essential concepts and methods of the solution, helping students to consolidate their knowledge by comparing good and bad answers. Productive failure has been

investigated in 26 Singapore schools, and has been replicated by studies in the USA, Canada, Germany, and Australia. The pedagogy requires students to embrace challenge and uncertainty. They may feel unconfident at first, but this experience can help them become more creative and resilient. In order to implement learning with productive failure, teachers will need a deep understanding of the topic and may need to make fundamental changes to how they teach.

3 **Teachback:** As well as learning from teachers, we can learn by explaining to other people what we think we know. This is the basis of Teachback. One person (who may be a teacher, an expert, or another student) explains their knowledge of a topic to a learner. Then that learner attempts to explain, or teach back, what they have understood. This offers two benefits. It helps learners to understand a topic or problem by reframing it in their own terms. They also need to explain what they have learned in a way that is understandable. If the listener cannot make sense of the learner's explanation, then they discuss the topic until they understand each other. Teachback has been used in healthcare. Doctors and nurses can check that they have explained a treatment clearly by asking their patients to explain or demonstrate what they have been told. The method could be adopted more widely, for any topic where it is important to reach a shared understanding. However, if neither person is knowledgeable, the outcome could be shared misunderstanding.

4 **Design thinking:** Design thinking solves problems using the methods and thinking processes used by designers. These include creative processes such as experimenting, creating and prototyping models, soliciting feedback, and redesigning. Design thinking places learners in contexts that make them think like designers, creating innovative solutions that address people's needs. Learners need to solve technical problems but they also need to understand how users will feel when employing the solutions. Design thinking is a social as well as a mental process. It involves thinking and working across different perspectives and often involves conflict and negotiation. For example, students designing an educational computer game need to think from the perspective of a good teacher as well as from the perspective of a game player. As a pedagogy, design thinking may involve civic literacy, cultural awareness, critical and creative thinking, and technical skills. When implementing this approach in the classroom, the teacher and students need to take risks and try new methods.

5 **Learning from the crowd:** Appealing to the crowd gives access to valuable sources of knowledge and opinion. Amateurs and experts exchange ideas, generate and discuss content, solve problems, vote for the best solutions, and raise funds. A classic example of the crowd in action is Wikipedia, the online encyclopaedia co-created and continually updated by the public. Other examples include citizen science activities such as identifying birds and classifying galaxies. However, we are not yet using the wisdom of the crowd to its full potential as a resource in education and for learning. Possible applications of crowdsourcing in education include collecting and curating teaching resources, letting students share and discuss their work online, and providing opinions and data for use in projects and research studies. Crowdsourcing can lead to research that is initiated by the general public, rather than by scientists, and the opportunity to seek solutions to real-life problems. Designing and supporting such activities offers a way to scale them up. It also teaches the public to think scientifically, to appreciate sciences, and to support the work of scientists. Approaches need to consider the quality and validity of the contributions that are made by the public; the crowd may be wrong!

6 **Learning through video games:** Video games are powerful market and social forces. They can make learning fun, interactive, and stimulating. 'Lemonade Stand' was a 1970s computer game that engaged children in pricing, advertising, buying, and selling lemonade. From this promising beginning an industry has grown that includes serious games, gamification and game-infused learning. The focus can be on games designed for education, the use of game elements in workplace training, simulations such as flight trainers, or on social benefit. Players can try out unfamiliar roles and contexts and make consequential decisions, for example in simulated financial trading. However, it is difficult to balance learning with fun. A solution may lie in collaboration between professional game designers, software engineers, and learning experts. Together, these groups could develop game engines based on effective pedagogy, employing learning analytics to adapt game experiences to players' educational goals and actions.

7 **Formative analytics:** Most current applications of learning analytics aim to measure and predict the learning processes of students by tracing their behaviour and inferring their thinking processes. Analytics track, for example, time spent on online learning, or performance on an assessment. By identifying who may be at risk of failing a test, summative learning analytics provide teachers with a digest of performance and insight into who needs support. In contrast, formative analytics support learners to reflect on what they have learned, what can be improved, which goals can be achieved, and how they should move forward. By providing analytics for learning rather than analytics of learning, formative analytics have the potential to empower each learner through timely, personalised, and automated feedback, including visualisations of potential learning paths.

8 **Learning for the future:** Learners need to be educated not just for today but for the future. They should acquire skills and dispositions that will enable them to cope with an uncertain life and a complex work environment. Learning for the future builds human capacity to learn. The emphasis is not just on mastering content, but also on acquiring skills to learn, unlearn and relearn. These include the ability to change perspectives in the light of new information and understanding. This approach can help students to acquire critical thinking skills, gain social competencies related to learning and working together, and develop resourcefulness in learning. Future-ready learners have agency and autonomy in planning what and how to learn. They have the skills to be responsible citizens, contributors and innovators in an uncertain future. They also have mature cultural and interpersonal understanding.

9 **Translanguaging:** In a globalised world, many learners are studying in and speaking a language that is not their mother tongue. Translanguaging refers to moving flexibly and fluidly between languages. Pedagogical strategies engage the language abilities of bilingual students in teaching and learning, for example by using bilingual partners, organising international collaboration, searching the internet in multiple languages and accessing a wide range of online communities and resources. Translanguaging can expand and deepen students' understanding and help them to gain broader perspectives. It can also enrich the cultural experience and world views of other learners. But a bilingual classroom may exclude monolingual learners or take for granted the ability of bilinguals to use their languages for effective learning. Translanguaging might also encourage fusion of languages and threaten the survival of 'standard' languages (such as International English) that can facilitate access to education and build mutual comprehension between people from different cultural backgrounds.

10 Blockchain for learning: A blockchain stores digital events securely on every user's computer rather than in a central database. This is the technology behind digital currencies like Bitcoin. Blockchain learning explores how this approach could be applied to education, shifting from central records of student performance held by schools and universities to a more democratic model in which achievements are recorded by a wider range of participants. Blockchain technology allows any participant to add a new record such as an exam score to a single digital chain of events. This chain is stored across many computers, yet cannot be altered or undone. A blockchain could be used as a permanent shared record of intellectual achievement. It enables anybody to store academic certificates, creative works such as poems or artworks, even original ideas. There is no need for individuals to claim their inventions – the record is there for all to see. Just as bitcoin is a financial currency, so an educational blockchain could be linked to a currency of intellectual reputation. People can gain credit for carrying out an intellectual task such as reviewing another person's creative work, or can donate small amounts of reputational credit to boost another person's artefact or idea – all recorded and visible on the shared educational blockchain. While blockchain technology opens new possibilities for trading educational reputation as a currency, it also raises significant concerns about treating learning as a commodity to be bought and sold.

Introduction

This is the fifth in a series of annual 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.

This report is the result of collaboration between researchers at the Institute of Educational Technology in The Open University, UK, and the Learning Sciences Lab at the National Institute of Education, Singapore. We have shared ideas, proposed innovations, read research papers and blogs, and commented on each other's draft contributions. We worked together to compile this report by listing new educational terms, theories, and practices, then reducing these to ones that have the potential to provoke major shifts in educational practice. This 2016 report introduces ten pedagogies that either already influence educational practice or offer opportunities for the future. By 'innovative pedagogies', we mean novel or changing theories and practices of teaching, learning and assessment for the modern, technology-enabled world.

