Lessons learned from adopting external online materials for an existing on-campus course

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Structured Abstract

BACKGROUND
Learning materials are becoming increasingly available online, being available both in batch mode, such as through Massive Open Online Courses (MOOCs), and continuously through web sites and Youtube. Existing traditional face-to-face courses may try to adopt such external materials, to substitute for some face-to-face learning activities or to augment them. This paper reports on our experiences in replacing face-to-face lectures with recordings from a MOOC, and how we used the subsequently available face-to-face time to add further value to the class experience. While several producers of online content have written about their experiences, this paper documents experiences from the perspective of smart use/consumption of external online materials.

PURPOSE
Our motivations for adopting externally produced online resources were to avoid the costs (both time and monetary) of developing high-quality online content, and to offer students a variety of content sources from which they could choose according to their personal preferences. Our goals in this trial were: to gauge student opinion about this delivery mode; to learn how to maximise student satisfaction with, and the educational value of, a course taught in this mode; and to develop teaching staff experience in how to successfully adopt online course content.

DESIGN/METHOD
We surveyed student opinions about the use of recorded videos before using them (in the previous instance of the class), and after using them for half- and a full semester. Positive feedback from the previous class led to our process of checking the availability and coverage of online materials. We then developed a procedure to determine what to cover in class time so as to add extra value beyond the recorded videos, including short lectures that distilled the essence of the recorded videos, and longer enrichment classes with local industry speakers, elaboration and more examples, and extension topics that were more challenging or detailed than the recorded videos. We developed systems to synchronise students with class activities, and a system for students to submit Requests For Information. We compared the academic performance of this cohort of students using videos to a previous cohort who did not, and study the qualitative feedback from students.

RESULTS
Average student performance on selected test questions was unaffected by the change in delivery mode (59% before, 57% after), and feedback from students about the new delivery mode was very positive, e.g. before the change: 86% for and 11% against (the remainder didn't care), n=54, and after the change 82% for and 6% against, n=34. We found that the enrichment material was best presented as elaboration followed by extension topics, even though that added contextualisation overhead, that a weekly class synchronisation email was popular but that the Requests For Information system was not. As judged by student attendance in the optional classes, students highly valued the essence lectures (over half of the class attending) and in the extras class we were surprised that it wasn't just the better performing students who stayed for the extension topics.

CONCLUSIONS
We were encouraged by the very positive feedback from students about using recorded lectures, and we hope that the teaching processes and experiences documented in this paper will help other teachers make better use of available online course materials.

KEYWORDS
Online education, recorded videos, blended learning

Introduction

Learning materials are becoming increasingly available online, both for content delivery (e.g. online texts and video lectures) and for more interactive activities such as to provide experience in applying skills through simulators and remotely accessed labs, to provide feedback through exercises, quizzes and exams, and to allow collaboration through discussion forums and video chat rooms. Existing courses that run in traditional face-to-face mode, which we will refer to as "on-campus courses", may try to adopt such external "online course" materials, either to substitute for some face-to-face learning activities or to augment them. While several producers of online content have written about their experiences and the benefits of using online content, e.g. (Belski and Belski, 2013) (Falkner and Willis, 2012) (Jackson, Quinn, Lonie, Rathore, and James, 2013) (Kestell, Willis, Grainger and Missingham, 2012) (Yousif, Basson and Hobohm, 2012), this paper documents experiences from the perspective of smart use/consumption of *external* online materials.

We were encouraged to investigate this because of support from a survey of students in our class in the previous year in which 86% supported the idea of using recorded videos and only 11% were against (the remainder didn't care), n=54. We were also encouraged by reports (Fox, 2014) that students "preferred to watch videos online, where there is no stigma attached to rewinding the video to improve understanding. Because the individual videos are short and focused on a single topic, it's easy for students to review only troublesome topics." Consequently, this paper reports on our experiences in replacing face-to-face lectures with recorded videos from a Massive Open Online Course (MOOC), and how we used the subsequently available face-to-face time to add further value to the class.

