



# eLearning Papers 37

March 2014

## Experiences and best practices in and around MOOCs

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eLearning Papers is a digital publication on eLearning by [openeducationeuropa.eu](http://openeducationeuropa.eu), a portal created by the European Commission to promote the use of ICT in education and training. Edited by P.A.U. Education, S.L..  
E-mail: [editorialteam\[at\]openeducationeuropa\[dot\]eu](mailto:editorialteam[at]openeducationeuropa[dot]eu), ISSN 1887-1542



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## Editorial

# Experiences and best practices in and around MOOCs

This special issue of the eLearning Papers is based on the contributions made to the EMOOCS 2014 conference jointly organized by the [École Polytechnique Fédérale de Lausanne \(EPFL\)](#) and [P.A.U. Education](#). The success of this conference with more than 450 participants demonstrates that MOOCs are at the beginning of a wave and a first step towards opening up education.

Why are MOOCs innovative? They provide alternative ways for students to gain new knowledge according to a given curriculum. MOOCs can also enhance learners' ability to think creatively to select and adapt a paradigm to solve the problem at hand. These are the main findings of a case study on the Discrete Optimization MOOC on Coursera.

Many higher education institutions are asking their staff to run high quality MOOCs in a race to gain visibility in an education market that is increasingly abundant with choice. Nevertheless, designing and running a MOOC from scratch is not an easy task and requires a high workload. Professors from Universidad Carlos III in Madrid offer a set of recommendations that will be useful to inexperienced professors. An MIT study also gives key findings on optimizing video consumption across courses.

What are the defining characteristics of a MOOC? Can we categorically differentiate a MOOC from other types of online courses? This is one of the central questions of the debate on the future of MOOCs. An UNED study proposes a quality model based on both course structure and certification process. Most of the debate around the future of MOOCs focuses on learners' attitudes such as attrition or a lack of satisfaction that leads to disengagement or dropout. A Stanford study shows how educational interventions targeting such risk factors can help reduce dropout rates, as long as the dropouts are predicted early and accurately enough. A French researcher shows that learners who interact on the forums and assess peer assignments are more likely to complete the course. Another Stanford study tested different approaches to measure the extent to which online learners experience a sense of community in current implementations of online courses. In a similar context, a German team of researchers studied the collaborative endeavour of planning and implementing a cMOOC.

One of the key elements of the discussion around MOOCs is their relevance to students in their respective cultural settings. A Leicester University researcher contemplates whether activities, tasks, assignments and/or projects can be applicable to students' own settings; for example, giving students the freedom to choose the setting of their projects and the people with whom they work. These questions are central to making MOOCs truly accessible to all.

**Pierre-Antoine Ullmo**, Founder and Director of [P.A.U. Education](#)  
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## Dropout Prediction in MOOCs using Learner Activity Features

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### Tags

[teacher inquiry into student learning](#), [learning design](#), [learning analytics](#), [orchestration](#), [formative assessment](#)

While MOOCs offer educational data on a new scale, many educators have been alarmed by their high dropout rates. Learners join a course with the motivation to persist for some or the entire course, but various factors, such as attrition or lack of satisfaction, can lead them to disengage or totally drop out. Educational interventions targeting such risk factors can help reduce dropout rates. However, intervention design requires the ability to predict dropouts accurately and early enough to allow for timely intervention delivery. In this paper, we present a dropout predictor that uses student activity features to predict which students have a high risk of dropout. The predictor succeeds in red-flagging 40% - 50% of dropouts while they are still active. An additional 40% - 45% are red-flagged within 14 days of absence from the course.

### 1. Introduction

Over the past two years, MOOCs have offered educational researchers data on a nearly unprecedented scale. In addition, since MOOCs allow students to join and leave freely, they have enabled new investigations into when and how students voluntarily engage with online course material.

One consequence of the availability of voluntary MOOC data is that researchers can attempt to predict when a student will stop visiting the course based on his or her prior actions. The ability to predict dropout offers both short-term and long-term value. In the short term, predicting dropout helps instructors to identify students that are in need of scaffolding, and to design and deliver interventions to these students. In the longer term, dropout prediction can provide valuable insights into the interactions between course design and student factors. For example, studying the relationship between student working pace and dropout across different courses can provide insight into the features of a course that make it more or less compatible with slow-paced students.

In the short term, the goal of intervention design and delivery defines several bounds on a practically useful dropout prediction model. For the model to be actionable, the instructor needs to know:

- Who is at risk of dropout and who is not: If the model cannot accurately identify high-risk students, then instructors obviously run the risk of sending interventions to the wrong students.
- When the student activity starts exhibiting patterns predictive of dropout: The sooner we can detect dropout risk, the sooner we can intervene. If an intervention is sent too late, it may be less effective.

In order to help instructors to identify high-risk students in a timely manner, we have developed a dropout prediction model that scans student activity for patterns we have found to be strongly predictive of dropout. Once a student starts exhibiting such patterns, the predictor red-flags the student, alerting the instructor or LMS.

This paper is organized as follows: Section 2 provides a brief account of factors from the education literature that we believe affect student persistence in MOOCs. Sections 3 and 4 establish required definitions for dropout and what it means to successfully predict it. The predictor design is discussed in Section 5. Section 6 presents performance results that illustrate the strengths and weaknesses of our prediction model. Conclusions and future work are presented in Section 7.

## Persistence Factors and Dropout

In this paper, we only develop our model for students who have joined in the first 10 days of the course and have viewed at least one video. We chose this cutoff because we expect instructors and researchers to develop interventions within the course materials, which would thus only be seen by students with some initial presence.

Given this cutoff point, what factors influence dropout? MOOC dropout is exceptionally heterogeneous (Breslow, Pritchard, DeBoer, Stump, Ho, and Seaton, 2013). Put simply, students have different goals and intentions that interact and change over time, and because of the low cost of entry and exit for MOOCs, the decision to leave can easily be triggered by any number of factors in a student's life. As Lee and Choi (2011) noted, these

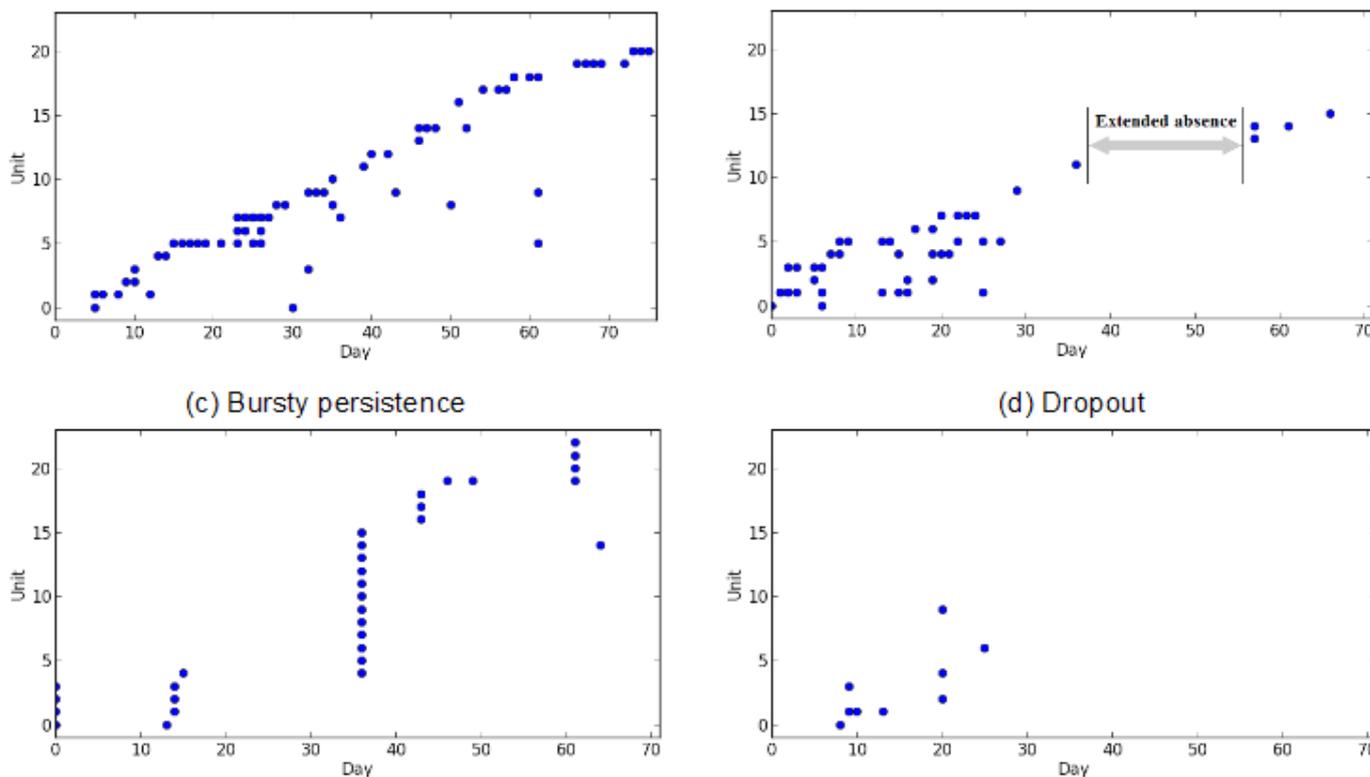


Figure 1. Four common persistence patterns that represent the majority of MOOC students

factors can be roughly divided into internal motivational factors (influencing a student's desire to persist) and external factors like outside life commitments (Rovai (2003)). External factors are practically impossible to intervene upon, and most are also virtually impossible to detect purely through the digital traces of behavior data on a website. They require survey questions such as "Are you taking this course while maintaining a full-time job?" In this paper, we focus entirely upon behavior data that are collected from a learner's interaction with the platform.

Focusing on internal factors, ability is perhaps the most obvious internal predictor of student performance and persistence. Across a wide range of academic settings, low-performing students tend to drop out more frequently than high-performing ones (Hoskins & Van Hooff, 2005). However, the effects of ability on dropout are mediated by self-perceived self-efficacy – the degree to which a student believes that he or she can achieve a particular academic goal. Self-efficacy has been identified as a central construct in motivational models, and self-reported self-efficacy is a strong predictor of academic persistence and performance (Zimmerman, 2000). Students who believe that they can achieve an academic goal are more likely to do so, and students judge their own self-efficacy from their own interpretations of their performance and from social cues (Bandura, 1994). We therefore might expect performance feedback to be an important predictor of dropout.

Students also vary widely in their ability to self-regulate their own learning, a skill set that is particularly important in learning environments like MOOCs with low entrance and exit costs and little external feedback. Researchers have defined taxonomies of self-regulation skills (Zimmerman, 1990), such as time management, self-teaching methods, and metacognitive evaluation of one's own understanding. These skills have been shown to recursively influence learning outcomes, motivation, and further self-regulation (Butler & Winne, 1995).

Other factors affecting dropout include students' level of interest in the material that they are learning. Lack of interest can cause students to dedicate less time to the course, leading them to skip pieces of content, disengage from assessments, or simply proceed through the content at a slow pace. However, pacing and engagement are also affected by external factors. The amount of time a student can allocate the course depends on what other activities the student is involved with in her life (Rovai (2003), Tinto (2006)). It can be challenging to decide whether a drop in persistence is caused by a drop in interest,

or by some external factors. In such situations, it is useful to try to elicit more information from the student herself through the use of surveys.

We emphasize that this work is the start of a long process of linking individual factors to student participation, but as a first approximation, we assert that any accurate predictor of student dropout will necessarily be tapping into both internal and external factors.

## Defining Dropout

Before discussing our prediction model, we need to present the definition of dropout that we used in this work. We have defined dropout so that it includes any student who meets one of the following two conditions:

1. The student has been absent from the course for a period exceeding 1 month.
2. The student has viewed fewer than 50% of the videos in the course.

Our choice to coin the first condition based on total absence time rather than the last time the student visited the course was the result of a study we undertook to understand what common persistence patterns students follow, and which patterns seem to correlate with drops on certain performance measures. We generated activity graphs for thousands of students from different MOOCs, and were able to identify the 4 common patterns illustrated in Figure 1. Each graph shows which units of content the student visited (viewed any of the unit's videos or attempted any of its assessments) on each day of a course.

Class (a) students visit the course once every few days at most. They usually spend several days on each unit. Class (b) students follow a similarly smooth trajectory, except that there are one or more "extended absences", defined in this work as absences of 10 days or longer after which the student continues from where she stopped previously. The reason for choosing a 10 day threshold is that it separates students who have periodic leaves (e.g.: students who only visit the course on weekends) from students whose persistence changes from continuous to sudden absence and then back to continuous. Class (c) students only visit the course occasionally, and usually sample content from different units each day they visit the course. Selectors (students who view only a selected subset of videos or units), mostly belong to this class. Class (d) students start off

Table 1. Performance comparisons between students of different absence periods for a MOOC

| Total absence       | Percentage of students* | Median percentage videos viewed | Median percentage assessments taken | Final exam entry rate | Mean final exam score |
|---------------------|-------------------------|---------------------------------|-------------------------------------|-----------------------|-----------------------|
| Less than 2 weeks   | 37%                     | 77%                             | 62%                                 | 66%                   | 71%                   |
| 2 – 3 weeks         | 36.4%                   | 62%                             | 60%                                 | 64%                   | 68%                   |
| 3 weeks – 1 month   | 13.8%                   | 44%                             | 33%                                 | 42%                   | 61%                   |
| Longer than 1 month | 12.8%                   | 21%                             | 17%                                 | 13%                   | 46%                   |

\* The denominator is the sum of the numbers of students in the 4 groups in this table.

as continuous or bursty visitors, but disappear totally after a certain point before the end of the course.

The analysis revealed that, just like complete dropout after a certain time causes the student to miss a part of the course content, students who have been absent for some time and then return tend to perform worse than class (a) students on many measures, as demonstrated by Table 1. For most of the courses we analyzed, the student’s ability to complete videos and assessments as well as the final exam entry rate and performance dropped as the total absence period lengthened.

We consistently observed drops in all of the performance indicators in the table across different courses for students in the third and fourth groups. Our choice was to use the more tolerant threshold of 1 month for our dropout definition.

## Dropout Prediction Merit

Our dropout predictor can be implemented as a LMS component that is run periodically (e.g. once every midnight). Every time it is run for a course, the predictor is applied once for each learner

$$pred_l = \begin{cases} 1 & \text{if student } l \text{ is believed to be at risk of dropout} \\ 0 & \text{otherwise} \end{cases}$$

in the course. The predictor analyzes the course activity for learner  $l$  and produces the binary output:

The main goal behind dropout prediction is to enable delivery of interventions to red-flagged students (those predicted to be at-risk). This goal must be the basis on which merit is defined.

As with any other predictor, accuracy (the ability of the predictor to accurately predict whether or not a student is going to drop out) is a main criterion. In a course where no treatment of any

kind was performed on high-risk students, we have ground truth data (who persisted in the course and who dropped out). Based on the prediction and whether or not the student actually dropped out, four classes of students exist:

1. True negatives (TN): Students who were never red-flagged, and never dropped out
2. False negatives (FN): Students who were never red-flagged, but dropped out
3. False positives (FP): Students who were red-flagged, but never dropped out
4. True positives (TP): Students who were red-flagged, and dropped out

In order to ensure that the sizes of these classes truly reflect the accuracy of the predictor, it is important to ensure that the prediction process has no induced effects on the course or students. Hence, all analysis and discussion must be restricted to courses where no dropout risk information was communicated to the student, and no persistence or performance interventions were implemented.

We can now compute the following traditional quantities:

$$Recall(R) = \frac{|TP|}{|TP| + |FN|}, \quad Specificity(S) = \frac{|TN|}{|TN| + |FP|}$$

Recall measures the predictor’s ability to have correctly red-flagged every student who will drop out of the course. Specificity is a measure of the predictor’s success in keeping students who will not dropout unflagged. Statistical merit requires the predictor to have high values of R and S.

This, however, is not the only relevant criterion. Practical merit of the predictor also requires that high-risk students be red-flagged early enough to enable timely delivery of interventions. The following prediction rule

Three days before the end of the course, red-flag every student who has been absent for the last four weeks.

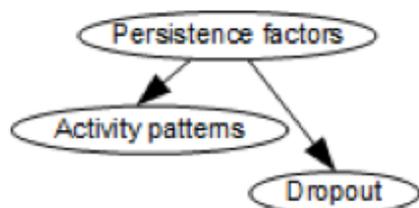
will yield a predictor with excellent specificity and recall but too little practical value because it leaves no time window for intervention.

## Predictor Design

Even though activity patterns and dropout decision are two distinct constructs, we believe that influence flows between them, as described by the following claim, which is the main principle underlying our predictor design.

### Design Principle

Since a student's activity patterns and dropout probability are both affected by his or her degree of possession of different persistence factors, a flow of influence potentially exists between the two, which may allow the use of activity patterns to predict dropout.



Utilizing student activity to predict dropout might imply that our predictor only operates on a student for as long as she is active in the course. Nonetheless, if some unflagged student goes absent for an alarmingly long period, it is still desired to deliver an intervention. Thus, our "integrated predictor" consists of two components, as illustrated in Figure 2.

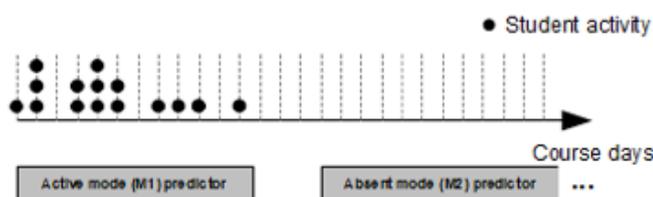


Figure 2. Active mode predictor switched out and absent mode predictor switched in after the student has been absent for an extended number of days.

1. Active mode (M1) predictor: Operates while the student is still active. It analyzes student activity, looking for patterns that suggest lack of motivation or ability. It continues to operate on a student as long as she is performing new activity.
2. Absent mode (M2) predictor: Operates once the student has been absent for a certain time period. It uses the number of days for which the student has been absent to evaluate the probability that the student is heading for a dropout.

## Active mode (M1) predictor

This predictor uses the following simple routine to determine whether or not the student should be red-flagged:

1. Compute scores for certain features in the student's activity
2. Make a prediction using each individual feature by comparing its score to a threshold
3. The output prediction is a red flag if any of the individual feature predictors predicts a dropout.

We started off with a large number of candidate features selected based on the persistence factors discussed in Section 2. Candidate features included:

1. Features that suggest a lack of ability, such as low quiz scores or a relatively high rate of seek-back in videos
2. Features that suggest a lack of interest or time, such as: Did the student skip any videos? Does the student re-attempt a quiz if her score on the first attempt was low?

Our goal was to find out which of these features correlate strongly with dropout for the majority of courses. We constructed a course-corpus consisting of 12 courses from different fields of study including mathematics, physics, agriculture, political science, and computer science. We created dozens of variants of our candidate features with different thresholds, aiming to find those that succeed in predicting a substantial number of dropouts with good specificity. Out of all the features and variants, the 4 features listed in Table 2 stood out and were hence selected in the design of the current version of the prediction model.

Note that none of the individual features has a recall that exceeds 0.5. This is acceptable, since students drop out for various reasons. The expectation from a predictive feature is

| Feature name     | Feature description   | S           | R           |
|------------------|---|-------------|-------------|
| video-skip       | Did the student skip any videos in the previous unit?<br>Decision rule: $pred = 1$ if yes, 0 otherwise.   | 0.80        | 0.31        |
| assn-skip        | Did the student skip any assignments?<br>Decision rule: $pred = 1$ if yes, 0 otherwise.   | 0.90        | 0.27        |
| lag              | Is the student lagging by more than 2 weeks? (Some students login to the course every few days, but view too few videos per login. Consequently the student can develop a lag. A lag of 2 weeks, for instance, is when the student is still viewing week 1's videos after week 3 videos have been released.) Decision rule: $pred = 1$ if yes, 0 otherwise. | 0.86        | 0.19        |
| assn-performance | Student's average quiz score < 50%? Decision rule: $pred = 1$ if yes, 0 otherwise.  | 0.97        | 0.007       |
| <b>M1</b>        | <b>Combined M1 predictor</b>  | <b>0.77</b> | <b>0.48</b> |

Table 2. Median specificity (S) and recall (R) for top ranked features and the combined M1 predictor

to successfully predict a subclass of dropouts without falsely flagging too many persistent students. Recall is of interest for the combined prediction, since a high combined recall suggests that our features have tapped into most of the common dropout reasons. The combined M1 predictor captures almost 50% of the dropouts, falsely flagging almost 1 in every 4 persistent students on the average.

### Absent Mode (M2) Predictor

For most students, absences of several days at a time are not uncommon. As the absence lengthens, however, the probability that the student may not continue to persist in the course increases. The job of this predictor is to red-flag a student once he or she has been absent for a certain number of days, called the “absence threshold”.

To determine the optimum threshold, we studied the variation of accuracy with threshold. The threshold was varied from 0 to 3 “course units”, where a course unit is defined as the time period between the release of two units of course content. For most courses, a course unit is 1 week long. The variation of specificity and recall with the threshold is presented in Figure 3.

At very low thresholds, S is very low and R is very high because almost every student has an absence at least as long as the threshold. As the threshold is increased, S improves and R deteriorates. We identified the point at 2 course units (14 days for a typical course) as a convenient threshold, where R and S are both above 0.75, and have selected this value to be the threshold of our M2 predictor.

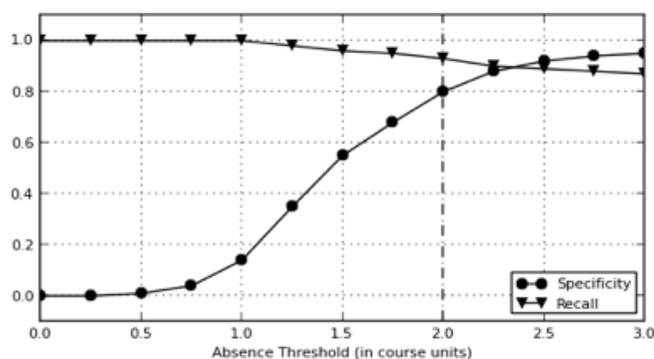


Figure 3. Variation of specificity and recall with the absence threshold

|                    | Individual feature predictors |            |           |      | M1 predictor | M2 predictor | Integrated predictor |
|--------------------|-------------------------------|------------|-----------|------|--------------|--------------|----------------------|
|                    | assn-performance              | video-skip | assn-skip | lag  |              |              |                      |
| <b>Specificity</b> |                               |            |           |      |              |              |                      |
| Best               | 1.0                           | 0.86       | 0.96      | 0.96 | 0.85         | 0.93         | 0.68                 |
| Median             | 1.0                           | 0.82       | 0.92      | 0.84 | 0.72         | 0.80         | 0.58                 |
| Worst              | 0.96                          | 0.40       | 0.73      | 0.47 | 0.36         | 0.70         | 0.29                 |
| <b>Recall</b>      |                               |            |           |      |              |              |                      |
| Best               | 0.008                         | 0.58       | 0.38      | 0.43 | 0.67         | 0.98         | 0.99                 |
| Median             | 0.006                         | 0.30       | 0.25      | 0.17 | 0.48         | 0.93         | 0.93                 |
| Worst              | 0.00                          | 0.23       | 0.10      | 0.14 | 0.41         | 0.77         | 0.91                 |

Table 3. Best, median, and worst specificity and recall for various predictor components

## Results

### Specificity and Recall

First, we evaluate our predictor’s specificity and recall observed over 10 test courses different from the 6 training-set courses. Table 3 shows the best, median, and worst observed recall and specificity figures.

In order to develop an understanding of what the strengths and weaknesses of our predictor are, we need to provide some interpretation of the numbers in Table 3.

### The ‘assn-performance’ (assessment performance) Feature

This feature generally has high precision and specificity. Over 95% of students it flags (students with average assessment scores below 0.5) eventually dropout. However, its recall was observed to be generally very low compared to the other features. For the majority of MOOC quizzes, mean scores are in the range of 70% - 85%. Even though some students occasionally score below 50% on certain quizzes, there are very few students whose average quiz scores are below 50%. This could be attributed to the deliberate easiness for which MOOC assessments are designed, or due to MOOCs’ self-selective nature (students who believe that the course will be too difficult refrain from enrolling or refrain from attempting assessments).

### The ‘video-skip’ Feature

This feature was observed to vary in specificity across different courses. Its specificity is high for the majority of courses, as demonstrated by the small difference between the maximum and median, so it is generally a robust feature. Specificity worsens, however, for courses with too many videos per topic. We observed that persistent and dropout students alike tend to start skipping videos when the total duration of videos to watch per week exceeds 2 hours. Some specificity drop occurs in courses where it is not necessary for students to view every video in order to be able to follow future content. In such cases, some students who fell behind in watching some videos skipped them totally and continued viewing other content.

### The ‘assn-skip’ Feature

Similarly, this feature’s specificity is generally high, with noticeable drops in courses with heavier assignment workload. The recall of this feature is worse than that of video skip, due to the presence of a group of students who are interested in viewing the videos but not in the assessments.

### The ‘lag’ Feature

This feature was observed to have higher recall in courses with stronger interdependencies between different parts of the content. In such courses, a student who falls back has to view what she has missed before proceeding to the more advanced

units. This increases the probability that the student will not be able to continue the course after dropping behind by a certain amount, especially in courses with higher work loads. The peak recall of 0.43 in our study was observed for a probabilistic graphical models course with 2.5 to 3 hours of video per week, and a topic interdependency map that makes it difficult to follow a topic without having mastered the previous topics.

## The Active Mode Predictor

This predictor was able to predict between 40% and 50% of dropouts most of the time. Its toughest challenge was courses with high workloads (all students tend to show signals of poor interest at some point in the course if the work load is constantly high, including those who persisted until the end of the course).

## The Absent Mode Predictor

This predictor was able to pick up over 90% of dropouts in most of the courses. Lower specificity was observed in courses with lighter workloads, since such courses make it easier for a student to catch up and continue in a course after an extended absence.

## The Integrated Predictor

The consistently high values of recall of the integrated predictor are a consequence of the integration of the M2 predictor. Recall of a combined predictor is at least as good as the recall of the

best of its components. The biggest weakness in the integrated predictor, however, remains to be specificity, which has to be worse than its worst component. The worst observed specificity (0.3) was for the probabilistic graphical models course, which has a relatively high number of videos and assignments per week, leading the predictor to falsely red-flag many students who skipped some videos and assignments. In future work, we hope to improve the overall specificity by making the features more sensitive to specifics of the course, such as workload. Another strategy is to try to add a second step to filter out false positives. This can take the form of a survey that starts by asking the student about their learning experience in the course to try to confirm whether the student is really at risk. If the presence of risk factors is confirmed, the survey advances the student to the intervention stage.

## Distribution of Intervention Window Lengths

The other important figure of merit of the prediction model is the length of the intervention window (the time between the first red-flag the student receives and the last activity the student performed in the course). Figure 4 below shows the distribution of intervention window lengths aggregated over several courses.

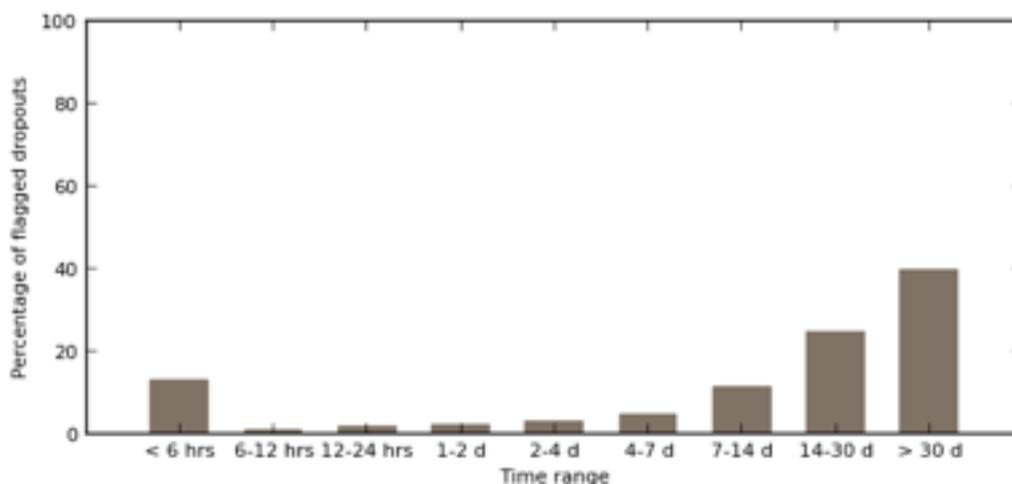


Figure 4. Percentage of flagged dropouts with intervention windows in 9 time ranges

The distribution shows that, for approximately 80% of the flagged dropouts, the student persists in the course for at least 4 days after the red flag is first raised. For well over 60% of the flagged dropouts, the student starts exhibiting activity patterns that raise the red flag more than 2 weeks before the last activity.

### Conclusions and Future Work

Predicting student dropout is an important task in intervention design for MOOCs. Our study has shown that complete dropout is only one type of bad persistence patterns. Absence times exceeding 3 weeks are associated with drops on multiple performance metrics.

We have designed a prediction model that scans the student activity for signs of lack of ability or interest that may cause the student to dropout from the course or go absent for dangerously long periods. For most courses, our model predicted between 40% and 50% of dropouts while the student was still active. By red-flagging students who exhibit absences of 14 days or longer, the recall increases to above 90%.