> "The method of design-based research has been widely adopted for educational innovation."

Together, the five reports have described 41 innovative pedagogies. Some of these have already had a major impact on education worldwide. Over 30 million people have engaged with massive open online courses (MOOCs), which we introduced in our 2012 report. MOOCs are now evolving into new types of pedagogy, including massive-scale social learning that applies techniques from social networks (such as Facebook and Twitter) to help people comment on topics, share and 'like' ideas, and review contributions from other learners.

With so many new and emerging pedagogies, the obvious question for teachers and education policy makers is "which ones should we adopt?" Where is the evidence that helps us decide whether to explore adaptive teaching systems (described in our 2015 report), to teach science through threshold concepts (2014), or to embrace dynamic assessment (2014)? Fortunately, alongside these innovative pedagogies has come a new science of learning, where findings from neuroscience, cognitive sciences, educational and social sciences are combined to produce a deep understanding of how we learn. Recent studies have compared different methods of teaching in classrooms and online to reveal which methods increase knowledge, improve exam scores, and keep learners engaged.

There has been a deep, and often justified, resistance from many educational researchers to the 'medical model' of evidence, which treats pedagogies as pills administered to students, tested in the same ways as a new medicine. Learning a topic is not the same as swallowing a pill – it involves a series of mental processes and often-complex social interactions with a teacher and other students. There is no educational equivalent of a 'placebo' (a similar-looking pill with no medical effect). It may take many months or years for the effects of good teaching to become apparent, as skills learned at school or in college are applied in the workplace.

Rather than relying solely on controlled experiments to evaluate new pedagogies, research is now piecing together evidence from multiple sources, rather like pieces of a jigsaw puzzle, to build up a picture

of effective methods of teaching, learning and assessment. The method of design-based research has been widely adopted for educational innovation. Researchers using this approach carry out a series of trials of a new method of teaching, with each trial (or 'design experiment') leading to improvements in the method and insights into learning theory and practice.

Cooperative learning

The most obvious success has been in cooperative learning. Until the 1970s, most research in educational innovation was directed towards individualised instruction – how to match teaching content to the needs and activities of individual students. Then, findings from social psychology began to show the value of working together. When students cooperate in small groups of between four and eight people, this can result in greater creativity and better outcomes than working alone. Over the past 40 years, hundreds of studies in labs, classrooms and online, have uncovered conditions for successful cooperative learning. For groups to work well, they need to have shared goals, each person should know how and when to contribute, and everyone should make an appropriate contribution. They should share rewards such as group marks in a fair way, and members of a group should all have opportunities to reflect on progress and to discuss contributions. For many students, learning in groups is not a natural process, and they need to learn how to cooperate by arguing constructively and resolving conflicts. The key phrase is 'positive interdependence' – everyone sees the benefits of learning together and works to achieve the group's goals. All over the world, schools and colleges now make time for group learning activities, founded on these principles of positive interdependence.

Collaborative and social learning online

More recently, learning through positive interdependence has been extended to collaborative and social learning online. Here, the groups may be looser and less coherent, without shared goals. For example, the learners may be people from around the world who have signed up to study a six-week MOOC. The learning benefits come from sharing ideas and perspectives through discussions and constructive argument.

The effects of such online computer-supported collaboration are much harder to measure than for group work in a classroom. A recent study has made an ingenious comparison of the learning benefits of 157 distance learning courses offered by The Open University. Each course had been carefully designed according to a set of pedagogic principles, with differing mixtures of individual and collaborative learning. The university collects the exam scores for all students taking the courses, as well as results from surveys of student satisfaction with the teaching, and data on how many students drop out from each course. From these data the researchers calculated which types of course produced the most successful outcomes.

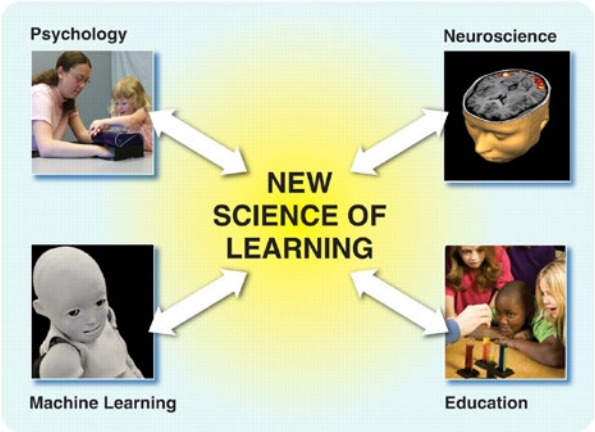
The researchers found that the design of the course had a significant effect on student satisfaction and performance. Students were more satisfied with courses that had a large element of individual reading and watching of instructional videos, but students were more likely to complete courses that had more collaborative learning. Furthermore, exam scores were lower on average for the courses that were based more on individual learning by reading and watching. These findings match other studies showing that although students may be reluctant to take part in group activities, they can benefit from the experience of pooling knowledge and sharing diverse views.

Feedback for learning

Another robust finding from studies of human psychology applied to education is the value of feedback to learning. Feedback can come from a teacher, another more knowledgeable person, another learner, or a computer. It is most successful when the feedback helps a learner to improve, by finding out how to correct a misunderstanding, or to build new knowledge in reaching a goal. I learn something and think

I understand it, I am tested on that learning and find some missing or faulty knowledge, then I am helped to correct it.

It is easier to study the effects of feedback than many other educational methods, so many experiments have been run on whether feedback should be immediate or delayed, positive or negative, and combined with praise or punishment. In brief, giving immediate feedback works best for easy learning tasks and when the student is building knowledge.



Elements of a new science of learning

Both positive and negative feedback can help learning. Negative feedback points out shortcomings and how to correct them; positive feedback can encourage students to continue. There is good evidence that praise alone does not produce learning. Feedback must be relevant to the task and lead to specific action.

Active and constructive learning

Active and constructive learning involves students carrying out an activity that can support learning – such as commenting, critiquing, constructing – while thinking about the purpose and aim of the activity. This contrasts with instructivist learning that mainly involves listening and watching, a lecture for example. A series of studies have compared the sequencing of constructivist and instructivist approaches. They found that students who actively explored a topic (for example, by trying out a science simulation) and then received instruction performed better on tests of knowledge than students who listened to the lecture before active exploration. The method is described later in this report, in the section on Productive Failure. The results are clear, but the explanations of why this happens are still speculative. A plausible explanation is that students who are instructed first and then explore become fixed on the specific items delivered by the lecture, whereas those who explore first gain a broader understanding of the possibilities and dimensions of the topic, which provide a framework for understanding the lecture.

Human memory and learning

The success of active, constructive and collaborative learning raises a question as to how young children learn. Around the age of 8, a typical child is learning to speak about five to eight new words a day, without the mental effort of exploring, discussing, and critiquing. How do they do it, and could that same accelerated learning be adopted or re-discovered in adulthood?

