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Will MOOCs transform learning and teaching in higher education? Engagement and course retention in online learning provision

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Abstract

Massive open online courses (MOOCs) have been the subject of much polarised debate around their potential to transform higher education in terms of opening access. Although MOOCs have been attracting large learner cohorts, concerns have emerged from the early evidence base centring upon issues of quality in learning and teaching provision, and there is clear evidence that impressive headline figures on MOOC enrol- ments often contrast with extremely low course completion rates. To address these concerns of quality, low retention and the need for engagement, this paper provides a review and case study of MOOC provision. The review considers the current position of MOOCs as a change agent for higher education provision, and the case study considers lessons learnt from an Astronomy MOOC which uses the Open2Study platform. This paper asks about new engagement strategies needed for face-to-face and online learners, and explores how course retention can be improved in online provision.

The transformation of learning and teaching in higher education: lifelong learning and the emergence of online learning

Due to the global economic downturn, we are living at a time of economic uncertainty and high unemployment; therefore, the need for individuals to up-skill themselves to become more employ- able is critical for ensuring local, regional, national and international social stability, and eco- nomic regeneration. Against this backdrop, the renewed importance of individuals of all stages of their lives learning new skills and information, whether at work, home or in study is part of a self-improving and developing trend that is underpinning lifelong learning and setting up tech- nology enhancements for learning in face-to-face, blended and purely online modes of delivery (eg, Evans, Schoon & Weale, 2013; Fallows & Steven, 2013). As a result, lifelong learning has become a more significant aspect of *how we learn* and *when we are able to learn*. Furthermore, advances in digital communications make the vision of universal higher education, as first put forward by Comenius in the seventeenth century, attainable in the twenty-first century (Sadler, 2013).

Moreover, the growing availability of broadband and the digital revolution have opened up new forms of learning content production and delivery: for example, *online learning* opening up ready- access to digital media rich content and more recently *mobile learning* allowing us to change *where*

Practitioner Notes

Massive Open Online Courses (MOOCs) are courses delivered via online modes:

- They are short learning courses.
- They reach large international audiences.

- They can be used to support learning needs of independent learners, university stu-

  dents and professional learners.

- They can provide a supplement to formal learning.

Inhibitors to successful MOOC course completion include:

• Unengaged students.
• Difficulty level not aligned to the skills of the student. • No accreditation.
• Ineffective assessment and limited feedback.
• Lack of interactivity of the course offering.
• No peer or tutorial support.

MOOCs can be more engaging:

• Game-based or gamification elements.
• Interactive digital content.
• Quizzes and immediate feedback.
• Correct difficulty level personalised to student.
• Link to longer course and deeper learning materials. • Real world challenges and testing.

we learn—anytime and anywhere. This more *flexible* learning or "*new learning*" as it can be termed has revealed benefits for learners of all ages and importantly opened *equal access* to education at all ages and stages of their lives at no extra cost (eg, de Freitas, 2013).

This is supported by a fast-changing environment where new digital interfaces from mobile to augmented reality appear so rapidly for consumption. To allow us to find new ways to fit learning into our lives and capitalising on the open access paradigm, non-co-located communities of learners can be connected together through online learning content delivery and mobile access. As part of this evolution, online learning has a new reach on mobile devices and among estab- lished online communities on scalable platforms from Coursera and EdX in the USA, FutureLearn in the UK and Open2Study in Australia. With these globalised mobile access points, students no longer need to pay for university notes; they can access the resources they need to support learning just by a touch of the screen.

Whether this access to digital online content is used to help clarify a difficult idea while studying for a school-level certificate, or to provide additional explanation for a particular concept while undertaking a graduate degree, or indeed, if it is used to learn a specific skill for work that is accredited by an open source badge or access to open educational resources can be a timely aid for supporting formal, informal, self-directed or work-integrated learning. This more flexible learn- ing importantly opens up the possibility of improving valuable soft skills, such as decision making and negotiation, and can improve employability in a fast changing global environment, but equally, it can extend our knowledge base and support pleasurable learning experiences.

MOOCs are massive open online courses, which are online offerings provided at no cost, typically including open access to media rich online materials and interactions for very large numbers of

students. MOOCs have been the subject of a remarkably polarised international debate in higher education. Their supporters see them as "the biggest innovation in education in 200 years" (A. Agarwal, quoted in Cadwalladr, 2012), while detractors claim they simply "take a failed [teach- ing] model and put it online" (E. Mazur, quoted in Parr, 2013). This is far from the only contra- diction apparent in the MOOC debate: as high-profile MOOC providers aim to reach 1 billion learners in the next decade, there is growing evidence that only a tiny fraction of MOOC's enrolled students complete the course. Nonetheless, it is easy to see the appeal of an education system that appears to promise higher education, for free, to an unlimited audience, serving international learners from all backgrounds throughout their lives. This aligns well with the dream of Comenius and many a university's mission to spread knowledge and engage new audiences.

But while the emergence of MOOCs may address widening participation and learning equity, questions remain as to whether they will help to reduce the considerable costs of higher educa- tion. Certainly, they have the capability to introduce serious commercial competition for formal learners going into university by the back door: learning without accreditation (eg, Barber, Donnelly, Rizvi & Summers, 2013). Mass education (or "massification") and open access for some present what appears to be a real threat to the role and growth of higher education, particularly when higher education is considered as part of an élitist education system. However, the threat of corporate institutions replacing accreditation powers of higher education is arguably a greater danger, as universities try to reach new audiences with their content through establishing commercial partnerships and as governments attempt to deregulate education and open up accreditation.