The time window from the first red flag to the last activity shown by the student in the course is a critical figure that affects the effectiveness of the interventions we can deliver. Our analysis reveals that, through our choice of predictive features, we are able to spot risk signals at least 2 weeks before dropout for over 60% of the students. This suggests that it is feasible to design and deliver timely interventions using our prediction model.

As future work, we plan to use multiple strategies to improve the performance and usefulness of our prediction model. First of all, we have answered the question “What are some different activity patterns, inspired by persistence factors, that we can use to predict dropout?” However, we have not answered the question of “Which of the persistence factors do we believe student X lacks?” If our model could be made to distinguish whether a student is at risk due to lack of ability, interest, or both, it would have better implications on intervention design in MOOCs.

Secondly, we believe that other persistence factors exist that have to be studied, including mindset, self-efficacy (Bandura, 1994), goal setting (Locke & Latham (1990), Locke & Latham (2002)), and social belongingness (Walton & Cohen (2007), Walton & Cohen (2011)). Expanding our feature set to measure these factors, as well as using more sophisticated machine learning algorithms to enhance the design and combination of features are two directions that could potentially improve prediction performance and deepen our understanding of what makes a student persist in or leave an online course.

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## Edition and production

Name of the publication: eLearning Papers  
 ISSN: 1887-1542  
 Publisher: [openeducation.eu](http://openeducation.eu)  
 Edited by: P.A.U. Education, S.L.  
 Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)  
 Phone: +34 933 670 400  
 Email: [editorialteam@openeducationeuropa.eu](mailto:editorialteam@openeducationeuropa.eu)  
 Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## Encouraging Forum Participation in Online Courses with Collectivist, Individualist and Neutral Motivational Framings

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Online discussion forums have been shown to contribute to the trust and cohesion of groups, and their use has been associated with greater overall engagement in online courses. We devised two experimental interventions to encourage learners to participate in forums. A collectivist (“your participation benefits everyone”), individualist (“you benefit from participating”), or neutral (“there is a forum”) framing was employed to tailor encouragements for forum participation. An email encouragement was sent out to all enrolled users at the start of the course (study 1: general encouragement), and later in the course, to just those who had not participated in the forum (study 2: targeted encouragement). Encouragements were ineffective in motivating learners to participate. The collectivist framing discouraged contributions relative to the other framings and no encouragement. This prompts the question: To what extent do online learners experience a sense of community in current implementations of online courses?

### Tags

forum participation, motivation,  
social-psychological  
intervention, MOOC

### Introduction

Massive Open Online Courses (MOOCs) have swept through higher education like wildfire since Stanford University launched three open-access computer science courses to the world in Fall 2011. The predominant instructional model for MOOCs to date is one that emphasizes instructionist, individualized learning, structured around regularly released video lectures and individual assessments. However, as demonstrated by decades of research and theory in the learning sciences, learning with others is a central mechanism for supporting deeper learning (Brown & Cocking, 2000; Stahl et al., 2006; Vygotskiĭ, 1978). Social learning requires individuals to articulate and externalize their ideas, learn through teaching and engage in dialogue with others who may have different perspectives or greater expertise.

This begs the question of where social learning occurs in MOOCs. In most courses to date, the discussion forum provides the primary opportunity for learners to interact with one another. On discussion forums, learners can ask clarifying questions about course content and their expectations, seek and provide help on assessments, discuss ideas related to and beyond the course, or simply socialize with one another, which creates a sense of cohesion and trust among the group (Garrison, Anderson and Archer, 1999). While in some ways this may be idealized behavior, prior work has also found that participants in open online courses who engage more actively with videos and assessments are also more active on the course forum (Kizilcec, Piech, and Schneider, 2013). This may simply reflect a higher level of engagement with the course overall, but it is also plausible that the social and informational flows in

the community create a positive feedback loop that helps some learners stay engaged at a higher rate than they would otherwise. Taking this theoretical and empirical work together, it appears that forum participation is a valuable aspect of online learning, and one worth encouraging.

A traditional approach to encourage forum participation in online learning environments is to make learners' grades depend on their level of participation, thereby creating external reinforcement. Deci (1971) found that external reinforcements can increase or decrease intrinsic motivation, depending on the type of external reward. Engagement-, completion-, and performance-contingent rewards were found to significantly undermine intrinsic motivation (Deci, 1999). Hence, rewarding learners with a higher grade is expected to reduce their intrinsic motivation as a result of reevaluating forum participation from an intrinsically motivated activity to one that is motivated by the anticipation of a higher grade. Positive feedback, in contrast, was found to significantly strengthen intrinsic motivations and interest, as people do not tend to distinguish such rewards from the satisfaction they receive from performing the activity (Deci, 1999).

An alternative approach to encourage forum participation is to increase the salience of the activity in the learner's mind, which may be achieved by sending out reminders. Beyond increasing salience, such reminders could act as positive reinforcement for active participants and spark intrinsic motivations that lead non-participants to start participating while avoiding engagement-contingent rewards. The framing of these reminders is likely to moderate their effectiveness, as research on persuasion highlights the importance of designing persuasive messages such that they are relevant to the audience (Rothman and Salovey, 1997). For example, in another setting, Grant and Hofmann (2011) found a moderating effect of framing messages that encouraged hand hygiene among health care professionals who are stereotypically less concerned about their own health than that of their patients. As a result, messages that emphasized patients' safety were more effective than those that emphasized personal safety. Consequently, the design of encouragement messages should be informed by online learners' motivations for forum participation.

Motivations for participation are likely to vary across learners' own goals for the course, perceptions of the community and perceived benefits from participation in the forum. Some learners may be self-interested and motivated purely by what

they can gain by using the forum – for example, help on a particular homework question – whereas others may be more motivated by the opportunity to help other individuals or to support the community at large (Batson, Ahmad, and Tsang, 2002). To leverage this insight in the MOOC setting, we devised two experimental interventions that used self- and other-focused framings to characterize the merits of participation in the discussion forum. The encouragement was framed as individualist (“you benefit from participating”), collectivist (“your participation benefits everyone”), or neutral (“there is a forum”). Within each course, across the randomly assigned groups of learners, we compared two proximal measures of participation – whether learners participated in the forum at all and how actively they did so – and an overall outcome measure, their attrition in the course over time.

## Background and Hypotheses

At the heart of most theories of human decision making in economics, sociology, psychology, and politics lies the assumption that the ultimate goal is self-benefit: in economics, for example, a rational actor is one that maximizes her own utility (Miller, 1999; Mansbridge, 1990). Another school of thought that spans across academic fields has suggested that while self-benefit is a strong motivation, it does not explain the human capacity to care for others and make sacrifices for family, friends, and sometimes complete strangers (see Batson, 1991, for a review). To successfully encourage forum participation, we need to form an understanding of what motivates people to engage in such participation.

A substantial amount of research investigated people's motivations for contributing to knowledge-sharing and knowledge-building online communities, such as Wikipedia or question-answering sites (e.g., Nov, 2007; Yang & Lai, 2010, Raban & Harper, 2008). Batson et al. (2002) present a conceptual framework that differentiates between four types of motivations for community involvement – egoism, altruism, collectivism, and principalism – by identifying each motive's ultimate goal. For egoism, the ultimate goal is to benefit yourself; for altruism, it is to benefit other people; for collectivism, it is to benefit a group of people; and for principalism, it is to uphold certain moral principles. This taxonomy of motives can be applied to the case of forum participation, such that a person may use the forum for their own benefit (egoistic or individualist), someone else's benefit (altruism), all course participants' benefit (collectivist), or to comply with course requirements or the

instructor's recommendation (principalism). Empirical evidence from online marketing research suggests that the framing of participation encouragements in terms of these different types of motivations can affect decisions to engage (White & Pelozo, 2009).

In the present study, we focus on encouragements that employ either an individualist or collectivist motivation. To quantify the effect of the individualist or collectivist appeal in the encouragement relative to an appropriate counterfactual encouragement, we employ a neutral reminder encouragement to participate. Consequently, we formulate the following hypotheses:

**H1:** The encouragements with collectivist or individualist framings lead to increased forum participation compared to the neutral framing or in the absence of an encouragement.

In testing this hypothesis, we measure two aspects of forum participation: the proportion of learners in each experimental group who choose to participate and the average number of contributions (posts and comments) that those who participate author on the forum. Beyond forum participation, recent theoretical and empirical evidence suggests that increased participation on the forum is associated with greater group cohesion (Garrison et al., 1999) and greater overall engagement in open online courses (Kizilcec et al., 2013). Hence, we formulate the following hypothesis:

**H2:** The encouragements with collectivist or individualist framings reduce attrition compared to the neutral framing or in the absence of an encouragement.

Grant and Dutton (2012) found greater commitment to pro-social behaviors after individuals engaged in written reflections about giving benefits to others rather than receiving benefits from them. This could suggest that collectivist appeals to encourage forum participation would be more effective than individualist ones. In contrast, collectivist appeals were found to be less effective than individualist appeals when responses were private rather than public, because people could not be held accountable for not engaging in socially desirable actions (White et al., 2009). Given this conflicting evidence, we have no definite hypothesis about the relative effects of the types of appeals and therefore pose the following as a research question:

**RQ1:** Which motivational appeal is more effective at encouraging forum participation: a collectivist or an individualist one?

We conducted two experiments to test these hypotheses and this research question. In study 1, an email encouragement was sent out to all enrolled users at the start of the course (general encouragement). In study 2, a similar encouragement was sent out later in the course to a subset of learners who had not participated in the forums (targeted encouragement).

## Study 1: General Encouragement

### Methods

#### Participants

A subset of learners who enrolled in a MOOC on an undergraduate-level computer science topic offered by a major U.S. university participated in this study (N = 3,907). Learners who enrolled after the intervention took place or did not access the course page at all after the intervention were excluded. Consent for participation was granted by signing up for the course.

#### Materials

Each user received one of three possible emails at the beginning of the course: either a neutral 'reminder' email about the discussion forum; a collectivist encouragement to use the forum; or an individualist encouragement to use the forum. The lengths of the emails were very similar and each text began with "Hello [name of student]". Specifically, this is a representative extract from the neutral encouragement: "There are a number of lively posts on the discussion board." Similarly, from the collectivist encouragement, "We can all use the discussion board to collectively learn more in addition to video lectures and assignments in this course," and from the individualist encouragement, "You can use the discussion board to learn more in addition to video lectures and assignments in this course." Note that the non-neutral encouragements emphasize the goal of learning more yourself or together as a community.

**Procedure**

The encouragement emails were sent using the course platform’s tool for sending mass emails and bucket testing, which randomly assigns enrolled users into the specified number of groups. Combining these two features, each user was assigned to one of three groups (neutral, collectivist, and individualist) and sent the appropriate email encouragement. The resulting groups comprised 1,316, 1,287, and 1,304 learners, respectively. The email was sent out at the beginning of the first week in the course. All forum contributions (posts and comments) used in the analysis were recorded automatically by the course platform.

**Results**

In total, there were 5,183 forum contributions from 182 (4.9%) of the study participants, i.e., the remaining 3,725 did not contribute.

A simple comparison of the proportion of contributing forum users between conditions one and ten weeks after the intervention yields no significant differences. As illustrated in Figure 1, the intervention had no significant effect on learners’ decision to contribute on the forum, neither one week after the intervention,  $X^2(2) = 3.15, p = 0.21$ , nor ten weeks later,  $X^2(2) = 2.04, p = 0.36$ .

Beyond the question of whether a learner contributed or not, we compare how many contributions learners in the three conditions made on the forum. Figure 1 illustrates the average number of contributions with 95% confidence intervals that were computed by fitting a negative binomial model to account for over dispersion. One week after the intervention, learners in the group that received the individualist encouragement made significantly fewer contributions than those who received the neutral message,  $z = 3.52, p = 0.0004$ , and marginally fewer than those who received the collectivist message,  $z = 1.77, p = 0.077$ . Those who received the neutral message made 2.6 (1.7) times as many contributions in the first week than those who received the individualist (collectivist) message.

Ten weeks after the intervention, at the end of the course, we observe very similar patterns in the number of contributions from the experimental groups as we observed only a week after the intervention. While the number of contributions is not significantly different between the individualist and collectivist groups,  $z = 1.42, p = 0.16$ , it remains significantly lower than for the neutral group (relative to the individualist group,  $z = 3.88, p = 0.0001$ , and the collectivist group,  $z = 2.34, p = 0.019$ ) by a factor of 2.3 and 1.6, respectively.

A longitudinal visualization of average cumulative forum contributions from learners in the three conditions suggests that the intervention permanently discouraged contributions from those who received the collectivist and, especially,

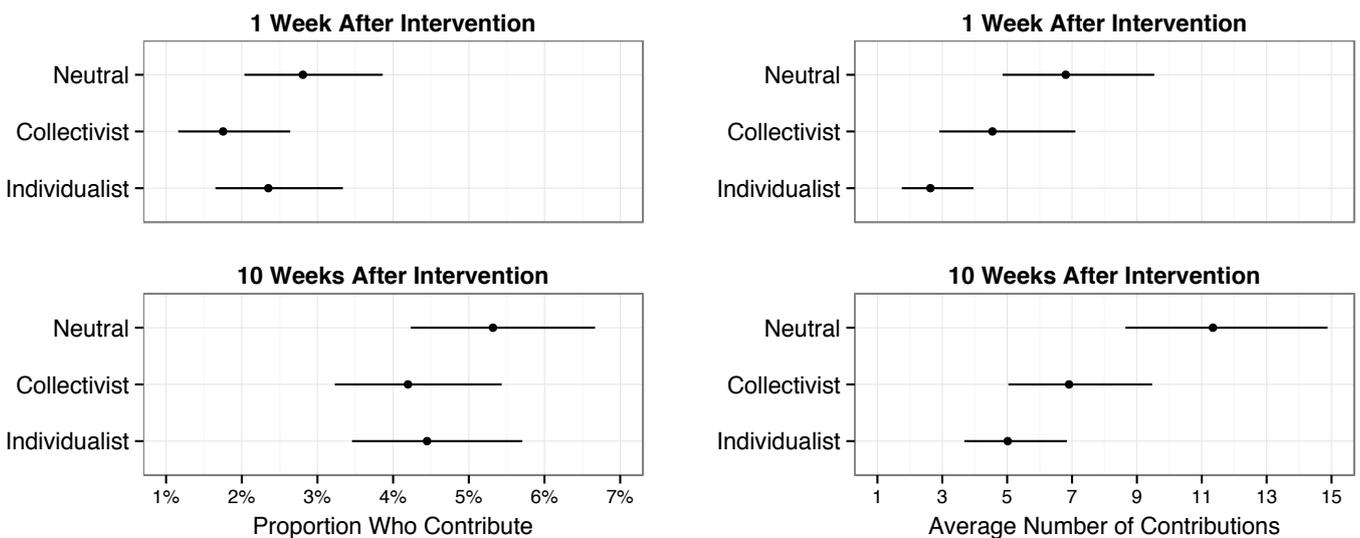


Figure 1. Proportion of contributing forum users in each condition (left) and their average number of contributions (right) one and ten weeks after the intervention with 95% confidence intervals.

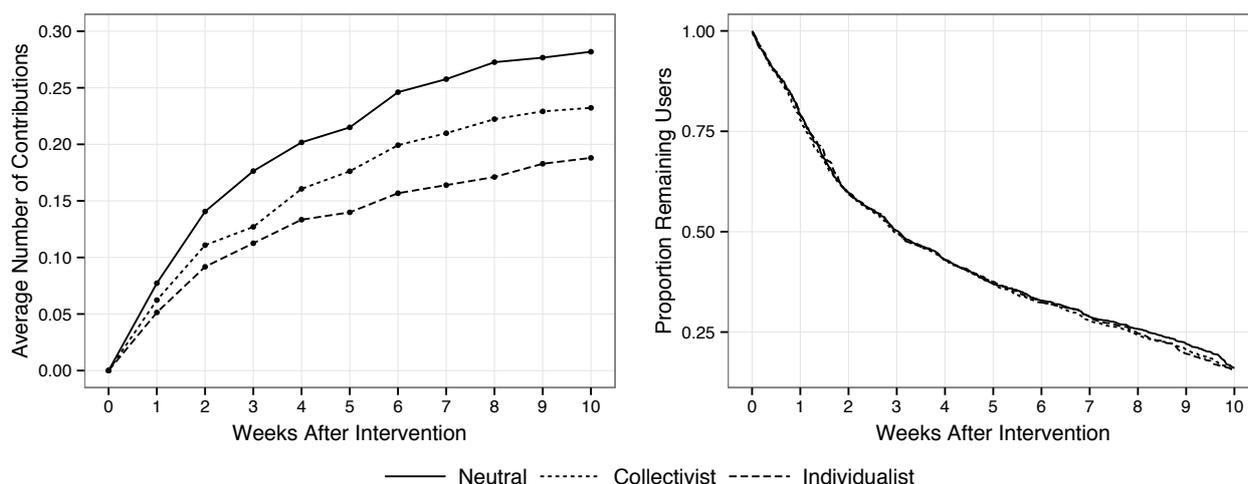


Figure 2. Average cumulative number of forum contributions (left) and Kaplan-Meier curves (right) by encouragement condition for the duration of the course following the intervention in the first week.

individualist message relative to the neutral group (Figure 2, left). Taking a step back from forum activity, we compare how the encouragements affected learner attrition. Figure 2 (right) shows Kaplan-Meier survival curves for each group, which indicate the proportion of learners remaining in the course after a certain time. There is clearly no evidence for differential attrition as a result of the intervention as the survival curves overlap.

Overall, there is no empirical support for hypotheses H1 and H2. Instead, the effect on forum participation measured by average contributions is found to be in the opposite direction than was hypothesized: the non-neutral framings discouraged participation rather than encouraging it. In answer to research question RQ1, we found no significant difference between the effect of the collectivist and individualist framings on forum participation.

## Discussion

We found the framing of the general encouragement as neutral, collectivist, or individualist to not affect learners' decision to contribute on the forum. While we cannot infer the effectiveness of the encouraging email because learners' behavior in the absence of the encouragement is not observed, it still suggests that the framing manipulation alone is too weak to push learners over the participation threshold.

A large, significant effect of the framing manipulation was found in the number of contribution authored by those who decided to contribute on the forum. Surprisingly, the collectivist

message and to an even greater extent the individualist message effectively discouraged forum contributions compared to a neutral reminder. This result stands in conflict with studies (e.g., Grant et al., 2011, 2012) that report positive effects of framing calls to action (requests, offers, encouragements, etc.) to highlight the personal benefit of action (individualist) or the benefit to others (collectivist, or altruist).

We can offer a number of possible explanations for why we observe the effect reversed: First, if the non-neutral encouragements were perceived as too strong persuasion attempts due to message wording, then we would expect a negative response. For instance, Feiler et al. (2012) found that providing both collectivist and individualist motivations in an encouragement to generate less participation than just using one framing, because using both revealed the persuasion attempt.

Second, the apparent effectiveness of the neutral encouragement could be at least partly explained by an extrapolation effect: for example, in a marketing context, when a person is told about a product without an explicit value judgment, they might assume that the reason they are told is because the product is good. Similarly, online learners who are simply told about the forum and encouraged to participate might assume that it is beneficial.

Third, the non-neutral encouragements frame forum participation as supporting learning rather than as a primarily social activity, which affects learners' perception and ultimately their usage of the forum. A content analysis of posts and comments authored in each condition could provide insight into

whether learners' perception is reflected in their contributions but lies beyond the scope of this investigation.

Finally, most social psychology studies are conducted in highly controlled environments rather than in the field, where participants might feel less pressure to be obedient or to perform the more socially desirable action (Blass, 1991). Moreover, the motivational structures of participants in laboratory experiments are unlikely to match those of MOOC participants. These interpretations could potentially explain the effectiveness of the neutral encouragement but require further validation.

We found no differences in attrition between conditions, despite the significant differences in forum contributions. This might suggest that the direction of causality between forum activity and course persistence does not point from forum activity to persistence. Instead, this suggests that a third variable, such as motivation for enrollment or time constraints, influences both learners' forum activity and persistence in the course.

## Study 2: Targeted Encouragement

### Methods

#### Participants

A small subset of learners who enrolled in a MOOC on a topic in Sociology offered by a major U.S. university participated in this study ( $N = 7,522$ ). Only those learners who had not contributed (posted or commented) on the forum three weeks into the course, and who had logged into the course page at least once after the encouragement intervention were considered. Consent for participation was granted by signing up for the course.

#### Materials

Each study participant received either no email at all (control) or one of three possible emails three weeks into the course: either a neutral 'reminder' email about the discussion forum, or a collectivist encouragement to use the forum, or an individualist encouragement to use the forum. The lengths of the emails were very similar and each text began with "Hello [name of student]". The email texts resembled those in Study 1, but were adjusted to fit the course topic and the instructor's writing style and tone in emails. Specifically, this is a representative extract from the

neutral encouragement: "The more people participate, the more posts there are on the discussion board." Similarly, from the collectivist encouragement, "The more people participate, the more we all learn together," and from the individualist encouragement, "The more people participate, the more they learn."

### Procedure

Encouragement emails were sent using the same system as in Study 1. This resulted in four groups of the following sizes: control ( $n = 5,241$ ), neutral ( $n = 782$ ), collectivist ( $n = 799$ ), and individualist ( $n = 757$ ). The emails were sent out three weeks into the course and all forum contributions (posts and comments) used in the analysis were recorded automatically by the course platform.

### Results

There were 830 forum contributions from 252 (3.4%) of the study participants, i.e., the remaining 7,327 did not contribute. In this section, we report results for the same measures as in Study 1, but for four instead of three comparison groups. The control group consisted of those learners who had made no forum contribution three weeks into the course and received no encouragement email. Figure 3 illustrates the proportion of users in each condition who authored a post or comment on the forum (left) and the average number of contributions made by contributing users from each group.

We observe no significant differences between groups in how many learners decided to contribute to the forum, neither one,  $X^2(3) = 0.56$ ,  $p = 0.91$ , nor eight weeks after the intervention,  $X^2(3) = 3.50$ ,  $p = 0.32$ . There were, however, significant differences in the number of contributions made by those who did contribute from each group. One week after the intervention, forum contributors who received the neutral message authored 1.7 times as many posts and comments as those who received no message at all,  $z = 2.18$ ,  $p = 0.03$ . Although contributors who received non-neutral messages contributed at not significantly different rates than those who got no message (collectivist:  $z = 1.13$ ,  $p = 0.26$ ; individualist:  $z = 0.73$ ,  $p = 0.47$ ), they contributed significantly less than those who received the neutral message (collectivist:  $z = 2.40$ ,  $p = 0.017$ ; individualist:  $z = 2.09$ ,  $p = 0.036$ ). This activity pattern shifted eight weeks after the intervention when the course ended. The collectivist message appears to have significantly discouraged forum contributions relative to

the other conditions by a factor of 2.3 on average (control:  $z = 3.1, p = 0.002$ ; neutral and individualist:  $z = 2.6, p = 0.010$ ).

From a longitudinal perspective on the average cumulative number of contributions (Figure 2, left), the collectivist message appears to have permanently discouraged contributions, while the neutral message encouraged contributions relative to the control group. The individualist message had almost no impact on contribution rates relative to the control. Note that the neutral message induced steep growth in contributions early on but the trend flattened out after the third week, such that contribution rates were consistent with those in Figure 3

(bottom left) by week eight (except that a smaller denominator is used in Figure 3 by only considering contributing users).

In an analysis of attrition (Figure 2, right), the Kaplan-Meier survival curves for each group followed similar paths. However, attrition for those who received the neutral email appeared to be relatively higher (the dotted line is below the other lines). Using Cox regression with the control group as the baseline, we find this observation to be only approaching significance,  $z = 1.88, p = 0.061$ , with 9% higher attrition for those who received the neutral message.

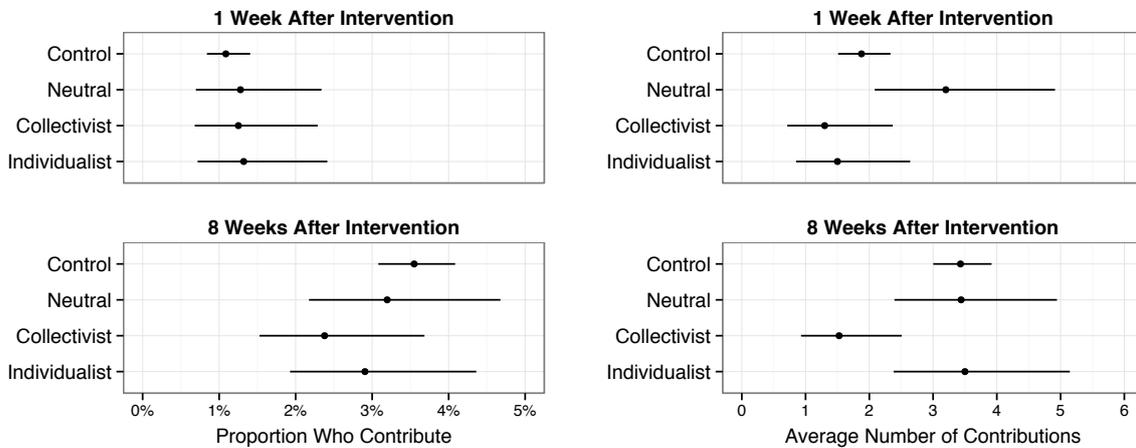


Figure 3. Proportion of contributing forum users in each condition (left) and their average number of contributions (right) one and eight weeks after the intervention with 95% confidence intervals.

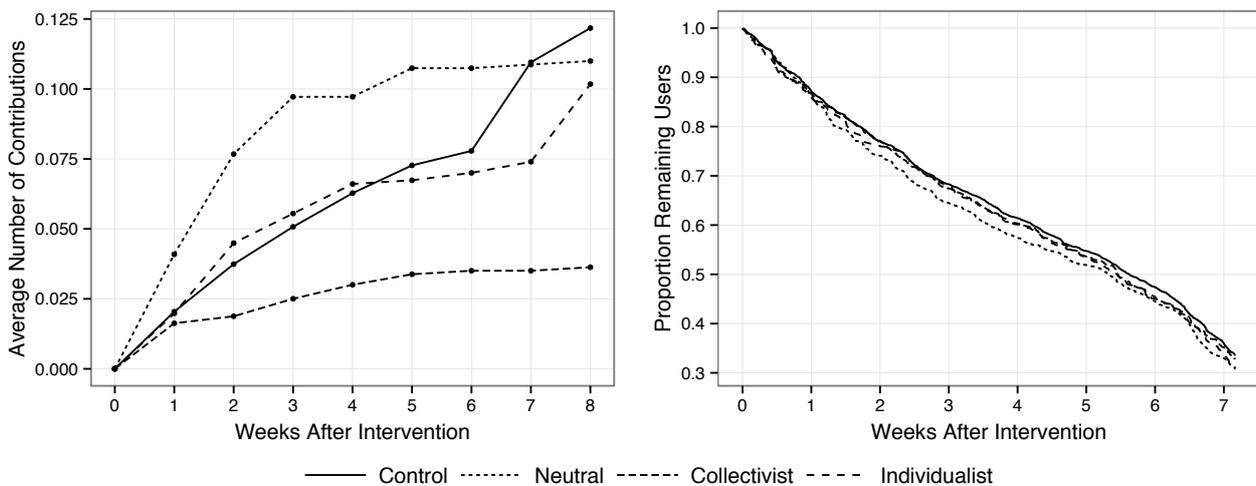


Figure 4. Average cumulative number of forum contributions (left) and Kaplan-Meier curves (right) by encouragement condition or control after the intervention in week three of the course.

Overall, there is again no empirical support for hypotheses H1. The effect of the encouragements is found to change with time: at first, we observe the same reversed effect where the non-neutral framings discourage participation measured by average contributions, but by the end of the course, forum participation is significantly lower for recipients of the collectivist encouragement compared to the other conditions, which also addresses RQ1. There is no empirical support for hypothesis H2, although attrition is marginally lower for recipients of the non-neutral encouragements compared to non-recipients.

### Discussion

In the targeted intervention, we found the encouragement email to be ineffective at motivating learners to start contributing on the forum, independent of its framing. About the same proportion of learners decide to start contributing one week and eight weeks after receiving an encouragement or not. This is consistent with our finding for the general encouragement where the different framings did not show differential effect. It is surprising, however, that no significant difference could be detected between encouragement recipients and non-recipients. This might be in part due to the noisiness of the data as we could not observe who actually read the encouragement email.

In terms of the effect on the number of contributions, we found the collectivist message to discourage contributions while the neutral message temporarily boosts contributions relative to how non-recipients' forum behavior. Figure 4 (left) illustrates the progression over time to reveal these trends. By the end of the course, eight weeks after the intervention, average contribution numbers are significantly lower for recipients of the collectivist message relative to all other conditions. It is conceivable that the message with an appeal to collectivist motivations reminded learners of the fact that they are not attached to a community given that they had not contributed to the forum by the time of the intervention. As a result, these learners are demotivated to contribute more actively compared to the other conditions in which no appeal to community is made. Moreover, the reasons put forward in the discussion of the first study's findings also apply in this context, except that the neutral encouragement does not turn out to be more effective in the long-run.