Availability of external online resources

In this section we consider the factors that affect the availability of external online course materials. Such availability is critical for our approach which emphasises using external materials rather than producing them in-house. We first consider the costs of producing and distributing online course materials, and what incentives might support such production and distribution, before discussing why such materials might only be available at certain times.

Production and distribution costs

The monetary cost to produce online materials can vary widely, e.g. from $5,000 to $150,000 per course (Mitchell, 2014), depending on the sophistication of the production. These costs cover both production equipment and labour, with one academic reporting (McKeown, 2013) that 20 minutes of recorded lecture video takes the lecturer about 1 hour to record and subsequently requires about 2 hours of editing and exporting.

Typical MOOCs provide between one and two gigabytes of content, dominated by the bulkiness of recorded videos rather than by lecture slides of textual discussion forums. Some MOOCs use Youtube to deliver videos (which doesn't charge the MOOC provider but raises revenue from advertising) and others use Amazon CloudFront which charges between 2 to 25 cents per gigabyte of content delivered depending on volume and location.

Support and incentives for production/distribution

Producers and providers of online content vary in their motivations. In this section we survey some of these motivations, because many of them justify the free availability of online course materials that underlies our approach, and others limit access to online course materials.

Public good: Many people recognise the value of education, and consider free access to education to be a public right, and so are willing to contribute time and resources to developing/offering online course materials for the public good. This is similar to the open source software movement (Raymond, 1999) in that it is an effort to develop intellectual property that advocates fawn upon payment for, and that can be shared online.

Esteem/Recognition: Some educators may freely provide online materials that they produced in return for the recognition that it bestows upon them. Exposure to a massive group of online students may also attract the best students for further on-campus study or research.

Loss leader: Online materials may be provided freely as a "loss leader" that leads to other purchases that are profitable. For example, the lecturer involved in the videos that we used (Wetherall, Krishnamurthy, and Zahorjan, 2014) is the co-author of a textbook (Tanenbaum and Wetherall, 2011) that is referenced in the videos, and the publisher of the textbook also makes the videos available freely online (Pearson Education, 2014) possibly to encourage use and purchase of the textbook.

Education for profit: A company aiming to make a profit may offer course materials for a fee or free in order to attract other products or services that the company charges for. Business models have been one of the most questioned aspects of the MOOC model, but given the low distribution costs, a company need not charge much or often (to many students) in order to recoup its costs. Extra services such as certification, tutoring, and recommendations to employers have all been trialled. MOOC providers may also license their course content and online platform to universities for a fee. For example, one Coursera license charges a university a flat fee of $3000 for a course plus a per-student fee that falls from $25 for initial students to $8 for more than 500 students (Kolowich, 2013). The ability of a provider to charge such fees depends on the licensing arrangements they have made with the content producers, e.g. while Coursera provides MOOCs using content for three courses related to our subject, it does not seem to have exclusive rights to the content which are also freely available from a publisher (Pearson Education, 2014) and on Youtube (Network20Q, 2014) (Severance, 2013). Preventing students from freely accessing content on-demand (e.g. offering free courses in batch mode) may also encourage universities to license content so that they can use it when their course is scheduled, rather than universities referring their students to content that can be freely accessed on-demand.

Timing

Although online materials can be continuously made available for access, some MOOCs (e.g. those provided by Coursera and Edx) only open access to courses at specific times. For example, common Coursera courses are run two or three times per year. Thus, while MOOCs may be open in the sense that they may not *charge* students for access, they are often not open in terms of *when* they are available. An advantage of this for a MOOC is to increase the pool of students studying the same topic at the same time, making discussion forums more lively and interactive for particular topics at particular times. However that schedule may not match the schedule being followed by an on-campus course that seeks to use MOOC materials, creating a barrier to using MOOC materials. Indeed, this may be a deliberate feature of limiting courses to specific times: encouraging campuses to license MOOC materials so that they can use them. About half of Coursera courses are "archived" after they run, so that their content (e.g. videos and quizzes) remain available to students who enrolled when the course was run, but discussion forums and assessment tasks are closed. This further opens the availability of MOOC materials: Students need only enrol some time when the MOOC runs (enrolments are generally accepted until the MOOC ends) and can then access materials at any time in the future. While two MOOCs with relevant content were online when our course started ((Wetherall et al, 2014) started 8 weeks earlier and (McKeown and Levis, 2014) 6 weeks earlier), uncertainty about the availability of content from those courses for the full period of our on-campus course led us to recommend students to access videos from an external source (Pearson Education, 2014).