Of course, the past has seen many "threats" to higher education: from film to television, radio to the Internet. However, the full potential of multimedia presentation and digital media-rich capa- bilities has never really managed to fully permeate the infrastructure of tertiary education to lead to any major reorganisation of the sector. Exceptions exist in special cases such as the Open University in the UK. But the question that many academics are asking is whether MOOCs really offer a threat to traditional tertiary education and can it really offer the quality of educational content delivery that is required for going into further education, such as graduate study pro- grammes or for meeting the stringent quality guidelines and audits of the national quality agencies such as QAA in the United Kingdom and TEQSA in Australia. However, as new students become increasingly unengaged from traditional learning methods, the dual threats of corporatisation of education and open access do have significant implications for the sector.

In this paper, we attempt to unpick this debate of mass education through open access to open learning materials, while considering the more student-centred concern of how to improve the engagement of the learning experience. Transformation of learning in universities should include increased engagement of learners (eg, to improve retention) while maintaining high quality and having the capacity to reach wider global audiences. While MOOCs may offer one approach to this, here in the review section (second section), we provide an overview of the development of MOOCs from the first online courses a decade ago; an overview of studies com- paring online learning with traditional learning; the role of retention in MOOCs; and a consid- eration of how engagement can be supported. In the case study section (third section), we draw on a variety of data to present a case study of an Astronomy MOOC developed by Curtin Univer- sity and Open Universities Australia for the Open2Study platform. In the final section (fourth section), we discuss our findings and opportunities for future work.

A recent history of online learning and MOOCs

While online learning is nothing new, and digital revolutions in education have been promised before, the MOOC phenomenon has gained considerable traction in recent years. This particular brand of online learning has emerged out of the growing access to broadband connectivity, the dominance of mobile and portable technologies, and the central role these technologies now play in our lives through social media communities. All of these have collectively created an environ- ment that has led to the development and growing profile of MOOCs (Bond, 2013; deWaard *et al*, 2011; Mallon, 2013; Nyoni, 2013). However, much of the innovation that is now tied up in the MOOC concept can be traced back much further.

Early online course delivery had started already by 1994 (Hill, 2012) and was followed by widespread uptake of learning and content management systems, such as Blackboard, WebCT and later Moodle. Many of these early virtual learning environments were repositories for digital content rather than pedagogically driven learning tools: While they made online learning easier to deliver, the pedagogic meaning of "learning objects" and reuse of content failed to ignite excitement in teachers and tutors, who preferred to develop their own content, and deliver it in more familiar modes. However, their scalability and cost reductions, coupled with student moni- toring capabilities, made them increasingly popular in the literature (Stacey, 2013), and very soon, they became invaluable content management and performance monitoring tools for universities.

Gradually, however, online learning capabilities and technology-enhanced learning developed, often in the training and professional development area of university activities. Furthermore, they were often applied in a fairly task-centred manner, emerging as they did out of computer- based instruction and training, which tended to use fairly linear and often text-based approaches to information presentation, punctuated by quizzes and online activities (Kulik & Kulik, 1991; Yoshida, 2013).

One of the earliest learning platforms to deviate from the traditional learning management systems was Fathom.com. First launched in 2000, this was an open learning platform led by Columbia University in collaboration with libraries, museums and other universities. While this initiative was based upon quality sharable digital content, a number of technical issues, a lack of motivation for pedagogical change and a dearth of broadband connectivity prevented its wider establishment as a learning tool (eg, Carson, 2012).

Around the same time, MIT began to evolve the idea of open access learning content. The MIT OpenCourseWare programme (www.ocw.mit.edu) arose from MIT Faculty discussions in 1999 that centred on how the web could be used to support the organisation's mission "to advance knowledge and educate students." The outcome was a bold initiative: as Dick K. P. Yue from MIT put it,

> The idea is simple: to publish all of our course materials online and make them widely available to everyone. (Yue: quoted on the MIT OpenCourseWare web site, 2013)

In 2002, 50 courses were published online, and that same year, the term "open educational resources" was first introduced at a UNESCO meeting, foregrounding the aim to "develop together a universal educational resource available for the whole of humanity" (UNESCO, 2002). By 2012, the MIT site had published 2150 courses. With 127 million visits recorded, the initiative can be considered a major success, both in terms of university outreach and as a model for how other universities can extend their reach and multiply their impacts on students through open access content (MIT OpenCourseWare Program Evaluation Findings Summary report, 2013). Indeed, the initiative has since morphed into the OpenCourseWare Consortium, with over 100 universities participating to make all notes, course materials and videos available for open access (Abelson, 2008; Caswell, Henson, Jensen & Wiley, 2008). So, from initial Faculty discussions to a global movement, OpenCourseWare is undoubtedly a major spark for the rise of MOOCs, as we know them today.

Throughout this time, there was a growth in the internet as a trusted source of information, including crowd-sourced information, such as Wikipedia. This and the rise of blogging and other