Finally, the survival analysis suggested that those who received the neutral reminder might be 9% more likely to disengage from the course, although this result only approached significance. If this finding holds up, however, it suggests that the neutral message could have led some learners to be less invested in the course, perhaps because the message was perceived as cold and less caring.

### General Discussion

Our findings suggest that while different encouragement framings do not affect learners' decision to participate in the forum, they do affect the contribution rates of those who participate; in particular, in both interventions the collectivist messages discouraged contributions relative to other framings or no encouragement. One interpretation is that an appeal to collectivist motivations in an asynchronous online learning environment with mostly anonymous participant profiles induces resentment, as there is a limited sense of community in online courses, due to their general emphasis on individual achievement and limited duration. Further work is required to uncover what mechanisms might lead to these outcomes. Specifically, heterogeneous treatment effects could occur in an intervention that employs collectivist and individualist framings, such that cultural background and being part of a minority group are likely moderators of the treatment effect.

A limitation of our results is that they are based on two experiments run in two different courses. Extending this research to a wider number of courses would support more general claims about the effectiveness of encouraging messages and could uncover individual differences in course topics or how a virtual community is supported. Another limiting factor in these studies is the missing information on who actually received the encouragement by reading the email. Our experiments can therefore provide an estimate of the intent-to-treat effect, which is relevant for the policy decision of whether encouragement emails should be sent out, but not the effect of the treatment on the treated, where the treated are those who read the email. To this end, emails could be tracked with pingbacks on opening and a monitored link to the forum could be added as an immediate call to action, which would likely increase the overall strength of the intervention as well.

Other variables worth investigating in this context are the number of encouragements and message personalization with course-specific information. For instance, an encouragement with an individualist framing could be supplemented with an example of a forum thread that discusses a question the recipient struggled with in the homework. Moreover, learners could receive positive reinforcement after authoring their first contribution to encourage persistent participation. However, despite the good intentions behind these encouragements, we should be careful not to overload learners with communication to ensure that important reminders in the course receive an appropriate amount of attention.

Our findings highlight the limited, and potentially negative, effect of certain email encouragements and the importance of careful framing of communication with online learners. They also raise concerns around the establishment of a sense of community in online courses. Given our current results, we may recommend sending neutral reminders for participation and continuing to test the framing and dosage of non-neutral reminders.

### Acknowledgements

We would like to thank Clifford Nass, Anita Varma, and our three anonymous reviewers for their insightful feedback on an earlier draft and Stanford's Office of the Vice Provost for Online Learning for supporting this research.

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## Edition and production

Name of the publication: eLearning Papers  
 ISSN: 1887-1542  
 Publisher: [openededucation.eu](http://openededucation.eu)  
 Edited by: P.A.U. Education, S.L.  
 Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)  
 Phone: +34 933 670 400  
 Email: [editorialteam\[at\]openededucationeuropa\[dot\]eu](mailto:editorialteam@openededucationeuropa.eu)  
 Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## Cultural Translation in Massive Open Online Courses (MOOCs)

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This paper discusses how courses are made relevant to students in their respective cultural settings. Practices that enable such contextualisation, or cultural translation, are investigated in five Coursera Massive Open Online Courses (MOOCs). I collected data from lecture videos, quizzes, assignments, course projects and discussion forums, using a cultural translation observation protocol I developed for this study. I found that cultural translation was enabled in the course design of two courses and in the forum discussions of all five courses. The course design that enabled cultural translation included activities, tasks, assignments and/or projects that are applicable to students' own settings and gave students freedom to choose the setting of their projects and people with whom they worked. As for forum discussions, students in the five courses created informal study groups based on geographical locations, languages and professional disciplines. Findings in this study can inform best practices in designing and learning courses addressed to a culturally diverse group. The study is particularly important to MOOC designers and students.

### Tags

massive open online courses,  
cultural translation, learning  
setting, student-oriented  
design, study groups

### Introduction

MOOCs have recently dominated the debate in higher education, and educational technology in particular. These courses addressed to the global masses have triggered polarized discussion in academia, the media and the blogosphere. On the one hand, there is optimism that these courses are transformative for higher education (Thrun, 2012; Koller, 2012; Anderson, 2013; Horton, 2013). MOOCs are also perceived as a possible way to open access to education (Koller, 2012; Anderson, 2013), especially to learners from developing countries (Koller, 2012; Thrun, 2012). The potential contribution of these courses to educational development in developing countries seems to be perceived by important stakeholders. In October 2013, the World Bank signed an agreement with Coursera to provide massive courses addressed to learners in developing countries (World Bank, 2013). On the other hand, it has been argued that MOOCs, in their original format, are not ready to be used for improving quality and access to higher education at the global scale (Daniel, 2012; Bates, 2012). MOOCs that are currently taught to students from almost any corner of the world need to be flexible enough to enable cross-cultural relevance. Without cross-cultural relevance, meaningful learning is significantly reduced, especially for students that take courses developed in foreign settings.

Practically, a perfect cross-cultural relevance is quite difficult to achieve in MOOCs since the courses are open to anyone who has access to the Internet. This openness enables students from different cultural backgrounds to enrol and take the courses. The Hofstede Centre suggests six cultural dimensions on which various countries can be compared (<http://geert-hofstede.com/dimensions.html>). These dimensions are power distance, individualism versus collectivism, masculinity versus femininity, uncertainty avoidance, long-term versus

short-term orientation and indulgence versus restraint. Taking the example of the individualism versus collectivism dimension and comparing the United States of America (USA), Sweden, the Philippines and Tanzania, the dissimilarity between countries, especially the developed countries and the developing ones, stands out. While the individualism versus collectivism indices for the USA and Sweden are high (91 and 71 respectively) those for the Philippines and Tanzania are low (31 and 25 respectively). Hence, some business ideas from an individualist society might not be compatible in a collectivist society.

MOOCs can, however, be designed with some flexibility to allow students from diverse cultures to adjust the courses to their specific settings. Such a recontextualisation of courses is not a brand new idea. D'Antoni (2007) advocates cultural translation as an important feature of Open Educational Resources (OER) to enable the adoption of these resources in foreign educational settings. Various institutions in Europe, namely University of Jyväskylä (Finland), Josef Stefan Institute (Slovenia) and The Universidad Nacional de Educación a Distancia (Spain), have already been engaged in cultural adaptation of OER produced abroad (Holtkamp et al., 2011). Mikroyannidis et al. (2011) argue that a collaborative adaptation of OER in the OpenScout project was enabled by social networking. Equally, Wolfenden et al. (2012), Lane & Van-Dorp (2011) and Kanuka & Gauthier (2012) recognize the critical importance of the possibility of adjusting OER to other settings. However, while OER allow no-cost access, use, repurposing, reuse and redistribution (Commonwealth of Learning & UNESCO, 2011) to increase the cross-cultural relevance of the resources, most MOOC materials are copyrighted under licences that prohibit such practices. These licences restrict making the original versions of the courses relevant and easily understandable to audiences from other cultural, geographical and professional settings. Tailoring MOOCs for a diversity of worldwide audiences has, indeed, been pinpointed among the challenges facing these courses providers (Leber, 2013). The more students' culture is distant from the course original culture, the more likely they are to find the courses difficult to understand. According to Jhunjhunwala (cited in Bartholet, 2013), language and cultural issues are challenges to many Indian students' comprehension of American MOOCs. Therefore, flexibility that allows students to adjust their learning to their everyday life and learning setting would make their learning more meaningful.

A low level of cultural translation or recontextualisation of MOOCs affects course management. Liyanagunawardena et

al. (2013) argue that cultural misunderstandings are likely to occur, especially in MOOC forum discussion. According to these authors, students can unintentionally make use of culturally embedded humour or expression and exclude learners that do not share their culture. Equally, students who are not highly competent in the course language, especially those that have learned that language informally, might unknowingly use slang expressions. This might hinder the understanding of other participants who are not from their regions. They might even innocently use inappropriate language. Distinguishing slang and formal language might be one of the difficulties encountered by foreign language learners, especially when informal learning has been a significant component of their language learning. It has also been noted that although cultural diversity is an invaluable resource in MOOCs, it might easily trigger the feeling of being offended for some students (Liyanagunawardena et al., 2013), even a clash of cultures (Severance & Bonk, 2013). That is why multicultural literacy and tolerance of different perspectives are critical ingredients for an effective discussion in such a diverse environment. Besides difficulties that might occur in MOOC learning, the disparity between these courses and local context and culture has also emerged as one of the potential hindrances to their uptake in foreign settings (Young, 2013; Sharma, 2013). Suspicion of foreign MOOCs, especially those imported to developing countries, is often triggered by the lack of empathic orientation in seeing the local problem. Claims that MOOCs open access to education in developing countries seem to be not supported by convincing evidence that pioneers understand the local situation. The lack of such evidence leads to criticism of neo-colonial attitudes (Sharma, 2013; Liyanagunawardena et al., 2013). Hence, cultural translation enablers need to be an integral component of MOOCs if these courses have to accommodate learners who enrol from a broad diversity of cultural backgrounds.

While no one size can fit the entire global body of MOOC students, best practices help students to adjust to the course in ways that make sense to them. One of many such practices has been the translation of courses into foreign languages. According to Thrun (2012), Artificial Intelligence, which is the first MOOC he taught at Stanford University in 2011, was translated into 44 languages. According to the author, this translation was made by 2000 volunteers who were enrolled in this class. Another good practice toward cultural translation in MOOCs consists of starting local study groups or geographical clusters for collaborative learning (Blom, et al., 2013). According to these authors, collaborative learning in such groups was required from

students enrolled at École Polytechnique Fédérale de Lausanne who took MOOCs offered by this institution. Such groups are also initiated in various Coursera courses. Alternatively, students might create study groups based on disciplines or fields of interest if the courses they are taking can be applied to various disciplines. For instance, knowledge and skills learnt from a course on entrepreneurship and innovation can be applied in the fields of education, computer science, business and others. For this reason, MOOC students who are employed as educators might want to study together and those who are employed in business likewise. Unlike translation into a foreign language which requires the intervention of a translator, who can be seen as a third person, the development of study groups based on geographical location or field of study requires engagement of students. The final practice discussed in this paper consists of including projects in a MOOC (McAndrew, 2013). Such projects can be designed in a way that requires students to find a solution to a real life problem. Cultural translation is enabled when students are given freedom to choose the problem in their respective societies. Implementing this practice is mainly the responsibility of the course designer.

The current study discusses MOOCs students' and instructors/designers' best practices that enable recontextualization/cultural translation of the courses. It investigates how activities oriented to solving problems in students' respective societies

are incorporated in MOOCs. It also probes how students make their learning relevant by learning through the language they are comfortable with and formulating study groups and/or geographical clusters for collaborative learning. Two research questions underpin the study:

- How were activities oriented to solving problems in students' respective societies included in MOOCs?
- How did students make their learning relevant to their context?

## Research methods

I conducted this research as a multiple case study that involves a cross-case analysis (Thomas, 2011). The study is based on qualitative data collected from five Coursera courses. Table 1 lists the courses that I investigated.

To be able to collect relevant and detailed data from these courses, I enrolled in the courses and took them with full engagement, like other students that were committed to studying them. Prior to the data collection phase, I sought ethical approval for the study from the University of Leicester. After securing approval, I collected data using an observation protocol (Table 2) I had developed for this purpose. The data were gathered from MOOC lecture videos, weekly quizzes,

| Course  | University                             | The run time            |
|---|--|-------------------------|
| Artificial Intelligence Planning (AIP)                      | University of Edinburgh                | 28 January-3 March 2013 |
| Internet History, Technology and Security (IHTS)            | University of Michigan                 | 1 March-28 May 2013     |
| Leading Strategic Innovation in Organisations (LSIO)        | Vanderbilt University                  | 5 March-6 May 2013      |
| Inspiring Leadership through Emotional Intelligence (ILTEI) | Case Western Reserve University        | 1 May-12 June 2013      |
| Competitive Strategy (CS)                                   | Ludwig-Maximilians-Universität München | 1 July-11 August 2013   |

Table 1: MOOCs investigated in this study

| MOOC/<br>Aspect | Design                                |                |                         | Study groups |          |                       |        |
|-----------------|---------------------------------------|----------------|-------------------------|--------------|----------|-----------------------|--------|
|                 | Lecture videos and in-lecture quizzes | Weekly quizzes | Assignments/<br>project | Discipline   | Language | Geographical location | Others |
| AIP             |                                       |                |                         |              |          |                       |        |
| IHTS            |                                       |                |                         |              |          |                       |        |
| LSIO            |                                       |                |                         |              |          |                       |        |
| ILTEI           |                                       |                |                         |              |          |                       |        |
| CS              |                                       |                |                         |              |          |                       |        |

Table 2: MOOC cultural translation observation protocol

exams and assignments as well as discussion forums. Focusing on lecture videos, weekly quizzes, exams and assignments enabled me to identify activities that provide students with opportunities to apply what they learned to finding solutions to problems in their respective settings. As for discussion forums, this is where I identified study groups for collaborative learning that had been created and the rationale behind their creation.

I aimed to maintain construct validity and reliability in my study. To this end, I applied Yin's (2009) principles: using multiple sources of evidence, creating case study databases and maintaining a chain of evidence. Multiple sources consisted of the five courses as well as various course components discussed earlier: quizzes, final exams, assignments and discussion forums. I saved all the materials relevant to this study on two external hard drives for later reference. The folders that contain these materials on the two hard drives constitute the case study database. As for maintaining a chain of evidence, I used a cross-sectional reference to link the research problem, questions, research methods and evidence, from my introduction to my conclusion.

The courses I analysed in this study were delivered by various universities. To be able to engage in MOOCs, I selected the courses in which I was interested. This engagement with courses of interest to me reflects most students' engagement with their courses. Since I wanted to approach cultural translation from a student's perspective, I tried to simulate how students engage with courses, from the course selection to the course completion level. The more courses respond to students' interest, the more students tend to engage with their learning. Had I not taken courses I was interested in, I might have dropped out before I had finished the courses, and my feeling about the courses would be unlikely to reflect that of other students who seriously engage in their learning. As an engaged student, I was a participant observer. Yin (2009) defines participant-observation as a mode in which the observer assumes various roles and actively participates in the phenomenon that is being studied (p. 111). He notes the researchers' ability to see the reality from the point of view of someone who is inside the case study rather than external to it as one of the major advantages of participant-observation (p. 112). In my case, I could see cultural translation from the students' point of view rather than from the perspective of an external commentator. Hence, interest-based engagement with the courses enabled me to sympathise with other course takers.

## Findings

At least one study group was created based on geographical locations, languages and fields of study. There were two attempts to create study groups based on students' age in IHTS. However, these initiatives were not successful. Some of the language-based study groups functioned in foreign languages I was not familiar with. To identify these languages, I used Open Xerox (<http://open.xerox.com/Services/LanguageIdentifier>), which is an online tool for language identification. The findings in this study are presented in the order the research questions were asked.

### Research Question 1: How were activities oriented to solving problems in students' respective societies included in MOOCs?

The five courses share various aspects, mainly similar video lectures, and in-lecture quizzes for formative assessment, weekly quizzes and forum discussions. However, there are disparities concerning how students are placed at the centre of some of these activities. In-lecture and weekly quizzes in all these courses were content-oriented. Similarly, the final exams for AIP, IHTS, ILTEI and CS focused on the content. However, LSIO and ILTEI incorporated reflective activities and projects that required students to apply the MOOC concepts and theories in their own settings and workplaces. How these two MOOCs included activities that are applicable in a diversity of students' settings is detailed below.

The LSIO MOOC included innovation constraint diagnosis surveys in its activities. In these surveys, the student had to evaluate her/himself, the organization or school s/he works for or s/he got service from vis-à-vis innovation constraints at the individual, group, organizational, industry/market, society and technological levels. These evaluations were done using constraint diagnosis surveys developed by the instructor. Then, the student had to keep a copy of the completed survey to use it as a reference for reflective writing, which was submitted to peers for feedback. At least three peers provided feedback to this writing and other peer-graded assignments. To receive feedback from their peers, students had also to provide feedback to at least three classmates.

Moreover, the course had two tracks: a standard track in which students were not required to work on an innovative project, and a studio mastery track in which students had to complete

an innovative team project. The studio mastery track project deliverables were submitted for peer feedback across six stages. The project had to start in a team of three to six people. In the first stage, each team member suggested an innovation project to the team. Then, the team discussed and agreed on one project to work on and created a project design brief, which was the output at this stage. Considering the high rate of drop out in MOOCs, the instructor tolerated drafts of the projects done by only two people in subsequent stages. In the second stage, each individual student generated and shared 101 ideas on the group project. In the third stage, the teammates shared one another's 101 ideas and distilled all this collection of ideas to formulate four solution concepts. Then, they defined each concept, presented the four concepts graphically and identified challenges and opportunities. In the fourth stage, each team member reviewed the feedback on their Stage 3 deliverable, chose the solution concept s/he personally thought was the best and completed a concept assessment worksheet that enabled her/him to evaluate the concept relative to the six categories of innovation constraint highlighted earlier. Then, s/he had to identify two most compelling constraints and devise strategies to mitigate them. In the fifth stage, the team came back together to determine the most promising of the four solution concepts they had formulated in Stage 3 and evaluated in Stage 4. Using a project prototype template developed by the instructor, the teams defined the information-generation experiments they would use in addressing remaining questions as they moved toward the execution of their project. The final stage had a video presentation of the entire project as a deliverable.

Similar to LSIO, ILTEI had reflective activities that the instructor referred to as personal learning assignments. These activities were student-centred in that they required students to reflect on how various course concepts apply to their lives. For instance, one of the personal learning assignments required students to think of a leader they worked with who was so inspiring that if s/he moved to another company the employee (the student) would want to seek a transfer and move with them or volunteer there. Then the students had to write specific things the leader did or said and reflect on how that leader made the employees feel. Finally, students shared their reflection notes and their feelings during the reflection experience.

ILTEI also had a practicum track that is comparable to LSIO's studio mastery track. Each student that followed the practicum track was required to conduct three practical tasks in his/her setting or workplace and write a report on each of them. The first task

required the student to identify two volunteers to participate in coaching sessions. The student assumed the responsibility of a coach with compassion and the volunteers were coachees. The student/coach had to ask coachees questions about their future dreams or ideal self (vision or hope), their current value and virtue (mindfulness), the person that helped them most become who they are (compassion) and their desired legacy, experience or achievement (playfulness). The coach would use such questions to maintain coachees in a positive emotional attractor state characterized by happiness, smile, energy or similar tipping points. Then the coach (the student) had to write an essay that reported how the coachees moved between Positive Emotional Attractor and Negative Emotional Attractor states, strategies used to bring the coachees back to the Positive Emotional Attractor state and the result of the conversation. The second task asked the student to interview ten to twenty people who were close in her/his life or workplace about the time s/he was at her/his best. Then, s/he had to look at the interviewees' responses and identify recurring patterns as well as emotional and social intelligence patterns. Finally, s/he had to submit a report of at least 500 words on this activity. As for the third task, which was similar to the second one, it required the student to ask her/his colleagues at work to pinpoint the time in which they were proud of the organization or team as well as when they were at their best. Then, s/he had to identify recurring patterns or themes from the colleagues' responses, which would constitute the elements of the shared vision for the organization or team. Based on these elements, the students had to draft a vision statement of at least 500 words for their organization or team.

### Research Question 2: How do students make their learning relevant to their context?

In LSIO, students could take advantage of the freedom they were offered and choose projects that were relevant to their cultural settings. For this to happen, students would choose teammates from the same setting or ones who were familiar with that setting. Alternatively, students could work on a project that would be transferable to their jobs, or applicable to their fields of employment or study. This could be especially valuable for students interested in multicultural literacy development. Such students preferred to work in teams whose members were from various cultural backgrounds. It was possible to form project teams based on one of the two criteria or both. Similarly, students in ILTEI could choose coachees and interviewees from

| MOOC/Aspect | Study groups based on |          |                       |     |
|-------------|-----------------------|----------|-----------------------|-----|
|             | Discipline            | Language | Geographical location | Age |
| AIP         | 5                     | 4        | 5                     | 0   |
| IHTS        | 0                     | 7        | 16                    | 2   |
| LSIO        | 14                    | 6        | 40                    | 0   |
| ILTEI       | 3                     | 7        | 41                    | 0   |
| CS          | 0                     | 5        | 26                    | 0   |

Table 3: Rationale behind the creation of study groups in MOOCs

their workplace or families. They could also choose volunteers among people who shared their professional interest. The freedom offered to students to choose their projects was a great enabler of cultural translation.

Students also made their learning relevant to their respective contexts through the way they engaged in the five MOOCs' forum discussions. In this respect, they created informal study groups based on geographical locations, fields of study/work and languages. Table 3 summarises study groups in the five courses.

As indicated in Table 3, study groups based on geographical location generally dominated in IHTS, LSIO, ILTEI and CS, but they were only five in AIP. ILTEI and LSIO had a higher number of study groups based on geographical location than other courses: 41 and 40 groups respectively. This was probably because contributions in the forum discussions counted toward the overall grades in both courses. In addition to study groups based on geographical location, each of the five courses had study groups based on language. Study groups based on disciplines of work or study were created only in LSIO, AIP and ILTEI. The number of such study groups was far higher in LSIO than in the other two MOOCs: 14, 5 and 3 respectively. As for study groups based on students' age, this was attempted only in IHTS. Two students started threads in attempt to discuss the content with peers of their age group: under 21 and under 16 respectively. However, these age-based threads could not attract other students: they received only three and five responses respectively.

## Discussion

The way assignments and projects in LSIO and ILTEI were flexibly designed demonstrates that it is possible to tailor MOOCs to individual learners' needs, in their own cultural settings. Project-based activities (McAndrew, 2013) constituted

a significant component for students in the studio mastery track in the LSIO MOOC. In both LSIO and ILTEI, students could relate their learning to their everyday/professional life. The inclusion of tasks, activities and assessments that are relevant to various cultural and professional settings in courses is what can be termed diversely student-oriented design. Unlike teacher-oriented design in which students work on tasks conceived from the teacher's perspective and setting, tasks in diversely student-oriented design are conceived from the learners' perspective and can apply to various cultural settings. Student-oriented design can be considered narrow if only students from the teachers' settings or other similar contexts can see a direct application of the course to their professional settings or everyday lives. However, in both LSIO and ILTEI, students from any cultural background could apply their learning in their specific settings. In other words, the student-oriented design was culturally diverse in the two MOOCs. In this way, the two courses were designed to allow a cultural translation (D'Antoni, 2007). In other words, students from various cultural backgrounds can adjust their learning to their own setting since they are given freedom to choose the project and beneficiaries of their work. The two MOOCs constitute good examples of how contextualisation (Wolfenden et al., 2012; Lane & Van-Dorp, 2011; Kanuka & Gauthier, 2012) can be achieved. As for AIP, IHTS and CS, opportunities for students to adjust their learning within their setting were limited. It should be noted, however, that the nature of some courses does not allow easy contextualisation for all settings. For instance, AIP and IHTS require students to be in a setting with high technological access and be familiar with at least basic computer and Internet technology to have a grasp of the application of the course concepts. Briefly, activities that enable students to solve real life problems in their respective settings can be included in MOOCs by designing for tasks, assignments and projects that can be made relevant to various settings and by offering freedom to students to choose

the setting of their projects and people they work with. This answers the first research question.

Students created study groups or teams for their project based on geographical locations, languages or professional disciplines. Unlike MOOC students enrolled at École Polytechnique Fédérale de Lausanne who were required to participate in collaborative learning groups limited to this institution (Blom, et al., 2013), study groups were not required in the five courses I investigated (except the LSIO project teams). LSIO had far more discipline-based study groups than other courses. This may have been catalyzed by the requirement to work in teams on the project for students in the studio mastery track. Many of these students might have preferred to team up with peers who shared their professional interests. With regard to study groups based on geographical locations, AIP had far less groups than other MOOCs. In AIP, only five geographical location-based groups were identified in the forum discussion. It should, however, be noted that collaborative learning in this course took place in many spaces including the discussion forum, the course wiki, twitter and the Second Life virtual world. These alternative discussion environments competed with the course discussion forum in attracting students' interest. As for the language-based study groups, they were present in each of the five courses. Therefore, students made their learning relevant to their context by choosing and working on projects that were applicable in their own settings and by discussing the course materials with peers who understood their cultural context. This answers the second research question: "How do students make their learning relevant to their context?"

Concerns that MOOCs developed in Western societies might not suit other settings (Young, 2013) are partially true, but this is mainly an issue in the course design and students' engagement. As discussed above, some MOOCs are designed to enable cultural translation at a high level, others are not. Equally, students create study groups to discuss MOOCs from their own perspectives. Some MOOCs might not be relevant to students in some settings. However, this tends to be an issue also for students who take other online and face-to-face courses developed elsewhere. This is especially the case when a course was not designed to accommodate students from a diversity of cultural backgrounds. In an earlier paper (Nkuyubwatsi, 2013), I highlighted that international face-to-face students may find their learning not relevant to their own setting, especially when their classes are not internationally diverse in terms of participants. In a class with only one international student,

class discussions easily slip into local cultural realities and, therefore, unintentionally exclude the stranger student. Equally, instructors can easily design culturally embedded activities that do not accommodate the minority foreign student. Home students in classes dominated by their colleagues from a single foreign cultural background can have a similar experience. However, if the class cultural diversity is kept in mind in the design process, the course can appeal to all students, regardless of their backgrounds as demonstrated in LSIO and ILTEI.

As noted earlier, the embedding of cultural translation enablers might be quite difficult in some courses, depending on their nature and focus. However, designers of courses addressed to a multicultural audience who try their best to incorporate cultural translation enablers are more likely to provide a cross-cultural satisfaction towards their courses. AIP, IHTS, and CS could have embedded cultural translation enablers by giving students the opportunity to reflect, discuss and write on how the concepts in these courses apply to their respective settings rather than having all assignments structured from the instructors' perspective. The application of artificial intelligence, the history, technology and security related to the Internet and competition in business can be explored in various settings. Giving students the opportunity to discuss these issues in their respective settings could have enabled them to reflect on problems that are of most concern to them. Therefore, keeping diversity in mind during the course design and stimulating students' engagement in study groups, virtual and face-to-face, can make MOOCs and other courses addressed to international students relevant across cultural backgrounds. The closing statement of the LSIO professor reflects a diversity of mindset in course design:

*So it surely is important to know that [sic] your constraints, in your context, using the language that matters to you. And so I've broken up the world in a way that makes sense in terms of teaching this stuff, but you need to break up the world in a way that makes sense in terms of implementing, in terms of getting the projects done that are important to you.*

(Owens, 2013) [Quoted with permission]

The discussion of cultural translation needs to be viewed through a medium-strength lens, rather than a weak or powerful one. As discussed earlier, courses developed in foreign settings tend to be rejected because there is the feeling of hegemony of Western education (Young, 2013; Sharma, 2013; Liyanagunawardena et al., 2013). Those who want to use MOOCs to transform lives of people in developing countries probably need to empathise

with local stakeholders and demonstrate an understanding of local problems from local people's perspective. Equally, openly licensing course materials to enable local practitioners to make them relevant and use them in the way that responds to their contexts will increase trust in MOOC providers who want to impact positively on lives of people in developing countries. At the other extreme, a radical rejection of MOOCs, simply because they are not home-made, limits educational exchange that could be beneficial to learners and educators worldwide. Diversity and multicultural learning experience tends to be richer in MOOCs and these two learning ingredients can be beneficial to students and teachers regardless of their location or cultural backgrounds. The good news for MOOCs and educational stakeholders across cultures is that embedding cultural translation enablers in a course makes it more relevant to students from a diversity of cultural backgrounds. This is a niche that educators and other stakeholders need to exploit to facilitate a cross-cultural and multi-directional exchange of knowledge, skills and expertise.

## Conclusion

In this paper, I discussed cultural translation, the process of making courses relevant to students in their respective cultural settings, across five Coursera courses. In two of these courses, cultural translation was enabled by the inclusion of activities that required students to work on projects or tasks that were practical in their cultural settings. Students were given freedom to choose the setting and participants in their projects/assignments. Cultural translation was also assisted by student-created study groups based on geographical locations, languages and professional disciplines. These best practices indicate that MOOCs can be tailored to each individual learner regardless of her/his cultural setting, and require course designers to keep diversity in mind. They also call on students to learn collaboratively via informal study groups created for this purpose. While students in the five courses participated in such groups, only two of the five courses were designed to enable cultural translation. The lack of cultural translation was found to be an issue of course design rather than being a typical feature of MOOCs. Designers of courses addressed to internationally diverse groups can learn from the LSIO and ILTEI designs in order to accommodate all students. If enabling cultural translation is deliberately kept in mind in the design process and students engage in collaborative learning with their peers, the course can be relevant to students regardless of their cultural background.

## Acknowledgement

I am deeply indebted to Professor David Hawkrige, Professor Gráinne Conole and the reviewers for their constructive comments on drafts of this paper.

