Learning from MOOCs: lessons for the future
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Introduction
In addition to stimulating a valuable worldwide debate about online learning in higher education, Massive Open Online Courses (MOOCs) have also triggered a large amount of very active educational and technological research. This research is helping to inform further developments in the design and delivery of MOOCs themselves, but importantly is providing insights into learning in more traditional higher education settings where use of technology is now commonplace. I shall review some of the research approaches to studying MOOCs and some of the findings from this research where broad agreement exists. Then I shall look to future opportunities in research and also in how MOOCs, and open education more generally, might align with a vision for digital education in universities in the 21st century.

Types of MOOC research

Two types of research into the learners who study on MOOCs are the most common, addressing respectively the questions: “Who studies on MOOCs?” and “What do MOOC learners actually do on course?”

In the first kind of research the data gathered are concerned with demographics, MOOC intentions, satisfaction, prior experiences and future intentions [1 - 3]. The data are obtained mainly from surveys of MOOC learners – before, during and after the individual courses, and as with all survey data these are never 100% complete as often only around 20% of potential respondents do offer information by completing surveys. Thus the majority of learners are ‘unknown’, although cross-comparisons with other more complete data from server logs for example, suggest that they are reasonably representative of the MOOC learner populations as a whole. There is an active debate taking place in the online learning community about the ethics of the data gathered from online learners, and whether they are aware that such data are being gathered, how they might consent (or otherwise) to its use for research, and how data can be shared [4]. Survey data have the disadvantage of their incompleteness but the advantage of being explicitly gathered.

The second type of research is concerned with identifying types of learners in terms of their engagement with the MOOC course technologies, at what points some learners cease to study the course (stop-out points), their use of the various online tools (e.g. forums, quizzes, videos), whether they repeat activities to improve their scores, and their posting, viewing or non-engagement with online discussions and groups [5-6]. As these data are system data, recorded as every click of the mouse and keyboard, they are 100% complete, but of course they can only record on-system study and not what is done offline. In terms of the ethics of the data gathering, they are less clear-cut than survey data, and although the MOOC platforms do explain data-gathering and its use in their terms

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and conditions, this is in the ‘small print’, and it is not certain that all learners are actually aware that their data are being analysed for research after they have been collected automatically.

I shall concentrate mostly on the first type of research in this chapter, as this is the research we have concentrated on in the University of Edinburgh, and authors of other chapters in this book deal with the second type [see e.g. 7].

It is worth noting here that the field of MOOC research is very new, with a very small number of early MOOCs being released in late 2000’s, and most of the very large scale MOOCs that attracted so much press attention were only being released from 2012 onwards. As a consequence there are still rather limited numbers of peer-reviewed publications based on MOOC research, especially using scientific experimental designs, with many reports being early data releases or individual case studies [8]. This is changing rapidly, and funding for MOOC research is supporting more rigorous studies [9]. I shall return to this theme later in the chapter.

What have we learned from this research?

Firstly, we have learned to work with, and become accustomed to, ‘learning at scale’, in sharp contrast to most educational research in traditional settings where class sizes are quite small, and research samples often even smaller. A medium-sized MOOC can easily have 30,000 learners enrolled, large ones twice that number, and so researchers have to re-think their frame of reference. Moreover, this is open education – anyone with an internet connection can enrol to study for no fee – and so the norms of formal higher education do not apply, such as being ‘obliged’ to complete courses, to participate in all or most activities, or to take the tests and exams. MOOC learners are present in each course voluntarily and can enter, leave and re-enter them as they wish. In the 2.5 years since we began offering MOOCs in late 2012 we have had enormous numbers of learners engaging with our courses, and we have gathered a very large volume data from as many people as possible. Table 1 below gives an indication of the volume of learner data that MOOCs generate, taken from the data logs of the University of Edinburgh MOOCs from end 2012 to summer 2015 (i.e. 2.5 years). This is on a scale that we did not imagine when we began designing our first six MOOCs in late 2012.

| 1.4 million enrolments (over 1 million unique individuals) | 218 countries represented |
| 10.5 million video views | 85 academics (+ 109 tutors) involved |
| 1.9 million quizzes submitted | 38 live course iterations |
| 667,967 active learners (took at least one week of study) | 24 different MOOC courses produced |
| 353,934 forum posts made | 15 academic Schools (of 22) in the university involved |
| 88,845 completion certificates awarded | 6 core central support staff |
| 745+ videos created | 2 MOOC platforms (Coursera - USA & Futurelearn - UK) |

Table 1: University of Edinburgh MOOC statistics 2012-2015
In the spirit of openness, we have made all our analyses public, and they can be found at: 
http://moocs.is.ed.ac.uk  We can summarise our findings about the characteristics of our MOOC 
learners as follows:

**Age:** The youngest MOOC learners are in their teens, the oldest above 65 years. The great majority 
are between 21 and 45, with a peak of learners in their 20’s-30’s.