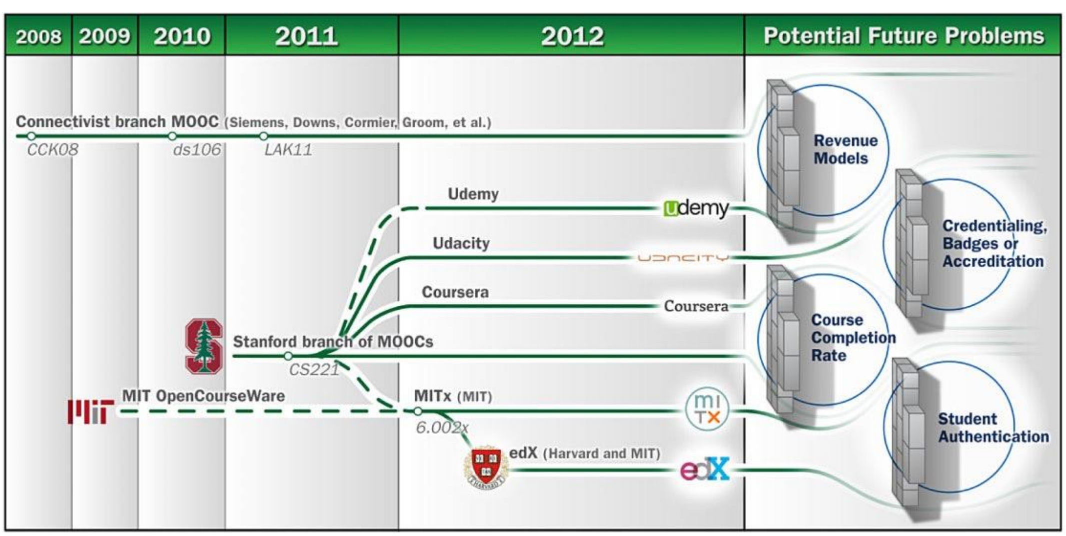


Figure 1: History of MOOCs. Taken from P. Hill 2012

self-publication platforms, such as YouTube, led to the accessibility of *ad hoc* educational resources, such as the Khan Academy, which uses videos and practice assignments, and tracks individual user achievement (Khan, 2011).

The earliest examples of MOOCs proper were started in 2007 and 2008 via open online courses. One course was designed and delivered by David Wiley at Utah University, *Introduction to Open Education course*, and the other was produced by Alec Couros at the University of Regina, *Social Media and Open Education*. They used open wiki technology to deliver their content.

The term MOOCs was originally coined by Alexander and David Cormier when they referred to the famous course developed by Stephen Downes and George Siemens: *Connectivism and Connec- tive Knowledge*. These MOOCs would come to be labelled cMOOCs, the "c" representing their connectivist heritage. However, the Stanford University variety known as xMOOCs have created more international media attention. In particular, the course *Introduction to Artificial Intelligence* by Sebastian Thrun and Peter Norvig in 2011 ignited this new branch of MOOCs. The large number of subscribers to the free course (160 000 people) ignited media attention. The xMOOC type includes a web home page, is based upon a learning management system that can be customised and includes lectures and assignments. Thrun left Stanford to set up Udacity (http://www.udacity.com/us), a *for-profit* provider of MOOCs, which has recently failed to find commer- cial success. Similarly, Coursera—another provider (https://www.coursera.org/)—was started up by other Stanford Professors who could see the commercial power of the form. Not long afterwards, MIT and Harvard announced their $60 million funding of *not-for-profit* EdX (http://www.edxonline.org). See Figure 1 for history overview.

Online versus traditional learning: the research findings

Understandably, research indicating that there was "no significant difference" between online and traditional learning helped to accelerate the pace of uptake of online learning, at least in the USA. Since 2002, when less than half of colleges and universities polled regarded online learning as critical to long-term strategy, the figure has increased to almost 77 per cent (Allen & Seaman, 2013).

Though greeted cautiously, most universities have invested and are investing heavily into online learning and see it as a method for gaining global audiences for reusable learning content development in the face of the real competition to higher education from large international commercial education providers. In the USA, "growth in online education has been rapid and there are now over six million students taking at least one online course, making up nearly a third of all enrolments" (Universities UK, 2013, p 4, quoted from Sloan Consortium, 2011).

While technological advances were setting the stage for the transformation of higher education, a deeper understanding of online learning was developing in the literature (eg, Garrison & Kanuka, 2004; Garrison, 2011; Al-Qahtani & Higgins, 2012). The main breakthroughs came in parallel with the growing evidence base in a large body of studies that were beginning to find "no significant difference" between e-learning and traditional learning courses. The number of studies with this finding was enough to fill a book, which listed them and became known to those in the field as the "No Significant Difference Phenomenon" (Russell, 1999a, 1999b).

Even though when studies comparing e-learning with traditional modes of learning generally found "no significant difference," the online learning segment was often regarded negatively, and in particular, early CBT-style programmes were regarded as being inflexible and not sufficiently interactive (Driscoll, 2010). In addition, the threat of online learning was that it would replace all face-to-face learning. Despite the prejudices against online learning, broadly blended learning approaches—which combined face-to-face and online modes of delivery—*were* championed as they did not suffer such low retention rates as CBT and pure online learning methods. Moreover, new studies were revealing that "blended learning" *was* "significantly different" and more effec- tive than either single approach. In other words, combining online with face-to-face or computer- mediated learning delivered the "best of both worlds" (Dziuban, Hartman & Moskal, 2004). This finding was confirmed by a recent US Department of Education report which found in its recent meta-analysis of comparative studies between online and face-to-face learning both that online learning was at least as effective as face-to-face learning and that blended learning approaches are considerably more effective than one or other used solely (Means, Toyama, Murphy, Bakia & Jones, 2010).

Addressing retention in MOOCs

Although MOOCs claim to offer a different delivery mode for learning content to that currently offered by most traditional higher education, issues remain around student retention on courses and the quality of learning experience and design, especially in relation to quality assurance and standards (eg, Dennis, 2012; Morris, 2013). Very low completion rates provide serious challenges to equity and accessibility (Pritchard, 2013), and also potentially set up online students to fail in formal contexts of learning. Worryingly, a recent doctoral thesis found a positive link between independent study course withdrawal and pre-attendance on an OpenCourseWare course (Stevens, 2012). Particularly for reasons of quality control, assurance and retention, it is argu- able whether MOOCs currently present a real challenge to formal education.