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## Edition and production

Name of the publication: eLearning Papers  
 ISSN: 1887-1542  
 Publisher: [openeducation.eu](http://openeducation.eu)  
 Edited by: P.A.U. Education, S.L.  
 Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)  
 Phone: +34 933 670 400  
 Email: [editorialteam\[at\]openeducationeuropa\[dot\]eu](mailto:editorialteam@openeducationeuropa.eu)  
 Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## Characterizing Video Use in the Catalogue of MITx MOOCs

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Lecture videos intended to substitute or parallel the on-campus experience are a central component of nearly all current Massive Open Online Courses (MOOCs). Recent analysis of resources used in the inaugural course from MITx (6.002x: Circuits and Electronics) revealed that only half of all certificate earners watched more than half the available lecture videos (Breslow et al. 2013, Seaton et al. 2014), with the distribution of videos accessed by certificate earners being distinctly bimodal. This study shows that bimodal lecture-video use by certificate earners persists in repeated offerings of 6.002x, with the distribution of video accesses being nearly indistinguishable. However, there are generally two modes of video use spanning the catalogue of MITx courses: bimodal and high use, both characterized via analysis of the distribution of unique videos accessed in each course. For both modes of video use, country-of-origin significantly impacts the measurement of video accesses. In addition, preliminary results explore how course structure impacts overall video consumption across courses.

### Tags

massive open online course,  
MOOC, learning analytics,  
videos, video use, online  
learning, distance education

### Introduction

Short videos interspersed with assessment items are a central feature in nearly all Massive Open Online Courses (MOOCs). This course component enables instructor-participant interaction in the absence of traditional on-campus lecture. Video length and the frequency of assessment items are intended to increase student engagement, and recent research suggests that the general format of short videos provides learning outcomes comparable to traditional on-campus lectures (Glance, Forsey, & Riley, 2013). Research aside, such video formats have proven to be quite popular in a number of non-traditional education settings, e.g., Khan Academy, implying the possibility of a lasting trend. In order to begin the process of measuring overall impact of videos in MOOCs, an analytics baseline must be established for participant-video interactions.

MITx, the Massachusetts Institute of Technology's MOOC division, releases MOOCs through the edX platform ([www.edx.org](http://www.edx.org)), offering participants a digitized set of course components motivated by both MIT on-campus activities and best practices in digital learning. Although variation in course components exists between courses, lecture videos are present within all MITx MOOCs. Each course is divided into weekly units (or chapters) containing approximately two learning sequences, typically made up of a number of short videos interspersed with content-engaging questions. The format of individual lecture videos differs, ranging from filmed MIT on-campus lectures modularized into short segments, to tablet recordings of instructors appending PowerPoint slides. Although consistently delivered in regard to interface, the total number of lecture videos, their length, and the frequency of lecture questions vary from course to course.

This work was initiated by a finding in the analysis of the inaugural MITx course 6.002x: Circuits and Electronic, namely, a bimodal distribution of unique lecture-videos accessed by certificate earners (Breslow et al. 2013, Seaton et al. 2013), namely, half of the 6.002x certificate earners accessed less than half of the lecture videos. These same certificate earners completed nearly all graded assignments for homework and the online laboratory, but chose not to use many of the supplementary learning components like the textbook and wiki. A number of questions emerge from this observation: Are bimodal video accesses a standard phenomenon in MOOCs? Is this simply an effect of Internet access? Are course features impacting video use? How are learners making decisions about which resources to use? In terms of video use, the 6.002x finding is supported by on-campus analysis of student interactions with online videos: medical school students provided with lecture recordings were found to have mixed usage and varying levels of impact on performance (Romanov & Nevgi, 2007, McNulty, et al., 2009).

The current study seeks to understand the most basic features of video use in MITx courses: unique accesses by participants and variation among courses. The distribution of unique video accesses provides a means of analyzing overall use by course participants; in this case, certificate earners. Metrics ranging from mean videos watched, to Beta function modeling, allow for comparison across courses, as well as for repeated offerings of the same course. As a first step, video accesses in the inaugural 6.002x course are compared against two repeated offerings in

which content changes were minimal, revealing remarkable similarity between all three courses. Gained insight is applied to the remainder of the MITx course catalogue, revealing courses whose overall accesses moves into a category of high use. For the entirety of the MITx course catalogue, country-of-origin is shown to be an important factor when analyzing video accesses. Finally, preliminary work explores the impact of course structure (design of lecture sequences) on course-wide video accesses.

## Courses and Participants

MITx Massive Open Online Courses (MOOCs) are delivered through the edX platform, with the intention that anyone with an Internet connection can enroll and interact with course content. A typical MITx course aims to recreate the on-campus experience at MIT by providing participants with a number of digital course components: lecture videos, lecture questions (short questions interspersed in lecture videos), homework, an eTextbook, student and instructor edited Wiki, and a discussion forum. Although these components represent the core of a MITx course, instructors have freedom to add supplementary components such as online laboratories (e.g., the 6.002x Circuit Sandbox used to construct and test simple circuits or the 8.02x TEAL visualizations used to model phenomenon in Electricity and Magnetism). Analysis of resource use in the inaugural 6.002x has shown certificate earners utilized course components in terms of overall time spent and unique resource accesses (Seaton et al. 2013).

| Course             | Description                               | Certificates Earned | Number of Lecture Videos | Number of Lecture Questions | Mean Video Length |
|--------------------|---|---------------------|--------------------------|-----------------------------|-------------------|
| <b>Spring 2012</b> |   |                     |                          |                             |                   |
| 6.002x             | Circuits and Electronics                  | 7157                | 416                      | 109                         | 5.5 min           |
| <b>Fall 2012</b>   |   |                     |                          |                             |                   |
| 3.091x             | Solid-State Chemistry                     | 2061                | 171                      | 120                         | 6.5 min           |
| 6.00x              | Intro. To Programming                     | 5761                | 153                      | 158                         | 8.2 min           |
| 6.002x             | Circuits and Electronics                  | 2995                | 416                      | 109                         | 5.5 min           |
| <b>Spring 2013</b> |   |                     |                          |                             |                   |
| 2.01x              | Elements and Structures (not analyzed)    | *                   | *                        | *                           | *                 |
| 3.091x             | Solid-State Chemistry                     | 547                 | 242                      | 163                         | 6.2 min           |
| 6.00x              | Intro. To Programming                     | 3313                | 150                      | 153                         | 8.1 min           |
| 6.002x             | Circuits and Electronics                  | 1101                | 416                      | 109                         | 5.5 min           |
| 7.00x              | Intro. Biology                            | 2332                | 142                      | 128                         | 11.9 min          |
| 8.02x              | Intro. Physics: Electricity and Magnetism | 1720                | 267                      | 229                         | 6.8 min           |
| 14.73x             | Global Poverty                            | 4608                | 158                      | 156                         | 7.6 min           |

Table 1: The MITx catalogue through Spring 2013 is listed in Table 1, providing labels and short descriptions of each course, along with the number of certificates granted, total number of lecture videos, total number of lecture questions, and mean lecture video length.

Although any combination of course components can form the structure of a MITx course, lecture videos are central component within all MITx courses. Each course is divided into weekly units of course work (chapters) containing one to two learning sequences consisting of a number of short videos with interspersed questions. As discussed in the introduction, the format of individual lecture videos can differ, but delivery is consistent across courses. Table 1 contains course information relevant to this study for the MITx course catalogue through Spring 2013. The course names will be an important reference throughout this work. Archived versions of most courses can be accessed via edX ([www.edx.org](http://www.edx.org)).

MITx courses have been host to massive enrollments as evidenced in Table 1 (total enrollments are often ten times the size of certificate earning populations). These enrollments have varied greatly in terms of their cultural and educational backgrounds, as well as overall level of participation. The impact of diversity on resource use can be found in initial analyses of 6.002x (DeBoer et al., 2013), as well as in terms of performance and participation in 8.02x (Rayyan, Seaton, Belcher, Pritchard, & Chuang, 2013).

## Methods

Current technology streamlines the collection of records on participants and their activities within a given MOOC, providing detailed data for a “massive”, and equally diverse, set of participants. A recent report has shown participation varies greatly in MOOCs (Kizilcec, Piech, and Schneider, 2013), e.g., some participants only watch videos, while others complete assignments asynchronous to course due dates. In the case of the inaugural 6.002x course, time spent measures indicate some participants simply take exams (Seaton, et al., 2013). Until future analyses can more generally classify participant-strategies, certification status provides a first-pass filter for those participants likely to interact with the majority of course content relative to due dates ((Seaton, et al., 2013) provides further justification based on time-on-task). Hence, lecture-video accesses are reported here only for participants having earned a certificate. Sample sizes for certificate earners in each course are listed in Table 1.

This study is centered on analyzing the distribution of lecture-video accesses for certificate earners in a given edX course. Click-stream data contain records of all participant-video interactions (pause, play, or loading of a video) and their associated IDs.

Other data are also stored within the click-stream, including timestamps, video speed, and participant IP address, but participant ID and video ID are the only fields required to estimate number of unique videos accessed by each participant. After calculating the number of unique lecture-video accesses per certificate earner, overall distributions can be generated for each course. Fraction of lecture videos accesses provides a simple transformation allowing for cross-course comparison.

As stated previously, videos as a resource type serve a number of purposes in MITx courses: “Problem Solving Tutorials”, “Welcome or Introduction”, etc. Course structure data can be extracted to link each video with a specific course component. Hence, this study focuses only on video interactions classified as “Lecture Videos”, or those representing the principal learning sequences found in each chapter (week) of a MITx course.

Plotting distributions of the fraction of unique videos accessed is a first step in understanding video use, but in addition, one can model such distributions using functions with support on the interval [0,1]. Beta functions provide a two-parameter model capable of accounting for floor and ceiling effects associated with the finite interval. Plotting resultant fitting parameters in a simple two-parameter space provides insight into the mean number of videos watched and the shape of each distribution. These modeling techniques have been effective in analyzing the impact of course structure on eText use in both on-campus (Blended, Flipped) and online (Distance, MOOC) settings (Seaton, Bergner, & Pritchard, 2013); although a closely related two-parameter model was employed. Beta functions also provide other unique applications in education research (Smithson & Verkuilen, 2006). All applications of Beta functions in this work have been carried out via statistical libraries in Python (Scipy.Stats).

Figure 1 contains three methods used to scaffold visualizations used in this study: PDF - Probability Distributions (Left), CCDF - Complementary Cumulative Distributions (Middle), and (a,b) - Beta Parameters (Right). PDFs provide a familiar way of analyzing distributions (histograms), while CCDFs allow one to more easily visualize many distributions in a single figure. The measured variable X represents the fraction of accessed videos. Five exemplary PDFs (Left) are plotted and labeled by the Beta Parameters used to simulate them. The two solid curves have identical means but quite distinct shapes: one unimodal (normal) distribution ( $a=b=4.0$ ), and one bimodal distribution ( $a=b=0.5$ ). Other example PDFs represent commonly encountered

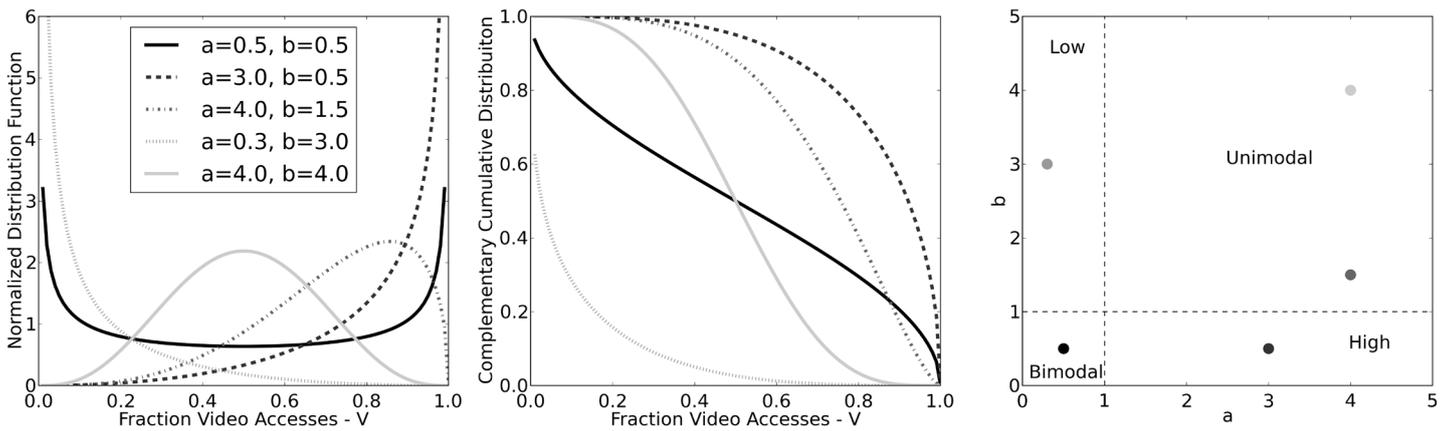


Figure 1. Example distributions for the fraction of videos accessed (left) generated using Beta functions whose parameters are given in the legend. These distributions can be transformed into Complimentary Cumulative Distributions such that features are more easily viewed in a single graph. Beta function fitting parameters can also be plotted (right) to help classify use. Regions are marked as low, high, bimodal, and unimodal.

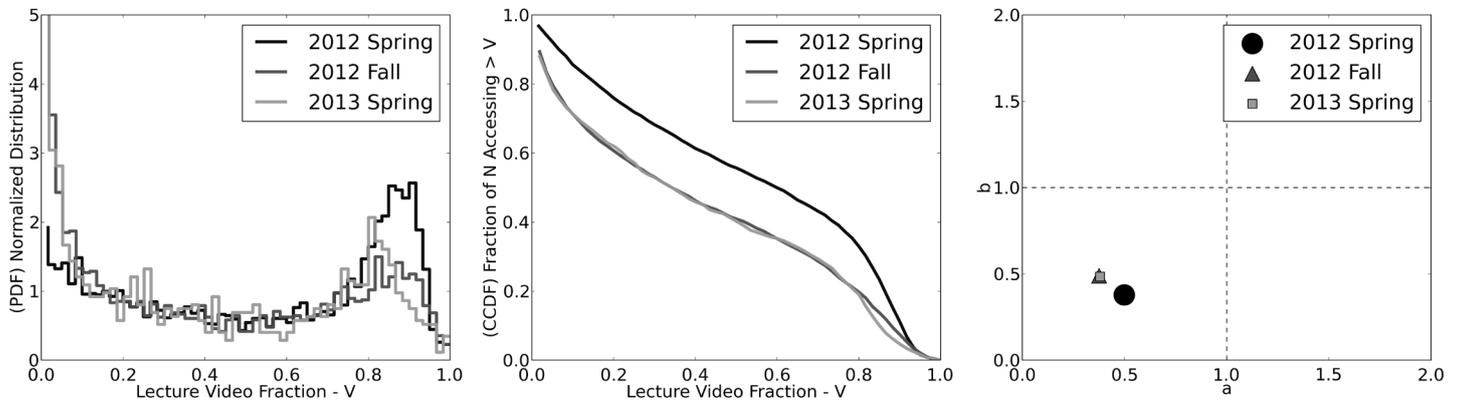


Figure 2. Fraction of videos accessed by certificate earners in repeated offerings of 6.002x plotted as Normalized Distributions (Left), Complementary Cumulative Distributions (Middle), and as resultant Beta Parameters (a,b) from fitting analysis (Right). Symbol sizes for Beta Parameters are proportional to the number of certificate earners.

distributions. CCDFs (Middle) are plotted for the same PDFs, where CCDFs weighted toward  $X=1.0$  appear in the upper-right quadrant ( $a=3, b=0.5$ ), and distributions weighted toward  $X=0.0$  appear in the lower-left quadrant ( $a=0.3, b=3.0$ ). Bimodal and unimodal distributions traverse the middle of the graph. Beta Parameters (Right) offer an even clearer representation of each distribution. Four relevant regions containing similarly shaped distributions are separated by dashed lines: bimodal ( $a, b < 1$ ), low usage ( $a < 1, b > 1$ ), high usage ( $a > 1, b < 1$ ), and unimodal ( $a, b > 1$ ). Within the unimodal region, the proximity of ( $a, b$ ) to the low and high usage implies a distribution mean shifted toward low or high usage. Beta Parameters provide a framework for classifying usage distributions and are an important aspect of this work.

## Results

### Persistence of Bimodal Video Use in 6.002x and the Impact of Downloads

The first major goal of this study addresses whether bimodal video accesses persist in repeated offerings of 6.002x. Figure 2 highlights the distribution of video accesses by certificate earners in all three offerings via our described visualization methods. Both the PDFs (Left) and the CCDFs (Middle) show that all three offerings have the same general bimodal shape, but that the inaugural course (2012 Spring) had slightly higher overall video consumption compared to repeated offerings (2012 Fall, 2013 Spring). Again, minimal changes were made to 6.002x content in repeated offerings of the course. Similarity in the shape of the three distributions indicates consistent behavior in how participants interact with course resources. Population sizes (number of certificate earners) can be found in Table 1; symbol sizes for Beta parameters reflect relative population sizes.

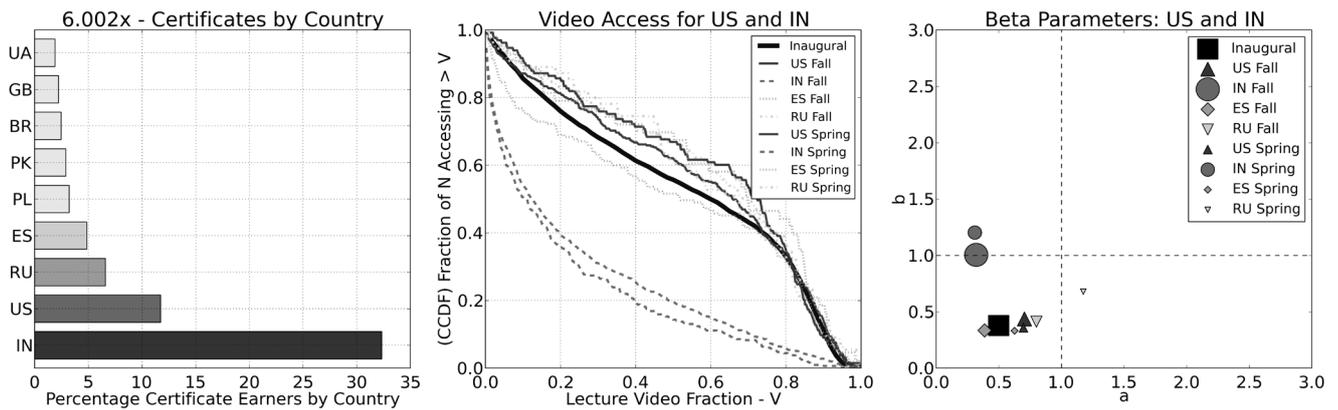


Figure 3. Percentage of certificates earned by country-of-origin (Left) for the Fall 2012 and Spring 2013 repeated offerings of 6.002x (note, metrics currently not available for the inaugural course). CCDFs (Middle) and Beta Parameters (Right) highlight the differences in video access distributions via the top four certificate earning countries. Symbol size is proportional to sample size.

Regarding the gap between distributions for the inaugural and repeated offerings of 6.002x, one glaring explanation stems from the addition of the “download video” option added to courses starting in Fall 2012 (inaugural course had no download option). Supporting that possibility is the striking overlap visible in both the CCDFs (Middle) and Beta Parameters (Right) for the Fall 2012 and Spring 2013 courses. In order to account for downloading, video accesses are explored through the lens of country-of-origin (provided via IP country look-up). The hypothesis is two-fold: one, if downloaders can be accounted for, the distribution of video access for repeated 6.002x courses will overlap the inaugural course, and two, country-of-origin provides a proxy for downloading due to potentially poor internet access.

Here, this hypothesis is explored by separating video-access distributions by country-of-origin for the Fall 2012 and Spring 2013 6.002x courses (Figure 3), where the top-four countries for certificates earned in 6.002x Fall 2012 and Spring 2013 (Left) are the United States, India, Russia, and Spain (IP analysis providing country look-up has not been performed for the inaugural course, but may in the future). Separating each video access distribution by country allows for the comparison of country-level data with the inaugural course. CCDFs (Middle) show interesting trends: India has substantially lower video consumption relative to the inaugural course (thick black line), while other countries are close in proximity to the inaugural course. The Beta Parameters (Right) also indicate the differences in video consumption by country. India distributions border bimodal and low use, while all others maintain bimodality, with the exception of Russia in the Spring 2013 course. Although not confirmatory, these results highlight a possible download effect, but at minimum, show that country effects are an important aspect of analyzing resource use.

### Video Consumption Across All MITx Courses

Of equal interest is the comparison of video accesses across courses. In Figure 4 CCDFs are plotted for all courses delivered in the Fall 2012 (Left) and Spring 2013 (Middle) cycles, along with Beta Parameters for courses from both cycles (Right). CCDFs for Fall 2012 (Left) highlight video consumption in two newly introduced MITx courses: 3.091x, which is bimodal, and 6.00x, which represents high rate of video accesses (6.002x is plotted as a reference).

All of the Fall 2012 courses were repeated in the Spring 2013 with minimal edits to content. The CCDFs for these courses are plotted as dashed lines in the Spring 2013 cycle (Middle Figure 4), while three newly introduced courses are plotted as solid lines (7.00x, 8.02x, 14.73x). The CCDFs for the Spring 2013 cycle show a clear distinction between courses with high video consumption and the two courses with bimodal use, 3.091x and 6.002x. At first glance, all new courses in the Spring 2013 cycle appear to be high consumption, but the Beta Parameters tell a slightly different story. 8.02x appears within the bimodal region, indicating a significant tail toward low video consumption (notice the slight inflection (convex) over the interval [0.0,0.6] in the CCDF). Results from Fig. 4 highlight two distinct modes of lecture video consumption: bimodal and high use. Such access rates for videos stand in contrast to the overall access of eText resources in MOOCs, which were found to be primarily low use resources within selected MITx courses (Seaton, Bergner, & Pritchard, 2013).

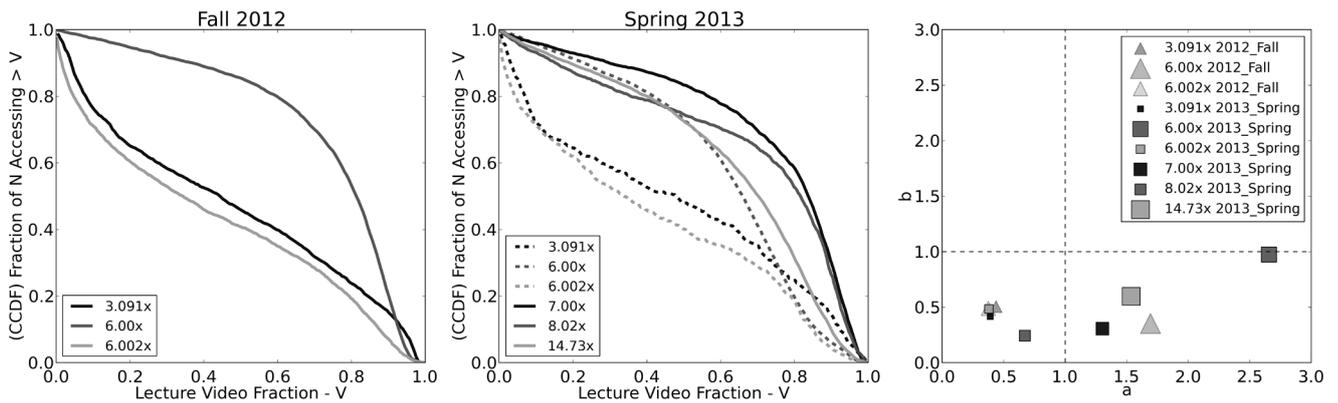


Figure 4. Fraction of videos accessed by certificate earners in all MITx courses from Fall 2012 (Left) and Spring 2013 (Middle). Beta Parameters (Right) indicate the overall shape of each distribution. Symbol sizes are again proportional to the number of certificate earners in each course.

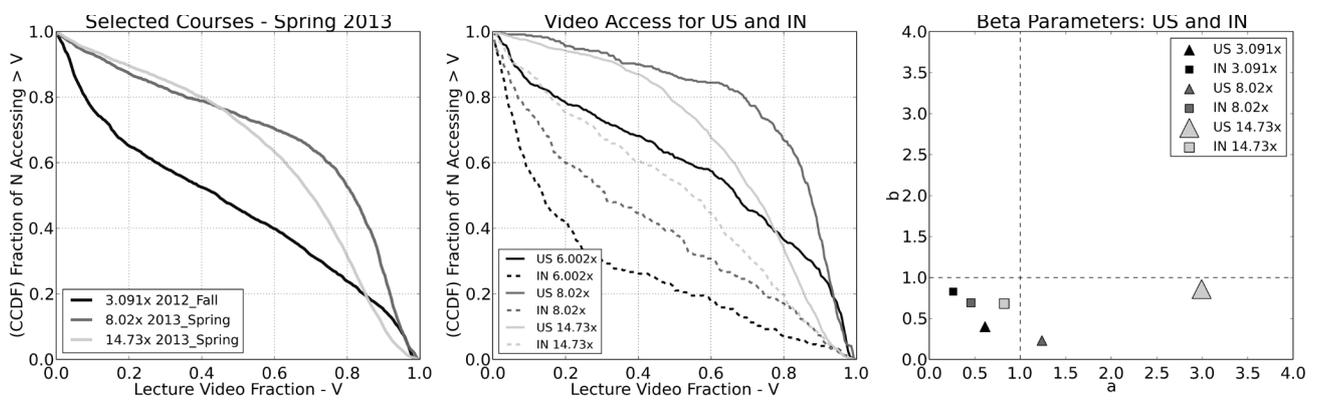


Figure 5. Fraction of videos accessed by certificate earners in 3.091x Fall 2012 and 8.02x Spring 2013. CCDFs (Left) are presented as a reference for comparing the separation of access distributions by the two largest enrolling countries (Middle): United States (Solid) and India (Dashed). Beta Parameters are plotted for each CCDF.

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## Course Structure Considerations (considering removal)

Course structure refers to the type, order, and weight of various resources within a course. As a preliminary step toward understanding how course structure impacts video use, the following metrics are analyzed for all previously discussed MITx courses: the ratio of total lecture videos to lecture questions (frequency of occurrence), total hours of duration, and mean length of each video.

Figure 6 highlights these lecture video metrics. The video-question ratio (Left) gives perhaps the most compelling connection between bimodal video use and course structure. 6.002x has a tremendous number of lecture videos (see Table 1), leading to an inflated ratio, while 3.091x (the other bimodal course) has the next highest ratio of approximately 1.5. All other courses have video-question ratios near 1.0. Total time required to watch all videos (Middle) could potentially provide context into fatigue and time constraints, however, the connection between this metric is not as clear as that found in the video-question ratio (however, this metric will likely be more important in understanding temporal habits in future work). The mean video length (Right) as described here also lacks any strong connection between overall video accesses and course structure.

## Discussion and Conclusions

Through the lens of unique lecture-video accesses, this study has provided a general overview of video use by certificate earners in MITx MOOCs. Bimodal video use measured from the inaugural 6.002x course has been confirmed to persist in repeated offerings utilizing the same content. In exploring this bimodality, country-of-origin was found to be an important factor influencing video use. However, country-of-origin did not account for the overall bimodal shape of distributions for all 6.002x offerings. For all MITx courses, two modes of video use have been observed: bimodal and high use. Country-of-origin was again shown to have significant influence on video use across courses, particularly for those courses with associated beta parameters existing near the boundaries of bimodal, high, and low video use.

Participants from India accounted for a large portion of certificate earners within MITx courses. Lecture-video use by participants from India was quite low relative to other countries in nearly all MITx courses. One aspect explored the simple idea that downloading videos due to poor Internet access may play a role in these observations; the reader is reminded click-stream data currently provide no information on participants that download lecture videos, instead, only indicating those participants streaming videos through their respective courseware. Downloading videos likely has some effect on low-video use in India, but other possibilities dealing with culture and learner preferences are not ruled out as contributing factors. Future efforts will be aimed at such effects.

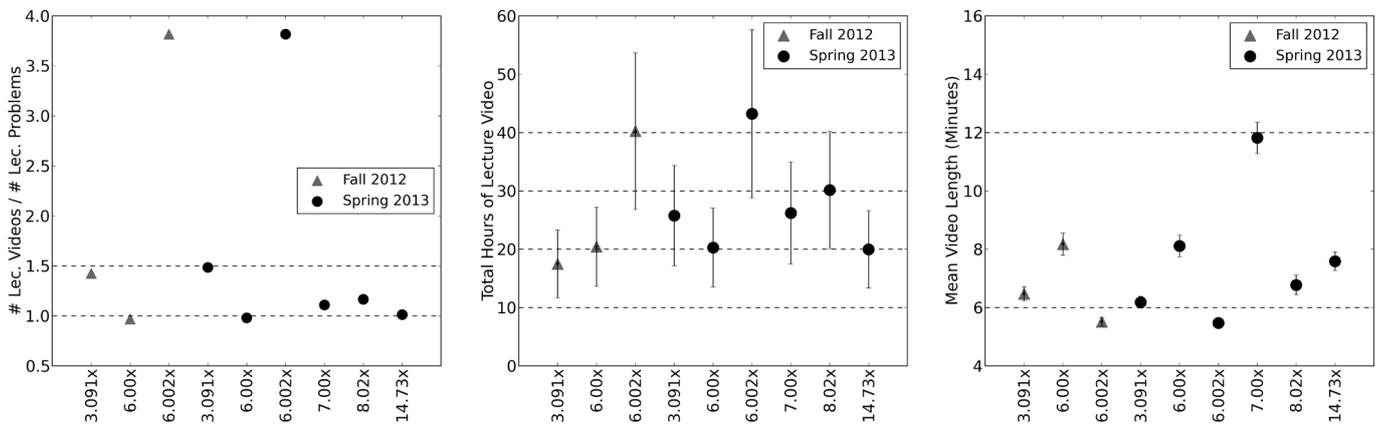


Figure 6. Visualization of Lecture Video features in all MITx courses: the ratio of Lecture Videos to Lecture Questions (Left) and the Total Duration in hours of all Lecture Videos watched in real time (Right). Error bars on total hours of lecture video denote the time difference in watching all videos at 0.75 or 1.5 times the normal speed. Error bars on Mean Video Length represent standard error of the mean. Dashed lines in both plots serve only as visual references.