Making associations, such as “hello – bonjour”, is the basic process of learning. Studies of associative learning began over 100 years ago. They show that trying to cram lots of facts and associations into memory does not work. Instead, we need to space the practice over time, so that the learning is repeated just as the association is fading from memory, for example at 5 seconds, 25 seconds, 2 minutes, 10 minutes, 1 hour, 1 day, 5 days, 25 days, 4 months and 2 years. Rather than just viewing the association at these intervals, it is better to try to recall it. For example, learners might be asked, “What is the French for ‘hello’?” while using ‘flash cards’ with the English word or phrase on one side and the French on the other. Many language-teaching methods are based on this method of spaced repetition. It is at the core of successful learning platforms such as Memrise and Duolingo.

Spaced repetition on flash cards is successful for making memory associations, such as learning vocabulary or multiplication tables. A similar method has been shown to work for more complex topics. A method called ‘spaced learning’ builds on findings from neuroscience that explain how humans form long-term memories. Things we remember in

short-term memory fade rapidly, but if they are transferred to long-term memory they can last a lifetime. The neuroscience studies show that permanent neural connections are more likely to be made when a brain cell is stimulated at intervals than when it is constantly stimulated. This is good evidence for learning by spaced repetition and it is already being applied to the teaching of curriculum subjects.

In a spaced learning session, students are given intensive teaching by lecture for 20 minutes or less. They then take a short break from mental effort by doing a sports activity or physical exercise. After this, the same or similar content is repeated for 20 minutes, followed by more physical activity, with a final teaching session to focus on applying the knowledge or skills the students have just acquired. A controlled study that compared one hour of spaced learning for school biology with a four-month course of classroom teaching found similar learning benefits. This is the nearest that education gets to a 'learning pill', so it has attracted media attention. It is still research in progress, though it is based on a century of research into human memory and learning. The studies are being repeated, with some variations, in 15 schools over an academic year.

A new science of learning

The cognitive and social processes involved in learning fundamentals of Biology may be very different to those required for discussion on MOOCs. Research is combining observations of learning in classrooms and online, controlled psychology experiments, investigations of human brain functioning, and computational models of machine learning. Together, this work is establishing a new science of learning. Researchers piece together the evidence to form a composite picture of how people learn, individually and together, with and without the support of a teacher, at different ages and in differing cultures. This new science of learning can already help in predicting which innovative pedagogies might work in which contexts.

New pedagogies based on principles of cooperative learning are likely to be successful when the students have shared goals, similar motivations to learn, and time and ability to reflect. These conditions may apply, for example, to professional development in the workplace. Findings about collaborative and social learning can inform the design of pedagogies for learning at massive scale, where the diversity of views create a 'social network effect' of vibrant discussion but with a need to manage and contain the discussions.

Research into feedback for learning is already leading to new forms of assessment (see Dynamic Assessment in the *Innovating Pedagogy 2014* report) and to computer-based systems for adaptive teaching (described in *Innovating Pedagogy 2015*). The value of active and constructive learning underpins many recent innovations described in our previous reports, such as Citizen Inquiry (2013), Flipped Classroom (2014), and Computational Thinking (2015). The neuroscience of human memory may provide a basis for new pedagogies of accelerated and optimized learning.

Amongst all this innovation in teaching, learning and assessment, some principles endure. The teacher still performs a central function, but that is changing from delivery of educational content to facilitating discussion and reflection. Structure is still important, perhaps even more than it was before, as we discover effective ways to initiate, embed and extend learning. Learners still need appropriate goals and support. Most important, learning is a collegiate process. It works best when people want to learn, enjoy the process and support each other. The next decade of innovating pedagogy may focus less on the individual elements of instruction and more on how to merge the new pedagogies into an effective process of lifelong learning.

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Innovating Pedagogy 2015

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

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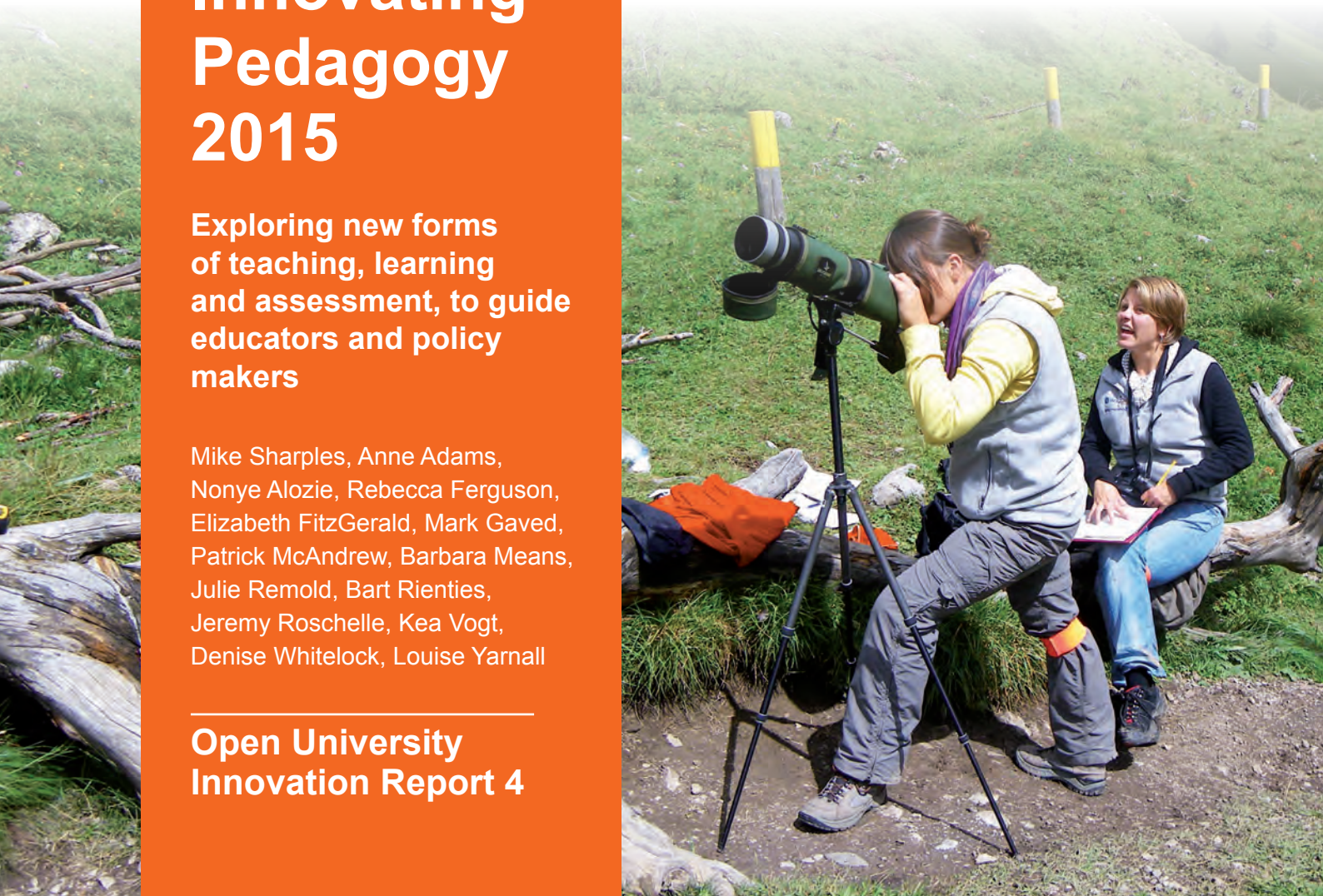

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Page 15. Argument visualisation in Cohere. Figure redrawn from Buckingham Shum, S. (2008). Cohere: Towards Web 2.0 Argumentation. In Proceedings of COMMA'08: 2nd International Conference on Computational Models of Argument, 28-30 May 2008, Toulouse, France. IOS Press, pp. 97-108.