**Gender:** Despite an initial expectation by some, mainly based on the first MOOCs in very technical 
subjects, most MOOC learners are not males (particularly young technically-oriented ‘nerds’) but are 
approximately evenly distributed between females and males. This is true across the age range.

**Geographical location:** Learners come from almost everywhere; ours are in 218 countries. The 
largest group, but not the majority of learners, come from western countries, with the US being the 
largest group dominant on US platforms and the UK on the UK platform (as the French are the 
largest group on the French platform FUN). As the number of learners from around the world 
increases, so the distribution flattens and learners from single countries diminish as a proportion.

**Education level:** As shown in Figure 1, most MOOC learners are well educated, on average 70% will 
have a first or second degree. Learners from less well-educated backgrounds, e.g. high school as 
highest achievement, are very much a minority, and this has led some to criticise MOOCs for failing 
to reach the relatively disadvantaged with their free education despite the initial hype and promises 
[10]. However, as the numbers of learners are large, so are the numbers of learners in minority 
groups, such as the low educational levels. For some people, albeit in a very small proportion of the 
total learners, being able to access free online university education has been very signifi 

![Figure 1: Education levels of learners on a typical University of Edinburgh Coursera MOOC](image)

**Publicity and public awareness of MOOCs:** The most obvious reason for the average composition of 
the learner populations on MOOCs is that, until recently, publicity has been mainly restricted to the 
English language media, and then to TV, radio and newspapers that address a mainly educated 
audience [12]. Little coverage has been achieved in ‘blue collar’ media channels, but as the subject
matter of MOOCs, and their overall presentation, have been mainly quite academic and at university level, they are unlikely to appeal to this readership. However, where MOOCs have been designed with a wider appeal, and where audiences have been more targeted, enrolments can be shifted towards other demographics. We have seen this in Edinburgh on our ‘Introduction to Philosophy’ MOOC; when teachers in Scottish schools were made aware of the course for their students we had increased uptake by these younger learners. Our ‘Equine Nutrition’ MOOC targeted the horse-owning population, through Facebook and other community channels, and had learners with a much wider education range than usual. As experience grows in designing MOOCs for designated audiences, as opposed to MOOCs for anyone, word about them can be spread through digital channels and special interest media outlets to reach those most likely to be interested in taking these courses. Such learners tend to stay to the end of the course more than average, and to be more active online during and after.

**Reasons for studying MOOCs:** From the outset we have asked everyone who enrolled on our MOOCs why they did so, and the consistent and overwhelming majority answer has been ‘to learn new things’. However, alongside this rather unsurprising answer were many people who also told us that they wished to see what online learning was like. One important conclusion that can be drawn from this finding is that, overall, the MOOCs have offered an opportunity to the general public to explore one form of online learning (albeit quite limited in many respects), without the overheads of enrolling in a college or university, paying fees and making a major commitment. Several tens of millions of individuals have now enrolled on MOOCs and had this experience, arguably something that was not achievable in any other way. This may well contribute to an already growing wider public acceptance in developed countries that online education is not only feasible but can be a solution to study whilst maintaining the other commitments in one’s life.

**Intended and actual achievement on MOOCs:** Around 20% (and rising) of our survey respondents said that they wanted a certificate at the end of the course, and that they also had career enhancement in view. There was a strong linear relationship between their age and this intention, with the youngest learners saying this most (50%) and the oldest least (10%). Again this is perhaps unsurprising; younger learners will be most career-conscious, and seek ways to improve their fortunes. However, when we examined the actual achievements of the learners who stated that they intended to gain a (paid for) certificate, the youngest were much less successful than the oldest learners in reaching their goal. Younger learners underachieved whereas older learners overachieved (Figure 2).
Figure 2: Intentions and outcomes (achievements) of learners on University of Edinburgh MOOCs by age group. Certificates are a paid-for option for completing the entire course.

Clearly, younger learners may well be more time-challenged, and perhaps may also be overly optimistic about what they can achieve, but this is a worrying finding for us and we, with the MOOC platform staff, are actively seeking ways to encourage and support all learners to stay the course, through automated prompts and reminders, and regular feedback on progress.