Another important feature of this work involves the striking similarities in video use between repeated offerings of the same course. Minimal content changes were implemented in each course cycle for repeated course offerings, and behavior (interactions with videos) followed the same trend. Considering the certificate earning populations were still in the thousands of participants (barring 3.091 Spring 2013), this similarity makes a strong case that course structure impacts much of the student behavior. Courses with bimodal video use present an ideal setting in which to implement an experiment aimed at increasing video use through changes to course structure, i.e., the type, order, and weight of various resources within a course. Analysis of such experiments for on-campus physics courses using eTexts has begun (Seaton, Bergner, & Pritchard, 2013).

One promising result not directly addressed in this study involves the evolution of MITx courses. As new courses are introduced within each cycle, the overall number of videos being consumed is increasing. One might speculate that such an improvement is meaningful, but the value, whether toward learning or content delivery, must be better defined. Such metrics as those presented in Figure 6 are a first step in exploring how course evolution impacts video accesses. The relationship between the video-question ratio and bimodality presents a number of intriguing hypotheses for understanding video engagement. However, this work needs to be extended in order to account for the many types of possible engagement throughout a given course. Other important features not discussed here relate to content within each video, presentation style, and instructor effects, all of which could play an equally important role in overall video use. Recent work has implemented a deeper analysis involving the “in-video” interactions of MOOC participants, focusing on in-video dropouts and click activity (Kim, et al., 2014).

Much work remains in terms of identifying video access patterns in MOOCs. This work has taken a baseline approach that involves using participant-video interactions to count the number of unique videos accessed. Future work will likely incorporate improved metrics for analyzing video interactions, such as time-spent measures that monitor whether an interaction was meaningful (not simply clicking through to lecture questions), or measures of weekly video accesses that provide insight into changing habits over the roughly 16 weeks of an MITx course.

### Acknowledgements

Authors thank the Office of Digital Learning at MIT and the HarvardX research team. Additional thanks given to Sarah Seaton and Yoav Bergner for helpful feedback on this manuscript.

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## Edition and production

Name of the publication: eLearning Papers

ISSN: 1887-1542

Publisher: [openeducation.eu](http://openeducation.eu)

Edited by: P.A.U. Education, S.L.

Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)

Phone: +34 933 670 400

Email: [editorialteam\[at\]openeducationeuropa\[dot\]eu](mailto:editorialteam@openeducationeuropa.eu)

Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## Toward a Quality Model for UNED MOOCs

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This article discusses a prototype quality model developed for courses in the first edition of the UNED MOOC initiative (where over 170,000 students undertook 20 MOOCs between October 2012 and May 2013). It is argued that since it is not easy to differentiate between a MOOC and other types of online courses, it is therefore difficult to specify a quality model for the former. At the time of starting this project there were no other quality models that could be applied directly. Hence, a practical two-part solution was assumed. Firstly, it considers the overall structure and function of each course in terms of a variable set of characteristics that can be used to evaluate the initial design of the course. Secondly, it uses a flexible student certification model, argued to demonstrate that a course has achieved its objectives given the results intended by the teaching team.

### Tags

quality framework, quality assurance, MOOC quality, UNED

## 1. Introduction

Vince Cerf, one of the inventors of the TCP/IP protocol, often referred to as one of the fathers of Internet, stated that certain things get invented when it actually becomes possible to do so, referring to the need for related technology, infrastructure and context to be ready for such developments to become feasible (Cerf, 2012). The first massive open online course (henceforth, MOOC) was run in 2008 (Downes, 2012; Daniel, 2012; Watters, 2012), when arguably the technological, pedagogical and sociological conditions were right for such a course to appear. MOOCs were subsequently hailed as an “educational phenomena” in 2012 (Pappano, 2012), and in June of that year, Spain’s national distance-education university, UNED, took the strategic decision to start its Open UNED Web portal (as a way to bring together work on Open Educational Resources and Practices undertaken in different parts of the university), and as part of this project, it was decided to include a MOOC initiative. In order to prepare courses for this initiative it was necessary to define a quality model that could be used to ensure that all courses that were developed would give the students the “course experience” associated with the UNED brand, which in turn, required an understanding of what a MOOC actually is and how it differs from other online courses.

It was Dave Cormier who coined the term MOOC, for this type of online course, in 2008 (Downes, 2012). It has been argued by Downes (2013a) that MOOCs combine the advantages of open content and open learning in a way that is compatible with large-scale participation thanks to the connectivist pedagogic philosophy, where knowledge is developed and distributed across a network. As well as the possibilities for learning and personal development that MOOCs offer, there are also pragmatic reasons for their wide-scale adoption by educational establishments around the globe. Higher education is competitive, not just for the students who finish their studies with a new qualification, when they try

to find a job, but also for the institutions themselves as they try to attract new students. Even though hosting MOOCs, which are essentially free to their students (if no paid certification is required), has associated costs for the institution, it is popular with the universities since these courses offer a way to provide potential students with “a taste of what is come”, if they enroll on related formal educational programmes at the institution.

However, while offering MOOCs has advantages for the institutions they must also do so with care since any course or educational initiative started by them must reflect the same quality control present in their standard formal educational programmes. Any other alternative would be counter productive and lead to a loss of potential students. When UNED started its MOOC initiative in 2012 there was a strong commitment to quality in the sense of both how a given course would be structured and run together with the control of the certification process of students that have actually finished a course. Specifically, an internal policy was developed in December 2012 to assign ECTS credits to MOOCs, along with other course-specific accreditation, in order to facilitate their integration into the regular academic course programme. In this article, the question of what quality actually means for a MOOC is considered together with the practical implications of how the quality of these courses undertaken at UNED has been achieved.

### When is an online course a MOOC?

UNED has over forty years of experience in distance education, and since 2000, has been using an eLearning platform as the main teaching vehicle for its online courses; the majority of which can be defined as using a blended learning methodology (combining online e-Learning with face-to-face sessions in regional study centres). Since then, the university has invested considerable effort in developing quality control mechanisms for its online courses with a special milestone in 2007, when the Spanish Ministry of Education gave instructions that all universities must have systems of internal quality assurance. UNED rapidly completed the design of its internal system of quality assurance as part of the ANECA's (Spain's National Agency for Quality Assessment and Accreditation) AUDIT Programme for all the university's degree programmes. This was verified by the ANECA, with very positive feedback, in 2009 in the First Round of the AUDIT program. Based on this quality system, an a priori control of how courses are actually conceived, structured and what resources are included together with the previsions

for supporting students and their difficulties is undertaken by the university's institute for distance education (Instituto Universitario de Educación a Distancia, IUED) Secondly, post-course questionnaires are used so that the students can give feedback on their experience of a given course. Hence, at the end of each edition of a course, the feedback from the student questionnaires is sent to the teaching teams and they are given the opportunity of answering any criticisms received and addressing any weaknesses identified.

When the university took the decision to start the MOOC initiative it was evident that there were a number of courses that could be prepared and started in the first edition. The objective was to have 20 MOOCs developed and running by January 2013. Given the heterogeneous nature of the subjects being covered in the courses and the way in which each teaching team wanted to undertake a course, it was evident that any kind of systematic quality control was going to be difficult to undertake, based upon previous experience. In order to develop a suitable quality model it was necessary to understand what actually constitutes a MOOC. As has been noted in the literature (Hill, 2012), the vary nature of MOOCs, their structure and associated pedagogy differ so much that it is even questionable referring to them by the same term. Downes (2013b)(see also Morrison, 2013a) differentiates between two types of MOOC: connectivist MOOC (or cMOOC, based upon principles of learning communities with active users contributing content and constructing knowledge) and extended MOOC (xMOOC, similar to standard online courses but with larger student numbers). Siemans (2012) notes that the former emphasizes creativity, autonomy and social networked learning whereas the latter focuses on knowledge creation and generation.

Other authors have gone further to highlight different aspects of courses that enable them to be called MOOCs, and even specify what type they are. An example is the taxonomy of 8 types of MOOC developed by Clark (2013): TransferMOOCs represent a copy of an existing eLearning course onto a MOOC platform, where the pedagogic framework follows the standard process of teachers transferring knowledge to students. An example would be the courses offered by Coursera. MadeMOOCs make a more innovative use of video where materials are carefully crafted and assignments pose more difficulty for the students. An example would be the courses offered by Udacity. SynchMOOCs are MOOCs that follow fixed calendars for start, end, assessments, etc. This has been argued to help students plan their time and undertake the course more effectively. Both Coursera and

Udacity offer these courses. AsynchMOOCs are asynchronous MOOCs that are the opposite of synchMOOCs in that they have no or frequent start dates, together with flexible deadlines for assignments and assessments. AdaptiveMOOCs try to present personalised learning experiences to the students by adapting the content they see to their progress in the course. The Gates Foundation has highlighted this approach as key for future online courses. Group MOOCs actually restrict student numbers to ensure effective collaborative groups of students. This is argued to improve student retention. As a course progresses, sometimes the groups will be dissolved and reformed again. ConnectivistMOOCs or cMOOCs, are as defined above. MiniMOOCs are shorter MOOCs that focus on content and skills that can be learned in a small timescale. They are argued to be more suitable for specific tasks with clear objectives.

Conole (2013), instead of actually trying to fit the MOOCs into specific locations within a taxonomy, classified them in terms of a set of dimensions that can be used to define them:

“the degree of openness, the scale of participation (massive), the amount of use of multimedia, the amount of communication, the extent to which collaboration is included, the type of learner pathway (from learner centred to teacher-centred and highly structured), the level of quality assurance, the extent to which reflection is encouraged, the level of assessment, how informal or formal it is, autonomy, and diversity”.

Morrison (2013b) prefers a simplified classification, which focuses upon the nature of the instructional methods used, the depth and breadth of the course materials, the degree of interaction possible, the activities and assessments provided, and the interface of the course site. What is evident is that there are difficulties in specifying what a MOOC actually is and defining when an online course actually can be called a MOOC. Even a fairly clear indication of this type of course, namely the large number of participants, is hard to actually specify. What does massive really mean? The authors of this article have online courses on the Computer Science degree programme at UNED with over 3,500 students that are not defined by the university as being MOOCs. Hence, trying to apply the same criteria used for specifying standard online degree courses to the development of MOOCs at UNED would have been difficult to undertake given the wide range of possible courses being developed and the way in which each teaching team wanted to run them (e.g., more or less content, activities, interaction).

Even though the strategic decision was taken early on to follow a standard approach to structuring the UNED MOOCs, using design templates to give each course a similar look and feel, differences between the courses would have made it impossible to just apply simple criteria for them all, as if each course were one specific type of MOOC as indicated by Clark (2013) above.

### A hybrid approach to MOOC quality at UNED

While research on the issue of MOOC quality is appearing in the literature, as can be seen, there is not currently a consensus on how quality assessment of these courses should be undertaken (Haggard, 2013, p.6) if indeed it makes any sense to try to measure it (Weller, 2013).

The MOOC Quality Project (Ehlers, et al., 2013), undertaken by the European Foundation for Quality, has involved many well-known researchers, to treat different aspects of the question of what quality actually means when MOOCs are concerned. The result of which, including the generation of blog entries and networked discussion, read and contributed to by more than 12,000 people, is that it is very difficult to define what quality means for these courses since their very nature is constantly changing, with new types and variants of courses appearing all the time. They highlight some factors that are related to the perception of MOOC quality: the notion of choice, what pre-course information is provided, the pedagogical approaches supported in a course, the level of student commitment required, is a course scheduled or not, technical requirements, the role of the teaching team, availability and level of interaction, whether certification is availability. A key issue is whether a course actually lives up to its promise.

Downes (2013c), as part of his contribution to The MOOC Quality Project, differentiates between the quality of a MOOC in terms of its platform and related tools (functionality, stability, etc.) and whether the outcome of a given instance of a MOOC is successful or not, in a given context with a given student body. He goes on to note that “measuring drop-out rates, counting test scores, and adding up student satisfaction scores will not tell us whether a MOOC was successful, only whether this particular application of this particular MOOC was successful in this particular instance”.

Another quality initiative that appeared in 2013 is that of the OpenUpEd label (Roswell 2012; Roswell 2013), which is based around the E-xcellence approach of using benchmarks for quality

assessment (Ubachs et al., 2007; Williams et al., 2012), but here it is applied to MOOCs. The idea is that a MOOC that has been evaluated using benchmarks can put the label on the course Web. The 32 benchmarks represent a good first step toward MOOC quality control but will inevitably need to be refined as more experience of applying them has been obtained.

Even though, as noted previously, a lot of the literature that has appeared on MOOC quality was not available in June 2012 when UNED started its MOOC program, some decisions had to be taken at the time, about how the courses would have their quality controlled, thereby protecting the university's brand, and ensuring that the first edition of these courses was successful. The initial quality model was based upon the one used for the online degree programmes, which had been developed and refined for more than 15 years. It should be noted that, in principle, preparing a MOOC represents much less of a problem for distance university lecturing staff than for their face-to-face equivalents, since typically the former have been using e-Learning platforms for several years already as part of their daily activities and are very familiar with using the tools available therein. In the case of UNED, the first platform was strategically introduced for a large part of the official courses in 2000 (although many courses had been run "unofficially" previously). Initially a part of the lecturing staff, not familiar with such platforms, had to be taught how to use the platform and its tools, but over the years its use of subsequent platforms has become second nature.

Hence, producing MOOC content and activities, which being somewhat different from those found in other standard university online courses, does not require the development of a new skill set, as might be the case in other areas. Several specific guidelines were established to guide course creators, such as:

- The division of the course syllabus into  $n$  modules (with an overall student workload of 1-2 ECTS).
- The inclusion of a short introductory video in each module.
- The use of a self-paced methodology.
- The establishment of interactive user forums to help the students, professors, and teaching assistants develop a community.
- The application of peer-review and group collaboration.

- The presence of automated feedback through objectives and online assessments, e.g. quizzes and exams.

Obviously, the videos used would be shorter than regular video tutorials used in other courses in the e-Learning platform. Instructions for the teaching assistants needed to be prepared, but this activity wasn't completely unfamiliar to the course authors. It's worth noting that in UNED MOOCs, the teaching roles were restricted to course facilitators and content curators. The latter acted as "critical knowledge brokers" to maintain the relevance of the information that flows freely between the students in the forums.

Hence, based upon the quality process used in UNED for the blended learning and e-Learning courses, a model was defined in terms of two types of control: firstly, the structural and functional coherence of a given course, based upon the objectives defined by the teaching team which would be matched to a set of characteristics that could be used to evaluate the initial design of the course, similar to those highlighted by Conole (2013), Ehlers, et al. (2013) and Morrison (2013). Secondly, the establishment of a flexible certification model (a freemium model), that would enable the students who had undertaken the course to demonstrate, in a standard test-like evaluation, that the course had achieved its objectives and that they had achieved the results intended by the teaching team.

Regarding the former, the establishment of a variable metric for each MOOC made it possible to control how each course was structured, what kind of resources were included and how activities, interaction and assessment was included. Specifically, the metric contemplated five aspects:

1. Topic: Each course should be as specific as possible, such that there could be an agglomeration of courses into a larger "knowledge puzzle" subsequently. Proposals for MOOCs that tried to cover too wide an area were reviewed and simplified, and where necessary, were split into proposals for more than one course.
2. Contents: In many cases materials previously prepared by the course author(s) could be reused, although they may have had to be adapted to the MOOC format (i.e., videos with an approximate duration of 5 minutes, guidelines that would be understandable without the support of teaching staff, activities that either finished with self-evaluation or involved some kind of forum-based collaboration

or interaction, etc.). However, in some cases certain recordings had to be re-scripted and recorded again; it was not possible to take a twenty minute recording and split it into four five- minute ones, due to the logical flow of the recording.

3. Duration: Due to the wide variety of MOOCs considered, it was necessary to accept course durations of between 25 and 125 hours. The majority of courses were nearer the former than the latter, although some were longer if they dealt with experimental simulations, remote laboratory control or the coordination of students undertaking real-world practical activities.
4. Structure: Courses were typically divided into 4 to 8 modules, depending upon duration and objectives. Each module would typically have between 4 to 8 videos with associated activities and evaluations. The latter were used to consolidate acquired knowledge and foster interaction between the students. When the structure of a given course was being reviewed in terms of its overall quality, given the differences in objectives and philosophy, more of a qualitative assessment was made than a quantitative one. A consideration was made of how the combination of videos and other materials facilitated the learning proposed by the course team in the objectives established for the course.
5. Specific instructional design guidelines: courses were designed to challenge the students who took part, and not as a series of lectures to be “passively consumed”. The data generated in the assessments could be evaluated ‘massively’ using automated systems. Also, self-assessment methodology was applied, which requires students to reflect upon their own work and judge how well they performed.
6. Social channels: Forums were the main interaction tool provided, although other associated Web 2.0 tools could also be included if the teaching team so desired. The forum tool present in the OpenMOOC platform enabled members to vote on any post. Posts with more votes appeared higher up in the relevant thread in the forum, so were encountered earlier when searches were made. The methodological approach used for UNED MOOCs, similar to most of these courses, didn’t take into account the participation of the course designers in the forums (although quite often they did, in fact, take part). Hence, the forum, and its ordered

message system, provided valuable feedback to students undertaking the courses, not only on specific course-related content but also on general platform-related and MOOC-associated topics.

Student dropout has been identified as a key problem for MOOCs (e.g., Gee, 2012; Yang et al., 2013). This is too big and complicated a problem to solve with one simple measure. One online survey [“MOOC Interrupted: Top 10 Reasons Our Readers Didn’t Finish a Massive Open Online Course”. Open Culture ] published a “top ten” list of reasons for drop out. The reasons included: the course required too much time, or was too difficult or too basic, the course design included “lecture fatigue” (due to too many lecture videos), a lack of a proper introduction to course technology and format, clunky technology and trolling on discussion boards. Furthermore, hidden costs were cited, including the need to complement course content with expensive textbooks written by the instructor. Other non-completers were identified as “just shopping around” when they registered, or as participating only for knowledge rather than because they wanted to obtain some form of credential. However, what has been noted in UNED MOOCs is that the mutual support possible thanks to the forum tool, together with the participation of the facilitator and curator there, have helped students keep in the courses and stay focussed on the tasks relevant to learning.

This was useful both for controlling the development process and also deciding when a course was finished and ready to be put into production. Regarding the latter, the freemium certification model used for this purpose had three types of awards. Firstly, badges that were gained automatically as the course progresses, for having achieved specific results, such as finishing an activity in a course, participating a certain number of times in the community, etc. Secondly, a type of certificate, defined by UNED as a Credential, that is awarded as a result of a student having finished the majority (80% or more) of a given course and subsequently taking an online test. Thirdly and finally are full certificates, which require a student to undertake a test similar to the online one but on a computer in one of UNED’s regional study centres, where proof of identity is required and the test is taken in authentic exam conditions. The third type of certification process was established to counter one of the criticisms of MOOCs and the assessments used therein, namely plagiarism and cheating (Oliver, 2012; McEachern, 2013).

## Conclusions

The first edition of the UNED MOOC initiative finished in May 2013 with over 170,000 registered users and more than 2800 paid certificates being awarded. Of the 20 courses started, the most popular ones were those on second language learning, as can be seen in Table 1. It was evident when this initiative was started that some control was needed to ensure that the courses developed would be both sufficiently flexible in nature to meet the teaching team's conception of what they wanted in their MOOC, and at the same time, guarantee that the user experience would meet what was expected from a UNED course.

| Course  | Enrolment |
|---|-----------|
| Starting with English: learn the first thousand words | 45,102    |
| Professional English                                  | 33,588    |
| German for Spanish speakers                           | 22,438    |
| Practical course on e-Commerce                        | 12,763    |
| Accountancy: the language of business                 | 9,799     |
| ICTs for teaching and learning                        | 7,448     |

Table 1. Top six MOOC enrolment figures at UNED

However, as has been argued in this article, it is not easy to specify what exactly defines a MOOC and differentiates it from other types of online courses. Even basic characteristics of a MOOC, such as the number of students, or the degree of involvement of the teaching team once a course has started, can blur between courses, some of which are called MOOC and some are not. Hence, it is difficult to specify a quality model, given the wide range of parameters for different online courses, which may or may not be conceived as being MOOC. Since a practical solution to the question of course quality was needed for the UNED MOOC initiative, a quality model was used that considered the overall structure and function of each course in terms of a variable set of characteristics that could be used to evaluate the initial design of the course, and the use of a flexible student certification model, to demonstrate, as far as is possible, that a course had achieved its objectives and had achieved the results intended by the teaching team.

The results of the first edition of these courses were very positive because as well as the quantitative data on participation, course completion, etc., the qualitative feedback from the students in the respective forums reflected their overall level of satisfaction both with the courses and the UNED MOOC

platform. The two part quality model had served its purpose and in general the courses were well received and undertaken with few problems. One area for improvement that will be addressed in future editions of these courses was the differing expectations of students starting the MOOCs based upon their previous experience of other UNED courses. Some students who are also undertaking other studies at the university (like degree programs) are used to how these courses work and had some difficulties initially with the MOOCs because the course dynamics were different.

In terms of recommendations for course quality that could be made for other institutions wanting to start a MOOC program, leaving aside the technological decisions about which platform to use (if an in house solution is desired) or MOOC hosting (if an external service is preferred), a lot of what has been learned here can be applied. Firstly, if the institution does not have a track record of putting together e-Learning courses, then the teaching staff will initially need to learn how to use the tools required for/in such courses. Secondly, regardless of whether the first point is true, then some experience of how MOOC content and activities differ from other low student-number online courses should be obtained before starting to develop courses. There should also be some control of course structure and educational coherence so that students undertaking different courses at the institution will have a familiar experience in the different courses. Thirdly, an important factor of the dynamics of MOOC that has to be anticipated and dealt with is that of the large scale interaction that occurs in the social media, typically the forums, given that the academic(s) who has(ve) developed the course typically won't participate. Facilitators and curators have had a key role in many different areas in UNED MOOC, ranging from maintaining course engagement through to steering students toward solutions to their problems. Fourthly and finally, if quality is understood, at least in part, as the overall satisfaction of the students who have undertaken the MOOC, then it is important that analytical mechanisms for learning analytics are present and combined with questionnaires. Experience shows that there is a far wider range of expectations present in potential MOOC students than in other e-Learning courses run on degree or masters programmes. Regardless of how well a given course has been prepared there are inevitably problems that arise as the students undertake it. Given the controls presented here a lot can be done to resolve them as the course progresses or for future editions of the course.

Given the wide range of educational scenarios and experiences that are included under the MOOC umbrella it may prove difficult to arrive at a clearly definable definition of what constitutes quality here. However, as the nature of such courses becomes more clearly identified, together with what “works and doesn’t work” for each type, then it will become easier to establish course structure, content and interactional dynamics a priori, thereby making the task of quality assessment easier to undertake.

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### Edition and production

Name of the publication: eLearning Papers

ISSN: 1887-1542

Publisher: elearningeuropa.info

Edited by: P.A.U. Education, S.L.

Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)

Phone: +34 933 670 400

Email: [editorialteam\[at\]openeducationeuropa\[dot\]eu](mailto:editorialteam@openeducationeuropa.eu)

Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## The Discrete Optimization MOOC: An Exploration in Discovery-Based Learning

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The practice of discrete optimization involves modeling and solving complex problems which have never been encountered before and for which no universal computational paradigm exists. Teaching such skills is challenging: students must learn not only the core technical skills, but also an ability to think creatively in order to select and adapt a paradigm to solve the problem at hand. This paper explores the question of whether the teaching of such creative skills translates to Massive Open Online Courses (MOOCs). It first describes a discovery-based learning methodology for teaching discrete optimization, which has been successful in the classroom for over fifteen years. It then evaluates the success of a MOOC version of the class via data analytics enabled by the wealth of information produced in the MOOC.

### Tags

MOOC, computer science  
education, problem solving  
skills, discovery-based  
learning

### Introduction

Discrete optimization is a subfield of computer science and mathematics focusing on the task of solving real- world optimization problems, such as the travelling salesman problem. Due to the computational complexity of optimization tasks, the practice of discrete optimization feels more like an art than a science: practitioners are constantly confronted with novel problems and must determine which computational techniques to apply to the problem at hand. As a consequence, the teaching of discrete optimization must not only convey the core concepts of the field, but also develop the intuition and creative thinking necessary to apply these skills in novel situations. Teaching such skills is challenge for instructors who must present students with complex problem- solving tasks and keep them motivated to complete those tasks.

Over fifteen years, a classroom-based introduction to discrete optimization was developed and honed at a leading U.S. institution. The class assessments were designed around the ideas of discovery-based learning (Bruner 1961) to provide the students with a simulation of the real-world practice of discrete optimization. The course design was successful, and was highly popular among senior undergraduate and graduate students. The recent surge of interest in Massive Open Online Courses (MOOCs) and readily available platforms (e.g., Coursera, Udacity, and edX) makes a MOOC version of discrete optimization technically possible. But it raises an interesting question: will the discovery-based learning methodology of discrete optimization translate and be successful on an e-learning platform such as a MOOC? Technical reports on large-scale MOOCs are fairly recent (Kizilcec 2013, Edinburgh 2013) and have primarily focused on course demographics and key performance indicators such as completion rates. Few papers discuss the effectiveness of different pedagogical and assessment designs in MOOCs.

This paper is an attempt to shed some light on the effectiveness of teaching problem-solving skills in a MOOC by use of discovery-based learning. It begins with some background about the subject area and the class design motivations. It then turns to data analytics to understand what happened in the inaugural session of the Discrete Optimization MOOC, and concludes with a brief discussion of the success and potential improvements of the MOOC version of the class.

### The Discrete Optimization Class

Discrete Optimization is an introductory course designed to expose students to how optimization problems are solved in practice. It is typically offered to senior undergraduate and junior graduate students in computer science curriculums. The prerequisites are strong programming skills, familiarity with classic computer science algorithms, and basic linear algebra. The pedagogical philosophy of the course is that inquiry-based learning is effective in teaching creative problem solving skills.

The course begins with a quick review of Dynamic Programming (DP) and Branch and Bound (B&B), two topics that are often covered in an undergraduate computer science curriculum. It then moves on to an introduction to three core topics in the discrete optimization field, Constraint Programming (CP), Local Search (LS), and Mixed Integer Programming (MIP). The students' understanding of the course topics is tested through programming assignments. The assignments consist of designing algorithms to solve five optimization problems of increasing difficulty, knapsack, graph coloring, travelling salesman (TSP), warehouse location, and capacitated vehicle routing (CVRP). These algorithm design tasks attempt to emulate a real-world discrete optimization experience, which is, your boss tells you "solve this problem, I don't care how". The lectures contain the necessary ideas to solve the problems, but the best technique to apply (DP, B&B, CP, LS, MIP) is left for the students to discover. This assignment design not only prepares students for how optimization is conducted in the real world, but is also pedagogically well-founded under the guise of guided inquiry-based learning (Banchi 2008). These assessments are complex monolithic design tasks, a sharp contrast to the quiz-based assessments common to many MOOCs.

The complexity and open-ended nature of these algorithm design tasks allows the students to have many successful solutions. In the classroom version, students are often inspired later in the course to revise their solutions to earlier assignments,

based on the knowledge they acquired throughout the course. Inspired by this classroom behavior, the MOOC version of the class adopts an *open format*. The students are allowed, and encouraged, to revise the assignments during the course. The final grade is based on their solution quality on the last day of class.

### Understanding the MOOC

The previous section discussed the basic design of the Discrete Optimization class and the pedagogical philosophy behind it. This section uses the vast amount of data produced by a MOOC to provide some evidence that the MOOC adaptation of Discrete Optimization was successful and the use of discovery-based assessment design can also be effective in an e-learning context. Before discussing the details of the students' experience in Discrete Optimization, we first review the basic class statistics to provide some context.

### Inaugural Session Overview

The inaugural session of Discrete Optimization ran over a period of nine weeks. During the nine months between the first announcement of discrete optimization and the course launch, 50,000 individuals showed an interest in the class. As is typical of a MOOC, less than 50% (17,000) of interested students went on to attend class and view at least one video lecture. Around 6,500 students experimented with the assignments and around 4,000 of those students made a non-trivial attempt at solving one of the algorithm design tasks.