High "attrition rates" have been problematic for wider uptake of online courses (eg, Simpson, 2013). The literature has also been clear about pointing to the high "dropout" rates associated with MOOCs, with around 7–10% completing the courses (eg, Daniel, 2012). For example, while 160 000 signed up for Stanford University's *Artificial Intelligence course*, only a very small per- centage actually completed it (Lewin, 2012). Similar observations have been made in dropout rates in Coursera and MIT courses, for example, only 7% passed a software engineering course offered on the Coursera-University of California Berkeley course (Meyer, 2012).

The "funnel of participation" has been observed in all online courses (Clow, 2013). So, while numbers are high for enrolment on the courses, many people appear to be "shopping, looking but not buying" the experiences, perhaps due to their being free and non-accredited; others perhaps drop out because of the minimal tutorial contact. Students are not engaged, motivated and committed enough, and therefore find it easy to simply not complete the course—often dropping out before even the first assignments are due. There are no easy answers for increasing partici- pation or widening the funnel of participation. Although one of the methods for dealing with this scale of students is to create more opportunities for social interactions and include more inter- active assignments, to introduce fees or to offer credit options, these approaches necessarily have associated development and delivery costs.

Engendering greater engagement in online learning

Unlike other fads that have come along to threaten the higher education sector, online learning as part of the wider digital revolution seems different; its longevity and power to persuade the sector after a decade of lukewarm acceptance seemingly make it a different potential threat. This point has been made clearer because the impact of MOOCs have the *potential* to transform everything we know about course delivery and revenue models in higher education. As the recent Universities UK report (2013) expresses it:

> As many aspects of higher education cannot readily be substituted online for free alternatives, particularly the provision of qualitative academic support and the right to award higher education qualifications, any digital transition may be quite different from those experienced in other sectors. *However, the development of free models of online learning may still have implications for the tuition-based revenue model of most higher education institutions.* (authors' emphasis, Universities UK, 2013, p 25)

It is conceivable that the impact of offering educational content for free or reduced cost could be maintained if the cost is borne elsewhere. But with increasing fees for face-to-face students, more transparency is required in terms of value for money and quality of service. Most students who are paying very large fees would look unfavourably to other students receiving similar services but paying a fraction of the cost or nothing at all. This is underlined by the fact that the OpenCourseWare and MOOC developments have been primarily driven by the USA, and this is perhaps not surprising at all. As much as MOOCs are offered for free, the cost of a course at MIT would cost the average student around $189 000; this disparity is creating real and increasing difficulties considering the rapidly rising fees in higher education (Kamenetz, 2009). In the UK, increasing fees threaten an increasing tranche of students who are unable to afford to study at universities and so have turned to studying through private, online or distance provision.

While some see them negatively, other commentators regard MOOCs as a potential "saviour" for tertiary education (Barber *et al*, 2013) institutions that rely upon less sustainable and scalable campus-based education that focuses upon predominately face-to-face teaching methods. While no one doubts the success of traditional methods, they are costly to deliver, are not very scalable and rely upon an inherent élitism in that small numbers of learners are optimal. Quality can be conferred and reliably validated in this established system because it is tutor-intensive and relies upon well-established quality assurance methodologies. However, in an environment of open access, growing student numbers and lifelong learning, it is clear that alternatives are required for supporting sustainable and increasingly global education, with this in mind, "access, affordability and personalized learning" are central drivers in the new education debates (Hill, 2012, p 84). Nonetheless, issues around validating quality seem relatively under-theorised in the MOOC literature.

It has to be said that the Americans have pioneered most of the early examples of MOOCs, and for whatever cultural reasons, Europe and the rest of the world have been resistant in general to wide scale uptake of e-learning and online approaches. As a result of this resistance, until recently, many of the early examples are US-based. Issues around the internationalisation of education and a posited Americanization of learning similarly have not been problematised or critiqued in the MOOC literature.

While blended learning approaches are more engaging as they include a face-to-face compo- nent with online materials (Means *etal*, 2010), other engagement elements such as gamification and media-rich content have real promise when combined with online only approaches (McDaniel & Telep, 2009). Learning in MOOCs differs from early computer-based training (CBT) approaches and is becoming more collaborative and often peer-led, also which may over time have an impact on increasing retention rates in purely online courses that adopt peer-based methods, as studies that consider high retention rates generally find a correlation with peer interactions and more engaged interactions. The use of "gamified" content, for example, has also indicated more success in efficacy of achieving learning outcomes than tra- ditional methods of training (eg, Knight *et al*, 2010). In theory, although retention rates and course completions today are low with pure online learning modes, in the future, with addi- tions of the engagement and motivation of social interactions, game play and multimedia- enriched content, learners might be persuaded to complete their courses in higher numbers than at present.

A case study of an Astronomy MOOC

In this next section, we present a case study and reflect on its lessons given the preceding elements of retention and engagement. The methodology we adopted was inductive; we amassed all the available data sources from the students attending an Astronomy MOOC developed by John Morgan and colleagues at Curtin University. We used different statistical analyses to triangulate the data sources and interrogate several hypotheses including: what were the main retention patterns of students and did the role of "gamified" elements have an impact upon engagement and retention?

Curtin University currently has around 20 000 online students many using the Open Universities Australia (OUA) delivery platform. The university has been offering online learning via distance modes for 20 years. The Astronomy MOOC was developed using the Open2Study (OUA) platform. Open2Study is an Australian MOOC platform that is designed to maximise student retention on online courses. A number of strategies are employed to achieve this, including quality measures and framework.

Astronomy has a wide appeal to learners of all ages and as a result enjoys a high profile in the mainstream media. Astronomy is also notable in that there are a large number of amateur astronomers, whose interests in the subject range from a pure aesthetic appreciation of the night sky to those who do genuine scientific research. Moreover, there is a growing cohort of people (approximately 10% in Australia) who are educated to degree level in a science, technology, engineering or mathematics subject; Curtin University aimed to build a course which would have as broad an appeal as possible.