Page 18. Children closely observe a banana slug during unstructured play. Photograph by Julie Remold. Reproduced with permission.

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Screen captured from **scratch.mit.edu/projects/10128368/#editor**

Page 27. ARROW remotely controlled radio telescope for Open University students. From the OpenScience Laboratory **learn5.open.ac.uk/course/format/sciencelab/section.php?name=af_sxpa288**

Page 31. Children interacting with a tabletop display on the JuxtaLearn project. Image © Anne Adams. Reproduced with permission.

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Page 39. Cover art for Portal 2 game. © Valve Corporation. **www.thinkwithportals.com**

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Executive summary

This series of reports explores new forms of teaching, learning and assessment for an interactive world, to guide teachers and policy makers in productive innovation. This fourth report proposes ten innovations that are already in currency and are having an increasing effect on education. To produce it, a group of academics at the Institute of Educational Technology in The Open University collaborated with researchers from the Center for Technology in Learning at SRI International. We proposed 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 the ten sketches of new pedagogies that might transform education. These are summarised below in an approximate order of immediacy and timescale to widespread implementation.

1 **Crossover learning** Learning in informal settings, such as museums and after-school clubs, can link educational content with issues that matter to learners in their lives. These connections work in both directions. Learning in schools and colleges can be enriched by experiences from everyday life; informal learning can be deepened by adding questions and knowledge from the classroom. These connected experiences spark further interest and motivation to learn. An effective method is for a teacher to propose and discuss a question in the classroom, then for learners to explore that question on a museum visit or field trip, collecting photos or notes as evidence, then share their findings back in the class to produce individual or group answers. These crossover learning experiences exploit the strengths of both environments and provide learners with authentic and engaging opportunities for learning. Since learning occurs over a lifetime, drawing on experiences across multiple settings, the wider opportunity is to support learners in recording, linking, recalling and sharing their diverse learning events.

2 **Learning through argumentation** Students can advance their understanding of science and mathematics by arguing in ways similar to professional scientists and mathematicians. Argumentation helps students attend to contrasting ideas, which can deepen their learning. It makes technical reasoning public, for all to learn. It also allows students to refine ideas with others, so they learn how scientists work together to establish or refute claims. Teachers can spark meaningful discussion in classrooms by encouraging students to ask open-ended questions, re-state remarks in more scientific language, and develop and use models to construct explanations. When students argue in scientific ways, they learn how to take turns, listen actively, and

respond constructively to others. Professional development can help teachers to learn these strategies and overcome challenges, such as how to share their intellectual expertise with students appropriately.

3 **Incidental learning** Incidental learning is unplanned or unintentional learning. It may occur while carrying out an activity that is seemingly unrelated to what is learned. Early research on this topic dealt with how people learn in their daily routines at their workplaces. For many people, mobile devices have been integrated into their daily lives, providing many opportunities for technology-supported incidental learning. Unlike formal education, incidental learning is not led by a teacher, nor does it follow a structured curriculum, or result in formal certification. However, it may trigger self-reflection and this could be used to encourage learners to reconceive what could otherwise be isolated learning fragments as part of more coherent and longer term learning journeys.

4 **Context-based learning** Context enables us to learn from experience. By interpreting new information in the context of where and when it occurs and relating it to what we already know, we come to understand its relevance and meaning. In a classroom or lecture theatre, the context is typically confined to a fixed space and limited time. Beyond the classroom, learning can come from an enriched context such as visiting a heritage site or museum, or being immersed in a good book. We have opportunities to create context, by interacting with our surroundings, holding conversations, making notes, and modifying nearby objects. We can also come to understand context by exploring the world around us, supported by guides and measuring instruments. It follows that to design effective sites for learning, at schools, museums and websites, requires a deep understanding of how context shapes and is shaped by the process of learning.

5 **Computational thinking** Computational thinking is a powerful approach to thinking and problem solving. It involves breaking large problems down into smaller ones (decomposition), recognizing how these relate to problems that have been solved in the past (pattern recognition), setting aside unimportant details (abstraction), identifying and developing the steps that will be necessary to reach a solution (algorithms) and refining these steps (debugging). Such computational thinking skills can be valuable in many aspects of life, ranging from writing a recipe to share a favourite dish with friends, through planning a holiday or expedition, to deploying a scientific team to tackle a difficult challenge like an outbreak of disease. The aim is to teach children to structure problems so they can be solved. Computational thinking can be taught as part of mathematics, science and art or in other settings. The aim is not just to encourage children to be computer coders, but also to master an art of thinking that will enable them to tackle complex challenges in all aspects of their lives.

6 **Learning by doing science with remote labs** Engaging with authentic scientific tools and practices such as controlling remote laboratory experiments or telescopes can build science inquiry skills, improve conceptual understanding, and increase motivation. Remote access to specialized equipment, first developed for scientists and university students, is now expanding to trainee teachers and school students. A remote lab typically consists of apparatus or equipment, robotic arms to operate it, and cameras that provide views of the experiments as they unfold. Remote lab systems can reduce barriers to participation by providing user-friendly Web interfaces, curriculum materials, and professional development for teachers. With appropriate support, access to remote labs can deepen understanding for teachers and students by offering hands-on investigations and opportunities for direct observation that complement textbook learning. Access to remote labs can also bring such experiences into the school classroom. For example, students can use a high-quality, distant telescope to make observations of the night sky during daytime school science classes.

7 **Embodied learning** Embodied learning involves self-awareness of the body interacting with a real or simulated world to support the learning process. When learning a new sport,

physical movement is an obvious part of the learning process. In embodied learning, the aim is that mind and body work together so that physical feedback and actions reinforce the learning process. Technology to aid this includes wearable sensors that gather personal physical and biological data, visual systems that track movement, and mobile devices that respond to actions such as tilting and motion. This approach can be applied to the exploration of aspects of physical sciences such as friction, acceleration, and force, or to investigate simulated situations such as the structure of molecules. For more general learning, the process of physical action provides a way to engage learners in feeling as they learn. Being more aware of how one's body interacts with the world can also support the development of a mindful approach to learning and well-being.

8 **Adaptive teaching** All learners are different. However, most educational presentations and materials are the same for all. This creates a learning problem, by putting a burden on the learner to figure out how to engage with the content. It means that some learners will be bored, others will be lost, and very few are likely to discover paths through the content that result in optimal learning. Adaptive teaching offers a solution to this problem. It uses data about a learner's previous and current learning to create a personalised path through educational content. Adaptive teaching systems recommend the best places to start new content and when to review old content. They also provide various tools for monitoring one's progress. They build on longstanding learning practices, such as textbook reading, and add a layer of computer-guided support. Data such as time spent reading and self-assessment scores can form a basis for guiding each learner through educational materials. Adaptive teaching can either be applied to classroom activities or in online environments where learners control their own pace of study.