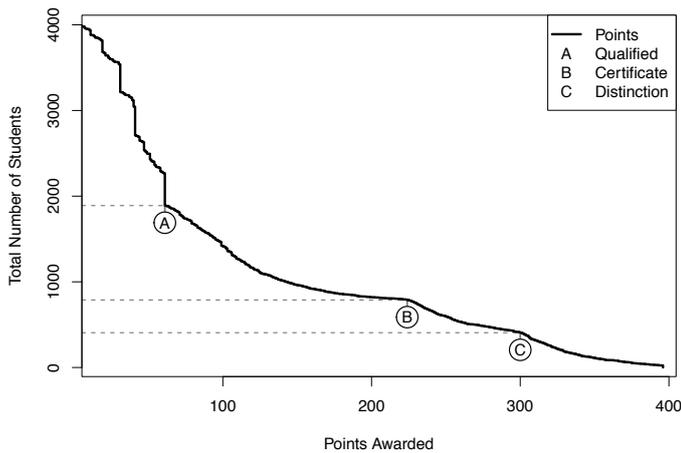


Figure 1. Cumulative Distribution of Grades

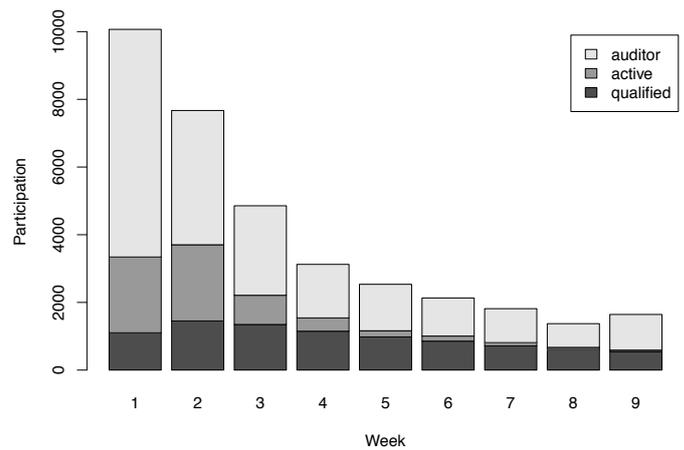


Figure 2. Weekly Student Activity

By the end of Discrete Optimization, 795 students earned a certificate of completion. This was truly remarkable as less than 500 students graduated from the classroom version in fifteen years of teaching. The typical completion rate calculation of  $795/17000 = 4.68\%$  could be discouraging. However, a detailed inspection of the number of points earned by the students is very revealing. Figure 1a presents the total number of students achieving a particular point threshold (i.e., a cumulative distribution of student points). Within the range of 0 and 60 points, there are several sheer cliffs in this distribution. These correspond to students abandoning the assessments as they get stuck on parts of the warm-up knapsack assignment (students meeting the prerequisites should find this assignment easy). At the 60 point mark (mark A in Figure 1a), 47% of the students (i.e., 1884) remain. We consider these students to be *qualified* to complete the course material, as they have successfully completed the first assignment. The remainder of the point curve is a smooth distribution indicating that the assignments are challenging and well-calibrated. Two small humps occur at locations indicated by mark B and mark C: These correspond to the two certificate threshold values. The shape indicates that students who are near a threshold put in some extra effort to pass it. However, the most important result from this figure is that if we only consider the population of students who attempted the assignments and were qualified, the completion rate is  $795/1884 = 42.2\%$ .

Due to the free and open nature of MOOCs, it is interesting to understand the student body over time. Figure 1b indicates the number of students who were active in the class over the nine-week period. The active students were broken into three categories: *auditors*, those who only watched videos; *active*, students who worked on the assignments; and *qualified*, active students who passed the qualification mark in Figure 1a. The steady decline in total participation is consistent with other MOOCs (Edinburgh Group - 2013), but the breakdown of students into the active and qualified subpopulations is uncommon and revealing. In fact, the retention rate of the qualified students is very good and differs from other student groups.

## Discovery-Based Learning

The use of discovery-based assignments was effective in the classroom version of Discrete Optimization, but it is unclear if it will translate to the MOOC format. It is difficult to measure precisely if the students learned creative problem solving skills, but we can look at their exploration of the course material for an indication.

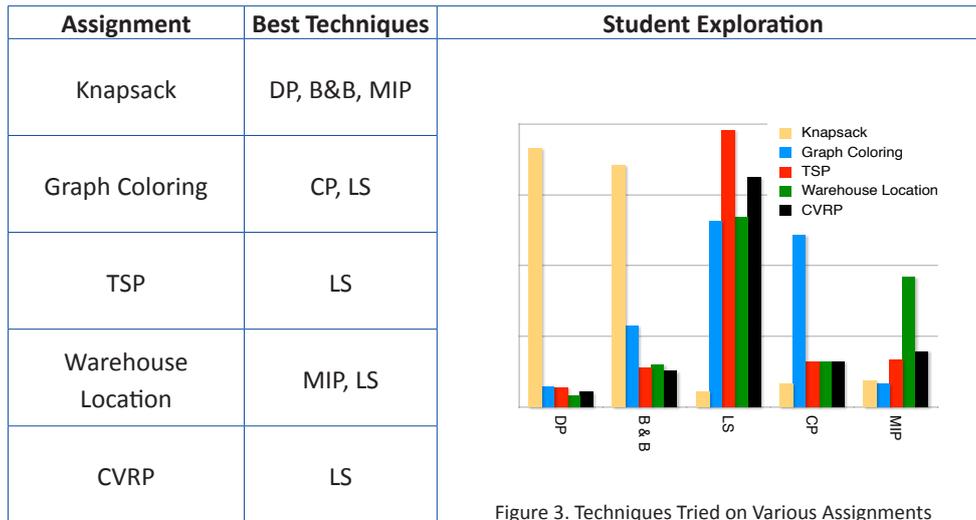


Figure 3. Techniques Tried on Various Assignments

Table 1: Comparison of the Technique to Assignment Solution Key and Student Exploration

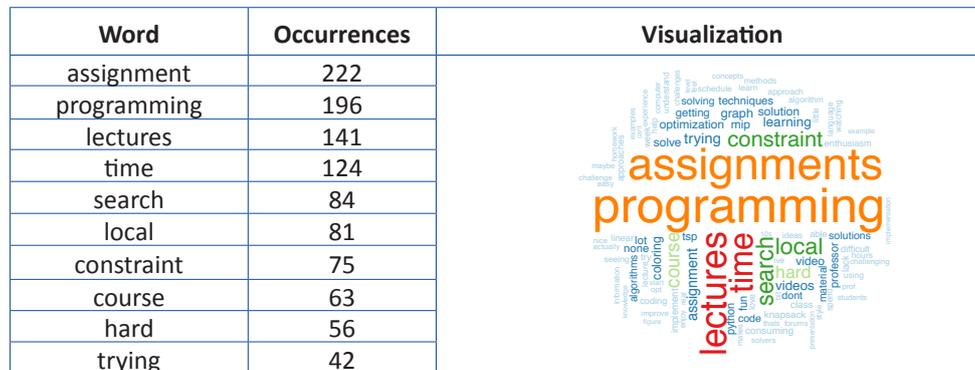


Table 2: Word Occurrences in Students' Free Form Responses Regarding their Favorite Part of the Class

In a post-course survey of Discrete Optimization, the students were asked to identify which optimization techniques they tried on each assignment. Figure 3 summarizes the students' responses and Table 1 compares those responses to the best optimization techniques for each problem. Looking at Figure 3, we can see that there is a great diversity among the techniques applied to each problem. This suggests that students took advantage of the discovery process and tried several approaches on each problem. Second by comparing Table 1 and Figure 3, we can see that there is a strong correspondence between the best techniques for a given problem and the ones that most students explored. This suggests that students are picking up on the intuition of how to solve novel optimization problems and applying the correct techniques.

However, the most telling evidence for the success of the discovery-based learning appears in the free form text responses that student produced when asked the open ended question, "My favorite part of this course is..." Many aspects of the course were discussed. However, looking at the frequencies of various words in their responses (see Table 2), indicates that the programming assignments were one of the most discussed elements of the course. Even on par with the lectures. This positive response to the assignments is consistent with student reviews of the classroom version of Discrete Optimization, and further suggests that the discovery-based learning approach was successfully translated to the e-learning platform.

## Success of the MOOC

Awarding 795 certificates of completion was a great success in itself, but there are many other ways to measure a class' success. The goal of Discrete Optimization was to provide a challenging course where dedicated students would learn a lot. The following statistics from a post-course survey of the students (n=622) indicates that this goal was achieved. 94.5% of students said they had a positive overall experience in the course with 40.7% of students marking their experience as *excellent* (Figure 3a). 71.9% of students found the course to be challenging while only 6.11% thought that it was too difficult (Figure 3b). The students were very dedicated to the challenging material with 56.6% working more than 10 hours per week. Despite the significant time investment, the vast majority, 93.7%, of students, felt that the assignment grading was fair. 94.5% of students said that they learned a moderate amount from the course (Figure 3c) and 74.9% feel confident in their ability to use the course material in real-world applications.

## Lessons Learned

Despite the success of Discrete Optimization, there is significant room for improvement in the course design. The vast number of students in a MOOC has the effect of shining light on all of the problems in the course design, no matter how small. For example one forum thread entitled, *"Somewhat torn, don't feel like I'm learning anything"*, discusses some of the challenges students face with discovery-based learning. It is clear that some students found the discovery processes disturbing and would prefer a more structured learning experience. In another thread, *"If you're looking for a new challenge: Find a way to remotivate me!"* a student explains how he became discouraged with the discovery-based learning approach after trying several ideas without success. These comments, among others, have inspired us to improve the class by making the exploration process easier. This will be achieved in two ways: (1) revising the introductory course material to include some guidance on how to explore optimization problems and (2) provide supplementary "quick-start" videos on how to get started exploring a particular optimization technique. We hope, by lowering the burden of exploration, more students will get the benefits of discovery-based learning without the frustrations.

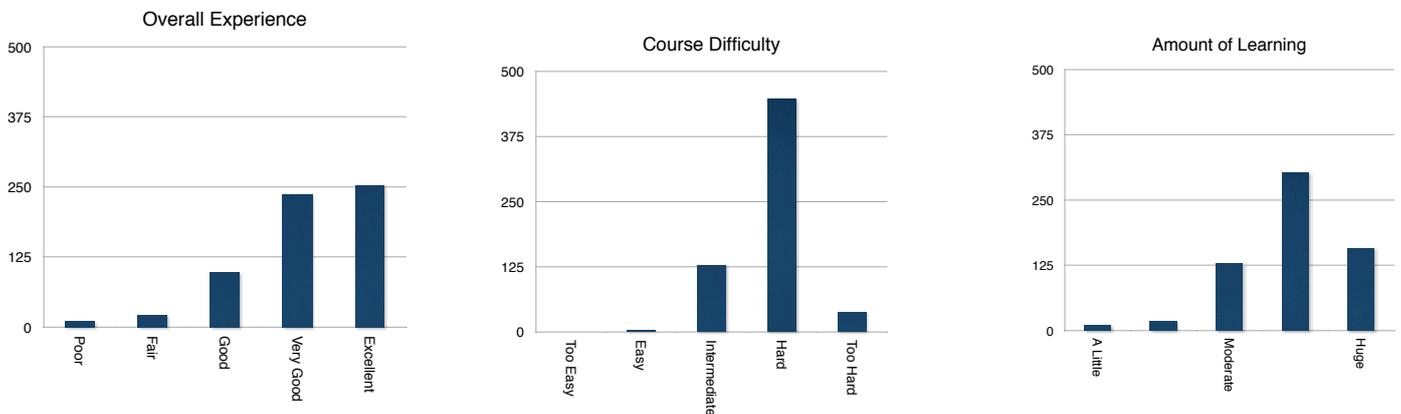


Figure 3. Results from Discrete Optimization's Post-Course Survey on Overall Experience (left), Course Difficulty (center), and Amount of Learning (right)

### Conclusion

Teaching the creative problem solving skills required by discrete optimization practitioners is a challenging task. This paper has presented initial evidence that teaching such creative skills is possible in a MOOC. The essential idea was to use assignments inspired by discovery-based learning, so the students not only learn the core technical skills but how to apply them to unfamiliar tasks. The success of the course design was demonstrated through data analytics, enabled by the wealth of information produced in MOOCs. We believe the significant resource investment required to make the custom discovery-based learning assignments was a great investment in the course, and we hope our experience will inspire other MOOC practitioners to put in the additional effort try discovery-based learning tasks in their classes.

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#### Edition and production

Name of the publication: eLearning Papers  
ISSN: 1887-1542  
Publisher: elearningeuropa.info  
Edited by: P.A.U. Education, S.L.  
Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)  
Phone: +34 933 670 400  
Email: [editorialteam@openeducationeuropa.eu](mailto:editorialteam@openeducationeuropa.eu)  
Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## Designing Your First MOOC from Scratch: Recommendations After Teaching “Digital Education of the Future”

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### Tags

MOOCs, educational  
technologies,  
recommendations, design  
decisions.

Massive Open Online Courses (MOOCs) have been a very promising innovation in higher education for the last few months. Many institutions are currently asking their staff to run high quality MOOCs in a race to gain visibility in an education market that is increasingly abundant in choice. Nevertheless, designing and running a MOOC from scratch is not an easy task and requires a high workload. This workload should be shared among those generating contents, those fostering discussion in the community around the MOOC, those supporting the recording and subtitling of audiovisual materials, and those advertising the MOOC, among others. Sometimes the teaching staff has to assume all these tasks (and consequently the associated workload) due to the lack of adequate resources in the institution. This is just one example of the many problems that teachers need to be aware of before riding the MOOC wave. This paper offers a set of recommendations that are expected to be useful for inexperienced teachers that now face the challenge of designing and running a MOOC. Most of these recommendations come from the lessons learned after teaching a nine-week MOOC on educational technologies, called “Digital Education of the Future”, at the Universidad Carlos III in Madrid, Spain.

## Introduction

Higher education institutions are overwhelmed by the appearance of Massive Open Online Courses (MOOCs), which are a disruptive alternative to traditional education (McAuley et al. 2010) that has become very popular in the last few months. MOOCs enable teachers and institutions to provide high quality courses, generally free of charge, to students worldwide. Many MOOC initiatives have recently emerged across the globe, such as Coursera, edX and Udacity in the United States, FutureLearn in the United Kingdom, iversity in Germany, FUN in France or MiríadaX in Spain.

MOOCs entail several challenges for institutions and educators. New teaching methods (Kop et al. 2011, Sharples et al. 2013) and assessment methodologies for large groups of students (Sandeen 2013), appropriate certification mechanisms (Cooper 2013), and solutions to include MOOCs in current higher education structures (Fox 2013) are examples of MOOCs open research challenges that still need to be addressed. Another of these open challenges concerns the design of MOOCs. MOOCs are very demanding compared to traditional courses and therefore efforts should be made at design time to plan them properly. For instance, Kolowich (Kolowich 2013) estimated the workload of making a MOOC from scratch to be

100 hours, plus 10 more hours weekly on upkeep. This workload depends, for instance, on the duration of the course, the kind of materials that need to be generated, and teacher involvement in discussions about the course topics in the social tools of the MOOC. In any case, this additional burden is not acceptable in most universities, where educators typically already handle traditional teaching and research duties.

Some strategies to reduce this burden are to seek help from institutional services, to reuse open content generated by third-parties, to limit the number of social tools that are supported during the course, or to share the teaching of the MOOC with other colleagues (König 2013). But these are just a few examples of design decisions that must be taken before launching a MOOC. In fact, a well-thought design is essential to minimize the risk of trying to run overambitious MOOCs. This design should be agreed upon by the teaching staff and take into account previous experiences of other teachers that have created MOOCs in the same area. There are already several frameworks in the literature, such as the MOOC Canvas (Alario-Hoyos et al. 2014) or the design and evaluation framework (Grover et al. 2013) aimed at helping teachers reflect on and discuss the issues and dimensions that surround the design of MOOCs.

This paper brings the experience of the professors that participated in the creation and running of a nine-week MOOC on educational technologies, deployed on the platform MiríadaX in early 2013 and called “Digital Education of the Future” (DEF – “Educación Digital del Futuro” in Spanish). The aim of this paper is to advise teachers and institutions with no experience in running MOOCs, by indicating the main design decisions that were taken in DEF and how these decisions were received by the different stakeholders. The decisions that were most highly assessed and the lessons learned are provided as recommendations for the community of MOOC teachers.

### “Digital Education of the Future”

“Digital Education of the Future” (DEF) ([https://www.miriadax.net/web/educacion\\_digital\\_futuro](https://www.miriadax.net/web/educacion_digital_futuro)) was a multidisciplinary MOOC on educational technologies delivered at the Universidad Carlos III de Madrid from February to April 2013. DEF was created from scratch, since professors wanted to offer a MOOC that addressed the latest trends that are changing the education system. All the contents and activities in DEF were generated a few weeks before the course started. This approach

has two counterparts. On one hand, this kind of MOOC satisfies those that want to learn about the latest in the area and cannot do so through traditional undergraduate or postgraduate programmes, which are less able to quickly adapt to the latest trends. On the other hand, this kind of MOOC requires a big effort, as it involves generating a lot of new materials from scratch in a short time. Furthermore, a MOOC that addresses recent trends could quickly become outdated, which implies a serious burden when updating the materials (particularly the video lectures).

Five professors participated in the design and deployment of the MOOC. The fact that five people were part of the teaching staff allowed for sharing of the teaching workload of the MOOC and made it possible for everyone to contribute to the areas where they were experts. On the negative side, there was an extra non-negligible coordination effort to make decisions on how to design and run the MOOC. There was also a full-time facilitator in charge of solving questions related to the less academic aspects of the course, fostering debate on social networks around the MOOC and acting as intermediary between professors and participants.

DEF was created within a Higher Education institution and therefore it had the support of several services belonging to the University. Among them, audiovisual technicians helped record some of the more elaborate videos, advised on the recording of video lectures (e.g. lighting, sound quality...), and did the video post-production (e.g. adding the University logo to them). Also, library staff helped subtitle all the video lectures, which turned out to be a very burdensome task. Subtitling may seem unnecessary for some MOOCs, especially when most participants speak the language natively (as was the case in DEF). However, noises or linguistic differences between countries may hinder proper understanding of the explanations, and this can easily be addressed by transcribing the speech.

DEF was delivered in Spanish, targeting a Hispanic audience - a market for which there were very few MOOCs in February 2013 compared to those for English speakers. The teaching staff decided to deploy DEF on the platform MiríadaX, which was developed a few weeks before by Telefónica Learning Services and Universia, to allow higher education institutions from Spain and Latin America to deploy MOOCs in Spanish.

DEF was structured in three modules, the first of which addressed the use of educational technologies from the pedagogical point of view, and the other two from the

technological point of view. In particular, the first module covered the concept of interaction and its evolution through the years in parallel with the development of new hardware devices and interfaces. The second module addressed the use of mobile technologies in education (m-learning), presenting the most current technologies, applications and projects in the area. The third module explored the MOOC world, delving into the generation of multimedia contents as well as into the most common assessment methods, gamification strategies and learning analytics approaches that could be found in MOOCs at that time.

Each module was divided into three lessons, and each lesson was delivered in a different week (9 weeks in total). Each lesson contained nine video lectures of about ten minutes long, a multiple choice test at the end of each video, a multiple choice test at the end of each lesson, and recommended readings (i.e. links to related information selected by the teaching staff). At the end of each module, participants had to carry out an individual assignment that was peer reviewed. At the end of the course, participants had to fill out a multiple choice test with questions about the three modules. There was also a presentation module ("module zero"), which was released one day before the MOOC started. The purpose of the "module zero" was to introduce the course and provide general information about the course structure, the assessment system, the use of the platform, and the social tools offered through the MOOC. Figure 1a shows the structure of one of the lessons in DEF.

Learning contents were offered in the form of video lectures. On the grounds that the platform did not support video hosting, all videos were uploaded to YouTube, linked to MiriadaX, and preceded by a brief description. DEF professors always appeared in the videos, although two different formats were employed in these videos. Most videos in module 1 had the teacher explaining in the foreground with an illustrative picture in the background. Most videos in modules 2 and 3 had the teacher explaining in the lower right corner with supporting slides in the background; these supporting slides were uploaded to MiriadaX as PDFs, so that participants could use them to review the concepts explained. There were also weekly interviews with national and international experts in the area to complement the lectures. Figure 1b shows an example video lecture from module 3, with a short description of the video on top, and a link to a PDF file with the slides to be downloaded by the MOOC participants at the bottom.

The assessment system included formative assessment activities and summative assessment activities. Formative assessment activities could be completed at any time, but summative assessment activities had to be completed at scheduled intervals according to the calendar published during the first week of the course. Specifically, the multiple choice tests after each video lecture were part of the formative assessment, providing immediate feedback to the participants about the concepts explained in the related video. The end-lesson multiple choice tests were part of the summative assessment, with a maximum score of 5 points each (9 tests). The end-module peer assessment activities were another part of the summative assessment, with a maximum score of 10 points each (3 activities). The final multiple choice test was also part of the summative assessment, with a maximum score of 25 points. In total, participants could get up to 100 points in DEF. They needed 50 points to pass the course. The selection of an assessment system based only on multiple choice tests and peer assessment activities was conditioned by MiriadaX, as these were the only two assessment tools offered by the platform at the time when the MOOC was run. At the end of the course, certificates of participation were provided with participants' final scores. These certificates included a clause in which it was explicitly stated that it had not been possible to verify the users' identity or the authorship of works.

In addition, five social tools were employed during DEF to promote social learning, foster discussion and share additional materials. Two of these social tools were natively provided by the platform MiriadaX (built-in social tools), and three others were provided by third-parties (external social tools). The two built-in social tools were Questions and Answers (Q&A) and a forum. The three external tools were Facebook, Twitter and MentorMob, which is a tool for sharing lists of resources related to a given topic. Of the five social tools, the forum was the one with a highest number of contributions, although there were also large communities of participants around Facebook, Twitter and Q&A (Alario-Hoyos et al. 2013). Three other non-social tools were also employed by the teaching staff during DEF: Storify to share a collection of the most relevant tweets each week, a built-in blog to post announcements and the latest news related to the course, and Google Drive to deliver questionnaires related to participants' profiles, performance and degree of satisfaction with the MOOC.

**C**

Actividades del Módulo

- **Módulo 3: La nueva educación.**
- Lección 1: Revolución en educación**
- ✓ 3.1.1 Revolución educativa
- ✓ 3.1.1 Test
- ➔ **3.1.2 Innovación perturbadora**
- ✓ 3.1.2 Test
- ✓ 3.1.3 eLearning antes de 2012
- ✓ 3.1.3 Test
- ✓ 3.1.4 eLearning después de 2012
- ✓ 3.1.4 Test
- ✓ 3.1.5 Formatos
- ✓ 3.1.5 Test
- ✓ 3.1.6 Modelos de negocio
- ✓ 3.1.6 Test
- ✓ 3.1.7 Nuevas metodologías pedagógicas
- ✓ 3.1.7 Test
- ✓ 3.1.8 Entrevista a Piotr Mitros
- ✓ 3.1.8 Test
- ✓ 3.1.9 Resumen
- ✓ 3.1.10 Lecturas recomendadas
- ✓ Test fin de lección

**3.1.2 Innovación perturbadora**

¿Por qué se considera que en el año 2012 hemos sufrido una revolución en educación si hace ya bastantes años que hablamos del uso de tecnología en educación? ¿Son los MOOC tan innovadores como para "perturbar" la educación tradicional? ¿Podrán sustituir los MOOC a los cursos presenciales?

En este vídeo se explica qué se entiende por innovación "perturbadora" y se analiza el caso de Salman Khan y la Khan Academy como escenario de éxito de innovación "perturbadora" en la educación online basada en vídeos cortos explicativos y ejercicios de apoyo.

3.1.2. Innovación perturbadora

3.1.2. Innovación Perturbadora.pdf

Figure 1. Screenshot of the MOOC “Digital Education of the Future” deployed in MiriadaX: a) Structure of one of the weekly lessons (module 3, lesson 1); b) Example of video lecture with the teacher in the lower right corner and slides in the background; c) Built-in social tools supported by the platform MiriadaX (Q&A and forum).

|                          | Recommendations   | Design decisions in DEF  | Notes  |
|--------------------------|---|--|--|
| Platform                 | To choose the MOOC platform based on <ul style="list-style-type: none"> <li>institutional agreements with popular initiatives or</li> <li>target learners.</li> </ul>                         | At design time, there were no institutional agreements between Universidad Carlos III de Madrid and major MOOC initiatives. Teachers selected MiriadaX in order to target the Hispanic community of learners.  | More than 100,000 learners (mainly from Spain and Latin America) were registered in MiriadaX at the time DEF started. 57 courses from 18 universities were simultaneously taught in MiriadaX from February 2013 to April 2013.   |
| Overall Course Structure | To study the platform constraints before creating the course structure and learning materials.  | MiriadaX constrained the type of assessment activities that could be added to the course and led to the use of YouTube to host video lectures.   | -  |
|                          | To be aware of the workload required for the creation of the course structure and the upload of learning materials to the platform.   | The teaching staff and the supporting facilitator shared the burden associated with the creation of the course structure and the uploading of learning materials.  | Setting the course in the platform once the learning materials were generated represented an additional workload of 15-20 hours due, among other things, to the lack of features to automatically upload multiple choice tests.  |
|                          | To define a flexible schedule so that interested latecomers can still enroll in the course.   | Users could join the course while it was being taught. Summative assessment had a greater weight towards the end of the course, so that participants who registered up to 5 weeks late could still pass the course.                                  | On day 1 there were 3105 registered users with 5455 participants after week 6 and 5595 participants at the end of the course. Latecomers could follow the course normally, accessing all previously released materials.  |
| Teaching Staff           | To have several teachers, which enriches the contents, allows greater heterogeneity of topics and splits the workload, but demands a more complex coordination.                               | Five professors with different backgrounds on humanities and engineering participated in the course. One of the professors played the roles of coordinator and director of studies.  | The heterogeneity of topics attracted people from different backgrounds: 32% of learners had some technical background, 31% some background on humanities, and 46% some background in education.   |
|                          | To moderate the participation and awareness of the teaching staff by sending regular e-mails reporting the pending tasks and latest news.   | The facilitator was responsible for sending regular communications, and acting as a link between learners and the teaching staff.  | Every professor agreed that the inclusion of regular communications was necessary to be aware of what was happening in the course and to have continuous contact with the participants.  |
| Learning Contents        | To create original video lectures explaining the concepts easily and clearly, with appropriate tone.  | Professors employed videos of about ten minutes each. The advantages and shortcomings of different video formats were studied before starting to record. Video interviews with experts gave deeper insight.  | MOOC participants reported overall positive comments about the video lectures and the explanations of professors.  |
|                          | To use additional materials that learners can follow easily to complement teachers' speech and study offline (e.g. slides).   | Videos in modules 2 and 3 employed supporting slides, following an agreed template. Explanations in module 1 were accompanied by a supporting book.  | 69% of the people preferred a video format based on slides with the teacher in a corner, while 23% of them preferred the teacher in the foreground without slides.   |
|                          | To plan when video lectures need to be ready, leaving enough extra time to add subtitles. Not to underestimate the time required to generate videos.  | Videos in modules 1 and 2 were created with a few weeks in advance. Videos in module 3 were created with a lower time frame. All videos were subtitled for easier understanding.   | Professors estimated the time to record 10 minute videos to be 60-90 minutes, including preparation of the speech, recording the video, correcting errors, and setting and checking the final version.   |
| Assessment               | To define the competences that participants must acquire during the course.   | Competencies were defined beforehand and included ICT competencies, time management and self-discipline. Learning objectives matched these competencies.   | -  |
|                          | To define formative and summative assessment activities from the beginning. To inform clearly on assessment policies, and how final scores will be calculated. To provide immediate feedback. | Participants needed 50 out of 100 points to pass the course. In each module they could get 25 points considering the end-lesson multiple choice tests and the peer review activities, plus another 25 points in the end-course multiple choice test. | There were no complaints about the general assessment policies. There were some complaints about the tight schedules to resolve the assessment activities. Professors detected some participants revealing the answers to tests in the social tools. This suggests the need for more efficient assessment mechanisms in MOOCs. |

|                | Recommendations   | Design decisions in DEF   | Notes   |
|----------------|---|---|---|
| Social Support | To promote social learning. Giving support to several social tools is burdensome for teachers, but allows people to choose the tools they feel most comfortable with.         | To promote social learning. Giving support to several social tools is burdensome for teachers, but allows people to choose the tools they feel most comfortable with.   | The forum was the most popular tool for learners to contribute and participate in discussions, followed by Facebook, Q&A and Twitter (Alario-Hoyos et al. 2013). MentorMob did not receive the attention expected by the teaching staff.  |
|                | To define from the beginning the degree of teachers' commitment regarding their activity with the social tools, and announce it to participants.                              | There was a facilitator dedicating about 3-4 hours per day on weekdays, and 1 hour per day on weekends. Professors hardly interacted directly with social tools but were informed about the hot topics by the facilitator.  | Despite the dedication of the facilitator, participants complained, particularly at the beginning of the course, about the lack of support by teachers in social tools.   |
| Certification  | To define from the beginning the type of recognition people will get for completing the course, what they will need to obtain such recognition and when they will receive it. | Participants got a certificate if they had obtained 50 or more points out of 100 at the end of the course. The certificate included the name of the course and University. Nevertheless, the certificate also had a clause indicating that it had not been possible to verify the identity of the learner or the authorship of works. | Many questions regarding certification were posted in social tools, especially at the beginning of the course. The teaching staff had doubts about this issue until the end of the course, because the platform was responsible for generating and distributing the certificates. |
| Others         | To establish and start the marketing strategy as soon as possible, since registrations steadily increase even after the course begins.  | The marketing strategy was carried out by MiriadaX, Telefónica Learning Services and Universia, especially through social networks and media, and took place during the month prior to start of the course.   | 32% of registered users found out about the course in social networks, 22% of them through advertising campaigns on the Web, and 37% of them through friends and colleagues.  |

Table 1. Recommendations after teaching DEF, design decisions in DEF and additional related notes

## Recommendations after teaching DEF

Recommendations from the professors after teaching DEF are collected in Table 1, highlighting in bold the most important ones. Recommendations are organized in the following eight categories: (1) Platform, (2) Overall Course Structure, (3) Teaching Staff, (4) Learning Contents, (5) Assessment, (6) Social Support, (7) Certification, and (8) Other Related Aspects.