All Open2Study courses follow the same short, consistent format, comprising four 1-week modules. The modules were subdivided into approximately 10 units each with a TV quality production short video followed by a single multiple-choice question. The courses are only par- tially "open" both in the sense that the course materials have a restrictive copyright and that they are not freely accessible, rather a prospective student must sign up for the course and await a start date. This closed system allows the control of student flow through the course, ensuring that cohorts pass through the course at roughly the same time to maximise near real-time student interaction on the forums.

The layout of the interface is also designed to facilitate student interaction and engagement: the "classroom" shows both the video and forum in a single screen, with posts filtered to be relevant to that video. The platform is gamified to a degree; students on the platform receive badges as an additional mark of their achievement, which can then be shared through social media. In addition, many of the courses, including the Astronomy course, have a "simulator"—a game, which allows students to interactively explore a learning objective. Notably, the students have no direct interaction with a subject matter expert. Students interact with each other on forums, and these are monitored by a tutor who can provide help with more general queries and, on rare occasions, pass any perennial issues on to course managers and/or the subject matter expert to amend the course.

Finally, the assessment for completion of the MOOC is extremely lightweight, in comparison to a traditional campus-based course, consisting of four assessments each with five multiple-choice questions and the final course certificate showing the best score out of three attempts for each module.

A number of additional decisions were made by one of the authors (Morgan) to maximise the reach of the Astronomy MOOC. Course materials were pitched at a similar level to the beginning of a first-year non-specialist university course. No specialist knowledge was assumed beyond middle high school level.

Multiple-choice questions were devised that were challenging enough to provide a sense of achievement in order to ensure that the course was not an entirely passive experience. Math- ematics was not entirely excluded from the course but was optional; in assessments, students were free either to calculate the answer or look it up. The non-mathematical nature of the course and the fact that it was designed for *everyone* were emphasised in the introductory video. The initial parts of the course emphasised astronomy as a human endeavour pursued throughout history by people all over the world. The simulator was used to allow the students to explore key mathematical relationships but without explicitly using mathematics.

Anecdotally, the course appears to be reaching a very wide variety of students, including nona- genarians; students with only a limited command of English; and students in developing coun- tries, some of whom were forced to learn from video transcripts due to limited bandwidth. A number of students also took their assessments extremely seriously, a number professing to do many hours of independent research in order to achieve a top score.

Q1: How did students view the course after completing it?
Student reviews of all Open2Study courses are available online. Up to the end of 2013, the Astronomy course had garnered 369 reviews in total, of which 102 contained written comments (the remainder were star ratings only). Each of these written comments were reviewed to deter- mine whether they were positive, negative or neutral overall. The comments were then examined for common themes.

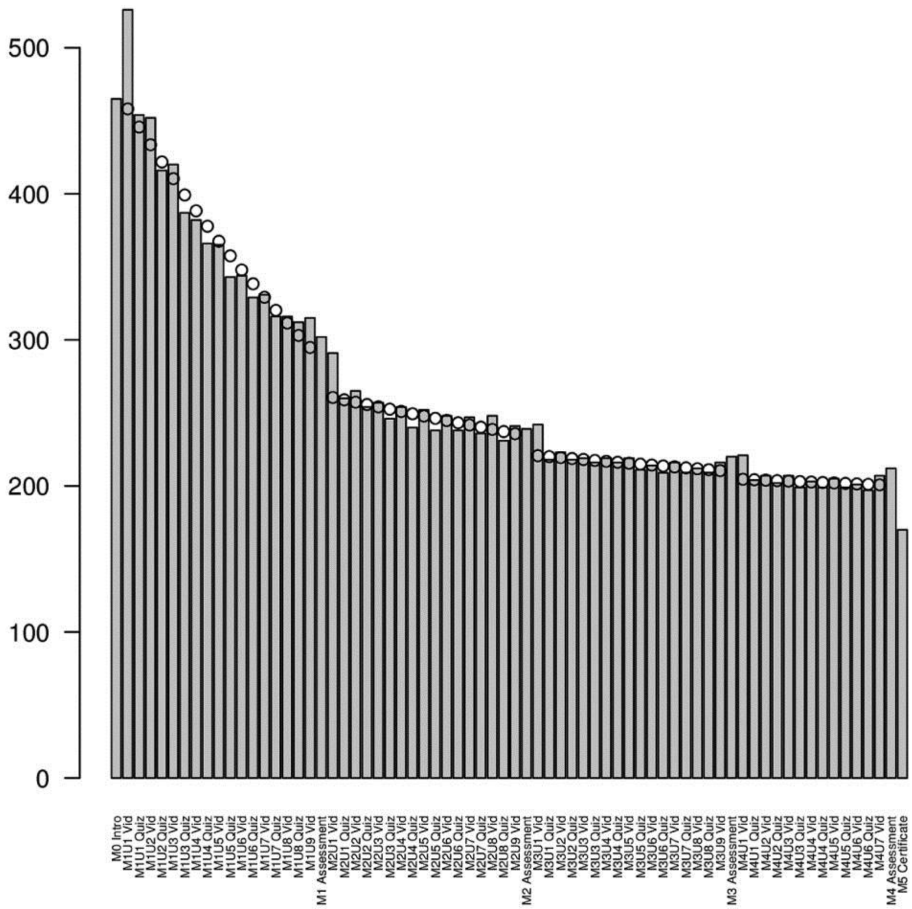
Overall, the reviews were extremely positive, with an overall course rating of 90%. Of the written comments, 95 were positive and four were neutral. Three were negative, complaining that the course was too short (two comments) or that the course/platform compared poorly with other MOOCs (one comment). The most common positive comments were that the course was "enjoyable/loved it/fun/pleasing" (32 comments) or that it was "interesting/fascinating" (22 comments). It is noticeable that in nine of the comments the students felt the need to self-identify as "non-scientific/layperson" or having no prior experience. In contrast, no student described him or herself as a subject matter expert, though two mentioned that astronomy was their hobby and one was "thinking about becoming an astrophysicist." It is therefore not surprising that the course was considered "challenging" (12 comments) rather than "too easy" (four comments). However, nine comments praised the course for the fact that it made difficult subject matter "easy to understand." The evidence from the comments points to a well-motivated cohort, many of who were conscious of their lack of subject knowledge, whose abilities are well matched to the diffi- culty of the course.