9 **Analytics of emotions** Automated methods of eye tracking and facial recognition can analyse how students learn, then respond differently to their emotional and cognitive states. Typical cognitive aspects of learning include whether students have answered a question and how they explain their knowledge. Non-cognitive aspects include whether a student is frustrated, confused, or distracted. More generally, students have mindsets (such as seeing their brain as fixed or malleable), strategies (such as reflecting on learning, seeking help and planning how to learn), and qualities of engagement (such as tenacity) which deeply affect how they learn. For classroom teaching, a promising approach is to combine computer-based systems for cognitive tutoring with the expertise of human teachers in responding to students' emotions and dispositions, so that teaching can become more responsive to the whole learner.

10 **Stealth assessment** The automatic data collection that goes on in the background when students work with rich digital environments can be applied to unobtrusive, 'stealth', assessment of their learning processes. Stealth assessment borrows techniques from online role-playing games such as World of Warcraft, in which the system continually collects data about players' actions, making inferences about their goals and strategies in order to present appropriate new challenges. This idea of embedding assessment into a simulated learning environment is now being extended to schools, in topics such as science and history, as well as to adult education. The claim is that stealth assessment can test hard-to-measure aspects of learning such as perseverance, creativity, and strategic thinking. It can also collect information about students' learning states and processes without asking them to stop and take an examination. In principle, stealth assessment techniques could provide teachers with continual data on how each learner is progressing. However, much research remains to be done, both to identify the measures of student learning process that predict learning outcomes for different learning systems and to understand the amount and format of student learning data that are useful to teachers. Concerns have been raised about collection of vast amounts of student learning data and the ethics of using computers to monitor a person's every action.

Introduction

This is the fourth in a series of annual 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.

This report is the result of collaboration between researchers at the Institute of Educational Technology in The Open University and the Center for Technology in Learning at SRI International. We have shared ideas, proposed innovations, read research papers and blogs, and commented on each other's draft contributions. We compiled the report by first producing a long list of new educational terms, theories, and practices, then reducing these to ones that have the potential to provoke major shifts in educational practice. This 2015 report introduces ten pedagogies that either already influence educational practice or offer opportunities for the future. By 'innovative pedagogies' we mean theories and practices of teaching, learning and assessment for the modern, technology-enabled world.

> "six overarching themes: scale, connectivity, reflection, extension, embodiment, and personalisation"

We are aware that innovative pedagogies are proliferating like fundamental particles in physics. What started as a small set of basic teaching methods (instruction, discovery, inquiry) has been extended to become a profusion of pedagogies and their interactions. So, to try to restore some order, we have examined the previous reports and identified six overarching themes: scale, connectivity, reflection, extension, embodiment, and personalisation. In describing these, we have highlighted in bold the pedagogies identified in our previous reports.

Scale

Delivering education at massive scale has been the headline innovation of the past three years. **Massive Open Online Courses** (MOOCs) now engage millions of people in learning online. It is not clear whether the business of offering university-level courses for free can be sustained. However, MOOCs have demonstrated that it is possible to design methods of learning that improve with scale. Where the pedagogy of a MOOC is based on **learning through conversation and social networking**, then the more people who take part, the richer the interactions, with people around the world exchanging ideas and sharing perspectives. In July 2015, the largest-ever gathering of learners took place on the FutureLearn platform, with 270,000 people taking a course from the British Council on preparing for the IELTS language examination. Just one video from that course, asking the participants to discuss how they feel about taking exams, attracted 56,000 comments and responses. To manage this level of engagement requires techniques from social networks, of 'liking' comments, 'following' learners and educators, and rewarding popular learners and their contributions, so the most successful contributions are highlighted.

Other pedagogies that are being explored at massive scale include **badges to accredit learning**, **crowd learning** (participants post questions, stories, images, videos and computer programs for other learners to answer or review), **citizen inquiry** (members of the public propose and engage in investigations and science projects) and **rhizomatic learning** (learners work together in dynamic ways to determine their own curriculum and modes of learning).

Themes	Pedagogies (with year of report)
Scale	Rhizomatic learning (2012) MOOCs (2012, 2013) Crowd learning (2013) Citizen inquiry (2013) Badges to accredit learning (2013) Massive open social learning (2014)
Connectivity	Seamless learning (2012, 2013) Flipped classroom (2014) Bring your own devices (2014) Crossover learning (2015)
Reflection	Assessment for learning (2012) Learning analytics (2012, 2013) Learning to learn (2014) Learning design informed by analytics (2014) Learning through argumentation (2015)
Extension	Geo-learning (2013) Learning from gaming (2013) Event-based learning (2014) Learning through storytelling (2014) Threshold concepts (2014) Computational thinking (2015) Context-based learning (2015) Incidental learning (2015) Learning by doing real science (2015)
Embodiment	Maker culture (2013) Bricolage (2014) Embodied learning (2015)
Personalisation	Personal inquiry learning (2012) Dynamic assessment (2014) Adaptive teaching (2015) Analytics of emotions (2015) Stealth assessment (2015)

Pedagogy themes that have emerged from the Innovating Pedagogy reports

Connectivity

Learning at scale offers opportunities for connectivity between learners from different nations, cultures and perspectives. The opportunity now is to understand how to create and manage courses that encourage productive discussion on controversial topics.

Connectivity not only covers learning between people, but also across locations. **Flipped classrooms** allow students taking courses in conventional schools and universities to learn the basic principles of a subject by watching videos and reading instructional text online, then meeting with tutors on campus to explore and discuss the topic in greater depth. In **crossover learning**, students may start an investigation in class, initiated by a teacher, then continue it outdoors or at home, using mobile devices such as smartphones to collect data and evidence that are then shared and presented back in class. These are specific kinds of **seamless learning**, connecting learning experiences across locations, times, devices and social settings. A policy of **bring your own devices** not only supports these teacher-managed forms of connected learning, but also allows students to follow their own lines of research and collaborative learning inside and beyond the classroom.

Reflection

All this activity online and in the physical world could suggest a future for education that is hugely dynamic and mobile. That may be one vision. But knowledge also comes from reflection and contemplation. The engine of learning is a continuous cycle of engagement and reflection, with our activity in the world – as we explore an environment, perform an experiment, or read a book – producing new information that must be assimilated with existing knowledge. This provides both the enrichment and the mental conflict that are sources for reflection and understanding, perhaps leading to discussion and plans for further investigation. This cycle of productive learning appears in school classrooms (where teachers encourage reading, reflection and discussion), the science lab (through experiment, note taking and synthesis of data), and field or museum trips (where students form an inquiry question, collect data in the field, then reflect on the findings at home or in the classroom). By learning the skills of structured **argumentation**, students can explain their reflective processes to others, thus engaging in a collaborative process of experimentation and discussion. This is part of a process of **learning to learn**.

Assessment for learning can help each learner to reflect on current learning difficulties, find relevant resources and overcome difficulties. At its most effective, this kind of formative assessment fits into the cycle of learning, providing feedback on how well new information has been learned and giving pointers to new learning activities that will fill gaps in knowledge.

Learning analytics, which enable data on processes and outcomes of learning to be used to improve the quality of teaching, offer a means for educators to reflect on how they teach and on the ways in which they **design for learning**. More broadly, schools and universities can introduce a process of institutional learning, with everyone, including students, using idea-sharing software such as IdeaScale to reflect on successes and failures, and propose ideas to improve the quality of education.