**MOOC to MOOC variability:** The analyses and interpretations above, like those reported by others, are based on data pooled from many individual MOOCs, indeed from multiple offerings of those MOOCs. Although this allows us to see generalised phenomena and trends, it also masks any differences in the data drawn from individual MOOCs, and also any variations over time. It also results in many public commentators using these data as the basis of their work, and creating a greatly over-simplified picture of what is taking place.

We have made two clear observations from our data. Firstly, that the patterns of commonly measured features of MOOCs, such as retention of learners, age, educational levels, gender and achievement of certificates (i.e. full course completion) vary greatly between MOOCs. As examples, our range of those who enrolled who turned up and were active in Week 1 ranges from 20% to 60%, those who gained a certificate from 1% to 25%, and the percentage of the learner population in the age range 18-24 varies from 10% to 36% and in the age range 55-64 from 2% to 11%. Secondly, despite the fully open nature of MOOCs where anyone in the world with an internet connection can take them, MOOCs have rather stable characteristic patterns of these common features, and they generally change only slowly with time. This is not something we would have predicted at the beginning of our venture into MOOCs. The reasons are unclear; social media channels, the way each MOOC is promoted (each has a short video with the key academics talking about the course), or the news and media channels in which reporting takes place are all possible factors.

Greater detail on our Edinburgh data, and our analyses of them, can be found in [13-14, 3; open access versions at http://thinking.is.ed.ac.uk/jeffhaywood]. Our results align well with those of other researchers [15-16].
Where next for MOOC research?

Research into who studies on MOOCs, their motivations and what helps them to succeed, will continue, as will more technical research into how learners use the technology tools of the MOOC platforms. This will grow richer as more MOOCs and MOOC platforms become available, and especially more robust as educational researchers seize the opportunity for rigorous studies that the early, very rapid, phase of MOOCs made difficult. The staff of the MOOC platforms, often with strong academic backgrounds, have also shown themselves to be interested in this type of research [16-18]. There is rich potential for research into aspects such as: which pedagogical designs best support different types of learners; how to create effective large-scale and rigorous assessment methods; what is the real-world value to learners of MOOC study; what are the best ways to conduct citizen science within MOOCs; and how to support multilingual, multicultural collaborative learning.

Another strand of research that has opened up is designing and testing new software tools that support a wider and more complex range of learning activities than MOOCs currently offer. The major educational leap forward that was taken with the first MOOCs was not that they enabled learning online, which was well established by 2012, but that they used technology to take higher education to very large scale (‘massive’) with very small numbers of professors and tutors (our Edinburgh MOOCs typically have a learner:tutor ratio of 10,000:1).

In his 2012 Tanner Lecture, William Bowen, a well-respected higher education economist, wrote that: “Information technology has been extremely consequential in higher education over the last 25 years but principally in ‘output enhancing’ ways that do not show up in the usual measures of either productivity or cost per student.” [19 p.6]. One opportunity that MOOCs offer is to provide a testbed for experiments in teaching at large-scale through technology. For delivery of educational content, video is already a highly efficient educational tool, and streamed video over the internet is able to support almost unlimited numbers of learners, with flexibility of time and place. At the opposite end of the spectrum, some educational activities are unlikely to be truly scalable through technology in the foreseeable future, for example high stakes examinations requiring essays and personal advice and guidance. But between these two extremes, for example in simple formative and summative assessments, in the management of large numbers of groups working together, in coping with very large volumes of messages on forums etc., technology might enable a single tutor to manage and support very large numbers of learners by giving them a ‘lever for scale’.

An example of this technology leverage is to support peer review and assessment on a large-scale to enable MOOCs to offer learners the chance to write extended prose rather than using objective, multiple choice tests, which are less appropriate in some subjects. In the University of Edinburgh we have begun to trial some new technologies that support adaptive comparative judgment (ACJ) in which learners can rank a group of assignments allocated to them, and by automating a large number of overlapping rankings, very many assignments can be ranked before an expert grades a sample [20]. We are also testing software that will analyse MOOC Twitter accounts to detect routine questions or queries (for example assignment due dates) and will provide an automatic reply without teacher intervention [21]. Finally, we are considering whether similar techniques to those used in learning analytics and the types of visual dashboards that are used to make complexity intelligible (e.g. CourseSignals at Purdue University, http://www.itap.purdue.edu/learning/tools/signals/), might be used to enable single tutors to
‘survey’ large numbers of discussion groups to identify those with problems and thus where human intervention is needed.