Q2: What were the main retention patterns of students?
Low completion rates are a concern for MOOCs, motivating a detailed look at the way in which students engage with the course, and at which point they drop out. Figures 2 and 3 show the number of unique students who completed each activity within the course for two consecutive cohorts. There is remarkable consistency between these two cohorts.

These data have been modelled as a fixed fraction of students dropping out after each course segment (ie, an exponential decay), with a differing dropout rate for each module (a quarter of a course) and for each cohort. This model suggests a relatively rapid dropout rate of approximately 5% per unit at the start of the course, which quickly stabilises to an almost negligible rate by the final module. These patterns point towards students making a fairly rapid decision that the course is or is not for them. There is no evidence that the assessments described as "challenging" in the reviews have turned students away from the course. According to the model, only 20–25% of students who drop out do so after taking an assignment (ie, on a module boundary).

It is worth noting that the most interactive and gamified aspect of the course, the "simulator," is undertaken just before the assessment. It is therefore possible that the simulator plays a role in retention of students between modules.

Figure 2: Completion of activities for Cohort 5. The x *axis lists the activity in the order they appear in the course (these are fully described in the third section), and* y *axis is the number of students undertaking the activity. Actual (bars) and model (circles) are shown*



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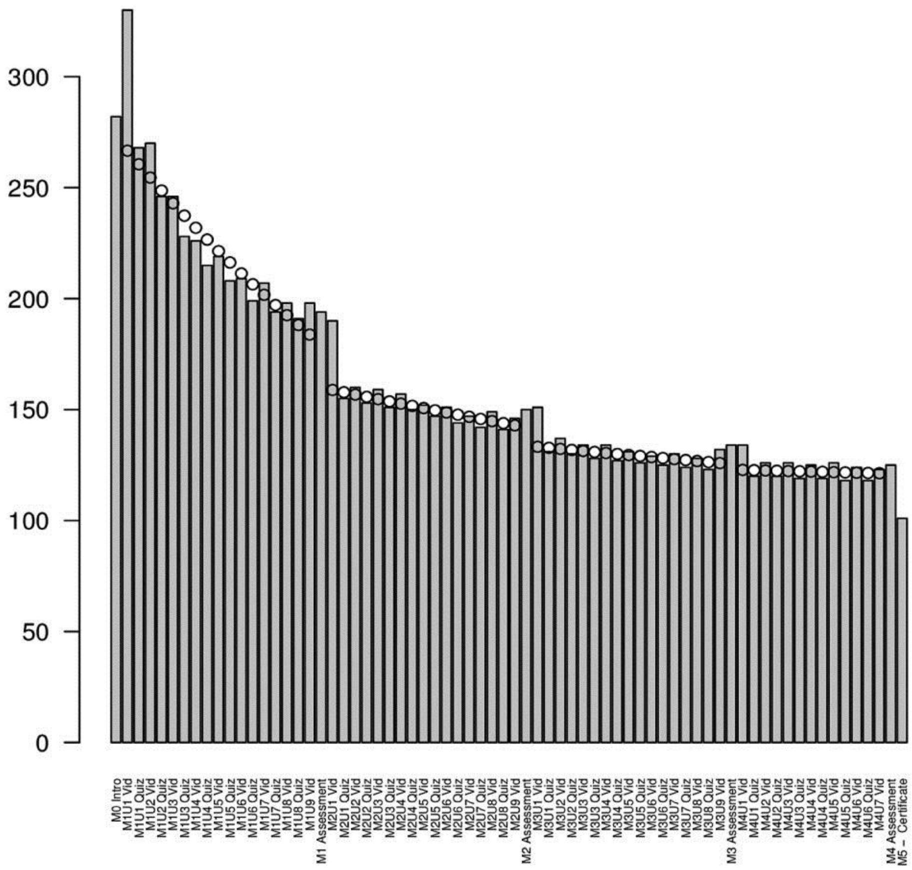
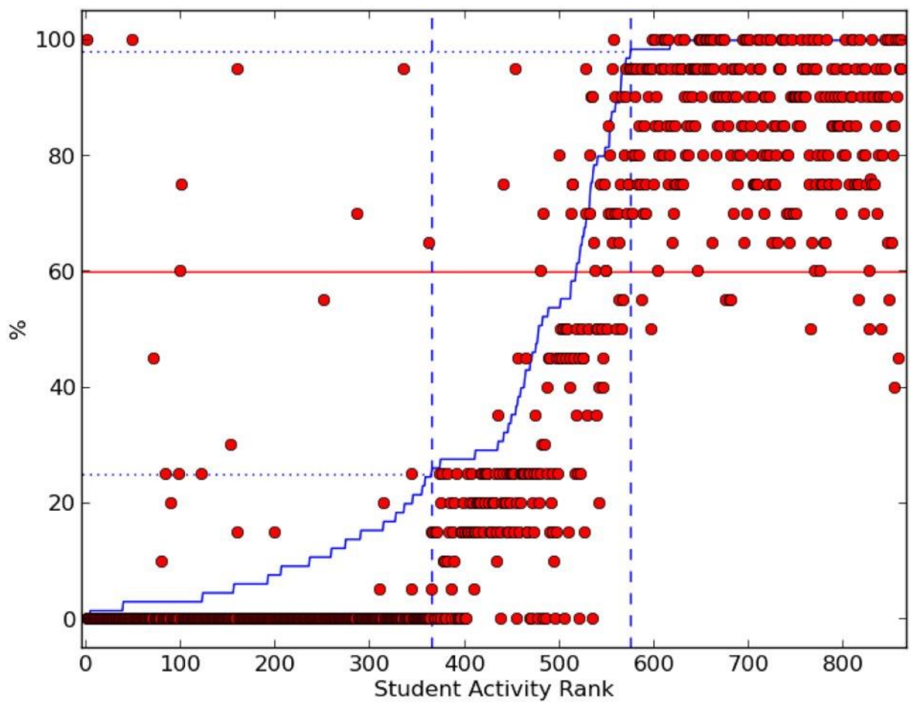