Extension

Some innovative pedagogies form part of this process of institutional improvement not by offering radically different ways of teaching, but by extending the scope of current teaching methods and overcoming their weaknesses. **Threshold concepts** are ideas that open up new ways of thinking about a problem. If a threshold concept such as ‘heat transfer’ or ‘centre of gravity’ is taught well, it can inform everyday activities such as cooking or sports coaching.

Learning through storytelling offers new perspectives on an ancient tradition through techniques such as practomime that blend classroom and online storytelling, with teachers and students creating shared stories. **Computational thinking** offers a powerful approach to solving problems using structured techniques derived from computing, including iteration, debugging and problem decomposition.

Technologies also enable us to extend the settings in which learning takes place. Students can now **learn by doing real science**, making use of lab equipment and expensive technology that is not

available on site but can be controlled remotely at distant locations. A variety of technologies, from televisions to augmented reality, also provide opportunities for **event-based learning** and **context-based learning**.

Management and orchestration of learning are essential to ensure that students are learning productively. As educators, researchers, and policy makers, we need to move beyond assumptions that playing games and chatting online with friends are necessarily bad. Instead, we should look for ways to integrate the worlds of social media, gaming and formal education. This will not be easy, given entrenched views, and it cannot be done in a naïve way, by adding a layer of game playing or social chat to traditional schooling. Perhaps the greatest challenge, and opportunity, facing education is to connect the productive **incidental learning** – that goes on in homes, workplaces, museums and the outdoors – with formal classroom education. This connection could be made using **learning from gaming** (an approach that enables employees to gain occupational skills of decision-making, strategy and negotiation through playing online strategy games) or **geo-learning** (students explore their local environment with the support of interactive maps and guides while connecting with other learners investigating the same environment online).

Embodiment

School, university and online learning all promote the primacy of abstract academic knowledge. Yet **embodied learning** recognises that we are creatures with bodies that we use to explore, create, craft, and construct. A renewed interest in **maker culture** has seen people gathering for maker faires, jamborees and craft days.

Enthusiasts use modern tools, such as Raspberry Pi hobbyist computers or 3D printers, to carry out environmental surveys, create soccer–playing robots, or design intricate jewellery. **Bricolage** is a practical process of learning by tinkering with materials, transforming products or materials that are ready to hand into new constructions. It is a fundamental process of playful learning, from building sandcastles to creating improvised art and fashionable clothing.

Personalisation

Continuing the physics analogy, personalisation is the mysterious missing particle of education. Since the early experiments with teaching machines in the 1950s, educational technologists have attempted to develop new methods of personalised instruction that will respond to the behaviour of each student, or infer students' mental states and correct their misunderstandings. So far, this has only been successful for limited topics in mathematics or science.

Adaptive teaching now offers the promise of using data about each learner's previous and current learning to create a personalised path through educational content. At the same time, **analytics of emotions** promise to provide personalised learning based on emotional responses, and **personal inquiry** provides opportunities for investigations based on a learner's own questions and interests.

Personalised learning is a wider process of understanding and developing the aptitudes and skills of each learner through methods such as **dynamic assessment** and **stealth assessment**. Is personalisation incompatible with learning at scale? Or will we be able to develop new pedagogies that offer thousands of learners the opportunity to pursue their personal pathways to knowledge, at the same time as they engage in shared discussion and collaborative inquiry?

Innovating Pedagogy

In our reports, we have aimed to understand and acknowledge learning in a world of interactive digital technologies. A focus on technologies could run the risk of chasing each invention up and down the switchback of innovation, marketing, hype and obsolescence. Some devices for education that have long been out of fashion, such as teaching machines, language labs, and integrated learning systems, reappear in new guises for the next wave of technology. By examining innovative pedagogies, we aim to ride the roller coaster of technology adoption, highlighting ways of teaching, learning and assessing that can be successful both now and in the future.

Resources

A provocative and enlightening blog post dealing with the perils of predicting the future of technology for education:
followersoftheapocalyp.se/i-watch-the-ripples-change-their-size-but-never-leave-the-stream-altc-2015/

IdeaScale software to create and share ideas:
Ideascale.com

The Open University

Innovating Pedagogy 2014

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

Mike Sharples, Anne Adams, Rebecca Ferguson, Mark Gaved, Patrick McAndrew, Bart Rienties, Martin Weller, Denise Whitelock

Open University Innovation Report 3

Contents

Executive summary

This series of reports explores new forms of teaching, learning and assessment for an interactive world, to guide teachers and policy makers in productive innovation. This third 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 Institute of Educational Technology in The Open University proposed 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 the ten sketches of new pedagogies that might transform education. These are summarised below, starting with two updates to last year's report, followed by eight new entries, in an approximate order of immediacy and timescale to widespread implementation.

1 **Massive open social learning:** Massive open social learning brings the benefits of social networks to the people taking massive open online courses (MOOCs). It aims to exploit the 'network effect', which means the value of a networked experience increases as more people make use of it. The aim is to engage thousands of people in productive discussions and the creation of shared projects, so together they share experience and build on their previous knowledge. A challenge to this approach is that these learners typically only meet online and for short periods of time. Possible solutions include linking conversations with learning content, creating short-duration discussion groups made up of learners who are currently online, and enabling learners to review each other's assignments. Other techniques, drawn from social media and gaming, include building links by following other learners, rating discussion comments, and competing with others to answer quizzes and take on learning challenges.

2 **Learning design informed by analytics:** Learning design is used in the development of courses or series of lessons to help educators plan a coherent sequence of media, technologies and pedagogies. The use of learning design tools and templates shifts attention away from content, towards learner activities and the learning journey. A learning design specifies intended learning outcomes, identifies the ways in which these are to be achieved, and sets out how they will be assessed. Data from tracking and management of learning activities can inform learning design by providing evidence to support the choice of media and sequence of activities. When analysis of learning data is also used to evaluate and improve

learning design, the circle is complete, so design and analytics work together to support the development of successful learning and teaching.

3 **Flipped classroom:** Flipped learning reverses the traditional classroom approach to teaching and learning. It moves direct instruction into the learner's own space. At home, or in individual study time, students watch video lectures that offer them opportunities to work at their own pace, pausing to make notes where necessary. This allows time in class to be spent on activities that exercise critical thinking, with the teacher guiding students in creative exploration of the topics they are studying. Flipped learning is sometimes seen simply as a different approach to delivering content. It also offers opportunities for the classroom to become a more flexible environment, where the physical layout can be shifted to enable group work, where students can make use of their own devices, and where new approaches to learning and assessment are put into practice.

4 **Bring your own devices:** When students bring their own smartphones and tablet computers into the classroom, this action changes their relationship with the school and with their teachers. They arrive equipped not only with individual technologies that they maintain and improve, but also with their own personal learning environments and social networks. This means that teachers become managers of technology-enabled networked learners, rather than providers of resources and knowledge. This shift opens opportunities for connecting learning inside and outside the classroom. Computer-based activities that are set in the classroom can be continued elsewhere and then shared at school. Students' personal collections and networks, gathered inside and outside school, can become resources for learning. Bring-your-own-device (BYOD) approaches have the potential to reduce the cost of ICT provision and introduce new possibilities for learners, but they also offer new challenges. Schools need to be willing to support a wide range of technologies and to open their educational networks to new devices. They must also avoid disadvantaging learners who cannot afford suitable devices, and develop ways for individuals to keep their social and learner identities apart if they prefer to do so.