The subject and syllabus

The subject of network technologies is particularly well suited to online courses since it covers the very mechanisms that allow courses to be provided online, which means that students and staff are typically well-versed in online technologies. The subject is also fairly

descriptive, involving a fair amount of knowledge transfer and lower amounts of skills developed through experience or group work, and so has a significant lecture component that can readily be provided through video recordings. Consequently, there are already several online courses about networking (detailed below) from which we could choose resources. While that might suggest that our results could be peculiar to this subject and not transferrable to others, we believe that as online education expands, the support for other subject areas will also increase, so our experiences in this subject might be a harbinger of what to expect for other subject areas in the future.

While the subject of networks typically covers the digital transmission of information across networks, like any subject there are related subjects, and a course (on-campus or online) may cover a combination of subjects. In the case of network technologies, there are the related subjects of modulation (analog-to-digital conversion) and analog signal transmission, distributed computation systems, network security, and other types of networks such as social networks. This excluded some online course materials (e.g. (Chiang, 2013) and (Severance, 2013)) since we aimed to use a single source of online lectures and courses that also cover other subjects often sacrifice depth of coverage of the subject of our interest.

Network technologies themselves are often relatively simple in their core, but complicated by practice that often adds features for performance optimisation, to support rare circumstances, or for backwards compatibility with preceding technologies. For example, the mechanism through which congestion is controlled in the Internet is at its heart a basic feedback control system, but includes performance enhancing features such as Slow Start and Fast Recovery, is often implemented in response to packet events rather than timers to reduce implementation cost, was developed to run in devices connected to the Internet rather than in Internet switches for historical reasons, etc. For pedagogy we often try to start simply, which leads to overemphasis on theory to the detriment of practice which is what many engineering students crave (as indicated by end of course surveys). By considering the variety of possible perspectives of a subject area, courses can choose perspectives that are best aligned with their students, the perspective(s) taken by online resources need to be considered when matching them to an on-campus class, and enrichment material can be added to a course core to add coverage of chosen perspectives. Some possible perspectives of network technologies, and online courses that exemplify them, include:

Basic core: All courses include this, but some that are notable because they concentrate on this perspective include (Wetherall et al, 2014)(McKeown and Levis, 2014)(Chiang and Brinton, 2014)(Meinel, 2014).

Performance analysis: This often requires sophisticated mathematical skills that may need to be developed during the course. At UNSW we mainly defer this aspect to a sequel course; an example of an online course is (Chiang, 2013).

History of when protocols were created, by whom, and why features were included (when possibly now obsolete) (Severance, 2013). Such history both justifies the peculiarities of actual implementations and can also describe alternate design choices. A complement to history are courses that cover newly emerging network technologies, e.g. Software Defined Networking (Feamster, 2013).

Considering actual network protocols, including their implementations, e.g. describing the purpose of all of their features, not just the core features.

Design choices: Multiple designs have often been considered for the various aspects of networking. For simplicity, courses often only cover the choice(s) that are common today, but considering alternative design choices both can reinforce understanding by juxtaposing one system against an alternative, and also develop a research mindset that there might be ways to improve on what is commonly used today.

Practical use of networks: How to configure equipment to use network protocols, monitoring the proper operation of such equipment, and troubleshooting faults in such equipment. At

UNSW we leave this aspect for students to learn in labs, but there are many courses (especially proprietary vendor certifications, such as Cisco CCNA) that focus on this aspect.

Syllabus and course coverage

In this section we discuss how we matched the syllabus of online course materials to our on-campus course, checking both core and supplementary content, and how we checked the ordering of online course content.