Figure 3: Completion of activities for Cohort 5. The x *axis lists the activity in the order they appear in the course (these are fully described in the third section), and* y *axis is the number of students undertaking the activity. Actual (bars) and model (circles) are shown*

These results are encouraging and paint a different picture to stories of only a 10% completion rate for a MOOC. Of those students who interacted with the course to the extent of getting most of the way through the first module, the vast majority completed the course.

Q3: How did student activity relate to final grade?
Comparing student activity to grade can give important insights into the way that students engage with the course. Since there is nothing to stop a student carrying out all of the learning activities and not completing a single assignment, it should be possible to understand the importance students place on the assignments. In addition, looking at the fraction of the course completed by each student individually, rather than the number of students completing each activity in aggregate, could also give further insights into retention patterns.

Consequently, the number of learning activities undertaken by each student was counted (learn- ing activities are topic videos and quiz questions, assessments and certificate downloads are excluded for a total of 65 activities), Figure 4 shows the percentage of activities completed and the final grade for every student who completed at least one learning activity or one assessment. For this exercise, the data for the two cohorts



were combined.

Figure 4: Comparing percentage of activities completed (blue points) and final grade percentage (red points) each expressed as a percentage for each of the 862 students. The students sorted by percentage of activities completed (low to high). ——, activity; • •, grade

Table 1: Breakdown of number of students' activity levels and grades split into three categories each

Pass Fail Zero
Grade≥60%(%) 0<Grade<60%(%) Grade=0%(%) Total(%)

Non-active Partial Complete Total

Activity < 25%
25% ≤ Activity < 98% Activity > 98%

8 (1) 39 (5)

276 (32) 323 (37)

14 (2) 145 (17) 12 (1) 171 (20)

342 (40) 26 (3) 0 (0)

368 (43)

364 (42) 210 (24) 288 (33) 862 (100)

Using this figure (and the summary in Table 1), it is possible to draw some interesting conclu- sions. First, the assessments are clearly extremely important to the course participants. Of those who complete a significant fraction of the course, there are virtually none who attempt no assignments.

The partial completers group warrant detailed study. These are students who had sufficient sticking power and interest to make it through a considerable fraction of the course but for some reason dropped out early. Given the size of this cohort (almost as many as the passing completers), there is room for a considerable increase in course completion rate. Furthermore, for this group, there is a clear correlation between activity completion and final grade. The modular nature of the course, and fact that the vast majority of this group achieved some measurable learning outcome, some thought should be given as to whether the fraction of the enrolled students passing the course is a suitable metric for the success of a MOOC. Perhaps a fraction of activities completed per student would more accurately reflect the learning outcomes.

Figure 5: Screen shot from Simulator in Astronomy MOOC

Q4: Did the quality of the MOOC and its links to Astronomy degree level education have an impact upon retention?
The development of the MOOC focused upon gaining the highest quality of learning experience possible. Gamified and simulated elements were used to engage and retain the interest of students (see Figure 5). The learning design also kept a good level of difficulty for the assessments and utilised synchronous cohorts to support more social interactions with students. The quality of video was broadcast level and specialist industry partners who had experience with mobile applications developed the interactive widgets.

In this study, we note that the difficulty level of the assessments had a positive impact upon retention, perhaps indicating a measure of quality and signalling to the learner greater value of the MOOC and therefore enhancing interest. Studies have demonstrated the importance of "flow" within the learning experience and that difficulty levels are an important component of con- structing and maintaining that *flow experience* for students despite different levels of knowledge and understanding (Cziksentmihalyi, 1997; Kiili, de Freitas, Arnab & Lainema, 2012).

While more clearly designed metrics will be required for future studies to ascertain quality, engagement and retention measures and their impact from specifically designed online courses, many of the same metrics used for evaluating current traditional learning should be able to be reused in this online learning context.

Q5: Did the role of "gamified" elements have an impact upon engagement and retention?
In the case study reported here, we found that game-like elements may have contributed to the higher retention rate, although this needs to be tested through a more robust study design. The potential for producing new gMOOCs (gamified or game-based approaches used in MOOCs) would be an interesting and potentially profitable line of research, experiment and testing. The marriage between online learning and game-based learning could be a powerful one, and it is certain that it would be useful to test the hypothesis that games and play can in due course support higher completion and retention rates of students in MOOCs due to higher levels of engagement.