## Conclusions and future work

This paper has presented a set of recommendations distilled from the experience of the professors involved in the design and running of a MOOC about educational technologies called Digital Education of the Future. The most important recommendations are: to carefully study the features offered by the platform in which the MOOC will be deployed; to not underestimate the time needed for the preparation of learning materials (particularly video lectures), or for their upload to the platform; to support the discussions and queries in social tools, but indicating from the beginning the degree of commitment of the teaching staff (in order to reduce the number of complaints from participants); and to advertise the course as soon as possible, making use of social tools and creating attractive campaigns in order to catch the attention of potential participants. Such aspects increase

the complexity and workload of creating a MOOC from scratch, demanding teachers make more reflections and agreements at design time.

Of course, this is a particular example MOOC, and thus MOOCs in other areas that are deployed on different platforms should be analyzed in order to confirm and extend the recommendations presented in this paper. The ultimate aim is to create a community of practitioners that define generic best practices for designing and running MOOCs.

## Acknowledgements

This work has been funded by the Spanish Ministry of Economy and Competitiveness Project TIN2011-28308-C03-01, the Regional Government of Madrid project S2009/TIC-1650, and the postdoctoral fellowship Alianza 4 Universidades. Prof. Carlos Delgado-Kloos wishes to acknowledge support from Fundación Caja Madrid to visit Harvard University and MIT in the academic year 2012/13. He also thanks numerous people from MIT, Harvard and edX for fruitful conversations carried out during this research stay.

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### Edition and production

Name of the publication: eLearning Papers  
ISSN: 1887-1542  
Publisher: elearningeuropa.info  
Edited by: P.A.U. Education, S.L.  
Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)  
Phone: +34 933 670 400  
Email: [editorialteam\[at\]openeducationeuropa\[dot\]eu](mailto:editorialteam@openeducationeuropa.eu)  
Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## Offering cMOOCs Collaboratively: The COER13 Experience from the Convenors' Perspective

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### Tags

MOOC, open education  
resources, cMOOC,  
communication,  
collaboration

This paper shares the experience of offering the community-oriented MOOC called “COER13.” The focus is on how the convenors perceived the collaborative endeavor of planning and implementing this cMOOC, and on the lessons learnt in the process. COER13, the “Online Course on Open Educational Resources (OER)”, aimed at increasing awareness of open educational resources. It was offered in Spring/Summer 2013 in a joint venture by eight e-learning experts from Austria and Germany with affiliations to five different institutions. The course was designed to enable participants to become more knowledgeable about OER and finally to generate a small OER-piece. It attracted over 1000 registered participants and instigated lively discussions over various social media communication channels. In this paper, the experience is described and discussed on the basis of interviews with five of the eight convenors, led and analyzed by an external expert. The final recommendations may benefit future convenors of (c) MOOCs.

### Introduction

Open Educational Resources (OER) are sometimes regarded as the most important impact made by the internet in the educational sphere (Brown & Adler 2008) and are promoted to “leverage education and lifelong learning for the knowledge economy and society” (Geser 2007, 12). In German speaking countries, however, the OER movement is still lagging behind international uptake of the OER concept (Ebner & Schön, 2011; Arnold, 2012). This paper describes the design and implementation of a Massive Open Online Course (MOOC) aimed at increasing awareness of OER and reaching a larger audience. The “Online Course on Open Educational Resources” (COER13) was offered in a joint venture in spring/summer 2013 by eight convenors from Austria and Germany with affiliations to five different institutions. The course was planned as a community-oriented cMOOC (as opposed to an xMOOC using the widespread distinction between two different types of MOOCs, introduced by Daniel 2012), i.e. it heavily relied on participants’ contributions (reflections, insights, task solutions and questions) and course convenors saw their roles as facilitators as well as content experts. All materials were published with an open license aiming to generate an OER on OER with the course itself.

In their systematic literature review of research on MOOCs, Liyanagunawardena, Adams and Williams (2013, 217) concluded that the most significant gap in the literature was the scarcity

of “published research on MOOC facilitators’ experience and practices.” Likewise, Anderson and Dron (2011) emphasized the importance of studying distance education pedagogy that is grounded in different learning paradigms and contexts. This paper thus presents qualitative data about the experiences of convenors of COER13. To collaboratively design and implement the innovative format of a cMOOC is challenging. To offer a course on an equally innovative topic such as OER to an open audience increases the complexity even more. To do so in an emerging, newly formed project team, comprising different institutional backgrounds, adds yet another layer of complexity to the challenge. Therefore, this paper focuses on the perspective of the COER13 convenors and attempts to unpack the collaboration process, and identify successful practices and lessons learnt during COER13. The results will inform and support future (teams of) convenors of MOOCs.

### COER13 – Online Course on Open Educational Resources

*Course design and timeline:* COER13 ran for 12 weeks in spring/summer 2013. There were no course fees or any other prerequisites for participating. The course comprised an introductory week followed by five thematic units that lasted two weeks each, and a closing week for summarizing and evaluating the learning experiences within COER13. The course was offered entirely online: The central course website provided instructional videos, reading materials and relevant web links for each unit. All materials were gradually added as the course evolved. One or two synchronous “online events” per unit with expert talks or panel discussions, offered via live classroom software, were key structural design elements. An introduction as well as a summary at the middle and the end of each unit was sent as a newsletter to all registered participants and also archived on the website. The interaction amongst students and between students and convenors was planned to take place via the integrated discussion forum or via tweets and blog entries that were aggregated on the course website by means of the course hashtag “#coer13”. Additionally, during the course some participants started a COER13 Facebook group (105 members), and others discussed COER13 issues within the already existing OER Google+ group (136 members). Furthermore, each unit presented a clearly circumscribed task that was meant to promote the production and usage of OER across educational sectors. Participants were asked to share their work on the tasks

with the course community and to document their work on the course website in case they wanted to obtain online badges. Online badges served as an alternative means of certification and were offered on two different levels.

*Collaborative planning of COER13:* The idea to offer a MOOC on OER stemmed from prior experiences with open courses in German-speaking countries (Bremer & Thillosen, 2013) as well as from fundamental work on OER through European projects (Schaffert, 2010; Schaffert & Hornung-Prähuser, 2007) and national initiatives (Ebner & Schön, 2012). An informal discussion about MOOCs and OER at a conference in November 2012, at which four of the eight organizers met, can be considered as the starting point. By the end of 2012 there were eight convenors: three researchers from the e-learning information portal “e-teaching.org”, three faculty members from the universities of Munich (Applied Sciences) and Tübingen, and the University of Technology of Graz, as well as two representatives of NGO’s involved in promoting OER. The eight convenors joined the team to promote OER, to gain experience in offering a MOOC, or for a combination of the two motives. All planning activities were done via synchronous online meetings that started in January 2013, comprising different members of the team (the whole team could not find a time to meet), accompanied by an email exchange. Decisions and tasks were documented in a closed wiki. Each thematic unit was assigned to one member of the organizers’ team so that he or she took responsibility for that unit, including the design and the organization of the online event. Once the course started, organizers occasionally discussed residual questions after the online events but email was the primary communication channel.

*COER13 implementation:* There were 1090 registered participants from many different strands of the educational sphere (e.g. higher ed lecturers 21%, school teachers 23%, freelancers 18%, students 15%). The website received more than 15.000 site visits and nearly 78.000 page views during the course offering. Course interactions took place on the discussion forum (673 posts), as well as on different social media platforms, e.g. via Twitter (2247 tweets by 363 people), blogs (316 posts from 71 aggregated blog feeds), a Facebook group and an OER Google+ group. The ten online events attracted between 40 and 134 live participants each and between 111 and 2953 views of the recordings. 89 of the participants stated that they were interested in a badge when the course started; 56 of them met the requirements at the end.

### Methodology

The convenors' perceptions of collaborative planning and implementation of COER13 are presented in this paper on the basis of semi-structured interviews with five of the eight convenors. The semi-structured interview protocol was based on elements of teaching presence in distance education pedagogy (Anderson & Dron, 2011), and contained questions about individual roles, collaboration in the planning and design of the MOOC, implementation, facilitation, and evaluation as well as perceptions of challenges and lessons learnt. The interviews were conducted by a researcher who had not been involved in the design or implementation of the MOOC and did not know four of the five convenors interviewed, which contributed to the trustworthiness of the data collection process. Interviews lasted between 30 and 40 minutes, and were conducted either on Skype or by phone. The researcher transcribed and open-coded (Mayring, 2010) the interviews without input from the participants.

### Findings

Interview findings are organized here according to convenors' perceptions of a) collaborative planning of COER13 b) implementation of COER13 and c) lessons learnt.

*Collaborative planning of COER13:* All the convenors highlighted the planning phase as crucial to the design and implementation of the MOOC. They expressed satisfaction with the planning process during which they took decisions on MOOC design and implementation. They stated that having multiple convenors had worked very well for them. They described the collaboration as "unproblematic," and that it "sometimes involved long-drawn discussions, but was pleasant". It was easier for them to design, implement and manage the MOOC as a group, instead of as individuals, because each convenor brought different strengths to the MOOC - to the extent that some felt they could not possibly have offered the MOOC on their own. For example, one person was able to set up and manage the online learning environment while another took responsibility for Twitter interactions. Decisions about design and content were taken as a group and the first unit was designed collaboratively, but afterwards, each convenor took responsibility for designing and planning content for specific thematic units. This made the MOOC more manageable to one convenor who expressed relief, "I didn't have to do everything. I also didn't have to know everything about everything." Another convenor stated that

the exposure to different perspectives was valuable not only for MOOC participants, but also for the convenors themselves.

*Implementation of COER13:* All the convenors interviewed reflected that the structure (offering two-week thematic units, online events, expert interactions, short videos, and badges) had worked well. The biggest theme that emerged from the interviews about the implementation of the MOOC was the multiple technologies or virtual spaces used for interactions (with participants and among participants). Convenors discussed their choice of specific virtual spaces, their "following" of the content of interactions in those virtual spaces, and the management of those virtual spaces where interactions occurred. In order to address the technical skills of all learners, and based on prior experiences of two of the convenors, a discussion forum was included in the course website for interaction. The convenors mentioned the discussion forum as having worked very well for interactions. This surprised a couple of convenors who felt that the interface was clunky and that participant use of the forum indicated the low learning curve and low familiarity that users had with online discussion forums as opposed to Twitter or Google+. The convenors' choice and use of the virtual spaces depended on their own familiarity and comfort level with the technology used. If a convenor decided not to use a certain technology, such as Facebook or Twitter, they were sometimes unaware of conversations and interactions taking place in the virtual spaces that they did not use, which one convenor perceived as highly problematic. Other convenors mentioned that they would have liked to keep up, but time and workload prevented them from following all conversations and interacting in all virtual spaces. Convenors typically facilitated interactions and "followed" interactions more closely during their assigned thematic units, and only stayed informed using aggregated conversations during the other weeks. This way, some of them felt they were realizing the key principle of cMOOC participation themselves: to select and prioritize which conversations to follow and which not. Facilitation strategies also differed from one convenor to the other, leading to each thematic unit offering a different learning experience despite the basic common design. All the convenors reflected on the challenge of managing multiple virtual spaces and following the conversations that participants had in those virtual spaces. Sometimes, there was redundancy and repetition in the conversations that occurred in the spaces, but including multiple virtual spaces enabled participants to choose their virtual spaces for discussions. Given the nature

of an open online course, the convenors could not predict the profile or background of the type of participant who would be interested in the course and thus had to offer multiple options that allowed participants the autonomy to choose.

*Lessons learnt from collaboration and implementation of COER13:* In terms of lessons learnt about planning a MOOC collaboratively, all the convenors emphasized the importance of the planning phase for a MOOC learning environment where it was difficult to anticipate the type of learner who would participate, as well as learners' expectations, incoming technical skills and content knowledge. In designing such a MOOC, two convenors highlighted the importance of building resources for learners with at least two sets of expectations or two levels - those who wanted an introduction to or overview of the topic and those who wanted to gain in-depth understanding of the topic. Given the diverse group of learners who participate in MOOCs, it was important to consider both those who wanted to learn at a basic level and those who want to learn at an advanced level in choosing resources and structuring instruction.

The convenors had previously identified clear responsibilities for thematic units, but they had only rudimentarily discussed the management of the different interaction spaces (e.g. the discussion forum, blogs, the emergent social media groups and Twitter), they had not clearly defined the roles and responsibilities for managing those interaction spaces and interactions in those spaces. One lesson learned was to clearly define roles and responsibilities not only in terms of design and implementation, but also virtual space management and interaction management. Another lesson learned was that the tools and infrastructure used for the MOOC influence the interactions that take place, therefore it is important to be very thoughtful about the technology and how it would be used. Further, convenors had developed their content for their thematic units individually, and did not have the time to share their units ahead of time with their co-convenors, which led to occasional overlaps in resources or experts who were considered for those weeks. They thus suggested that the pre-planning should involve content development to as large an extent as possible. Likewise, prior discussion about facilitation strategies as well as more active facilitation during the MOOC were suggested by one convenor as a way to decrease the drop-out rate in such courses. With respect to implementation, a regular synchronous meeting of convenors throughout the course was proposed by one convenor who stated that it was important to collaborate intensively during the planning phase,

but it was as important to meet during the implementation about how things were going and what needed to be changed.

## Discussion

*Collaborating:* It is not uncommon to have more than one convenor of a cMOOC, but the number of convenors in COER13 was rather high. An informal collaboration across five different institutions is also a special circumstance for collaboration. Taking into account that all planning and implementation was done collaboratively online, it is quite remarkable that convenors seemed to be quite content with the collaboration process and felt that it went smoothly. The initial planning phase seemed to have been of great significance, especially the process of clearly assigning leadership roles for different thematic units. The convenors shared the assessment that it would have been hard (or nearly impossible) for any one of them to offer such a MOOC by themselves. This might also have contributed to a positive perception of the overall collaboration process, in addition to the mutual feeling of belonging to a team that successfully offered a relevant course on a highly relevant educational topic. The wish, mentioned above, for even more intensive planning and exchange of feedback during the course evolution might be related to different participation patterns within the units. As with many MOOCs, participants were much more active in the first units and their engagement decreased somewhat towards the end. Perhaps the different degrees of participants' involvement were also related to the content itself. The initial thematic units targeted teachers and lectures whereas the latter units were more relevant for educational managers, policy makers, and alike. It would be worthwhile to investigate whether these different key audiences might have benefitted from different ways of convening and facilitating. In any case, these differences could have instigated the wish for more or closer collaboration when the course was already up and running. Interestingly, the degree of similarity in convenors' perceptions of both course and collaboration came as a surprise to some of the convenors. They thought that the perceptions within the team would render a much more diverse picture. The shared sense of achievement amongst the team might have overshadowed nuances in perception – or the similarity points to some inherent limitations of our methodological approach: As all interviewees knew that findings would be discussed afterwards, even if anonymously, this approach might have prevented them from raising any points that could have caused conflict. Convenors with an NGO background were the ones who did not participate due to time restrictions. As these

interviews are completed, attention will be paid to whether the similarity of opinion among convenors decreases.

*“Digital habitats”*: The frequently mentioned theme of diverse and emergent virtual discussion spaces within COER13 and the challenge of facilitating and convening within them brings Wenger et al.’s (2009) notion of “digital habitats” to mind: The choice of technologies to support online learning is not only a question of choosing the right tools but also of providing a sense of “home” within the virtual spaces they afford. The diversity of virtual spaces planned for in COER13 and the use of emergent social media spaces like Facebook and Google+ meant changed “digital habitats” for some convenors. In particular, those more used to teaching online in clearly prescribed virtual spaces, like closed learning management systems, might have felt somewhat “unsettled” when suddenly exposed to a rather “nomadic” setting for facilitating and convening.

*Methodological reflections*: Possible limitations of our methodological approach are already mentioned above. In general, the participation of three interviewed convenors as authors of this paper could be perceived as conflict of interest. However, the convenors were not aware of the questions that would be asked during interviews. Furthermore, including an insider view and being able to go through a process of communicative validation after the qualitative interviews added to trustworthiness of the data as much as the systematic, external, non-involved view of the fourth author who led the interviews.

## Conclusion

For future convenors of cMOOCs the following issues should be considered:

- An intensive planning phase as to the basic design of the course and assigning leadership roles for certain units eases the process of collaboration, finding one’s own role as convenor and the actual implementation of the MOOC;
- A structure for ongoing collaboration or exchange of feedback while the course is running can support the convenors in taking up their leadership roles;
- Virtual communication spaces must be designed carefully, including being prepared for emergent new spaces that are set up by participants;
- It could be helpful to discuss a system of distributed responsibilities for convenors to contribute to different discussions in the various virtual discussion spaces used;
- It might be worthwhile to adapt virtual discussion spaces as well as facilitation methods across different thematic units, depending on the relevance of the content for different sub-groups of participants;
- It remains an open challenge to balance collaborative planning with “playing-by-ear” facilitating in newly emergent situations;
- Further research into any one of these issues seems rewarding – as much as offering a cMOOC collaboratively is a rewarding learning experience.

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### Edition and production

Name of the publication: eLearning Papers

ISSN: 1887-1542

Publisher: [elearningeuropa.info](http://elearningeuropa.info)

Edited by: P.A.U. Education, S.L.

Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)

Phone: +34 933 670 400

Email: [editorialteam@openeducationeuropa.eu](mailto:editorialteam@openeducationeuropa.eu)

Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## Mathematics Courses: Fostering Individuality Through EMOOCs

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When it comes to university-level mathematics in engineering education, it is getting harder and harder to bridge the gap between the requirements of the curriculum and the actual mathematic skills of first-year students. A constantly increasing number of students and the consequent heterogeneity make it even more difficult to fulfil this task. This article discusses the possibility of complementing an introductory course in mathematics with learning environments designed by the international ROLE project in order to use a MOOC to provide an internal differentiation of large learner groups such that it gets easier for students to gain the knowledge needed for the content of the curriculum.

This article examines the project Vorkurs mit Open Educational Resources in Mathematik (VOERM) (Mathematical Introductory Course with Open Educational Resources (OER)) that as first offered at the Bonn-Rhine-Sieg University of Applied Science in the winter term of 2013. The course was conducted in September and October 2013. The course is not part of the curriculum but is taught every year during orientation. The objective of the project is to turn parts of the course into a MOOC. Following a short summary of the actual situation, we will present the idea of the project as well as research questions and aims. Furthermore, we reflect on the experience and possible future developments.

### Tags

mathematics, MOOC, orientation, role, differentiation of learners

## Introduction

### Problems in mathematics courses

In general, mathematics continues to play a dominant role in our everyday life. Technologies, techniques and procedures, like for example the optimization of parameters or chain supply management, are fundamentally mathematical based (Ziegler, 2006). In order to keep pace with modern technology and also to understand existing concepts, future engineers have to have a deeper understanding of mathematics. Thus, mathematics continues to play an important role in their education.

When it comes to engineering education, a German survey dealing with sustainable university development in 2011 has shown that nearly half of engineering students cancel their studies and one in four students is still leaving the university without a university degree. Students stated that the most common cause for dropping out of studies in these courses is that academic entry requirements often ask too much of them (Hetze, 2011). During their orientation phase at university and their first semester courses, students decide whether they continue their studies or give it up.

Engineering disciplines are fundamentally based on mathematics and problem solving. As a consequence, the entry requirements of these courses still represent a major obstacle for the students due to their heterogeneous levels of mathematical knowledge. Mathematics education at school level differs from school to school and unfortunately some contents are hardly taught anymore. Thus, students lack formal and important symbolic elements. Due to changes in the school curricula the learning behaviour has also changed so that for example “teaching to the test” does not stimulate the integration of knowledge in the long-term memory.

After finishing school students also often mention that there are inadequate overall conditions at universities when it comes to repetition of school mathematics. As a consequence, the gap between the initial requirements of the mathematical courses at universities and the prior knowledge of the first semester students is steadily enlarging (Knorrenschild, 2009). Students lack the mathematical ability needed for their future courses. A constantly increasing number of students and the consequent heterogeneity make it even more difficult to fulfil the task of bridging the gap. Hence, the problem of giving lectures for large audiences with heterogeneous levels of mathematical knowledge must be resolved.

### MOOCs

In order to deal with a large number of students and with the problems of prevalent passivity of students in a large audience, information must be presented in different ways. The lecturer has to support each individual learner and their individual learning processes. One way of doing this is the usage of **Massive Open Online Courses** (MOOCs). The term was first used as a result of a large online course run by George Siemens and Stephen Downes in 2008 (Cormier/Siemens 2010). The *massive* part of a MOOC “comes from the number of participants, which could range from hundreds to thousands to hundreds of thousands” (Bond 2013). Discussions have suggested that a group of 100 participants is a minimum. The word *open* comes from the fact that “anyone is free to register ... [and that] [t] here are no prerequisites, other than Internet access, and no fees are required” (Bond 2013). Typically, open source software is involved and OER are used as material for the course. Online refers to the fact that the internet is used for the courses and the word *Course* itself states that MOOCs are courses with “schedules and facilitators, readings or other course materials,

and sometimes projects, all organized around a central theme or topic” (Bond 2013).

In (Powell/Yuan, 2013) there are different issues and challenges for MOOCs mentioned. Three of the main challenges are pedagogy, quality and completion rates. The concept of MOOCs raises the question of whether the courses and their organizational approach to online learning will lead to quality outcomes and experiences for students. New pedagogies and strategies are required to deliver a high quality learning experience for the students. On the one hand, MOOCs provide great opportunities for non-traditional teaching styles and getting the focus on the individuality of each learner. Each learner can experience his own difficulties and the lecturer is able to provide material so that each student is able to work on his deficits using his own speed. Individual or alternative routes of learning can be taken and online communities can always answer to given problems. On the other hand, the lecturer is not able to deal with each student personally. Social learning experience is not provided by MOOCs. Also, as a consequence of the lack of structure of the online courses, the self-directed learning demands from the students that they motivate themselves to participate and structure the online material for themselves. Lectures demand a certain level of digital literacy from their participants.

In order to deal with the heterogeneity of first-year students, the Bonn-Rhein-Sieg University of Applied Science intends to use a MOOC as an extension of the traditional mathematical introductory course. The above mentioned gap between output orientation, the minimum mathematical requirements of the course of studies, and the input orientation, the compensation of personal mathematical shortcomings of the first-year students, cannot be sufficiently filled by the introductory courses at universities. In only a few weeks before the semester starts, the lecturer is not able to communicate new subject matters completely (Knorrenschild, 2009). Each student has different mathematical abilities after finishing school and is lacking some topics that will be important for his engineering studies. Since the university is facing approximately 300 students the lecturer is not able to provide an individual learning environment for each student in a traditional lecture. Instead this should be put into practice by an extra MOOC that supports the traditional lecture. The next section outlines the idea of the new project.

### The VOERM project

#### The ROLE platform

In order to solve the problems mentioned in the previous section the Bonn-Rhein-Sieg University of Applied Science in cooperation with the Fraunhofer Institute for Applied Information Technique (FIT) tries to combine the traditional mathematical introductory course with a MOOC. This course uses the so-called ROLE platform of the FIT. ROLE is an acronym for *Responsive Open Learning Environments* and is a European collaborative project with 16 internationally renowned research groups from 6 EU countries and China. ROLE technology is “centred around the concept of self-regulated learning that creates responsible and thinking learners” (ROLE 2009). On the ROLE platform the lecturer is able to develop the open personal learning environments for his students where they work on material that is provided by the lecturer. There are platforms available for several topics of school or university education.

On the ROLE platform the lecturer can choose between many widgets, which are small graphic windows that can be integrated as a small program on the online platform. Each widget can be individually fitted to the learning material of the subject matter and some are even developed especially for certain topics. Examples for widgets are the *Language Resource Browser Widget*, where students can use a web browser, that is adjusted to finding texts matching the actual subject matter, to search the internet for texts and use a translator and a vocabulary trainer for these texts, or the *WolframAlpha Widget*, which can be used by students for example to plot functions or solve logarithmic equations.

Using these widgets, students are able to:

- structure their own learning process individually,
- search for learning material on their own,
- learn and
- reflect their own learning process and progress.

For the collaboration with the Bonn-Rhein-Sieg University the FIT will set up a platform that will be accessed by the students via their online account for the eLearning platform of the university. Thus, there are only little administrative difficulties since the students have to create their online accounts anyway. Next, lecturers of the introductory courses in mathematics were

able to create their own spaces on the ROLE platform by using widgets from the existing compilation of the ROLE project. If widgets performing a certain needed function were missing, the FIT tried to create these widgets on their own. Before the creation process began, the lecturers got an instruction for the ROLE platform and the widgets, and the staff of the FIT accompanied each step of the creation of the online space. Assistance and ideas for improvements were given for the choices of the different widgets and for the usage and production of OER. Furthermore, lecturers were able to exchange experiences with the eLearning team of the university.

#### The introductory course

The project started at the university in the winter term of 2013 and the introductory course is divided into three different phases that are presented in Figure 1.

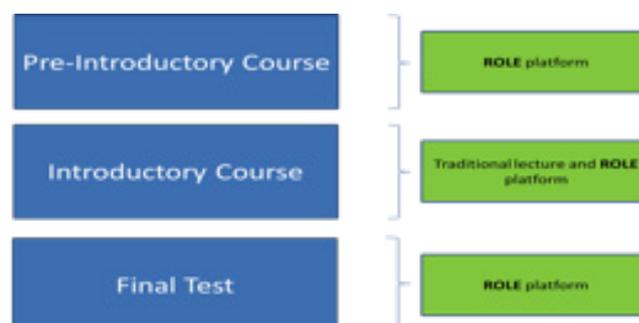


Figure 1. The structure of VOERM

The course lasts ten days. The first phase is a pre-introduction and lasts three days. The first-year engineering students of the university will be welcomed and alongside information about their upcoming studies the structure of the new introductory course and the platform of the ROLE project will be presented by the lecturer. On the following two days the students will work on the ROLE platform. This phase is a MOOC and thematically deals with the mathematical fundamentals needed for the rest of the course (equations, algebraic signs, brackets and number range). For this purpose the lecturer has assembled several widgets with OER contents:

- Videos
- PDF documents
- Exercises
- Calculator, tools for formulas, function plotter

- Forum
- Bulletin board
- ...

An *Activity Recommender* contains instructions on how the MOOC works and how the widgets can be used by the students. This recommender also helps to create a *To-learn list*. The students are able to cross off the points on this list to mark the completed tasks. The forum can be used to discuss problems, exchange further material or get in contact with fellow students or the lecturer. The videos can be taken from the pool of OER found for example at YouTube or the famous *Khan Academy*, which produces online learning material for mathematics since 2007. For the project at the Bonn-Rhein-Sieg University, the lecturer produced most videos were in advance. Thus, the videos are exactly fitted to the subject matter. Additionally several other tools, like for example the previously mentioned *WolframAlpha Widget* or the *MathBridge Widget*, which is a search engine for mathematical phrases, are integrated. In general, students are free to use each widget when they want to. They can decide on their importance for themselves and on the order in which they are using the widgets. Hints for advisable combinations can be found in the *Activity Recommender*.

After this online experience the second phase of the introductory course is a mixture of a traditional lecture and the online course. During the next six days, several topics of engineering mathematics, such as trigonometry, powers or roots, are discussed in class. After each lecture the students are able to log onto the ROLE platform and work on the topics discussed earlier that day. For different topics, there are different spaces on the platform, which can be given to the students one at a time. These spaces were prepared in advance in the same way as the spaces for the first three days of the introductory course. The advantage for the lecturer is that the space can contain the material of the traditional lecture and additional material for each topic so that students who realized that they have deficits in some areas can pick the learning material that is most suitable for them. Additionally, more difficult tasks can be given to students whose mathematical ability is more advanced. In summary, if students decide that they prefer to work online they are not depending on the traditional lecture in order to get the information and material needed.

The third phase of the project involves testing the online platform, which will be conducted on the last day of the project. This test checks whether the students have understood the topics presented during the last nine days. It contains ten questions and each student is supposed to work on the test alone. The results will be used to identify students lacking the mathematical ability for their engineering education so that the lecturer can provide a special mentoring program for them during their first year of studies.

In summary, the project should support individual learning strategies and the acquisition of mathematical skills through an internal differentiation by giving students the possibility to work with their own speed on the topics of the subject matter that are the greatest obstacles for them. Students lacking elementary skills get the chance to fill in gaps in their own time without the pressure of their peer students and also students that show a deeper understanding of the subject matter can be challenged by more difficult tasks on the online platforms. Additionally, students can contact the lecturer in private and not in front of a large audience via personal chats. Thus, students who apprehend that any form of oral communication in huge classrooms would humiliate them in front of their fellow students are encouraged to use these personal chats.