Core content: Given that courses vary in their treatment of the subject, it is important to check that online materials cover the core on-campus syllabus, and to create supplementary materials to cover any omissions. This is reasonably easy to check since courses tend to be fairly explicit (and predictable) about the high-level syllabus that they cover. Nevertheless, we found that sometimes core concepts were covered but under a synonym (e.g. "statistical multiplexing" rather than "packet switching") and it was necessary to detect such synonyms and explicitly tell students the equivalent term that might be used elsewhere in the course. We also found that online materials did not explicitly define some core concepts (e.g. "protocol" and "client/server") but only gave multiple examples of the concepts, so we added explicit definitions.

Supplementary content: A subject can also contain non-core topics and like the core topics it was important to check which were covered, but unlike core topics lack of coverage could be addressed by changing the course or other course activities. Non-core topics include those that provide deeper coverage of a topic (e.g. analysis of the amount of redundancy needed to provide error detection/correction rather than just description of the principle of adding redundancy), reinforce a topic by juxtaposing it against or showing similarities to other topics (e.g. comparing packet switching to circuit switching), and sub-topics that provide more detail than a syllabus (e.g. virtual LANs and multicast routing). We needed to check coverage of these supplementary topics to align the online lectures with other class activities, since we retained our existing lab, tutorial and assessment activities and they could only build on a topic if it had been covered in lectures. Sometimes we decided to omit from the course supplementary topics that were not addressed by online videos (though such topics were often covered in optional Extension lectures, see later) and that prevented us from directly comparing total assessment marks between this year and previous years (see later).

An unexpected benefit of checking coverage was that discrepancies raised questions about whether a course should cover a topic that was not covered in an online version, which led to updating and prioritising the topics that we cover in our on-campus course. For example, our on-campus course has historically covered email protocols (e.g. SMTP and IMAP) but they were not covered by Wetherall et al (2014) (perhaps because so many people access email through web browsers rather than dedicated email clients, making mail transfer the interest only of back-end servers) so we replaced our coverage of email with extra coverage of peer-to-peer file transfers.

Ordering: While the syllabus may define the set of topics covered, any course covers those topics in a particular sequence, and it is also important to align the sequence of online materials to that of other class activities, e.g. tutorials and labs. While stored videos can be viewed in arbitrary order, they are generally created in the context of a particular course, and so may include implicit dependencies that impede viewing in different orderings. Alignment with existing class activities was a significant factor in our choice of one online course (Wetherall et al, 2014) over another (McKeown and Levis, 2014) which consequently somewhat sacrificed the range of supplementary topics covered.

Because coverage and ordering had the potential to create problems from the start of the course, we checked these up-front before the on-campus course started, creating a start-up cost. The process required at least checking all of the lecture slides used to determine the coverage and ordering of sub-topics, and we decided to even watch all of the lecture videos to ensure that we agreed with the explanations/descriptions given and at least were prepared

for any divergence of opinion. While time consuming, while doing this, we also prepared notes about what might be missing or done differently than the online videos, and these were used in the extras/extension lectures that we used to add extra value to our class.

Adding value

This course has historically used 3 hours per week of lecture class time (a 2 hour block on Mondays and a 1 hour block on Wednesdays), and with lectures being available on recorded videos, this time became available for further enrichment/value-adding activities. The ways in which we attempted to add value were in addition to existing physical activities on-campus that involved labs, tutorials, a design project, and invigilated and authenticated assessment for mid-session and final exams. We used the class time for lecture-like activities that were entirely optional for students in that students could receive full marks for the course without attending these optional classes. This approach is in contrast to the "flipped class" model (Reidsema, Adam, Besterfield-Sacre, Clark, Hadgraft, Kavanagh, Leifer, Long, and Pardo, 2014) in which class time is used for interactive activities. We used the Wednesday class for "Essence" lectures, and the Monday class for "Extras", starting with Special topics, then Elaborating on the videos and then covering Extension topics, as detailed below.