5 **Learning to learn:** We are always learning. Throughout our lifetime we take on board new ideas and develop new skills. What we find difficult are learning what others want to teach us, and managing our learning in order to achieve particular goals and outcomes. Self-determined learning involves learning how to be an effective learner, and having the confidence to manage our own learning processes. 'Double-loop learning' is central to this process, for double-loop learners not only work out how to solve a problem or reach a goal, but also reflect on that process as a whole, questioning assumptions and considering how to become more effective. This helps them to become self-determined learners with the ability to seek out sources of knowledge and make use of online networks for advice and support. Web tools and activities such as reflective journals and concept mapping have been designed to support learning to learn, but these are rarely well integrated into a learner's social world. There may be more value in adapting for wider use social research environments such as ResearchGate, or question-answering communities such as StackExchange and Quora.

6 **Dynamic assessment:** Dynamic assessment focuses on the progress of the student. The assessor interacts with students during the testing phase of the process, identifying ways to overcome each person's current learning difficulties. In the dynamic assessment process, assessment and intervention are inseparable. This approach has been used with university students, with school children learning physics, and with children who have particular learning difficulties. Although labour intensive, it has the potential to be used as part of a range of assessment tools.

7 **Event-based learning:** Event-based learning runs over a few hours or days and creates a memorable sense of occasion. Examples are the 'maker fairs' that gather together enthusiasts who are keen on do-it-yourself science, engineering and crafts projects, and the 'Raspberry jams' where fans of the Raspberry Pi computer meet up and share ideas. Local events spark national gatherings and these build into international festivals. Many, like the UK's annual Springwatch week or the worldwide Scratch Day for computer programming, are initiated at national or international level, but all depend upon local enthusiasm and initiative. The time-bounded nature of an event encourages people to learn together, its local setting supports face-to-face encounters between amateurs and experts, and the scale of an event can provide access to resources that would otherwise prove inaccessible. Having such an event as a focus gives learners something concrete to work towards and to reflect upon afterwards, together with a sense of personal engagement and excitement.

8 **Learning through storytelling:** Learning requires a structure that helps learners to embed and revisit their understanding. Stories provide one way of creating this structure. Developing a narrative is part of a process of meaning making in which the narrator structures a series of events from a particular point of view in order to create a meaningful whole. Writing up an experiment, reporting on an inquiry, analysing a period of history – these are all examples of narrative supporting learning. Indeed, much of our education involves combining different things we know in order to create an understanding of what has happened and, as a consequence, what can be expected to happen in the future. These accounts can be used to link memories of events, binding them together to form larger, more coherent chunks. In a narrative approach to learning, the creation of stories is emphasised, allowing learners to navigate resources and to add coherence to different experiences. Narrative encourages the combination of historical overview and modern practice. It can provide emotional engagement and relevance for learners, together with personal involvement and immersion.

9 **Threshold concepts:** A threshold concept is something that, when learnt, opens up a new way of thinking about a problem, a subject or the world. An example is the physics concept of 'heat transfer' that can inform everyday activities such as cooking or home energy use. These concepts help to define subjects, they shift learners' perceptions of a topic area, and they usually prove difficult to unlearn. Teachers are increasingly using threshold concepts as starting points for the design of effective lessons. They can also be used as a focus for dialogue between students, teachers and educational designers. A challenging aspect of threshold concepts is that they often seem strange and unintuitive. Students who appear to have understood these troublesome concepts may be unable to put them into practice, instead falling back on common-sense, but inaccurate, beliefs. Momentum for using threshold concepts to help teaching is growing across disciplines. One approach is to develop standard sets of threshold concepts for different subject areas; another is to embed them in teaching and learning processes and practices.

10 **Bricolage:** Bricolage is a practical process of learning through tinkering with materials. It involves continual transformation, with earlier products or materials that are ready to hand becoming resources for new constructions. It is a fundamental process of children's learning through play, as they create castles out of boxes and tell stories from remembered events. It also forms a basis for creative innovation, allowing inventors to combine and adapt tools and theories to generate new insights, while also engaging with relevant communities to ensure that the innovation works in practice and in context.

Introduction

This is the third in a series of annual 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.

As in previous years, this report has been written by a small group of academics in the Institute of Educational 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 reducing these to ten that have the potential to provoke major shifts in educational practice. For this 2014 report, we take different perspectives on two topics that were covered in the previous reports and introduce eight further pedagogies that are already being introduced into educational practice or offer opportunities for the future.

Massive open online courses (MOOCs) are still making headlines. The focus now is not on the phenomenon of free courses, but on how they are starting to transform education by offering 'nano-degrees' that teach the minimum skills needed to enter a new career, or by providing complete degree courses constructed from open access materials. MOOCs are also a giant laboratory for testing new methods of teaching, learning and assessment. Analyses of the ways in which many thousands of people are learning online are already starting to influence the design of courses in universities and workplaces.

A central theme of massive-scale courses is 'personalization'. The idea is that each learner can be given the power to choose when, where and how to study, and that the teaching adapts to the learner, either by providing instruction that is matched to a person's approach to learning, or by offering supplementary teaching if the learner makes a mistake in an online test.

Ninety years ago, Sidney Pressey developed the first adaptive teaching machine – a mechanical testing device that presented a question with a choice of multiple answers. If the student got an answer wrong, the machine removed that answer until the student selected the correct response: the first demonstration of automated 'mastery learning'. In his 1933 book, Psychology and the New Education, Pressey wrote,

> "There must be an 'industrial revolution' in education, in which educational science and the ingenuity of educational technology combine to modernize the grossly inefficient and clumsy procedures of conventional education. Work in the schools of the future will be marvelously though simply organized, so as to adjust almost automatically to individual differences and the characteristics of the learning process. There will be many laborsaving schemes and devices, and even machines – not at all for the mechanizing of education, but for the freeing of teacher and pupil from educational drudgery and incompetence."

Pressey's prediction of an industrial revolution in education by automating the teaching process never happened. Over the years, many projects have developed personalized methods of tutoring that adapt to a student's knowledge, skills, strategies and preferences. Some, such as the Cognitive Tutors® from Carnegie Learning, track each response from the learner, infer the current state of the learner's knowledge, and adapt the teaching accordingly. Each Cognitive Tutor has taken many years to develop, for a specific area of mathematics. These are promising developments, with successful outcomes, but they will not address the worldwide need for education in practical skills, arts, sciences, and humanities. In a post-industrial world of interconnecting networks of people and technologies, there is a growing realisation that social learning alongside personalized instruction may be the key to mass online education.

Pressey's Automatic Teacher, circa 1929

One new development brings the power of social networks to massive online courses, so that learners create personal profiles, engage in conversations, follow people they find interesting, seek 'study buddies' for learning together, form study groups, and build communities of shared interest. New directions in social networks are already starting to influence education. These include live feeds of current activity (such as news items relating to the course, or the learning activities of a group of study friends) and location-based activity, with people contributing video, images or sounds related to their local environment. Social learning is not just a means of sharing learning resources, but a valuable activity in itself. Learning together creates a 'shared mind' that combines different perspectives and alternative ways to solve problems.