In addition to the error of viewing all MOOCs as the same (see above), there is a tendency to view all MOOC platforms as the same, and this is equally incorrect. Part of the problem is that commentators often come from English-speaking countries, especially the USA, and so are not always aware of the worldwide changes that are taking place. For example the French platform FUN offers MOOCs in French, and hence is addressing Francophone countries, especially in West Africa [22]. The Arabic language platforms address a worldwide diaspora of Arabic speakers as well as those in the Middle East [23], and platforms are appearing in India, China and Japan [24-26]. Even the technology, often assumed to be ‘neutral’ can be used to create platforms with different affordances, especially in the pedagogical designs that the MOOCs are built upon, e.g. didactic versus social constructivist [18]. Finally, the MOOC platform companies are constantly seeking to expand their reach and their number of enrolled learners, and so they experiment with different approaches. To address the growing number of learners who wish to study for career enhancement or towards college and university entry, MOOCs are being offered as mini-curricula, in a series with a capstone course at the end. To permit learners to complete the curriculum in a reasonable period of time requires that the MOOCs are re-run often, something that is not presently done by most universities offering MOOCs. To address this problem, Coursera in the USA is now offering its MOOCs in an ‘always-on’ format rather than in the traditional sessional course with a defined start and end [27], and we in Edinburgh are converting most of our MOOCs on Coursera into this new format.

New MOOC platforms and formats, with new audiences, new subjects and at a wider range of educational levels, create a rich field for educational research, but they also indicate the need for great caution in generalising too much about ‘what MOOCs are’. Much of the early hype about MOOCs has declined but the early generalisations are ‘sticky’ and still rely on those early data and their analysis. In this rapidly changing area, which is often quite hard to keep up with, we have few data points over time – MOOCs are still quite new – and so, unlike educational research in traditional higher education settings, there is a limited baseline from which to work. This is a field in which agility in research will be important if research is to keep up with rapidly changing practice.

The implications of MOOCs for the future of higher education

The substantial experimentation that is being done to use MOOCs in quite different ways to their original design as free-standing, open online courses is bringing them closer to the mainstream of traditional higher education. They are being used as closed online courses for residential students [28], for university credit [29], as educational content that can replace lectures as ‘flipped classroom’ as illustrated by Gunnar Karlsson and Sverker Janson in Chapter 3 of this volume [30, see also 31], as parts of degrees [32-33], to create joint online courses [34], and as franchised ‘content’ to universities other than their creators [35]. An increasing number of universities are offering MOOCs (https://www.mooc-list.com/) and some are offering substantial numbers of them (for example, the University of Edinburgh has launched 30). These activities are both mainstreaming MOOCs into normal academic business, and also increasing interest in open education generally. As a consequence, MOOC research is of direct importance to the mainstream of higher education, as it becomes more permeated by the use of technology (i.e. ‘blended learning’), as well as for the advancement of understanding about MOOCs themselves.
So, how might a traditional university incorporate MOOCs and open education into its educational portfolio, and how would they sit alongside its other offerings? The University of Edinburgh has a strong vision about the role that technology will play in all its degrees and courses; this is shown diagrammatically in Figure 3 below. The technology systems and software that we offer will be rich in diversity, supporting all types of educational activities, including laboratories and fieldwork as well as lectures and seminars. The digital library with a great abundance of electronic journals and books, and an expanding open access repository, lies at the heart of our education.

By 2025 we aim to provide all our residential students with at least one fully online course to choose in their degree programmes, as we know that, once graduated, adults return to studying for their careers and general interest in an online format. Thus learning online is a graduate skill for the future. Our fully online post-graduate degrees (mainly Masters, with many individual modules available as continuing professional development, CPD) will expand in number so that we shall have as many postgraduate students online (i.e. off-campus) as we have in residential courses (i.e. on-campus). Our lifelong learning (continuing education) offering is already substantial, with around 17,000 individuals on our register, although these are currently courses located physically in the city of Edinburgh. Alongside these face-to-face courses we shall be offering fully online short courses for anyone in the world, for a modest fee, and some will offer credit. Finally, open education will still be present in our portfolio in the form of whatever MOOCs have by then become. These four modes of study and qualification levels will be closely related in terms of both content, sharing video for example, and also in a learner’s freedom to move from one mode to another and carry recognition of that learning with them. As a consequence, the scale of the education that we offer will have grown enormously from what we might have imagined before MOOCs came on the scene.

We do not see MOOCs and open education as disruptors of our academic business, displacing us from our core business as some have predicted [36] but we do see them as perturbing our traditional approaches and irresistibly so [37]. We are therefore adapting, learning from research and experimentation, to enable us to offer a better, more fit-for-purpose education for the coming decades.
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