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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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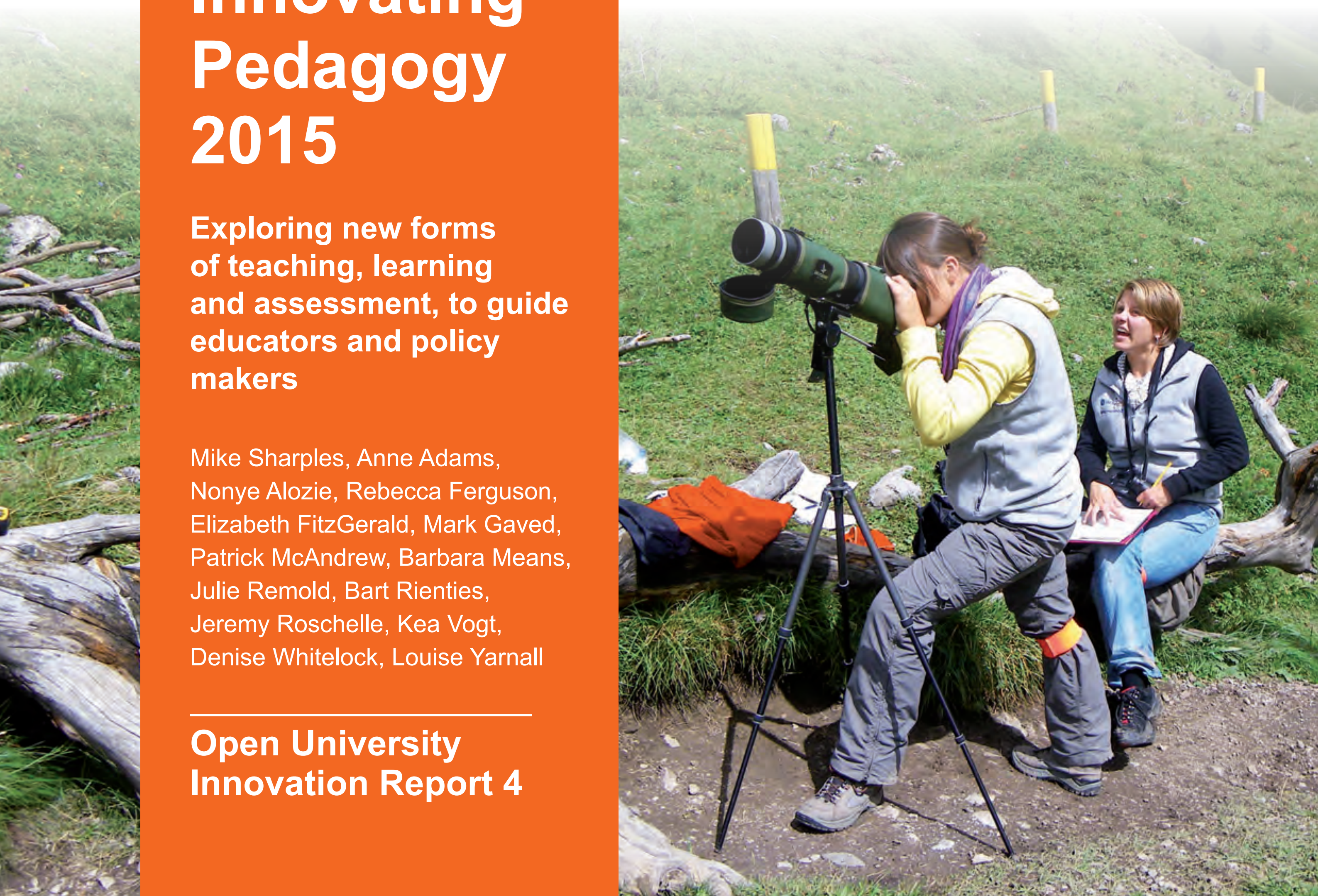

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Executive summary

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 Lastly, we drew on published and unpublished writings to compile the ten sketches of new pedagogies that might transform education.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**