New approaches to engaging students in MOOCs are clearly needed; however, there is little in the literature to reveal possible ways forward. Over the last 10 years or so, work being undertaken by the authors has focused upon the efficacy of game-based learning, including pragmatic and cluster-randomised trials that have compared traditional learning approaches with game-based approaches (eg, Knight *et al*, 2010; Arnab *et al*, 2013). The work has broadly indicated strengths with game-based approaches over traditional learning mainly because in the literature, immersion, motivation, engagement and immediate feedback have been found to support behavioural changes (eg, Garris, Ahlers & Driskell, 2002; Kato, Cole, Bradlyn & Pollock, 2008). This growing evidence-based research is increasing the credibility of games as a learning tool for hard-to-reach learners, motivating online learners and improving performance (eg, Erhel & Jamet, 2013; Schmitz, Klemke, Specht, Hoffmann & Klamma, 2012; Snow, Jackson, Varner & McNamara, 2013). Unfortunately, the potential for its use for improving retention and completion rates has yet to be quantitatively or qualitatively tested, and there are few if any longitudinal studies available due to the recent nature of the field; however, the promise for this seems consistent with the literature findings.

Discussion and future research

There are currently 150.6 million tertiary students in the world. That is an incredible 53% increase since 2000 (Altbach *et al*., 2009) and a number that is expected to increase substantially over the next 10 years. While it seems unrealistic to think that higher education could be swept aside by MOOCs, the growing demand for modularised and bite-sized online learning experiences could grow further to absorb the increasing demand for lifelong learning. Thus, the democrati- sation of learning by the ready and cost-free availability of high-quality learning resources comes at a time of transformation and uncertainty in the history of higher education with international private and public competition, growing numbers of students globally, and the capacity for improved digital communications and intuitive data-driven environments.

This paper has reviewed several of the most up-to-date papers and reports concerning MOOCs, but due to its relatively recent nature, understandably, there was a dearth of academic work and research available. However, through early academic papers, newspaper articles and some unpublished reports, the picture that has emerged is that the USA is very much trailblazing the area with most of the "startups" (*for-profit* and *not-for-profit*) based there. This is perhaps at least partly driven by rising costs for students learning on traditional courses in the USA but is also supported by the strong scientific evidence base that shows "no significant difference" between online learning and traditional face-to-face learning while there is "significant difference" in favour of blended learning (Altback *et al*., 2009; Means *et al*, 2010).

The critical challenge for MOOCs seems to be whether they can deliver better completion and retention rates in the future. In terms of market share of higher education, will pure online MOOCs rise to threaten the effectiveness of the blended model? The Astronomy MOOC shows that it is possible to attract new markets of learners. Perhaps more significantly, it indicates that with higher levels of engagement, creativity and experimentation, which are available in simulations, and game-based learning approaches, a significant impact can be made upon the usual problem of high dropout rates. In the drive for scalability, the adherence to quality and a close proximity with knowledge of the research in the field therefore is also critical, as well as a consideration of quality in well balanced and high-quality content and well-considered assessments that stretch the learners sufficiently to keep them engaged.

It is notable that many MOOCs share similar core functionalities including centralised open access to course materials, notes and assignments, webinars, video lectures, discussion fora, other social software support such as Twitter and Facebook groups, translations of some content into different languages, quizzes for assessment, and automated assessment tools. But to ensure retention rates are higher, future MOOCs would do well to integrate a suite of additional tools, including automatic translation tools, data capture learning analytics, and games and gamification elements to enliven course materials and assignments, as this would likely have a significant positive impact upon retention.

Less clear from our research is whether an ecosystem of MOOCs can provide an independent learner with a complete path from high-school to graduate level. The Astronomy MOOC repre- sents only 4 hours of video time with the content pitched at high school/ non-specialist first year university level. Further research is needed to see whether high retention rates and learning outcomes can be ensured in longer courses covering more advanced material.

Online learning has two main advantages: it can scale well, and it can provide flexibility in terms of times and places for accessing content and delivering assignments. While online learn- ing has met problems and early approaches such as CBT were rightly accused of being too static and unengaging, new approaches that make better use of (1) video lectures and stored course materials and notes, (2) activities for engaging learning such as quizzes, games and interactive digital media content, and importantly (3) social interactions with other students through social media channels and peer assessment provide a potential model for effective massive online learning.

The authors propose a "third model" (beyond xMOOC and cMOOC) for MOOC and online learning development, using one-third of the experience presenting video and audio materials, one-third devoted to activities including interactive media as well as quizzes and assignments, and one-third of the time for social interactions. Getting an equal balance between these three elements, using good quality tools and materials, richly varied and engaging resources and interactive digital content all seem keys to making the second generation of online learning more accessible and more meaningful to all learners.

Although contentious, MOOCs offer the promise of truly open access to high-quality learning resources reaching much wider audiences of learners, such as independent learners and profes- sional learners. MOOCs provide new ways for universities to share their learning and teaching resources. But metrics that guide evaluation of quality, engagement and retention need to be implemented to ensure quality is measured and that can be used to iteratively improve learning design. Simple and well-validated frameworks, metrics and measures should be used to bench- mark quality across global boundaries, ensuring that all learning experiences are interactive, engaging and effective.

While online learning over the last 20 years has improved significantly in engagement since its earliest CBT days, the need for greater engagement through gamification and other social inter- active learning tools need to be designed as an integral aspect of the provision of effective and lively learning experiences to enhance motivation and help to retain students from any physical location. Through this new and careful balance of quality, engagement and learner retention, learning is changing from curriculum-focused to experience-centred design, linking more closely to 21st century skills, employability and real world preparation inspired by media-rich content development, mobile interfaces and data-driven environments.

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Statements on open data, ethics and conflict of interest

a. Open data: Due to data protection legislation, the large amount of source data used for this study cannot be made publicly available.

b. Ethics statement: The study was undertaken in line with Curtin University ethics procedures and guidelines.

c. Conflicts of interest statement: The authors are unaware of any conflicts of interest with this study.

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