Alternate form: This subject can span so many topics that students often seek guidance as to which topics are more important. We listed the important topics in a weekly email (see later) and also provided a one hour 'Essence' lecture that presented the most important topics of the week by using around 15 of the average 125 slides used in videos each week with an average play time of 135 minutes. This was inspired by the popular 80/20 "rule", that it might be possible to create lectures that cover 80% of the important topics in 20% of the time. We expected that students might find such 'Essence' useful in one of three ways: As an introduction to preface viewing of the videos, as a summary after viewing of the videos, or as a shortcut to having to view all of the videos. About half of the class attended these Essence lectures. We tried to use verbatim copies of the original slides so as to minimise the amount of new information, but tried to use different examples where possible (e.g. choosing different sources or destinations when describing how to calculate the shortest route across a network displayed on a slide) to avoid boredom from exact repetition. The choice of slides showed bias in favour of neat summary slides rather than earlier slides used to develop a concept.

We expected that the process of watching videos would raise questions in the minds of students, and that they might find it convenient to ask those questions when they arise, and useful if those questions could be answered in the Elaboration class. We also expected that some topics would elicit more questions than others (due to the topic being challenging, or the video being unclear) and that it would be useful to store those questions and corresponding answers in a way that was indexed against the videos so that future students could find previous Q&A about particular parts of the videos when they watch those videos, and so receive immediate (stored) answers to their questions. To enable that, we provided a "Requests For Information" mechanism that students could access in two ways: By posting a message in a Moodle forum, or by completing an online form - both asynchronous communication mechanisms that allowed students to post questions at any time. Both approaches required the student to identify which slide in the lectures their question related to so that it could be linked to the lecture videos for future students. The online form had the advantage that it allowed anonymous entries, and was the more popular approach, receiving 13 requests compared to only 2 requests on the Moodle forum. With such low response rates, this mechanism was clearly not popular with students, who seemed to prefer to ask questions verbally, and consequently did not elicit many topics of particular interest to the class for discussion in the Elaboration lectures.

Localisation: We thought that adding local context to videos that are created for a global MOOC would add value for our on-campus students. To this end, we invited speakers from local industry, one from an equipment manufacturer and another from a telecommunications service provider, both graduates of our university, to give guest lectures. We scheduled

these guest presentations at the beginning of the Monday class so that guest speakers need not stay for the whole class. When we had no guest speakers, we sometimes covered "Special topics" at that time which provided details that the class needed when they were not provided by the online lectures, in particular about the course programming project.

Elaboration: A second way in which we added value in the Monday classes was to elaborate on topics that were introduced in the online videos. Such elaboration included providing more examples of concepts covered in the videos, further localisation by describing Australian examples of the technology (e.g. the NBN), discussing records of actual network traffic that demonstrated the abstract protocols discussed in videos, and linking concepts in the videos to related concepts that students had encountered in other courses of their on-campus program. We also found that MOOC discussion forum threads that were popular (in terms of views or "points" given by MOOC students who found them useful) were another good source of ideas for elaboration. The Elaboration lectures were intended to reinforce understanding, so were deliberately confined to the conceptual coverage of the videos, and assumed that students had already seen the videos and presented topics in the same order as (and with reference to) the videos.

Extension: After elaborating on the videos, we then covered more challenging extension topics. Since these lectures were fully optional, students were encouraged to come and go as they pleased, and typically about one third of the class would leave between the elaboration and extension sections. Like the elaboration, the extension topics were covered in the same order as related topics appeared in the videos, and this sometimes entailed some backtracking to extend a topic that had earlier been elaborated upon, but that cost was deemed worthwhile in order to separate potentially new extension topics from core topics. The extensions included generalisations, performance analysis, discussion of alternative designs, design principles, issues that remain open for research, small differences of opinion, and some of the practical requirements that shaped real implementations of the core ideas. Many of these were identified when comparing the MOOC videos to our existing on-campus course materials, with many of the more difficult topics that we had covered being missing in the online videos. While relegating these to optional extension lectures may have somewhat "dumbed-down" the course, doing so allowed students to better focus on the primary topics without distraction from potentially confusing extension topics.