Another major trend is towards blending learning within and outside the classroom. This is shown in flipped classrooms, where students watch video lectures at home and discuss them in class. It is also appearing with students bringing their own devices into the classroom along with their personal software and social networks. Initially seen as an unwelcome disruption, or even a threat to school discipline and a danger to children, there is now a drive to educate young people in how to use their own technologies to be inquiring and collaborative online learners. In this way the personal and the social combine, to create a new form of learning based on networked collaboration through personal technologies. Pupils are saved, in the words of Pressey, from educational drudgery and incompetence by joining online communities, asking questions, seeking answers, creating and sharing resources. But this is no online utopia. We also realize the limitations and dangers of mass networked learning, from the spreading of hate literature, to the invasion of online forums by bullies and demagogues. Teachers and leaders have an important role in helping young people learn how to learn online, and in shaping safe and engaging communities.

"Learning together creates a 'shared mind' that combines different perspectives and alternative ways to solve problems."

Resources

Nanodegrees from Udacity:

http://blog.udacity.com/2014/06/announcing-nanodegrees-new-type-of.html

Cognitive Tutor® software from Carnegie Learning:

http://www.carnegielearning.com/

Review of Sidney Pressey's contributions to learning and technology:
Petrina, S. (2004). Sidney Pressey and the automation of education, 1924-1934. *Technology and Culture*, 45 (2), 305-330.

Quotation from pages 582-583 of:
Pressey, S. L. (1933). *Psychology and the New Education*. New York: Harper & Brothers.

The Open University

Innovating Pedagogy 2013

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

Mike Sharples, Patrick McAndrew, Martin Weller, Rebecca Ferguson, Elizabeth FitzGerald, Tony Hirst, Mark Gaved

Open University Innovation Report 2

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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

The Open University

Innovating Pedagogy 2012

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

Mike Sharples, Patrick McAndrew, Martin Weller, Rebecca Ferguson, Elizabeth FitzGerald, Tony Hirst, Yishay Mor, Mark Gaved, Denise Whitelock

Open University Innovation Report 1

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Executive summary

This series of reports explores new forms of teaching, learning and assessment for an interactive world, to guide teachers and policy makers in productive innovation. The first 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 Institute of Educational Technology in The Open University proposed 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. We have not deliberately excluded school education, but that is not our area of expertise. Lastly, we drew on published and unpublished writings to compile the ten sketches of new pedagogies that might transform education. These are summarised below in rough order of immediacy and timescale to widespread implementation.

1 **New pedagogy for e-books:** As e-book technologies evolve, they will offer new ways of interacting with massively shared, adaptive and dynamic books. Teachers will be able to write alternative versions of text, embed graphs and simulations showing live data, add summarization, and use tools such as timers and calculators to support structured learning and formative assessment. Students will be able to share annotations or contact other people reading the same page of a book. New forms of learning with e-books could include crowd authoring (where textbooks are produced by students, for students), embedded tutoring (where readers offer to explain or discuss a difficult passage), or co-reading (where readers are automatically put in contact with others currently reading the same page).

2 **Publisher-led short courses:** These are short courses offered by publishers either in affiliation with recognised educational providers, or independently. The publisher's incentive is to understand learners in the subject areas covered by their regular publications, and to engage consumers in extended learning activities. For the learner, these courses offer self-directed learning for professionals, with institutional affiliation providing respectable 'leisure learning' products.

3 **Assessment for learning:** Assessment can support the process of learning, not just measure its outcomes. In diagnostic testing with rapid feedback, the results of summative computer-based assessment are provided immediately to learners and teachers, then used as a basis for addressing misconceptions and

providing supplementary teaching. Research from computer games has explored how continuous feedback can guide performance and improve motivation. This requires software to monitor how learners progress through the course materials, diagnose misconceptions, know when to intervene, and offer appropriate advice. A teacher can be provided with a 'dashboard' that displays the progress of each student and offers a range of actions from simple automated prompts to online student-tutor conversation. Students can be offered 'open learner models' that show their progress in relation to peers.

4 **Badges to accredit learning:** Badges offer a way of accrediting non-formal learning. A badge, analogous to a Scout badge, is awarded when a learner completes a task or challenge that demonstrates a learning achievement. Badges may be awarded by authorities, by peers, or may be automatically assigned on completion of certain tasks. Badge systems have been used to encourage participation in online help forums and to acknowledge expertise in gaming environments. New approaches support the collection and validation of badges for learning, and work is in progress to develop an infrastructure to award, manage and validate badges.

5 **MOOCs:** Massive open online courses are attempts to create open-access online courses that provide no constraints on class size. They run over a defined period of time and are open to all. The early instantiations followed a pattern of 'let's put on a course here, right now'. More recent offerings take the form of free courses based on existing university teaching materials freely available online, with computer marked assessment and certificates of completion. Some courses have engaged over one hundred thousand participants.

6 **Rebirth of academic publishing:** There are two commonly used approaches to open access publishing: the Gold route, whereby the author or research funder pays a publisher for the cost of making an article open; and the Green route, where the individual author self-archives the article. Some journals have begun to experiment with open review where the reviewers' comments are made public and not anonymised. Others adopt a low threshold for acceptance, replacing peer review selection with post-publishing commentary.

7 **Seamless learning:** Seamless learning occurs when a person experiences a continuity of learning across a combination of locations, times, technologies or social settings. Previous work on seamless learning has focused on designing software for mobile devices that allow people to carry their learning with them and to switch quickly from one learning activity to another. Recent studies have also examined how to support learning journeys. These are extended learning projects that can be accessed on multiple devices, flow across boundaries between formal and informal settings, and continue over life transitions such as school to university and workplace.

8 **Learning analytics:** Learning analytics involves the collection, analysis and reporting of large datasets about learners and their contexts in order to improve learning and the environments in which learning takes place, for example visualisations and recommendations that can influence student behaviour while a course is in progress. Current research is attempting to identify key indicators that show when a student is making good progress or is struggling. From a practical perspective, systems need to allow real-time analysis of disparate data and generate timely reports.

9 **Personal inquiry learning:** Typically, personal inquiry learning involves active exploration of an open question, with the student taking ownership of the inquiry process. Mobile phones can become inquiry toolkits. A typical inquiry might start in a formal setting, with a tutor helping students to refine their questions, continue at home or outdoors with the students collecting and viewing data, then return to the formal setting to share and present results. Inquiry learning can extend existing online or classroom learning. It also has the potential to catalyse citizen science experimentation.

10 **Rhizomatic learning:** This invokes the metaphor of a rhizome, a plant stem which sends out roots and shoots that allow the plant to propagate itself through organic growth into the surrounding habitat. Seen as a model for the construction of knowledge, rhizomatic processes suggest the interconnectedness of ideas as well as boundless exploration across many fronts from different starting points. For the educator, supporting rhizomatic learning requires the creation of a context within which the curriculum and knowledge are constructed by members of a learning community and which can be reshaped in a dynamic manner in response to environmental conditions. The learning experience may build on social, conversational processes, as well as personal knowledge creation, linked into unbounded personal learning networks that merge formal and informal media.