In one "Extras" class, students were asked what percentage of topics covered in the class were interesting, useful and clear, and were asked to identify which topics they found most/least interesting/useful/clear. Apart from providing feedback about the topics themselves, this survey also effectively identified the students since only one of 20 students who left feedback chose to be anonymous. This was collected at two points in the class: after the Elaboration material, and after the Extension material, and so identified which students left after the Elaboration material, and which stayed for the Extension material. This was done to help determine the audience for each part of the class. The students who left before the Extension material gave slightly more critical evaluations (62% interesting, 62% useful, 60% clear) than those who stayed (73% interesting, 70% useful, 71% clear). Examination of mid-session test rankings of these students indicated that the average mid-session rank (1=best, 100=worst) was 53 for the 4 who left, and 49 for the 15 identified amongst 16 who stayed. This surprised us, since we expected the extension material to only appeal to the higher-achieving students, while instead many of the lower-achieving students also stayed.

Synchronisation

While recorded videos give students the freedom to learn content at any time, that sacrifices the class synchronisation that comes from students having to attend lectures at regular times. This section describes the measures we took to try to synchronise the class to prevent students from falling behind and to ensure that activities only occurred after students had had a chance to learn prerequisite material.

We started each week on Monday mornings by emailing all students to introduce the topic of that week's videos, indicate precisely which videos should be watched, list the key ideas in each video, any corrections for the videos (discovered both from announcements on the MOOC that used the videos and from prior viewing of all videos), and also to describe links between the videos and other class activities (e.g. labs). This email also announced any Special Topics that the enrichment lectures would provide, e.g. guest speakers. The intention was to give the class an opportunity to watch the videos after this emailed guide and before the Wednesday Essence lecture, though they were not required to do so since the Essence lectures were self-contained. A survey in one Essence lecture indicated that roughly half of the class had watched the videos before the lecture, and roughly half had not started watching the videos, with a small minority part-way though watching the videos.

We expected most students to watch the videos some time during the week when they were announced, and for such viewing to lead to questions that would prompt students to make "Requests for Information" which we would then process on Sunday and address in the Monday "Elaboration" lecture. The Monday lecture (both Elaboration and Extension parts) assumed that students had already watched the videos, providing a deadline of sorts for students to watch the videos. Since, for copyright reasons, we did not host the videos, and because videos could be downloaded once and watched multiple times, we could not instrument a web server to record when and how often students watched videos.

Since the coverage of each topic took a week (from initial Monday email to the Enrichment class the next Monday), class activities that depended on a topic (such as tutorials and mid-session exam) needed to be scheduled at least a week after the topic was first introduced (plus time to allow students to reflect on the material). Thus, the mid-session exam held in week 6 covered topics that were started in weeks 1-4 and so ended in week 5.

Performance on assessment

We were uncertain before attempting this new approach of how it would be received by students and how it might affect student learning. So, we decided to trial it in the first half of the course and decide mid-way through the course whether to continue or revert to traditional teaching, based on a survey of student opinions and student performance in the mid-session test. Feedback from students about the new delivery mode was very positive, and matched student expectations before the trial, with 82% for and 6% against, n=34. The main criticism was that students were "not used to" such an approach. Comparing test results was somewhat complicated by our attempt to measure performance on individual questions by using multiple choice questions, a format that had not been used in this course for a couple of years and made class records hard to find. However, we did find some questions that had been both used in the past and fell within the scope of the mid-session test, and student performance on these questions seemed little affected by the change, averaging 59% in the past and 57% now. With positive student opinion, and no significant effect on assessed learning, we continued to use online videos for the remainder of the course.

Conclusion

We found that students welcomed the use of recorded videos to provide lecture content, and doing so did not affect assessment performance. We argued that online course materials are increasingly becoming available, which enables our approach of adopting external materials. We found it important to check the alignment of topics in online videos with existing course syllabus, and to check the dependencies of other learning activities. We added value beyond the recorded videos by offering optional lectures that either focused on the essence, or provided extras that localised the subject, elaborated to reinforce understanding of core subjects, or offered separate extension topics. We carefully synchronised the class so that students had the opportunity to choose when and what to study as part of their learning.

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