### Aims and Research Questions

The research questions of the project **VOERM** are the following:

1. What is the access frequency of the elements on the **MOOC** platform?
2. Has the result of the final test improved in comparison to the last year where there was no **MOOC**?
3. Do students express that the **MOOC** has supported their acquisition of knowledge?
4. Is the **MOOC** platform more suitable than the traditional lecture to support the students' learning processes? Do some students even prefer the MOOC and skip the traditional lecture?
5. Can an improvement of the mathematical ability be experienced during their first-year of studies in comparison to the last years?

The aim of the **VOERM** project is to use an additional **MOOC** to bridge the gap between the input and output orientation mentioned in the introduction. Students should reach a higher mathematical ability that enables them to perform better during their studies. They should dispose of their mathematical deficits and get ready to understand the subject matter of their later mathematical courses.

Short-term aims are an increase in students' motivation and facilitation of students' academic integration. Through the additional MOOC students should experience that their mathematical ability has increased and they should evaluate their own performance in a positive way.

### Evaluation and reflections

In this section I will try to give some provisional answers on the research questions raised in the previous section and reflect on these answers. Furthermore, we will share some of our experiences. Not all information is available yet since some data is still being processed and individual student answers are still pending.

#### Technical Details

On the technical side, the data on access have not been evaluated yet. However, during the course I was able to get an impression of how the widgets were accessed. First, there were some students that complained about not being able to access the entire online space. The online team of the university did its best to help these students and after two days no student complained about this problem anymore. Still, it may be the case that some students just took the traditional course and skipped the additional **MOOC**. Unfortunately, some students had problems accessing specific widgets, such as the videos made by the lecturer. Students that used Internet Explorer as a browser did not have a start button for the video. The university's online team was able to relink the videos through the online platform of the university so that these students were also able to see them on their home computers. In other cases the problem of not being able to see the video was fixed by changing the DivX-setup of the computer. If problems could not be fixed by the online team, students were advised to access the spaces from one of the computers of the university. In theory, each student should have had the opportunity to work on the **MOOC** course.

In class, students stated that the most common widgets used were the online videos and the PDFs with exercises and solutions. Also, Internet links providing further videos or additional reading material were used quite often. The additional helping devices, like for example calculators, functions plotters or the activity recommender were hardly used by the students. When asked why these widgets were hardly used the most common answers were that students had the specific function of one of the widgets on their calculators or that they did not need these functions. For future **MOOCs** on the **ROLE** platform students expressed the wish to have more learning videos and widgets that are explicitly designed for the different topics of the course. Most of the actual widgets are general mathematical applications, which can just be used for the introductory course. However, for future **MOOCs**, it would be better to design widgets with which the students can control and test their results of the exercises instead of auxiliary exercises. It should be mentioned that this would increase the workload for the lecturer and the members of the **ROLE** team significantly, as these new widgets would need to be programmed.

#### Participation and final test

In total, 279 students signed up for the course. 229 participated in the final exam. Even though the final exam was mandatory, a lot of students did not attend it. During their first year of studies these students will have the opportunity to take the final exam. Thus, their results are not included in the diagrams below. In comparison to the previous year the results of the final exam improved tremendously even though the test had the same questions (see Figure 2a and 2b for the results; on the horizontal axis there is the result of the test (in percentage), and on the vertical axis there is the number of students).

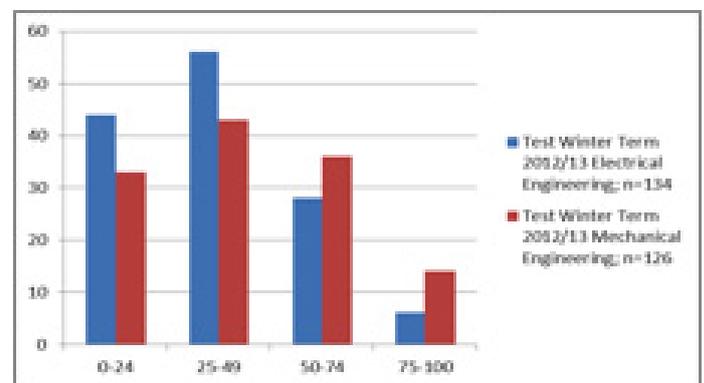


Figure 2a: Results of the finals exams in percentages

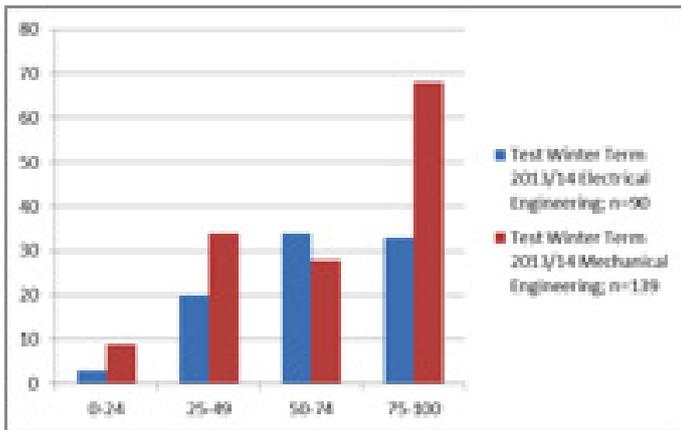


Figure 2b: Results of the finals exams in percentages

Unfortunately, this year's test was written online whereas last year's test was written under supervision at the university. Thus, students were able to use books, calculators and the course material during the exam. Additionally, they were able to work in groups. Nonetheless, there were no simple calculation exercises and the students did not have much time for each task of the exam, so that it can at least be said that students performed better in finding approaches that led to the solution. Furthermore, there were no consequences if students did not pass the test. The test served only as a classification of their pre-university knowledge and I explicitly explained that they would just betray themselves if they cheated on the students. While talking to the class after the test, I got the impression that most of the students tried to work on their own. Since we do not have the staff capacity to correct all the finals exams in two days in person, and in order to ensure more significant comparisons, the test will be performed again online next year.

One particular student retook the course and was able to compare the MOOC experience to the regular course of the previous year. He stated that the widgets on the online spaces were of great help. This student had deficits because some topics were not taught during his school education. When attending the course in the first year, he had problems following the lecture and solving the tasks provided. With the MOOC, he was able to watch individual videos again and test his knowledge on easier exercises. In the event of problems, he thought that the forum, provided on the online space, was of great help. He had a lot of questions that he was afraid to ask in class in front of his fellow students, so he used the individual message function of the online space to ask for help. He stated that not being exposed to the scrutiny of his fellow students made him more comfortable when asking his questions.

## Online evaluation

134 students completed the online evaluation of the course. In total, 113 students stated that the MOOC explicitly supported their understanding, and that the self-regulated learning on the spaces helped them gain the knowledge needed for their studies. 18 students said that the MOOC was only partially helpful and one person considered the MOOC to be useless. Students in class stated their appreciation for the opportunity to repeat exercises, watch the videos and get additional information. One of the main reasons they considered the MOOC to be useful is that during orientation, students do not go to the library of the university and pick a book that might help them. Some of them did not even have a library card at that point of their orientation. In the online spaces, additional information and course material selected and structured by the lecturer is made available. The positive effect of this is that students who skip searching for books after a short period of time when they are not able to find the material needed, and students who do not have access to the library are now able to work directly with the texts and exercises provided. This way these students work at home for the class instead of skipping this process. On the other hand, there is the negative effect that the lecturer takes more and more responsibility into his or her own hands. Thus, the experience of searching for literature is curtailed and students lose some of their learning autonomy.

Despite this fact, more than 80 percent of the students mentioned that the MOOC fostered their learning autonomy. They stated that the search engines and the possibility of selected their own level of difficulty on the online spaces made challenging experiences possible. Individual learners, mostly those with deficits resulting from incomplete school mathematics, told me that they needed the opportunity to take a closer look at the material. Hence, students' motivation definitely increased (more than 87 percent) and the reception of the MOOC course is very positive. The students think that they gained the knowledge, but one has to keep in mind that students often misjudge their own mathematical understanding. Even though they think that they have gained the knowledge, they are not always able to solve the tasks provided.

Their positive feeling after the course was supported by my experience during the first weeks of the current winter term. Despite the fact that a lot of elementary problems are still caused by a lack of knowledge, deficient accuracy or inattention, the overall impression of this year's course is much

better than that of the last winter term. This may also depend on the individual learners of the course, but especially when it comes to the topics of the introductory course, the students of the current class perform a lot better than last year's students. During the repetition course, which is held during the winter term, we discuss current problems rather than spending a lot of time repeating the fundamentals.

Finally, when students were asked if the MOOC could replace the traditional course, they stated that they feel there is still a need for in-class elements. They appreciated the existing structure with a basic course and lots of presence elements. Among other reasons they mentioned that they like the direct contact with the lecturer, that questions can be discussed in the plenum and that there is a direct student-student interaction, which is important for forming peer groups during orientation. Despite the fact that some students had technical problems with the online spaces and could barely participate, nearly all students stated that the MOOC played an important role in deepening their knowledge and bridging existing gaps. In class, they could get a glimpse of the necessary topics and an idea of their personal deficits. At home they were able to work on these deficits with their own speed. Exercises that they did not understand in class because the speed of the lecture and the tutorial was too fast could easily be repeated at home. They could watch the videos that explained the topics discussed in the morning if they had not fully comprehended each step. If the exercises of the traditional course were too simple, students could pick more advanced tasks or search for continuative literature.

In the survey, ten students stated that just a MOOC would be enough to gain the mathematical knowledge during orientation. 14 students stated that there was no need at all for an additional MOOC. The remaining 113 participants in the survey stated that they would keep the subdivision into a traditional course and a MOOC, as was the case in this year's orientation.

In summary, both the students and I were satisfied with the way the additional MOOC worked. Despite technical problems, and the necessity for selection of the widgets to be better adjusted to the topics of the introductory course, a further MOOC will be held during orientation at the Bonn-Rhein-Sieg University of Applied Science.

For the structure of this year's MOOC, a university would need access to the ROLE platform. Once this is set up, the online spaces can be linked to the universities' own online platform. ROLE spaces are available for many different subject matters. For additional information, please contact the Fraunhofer Institute FIT. Examples of different spaces and a widget search engine can be found on the web page: [www.role-project.eu](http://www.role-project.eu)

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### Edition and production

Name of the publication: eLearning Papers

ISSN: 1887-1542

Publisher: elearningeuropa.info

Edited by: P.A.U. Education, S.L.

Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)

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Email: [editorialteam\[at\]openeducationeuropa\[dot\]eu](mailto:editorialteam@openeducationeuropa.eu)

Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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## Analyzing Completion Rates in the First French xMOOC

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### Tags

engagement, background,  
completion, indicators,  
MOOC, forums, peer  
assessment

Massive Open Online Courses (MOOCs) have spread incredibly fast since the foundation of Coursera and edX in 2012, initiating a worldwide debate over the place of online learning in educational systems. Their low completion rates have repeatedly been criticized over the past two years, forcing researchers to take a closer look at their complex dynamics. Introduction to Project Management is the first French xMOOC; it was organized on Canvas.net in early 2013. Two certificates involving significantly different workloads were proposed to address the various expectations and constraints of MOOC participants. We show that learners' personal aims and achievements are highly dependent upon their employment status, geographical origin and time constraints. Furthermore, the use of forums and involvement in peer-assessment are significantly associated with the level of achievement at the scale of the MOOC. Learners who interact on the forums and assess peer assignments are more likely to complete the course.

### Introduction

Over the past two years, the importance of Massive Open Online Courses (MOOCs) has increased dramatically in higher education, giving rise to numerous controversies (Bates, 2012). Originally inspired by connectivism (Siemens, 2004, Bell, 2010), the teaching model for MOOCs has evolved drastically since the foundation of Coursera and edX in 2012 (Cisel & Bruillard, 2013, Daniel, 2012). The most recurrent criticism is probably the low proportion of participants completing the courses, generally below 10 % (Breslow et al., 2013, Jordan, 2013, Kizilcec et al., 2013, Rivard, 2013). Dropout rates in online courses are not a new issue (Angelino et al., 2007). However, the environment differs fundamentally from online courses that have formed the basis for various studies until now.

The open nature of MOOCs implies rethinking our understanding of learners' engagement and disengagement. The monolithic distinction between completers and drop-outs is in many ways inadequate to describe the diversity of learning engagement patterns (Clow et al., 2013, Kizilcec et al., 2013, Seaton et al., 2013). On the one hand, there may be different levels of completion among completers, on the other hand there are different levels of non-completion. For instance, Kizilcec distinguishes auditing learners from disengaging learners, among other types of learners. Auditing participants usually watch videos but do not submit assignments, while disengaging students usually follow the beginning of the course diligently and eventually give up. One of the major issues of MOOCs is to identify the factors associated with the different levels of engagement (Hart et al., 2012). Such an understanding could be used to tailor the course for different types of learners (Grünewald et al., 2013). MOOCs provide us with two different types of data that can be used in that scope: background data

collected through online surveys, and analytics collected by the platform on which the course is implemented (Breslow et al., 2013, DeBoer et al., 2013). This paper aims at identifying factors statistically associated with engagement in the French MOOC ABC de la Gestion de Projet (Introduction to Project Management), proposed by Ecole Centrale de Lille. How are the different levels of engagement linked to students' background? Which indicators could be used to predict completion rates based on the data collected by the platform?

### Course description

ABC de la Gestion de Projet (Introduction to Project Management) is the first French so-called xMOOC (Daniel 2012), launched by the Grande Ecole Centrale Lille, a competitive higher education institution. The course lasted five weeks, and it took place from March 18th to April 21st 2013 on Canvas.net. Participants enrolled from January 10th to March 21st 2013; there were 3495 registered learners when registration closed.

Two certificates corresponding to different workloads were offered, a basic one and an advanced one. The former relied on the completion of quizzes whereas the latter involved submitting weekly assignments. According to the professor in charge of the MOOC, completion of the basic certificate and the advanced certificate required respectively around ten hours and forty hours in total. The objective underlying this design was to address the various expectations and constraints of MOOC participants. Those who had little time to spend on the course could follow the basic certificate, and those who wanted to learn more could follow the advanced certificate. The course provided quizzes, weekly assignments and a final examination. To obtain the basic certificate, it was required to complete the quizzes and the exam with a minimum of 280 points out of 400. The deadline for these quizzes was set to the last day of the course. These quizzes were mostly based on content recall although a few calculus applications were also included.

In order to obtain the advanced certificate, participants were required to pass the basic one and submit at least three assignments out of four. They also had to reach a minimal score of 560 points out of 800. Out of these 800 points, 200 could be gained through quizzes, 200 through the exam, and 400 through assignments. Each assignment could bring a maximum of 100 points. Those assignments were based on a case study and assessed through peer evaluation. Learners could take part in the evaluation process only if they had submitted the

corresponding assignment. There was no time limit for peer assessment and learners did not gain any points by taking part in the process. Final marks were attributed by a team of teaching assistants based on the marks and comments previously left by assessors. Some new discussion threads were initiated every week, by the MOOC staff only, and monitored closely during the duration of the course.

In addition to a wiki, many resources provided information on the course and on associated tools, such as tutorials and FAQs. The type of certificate obtained will hereafter be referred to as "achievement". Similarly, the type of certificate initially aimed at by learners in the initial survey will be referred to as "personal aim". Based on achievements and personal aim, we designed an 'achievement gap' score. We qualify the score as negative when the achievement lies below the personal aim, and positive in the opposite case. It is considered as null when it corresponds to the personal aim. Furthermore, if the participant does not obtain a certificate and did not aim at it, the score is null as well.

Out of the 3495 participants who registered, 1332 (38.1 %) obtained a certificate. Among those who obtained a certificate, 894 (67.1 %) got the basic certificate only, and 438 (32.9 %) the advanced certificate. Among registered participants, 466 (13.4 %) did not go beyond the registration process. They will be referred to as "no-show". 1697 (48.5%) were active, but did not obtain any certificate. They will be referred to as Non completers, they include both dropouts and auditing learners.

### Available data

Student activity reports, gradebooks and survey responses used for this study were downloaded from the platform. Activity reports provide data on resources or discussion threads visited by the participants; timestamps or time spent on each resource were not available for every log. Therefore it was not possible to carry out any analysis based on time. Regarding the peer evaluation process, marks given by assessors and associated comments were extracted for all assignments. Participants were asked to fill in a survey at the beginning of the course. Out of the 3029 registered participants who went beyond the registration process, 74.3 % filled in this survey, on which subsequent analysis on demographics are based. 100% of those who obtained the advanced certificate, 98.5% of those who obtained the basic certificate, and 63.0% of Non completers filled in the survey. IP addresses were not collected, therefore all available data on geographical origin comes from surveys. Regarding the use

of videos, some analytics were provided by YouTube but they could not be associated to analytics from Canvas. Anonymised data was analyzed with the open source statistical software R 2.12 (Team, 2012). In the subsequent analysis, chi-square test was used in order to identify statistically significant associations between survey data and levels of completion.

## Results

### Course Demographics

In terms of course demographics, 68 % of learners were male, and the average age as a whole was 34.7 ( $\pm$  standard deviation = 10.0) years. Among participants, 14.3 % were students, 13.4 % had lower supervisory and technical occupations, 13.7 % were job seekers and 52.2 % had higher managerial and professional occupations. Most participants lived in France (60.6 %). Still, some learners came from many other countries, mostly from African countries where French is an official language, such as Burkina Faso (6.2 %), Senegal (5.2 %), Morocco (4.7 %), or Ivory Coast (3 %). For the purpose of this analysis, these countries were classified based on their Human Development Index (HDI), on the basis of information provided by the United Nations Development Program (UNDP, 2012). HDI ranged from low to very high, with medium and high as intermediate values. Among learners who completed the survey, 66.7 % came from countries with a very high HDI, 3.7 % from countries with a high HDI, 5.4 % from countries with a medium HDI and 24.2 % from countries with a low HDI. Among participants from countries with a low HDI, 10.3 % were students, 19.1 % had lower supervisory and technical occupations,

16.9 % were job seekers, and 44.6 % had higher managerial and professional occupations.

### Objectives, achievements and constraints

The following demographic comparisons are valid only under the assumption that responding to the survey is independent of the demographic indicators. At the launch of the course, 45.0 % of participants intended to obtain the advanced certificate, 28.9 % the basic certificate, and 26.0 % were unsure or were not interested in obtaining a certificate. Student achievements were significantly associated with personal aims ( $\chi^2 = 307$ ,  $df = 4$ ,  $p$ -value < 0.001) (Figure 1.A). 43.3 % of learners got a null score, 13.4% a positive score, and 43.2 % a negative score, showing that a significant proportion of learners failed to reach their objectives. Unsurprisingly, both achievements ( $\chi^2 = 191$ ,  $df$

= 6,  $p$ -value < 0.001) and personal aims ( $\chi^2 = 449$ ,  $df = 6$ ,  $p$ -value < 0.001) were significantly associated with the number of hours learners intended to spend on the course (Figure 1.C). Only 19.7 % of participants who intended to spend less than four hours per week on the course obtained the advanced certificate, whereas 33.6 % of those who planned to spend more than six hours received it.

### Background influence

Among demographic factors, HDI was the factor most associated with achievement ( $\chi^2 = 50$ ,  $df = 6$ ,  $p$ -value < 0.001), personal aims ( $\chi^2 = 143.8$ ,  $df = 6$ ,  $p$ -value < 0.001) and above all with achievement gap ( $\chi^2 = 193$ ,  $df = 6$ ,  $p$ -value < 0.001) (Figure 1.D). Learners from low HDI countries tended to overestimate their ability to get the advanced certificate. Among them, 62.9 % stated that they aimed at getting it, and only 10.8 % obtained it. This occurred less often with participants from very high HDI countries, since 36.8 % of them aimed at the advanced certificate, and 21.9 % obtained it.

We did not detect any association between gender and achievement ( $\chi^2 = 2.2$ ,  $df = 2$ ,  $p$ -value = 0.33), instead the association was highly significant with personal aims ( $\chi^2 = 53$ ,  $df = 2$ ,  $p$ -value < 0.001) and achievement gap ( $\chi^2 = 31$ ,  $df = 2$ ,  $p$ -value < 0.001). Women tended to underestimate their ability, contrary to men, who tended to overestimate their ability. Only 33.9 % of women aimed at the advanced certificate and at the scale of the MOOC, 65.3 % achieved or exceeded their objectives. In comparison, 50.2 % of men intended to get the advanced certificate, and only 52.9 % reached or exceeded their personal aims (Figure 1.B).

Participants' employment status had an impact on both achievement ( $\chi^2 = 21$ ,  $df = 8$ ,  $p$ -value < 0.01) and personal aims ( $\chi^2 = 59$ ,  $df = 8$ ,  $p$ -value < 0.001), but did not affect the achievement gap ( $\chi^2 = 12$ ,  $df = 8$ ,  $p$ -value = 0.15). For instance, unemployed learners tended to reach higher targets and achievements than students. Among students, 31.9 % aimed at getting the advanced certificate and 12.9 % got it. Among participants looking for a job, 56.2 % aimed at getting the advanced certificate and 22.8 % succeeded.

Experience in project management also had a slightly significant effect on personal aims ( $\chi^2 = 37$ ,  $df = 8$ ,  $p$ -value < 0.001) and achievements ( $\chi^2 = 24$ ,  $df = 8$ ,  $p$ -value < 0.01). Those who had experience in project management and who had followed some training in the field had higher personal aims and achievements.

Still, the participants' experience in project management did not have an impact on the achievement gap. Among learners who had some practical experience of project management and who had already followed some training in the field, 54.4 % aimed at getting the advanced certificate, and 21.3 % received it. 41.9 % of learners with no project management experience aimed at getting the advanced certificate, and 13.2 % obtained it.

### Participation in forums

We sought to isolate simple indicators associated with achievement, such as the use of forums. At the scale of the course, 430 (12.3 %) of registered participants posted at least one message on the forums. However, 2625 (75.1 %) read a discussion thread at least once. The proportion of learners who posted on the forums was pretty low compared to the ones who read discussion threads. Among learners who had never sent any message on the forum, 8.8 % got the advanced certificate, whereas 46.9 % of learners who had posted at least one message obtained it. This association was statistically significant ( $\chi^2 = 498$ ,  $df = 2$ ,  $p\text{-value} < 0.001$ ) (Figure 2.A). The number of viewed discussion threads was correlated to achievement (ANOVA,  $R^2 = 0.49$ ,  $F_{2,3023} = 1451$ ,  $p\text{-value} < 0.001$ ). Those who got certificates read the forums more than others. We showed that Non completers read only 3.1 ( $\pm$  s.d. 3.6) discussion threads, those who obtained the basic certificate read on average 8.6 ( $\pm$  s.d. 5.5), and those who obtained the advanced certificate, read on average 16.9 ( $\pm$  s.d. 7.4) discussion threads.

### Engagement in the advanced certificate

The use of forums is an interesting indicator at the scale of the MOOC, but some more specific indicators are needed for the advanced certificate. Among registered learners, 615 (17.6 %) took part in the advanced certificate by submitting at least one assignment; the drop-out rate was pretty low. Among them, 438 (71.2 %) obtained the advanced certificate at the end of the course. Among learners who took part in the advanced certificate, 116 (18.8 %) submitted less than three assignments, three being the minimum number of assignments required to obtain the certificate. 499 (81.1 %) submitted three or more assignments. Some of them did not get the certificate because they did not reach the minimum score of 580.

We sought to assess whether the participation in the peer evaluation process was associated with achievement within this certificate. Out of the 615 participants, 555 (90.2 %)

took part in the peer evaluation process at least once. Once a learner had started evaluating an assignment, he evaluated the four assignments that he was supposed to evaluate in 93.7 % of the cases. Taking part in the peer evaluation process was strongly associated with achievement within the advanced certificate ( $\chi^2 = 146$ ,  $df = 2$ ,  $p\text{-value} < 0.001$ ) (Figure 2.B). Those who evaluated assignments were much more likely to get the advanced certificate. Indeed, 78.0 % of participants who took part at least once in the evaluation process, 8.0 % of those who did not, obtained the advanced certificate. Among the 555 assessors who took part in the evaluation process, only 45.6 % gave some feedback on the assignment. Giving feedback was slightly associated with achievement ( $\chi^2 = 22$ ,  $df = 2$ ,  $p\text{-value} < 0.001$ ), but the association was weaker. The completion rate was higher among those who gave feedback at least once (87.0 %) than among those who did not (70.5 %).

### Discussion

The course completion rate was higher than those usually observed in MOOCs (Breslow et al., 2013, Jordan 2013, Kizilcec et al., 2013). On the one hand, this may be due to the course design and on the other hand, to the type of participants who followed the course. MOOCs were little known in France when Introduction to Project Management was launched (Cisel & Bruillard, 2013). The participants of the first session of this course may therefore be considered as early-adopters, probably more motivated than most MOOC participants. The MOOC design doubtlessly influenced its completion rate. The workload necessary to obtain a certificate was significantly lower for the basic certificate of completion than for the advanced one. Moreover, the course duration was shorter than most MOOCs since it lasted only five weeks. It was therefore easier to complete the course for learners who had little spare time. It is hard to compare MOOC completion rates among courses given the diversity of workloads that they involve. The highest completion rate reported so far was Functional Programming Principles in Scala, where around 20% learners completed the course (Miller & Odersky, 2013). Taken alone, the completion rate of the advanced certificate of Introduction to Project Management is more in line with the general results reported (Breslow et al., 2013, Jordan 2013, Kizilcec et al., 2013)

This course enrolled more male than female learners. This result is in line with results reported from other courses (Huhn, 2013, Kizilcec et al., 2013), sex ratio depending highly upon the topic of the course. Before being turned into a MOOC, this

course was an online module taught in the context of lifelong learning courses. As a consequence, it is not surprising that this course attracted more full-time workers than students. Around a quarter of the participants came from French-speaking, low HDI African countries. In comparison, the proportion of learners from low HDI countries in the three Computer Science courses described by Kizilcec et al. (2013) was below 3 %. This proportion is doubtlessly dependant on the teaching language; it would be interesting to compare course demographics from MOOCs in English, Spanish and French, since these three languages are used worldwide as official languages in a variety of countries. It is obvious that the participants did not consist of a random sample of the general population, especially for low HDI countries, given the required technological infrastructure, literacy level and language comprehension.

Completion rates were associated mostly with personal aims, which depended on employment status, geographical origin, experience in project management and time constraints. Further research is needed to understand why participants from developing countries and job seekers targeted higher levels of completion than others. Time constraints must also be taken into account in the interpretation of personal aims, since the situation is fundamentally different for a person looking for a job and for a full-time employee. A deeper analysis of the diverse motivations and constraints of the different groups of learners is needed to better understand both their objectives and achievements.

Understanding drop-out rates and, generally speaking, the gap between learners' objectives and achievements is a major issue for MOOC pedagogy. The achievement gap observed in low HDI countries is probably caused by various cultural and technical issues such as low broadband, for instance, or language issues. As a reminder, French is not the native language of many African learners and could be an obstacle. Kizilcec reported that in the Probabilistic Graphical Models MOOC (Graduate level course), completion rates were four times smaller in low HDI countries compared to very high HDI countries, reaching only 2 %. Further research is needed to understand the causes of the gap between objectives and achievements in those countries.

Identification of indicators associated with course completion is a major issue in order to tailor and adapt eventual interventions (Arnold & Pistilli, 2012). For this reason, we searched for simple indicators, such as participation in forums and in the peer evaluation process. Regarding the use of forums, learners were

more active than what was reported in some other MOOCs (Randy, 2013). For example in the Circuits and Electronics (xMOOC) course held on the edX platform, only 3 % of all learners interacted with others. In many courses, this proportion is lower than 5 %. This is probably due to the humble size of Introduction to Project Management compared to courses like 6.002x, which made it easier for the MOOC staff to interact with learners on the different aspects of the course. Getting quick feedback from the MOOC team may have encouraged participants to post more frequently on the forums. Participation in forums was significantly associated with achievements, which suggests that it is a relatively good predictor for completion. This trend was observed in many other courses from Coursera. Organizational Analysis, a MOOC held on Coursera in the fall of 2012, is the only course that reported that more than half of the students who had posted on the forums completed the MOOC (Randy, 2013).

The quest for more precise indicators led us to analyze the peer evaluation process. All learners do not engage in peer assessment in the same way. As far as the evaluations are concerned, some of them give consistently lower or higher marks than other assessors (Sadler et al., 2006, Bachelet & Cisel, 2013, Piech et al., 2013). From the engagement point of view, some take part in the process while others do not. Participation in peer assessment was a good predictor of achievement within the advanced certificate, whereas providing feedback along with the assessments was a weaker predictor for success. It is very likely that learners who do not take part in the evaluation process will not complete the course. Indicators must have a strong predictive power and still be simple enough to be accessible and understandable by MOOC designers. In the long run, some more precise indicators should be developed in order to monitor the course in real time. It requires the development of standards for MOOC data (Veeramachaneni et al., 2013), based on which algorithm-based indicators could be designed.

Another session of the course was launched in September 2013 and more than 10,000 learners registered. Some innovations were introduced, such as Mozilla Open Badges, and some novel course content was added. This will allow us to assess the repeatability of the results obtained during the first session of the MOOC and, to some extent, to assess the impact of the course design on completion rates. One of the most important challenges for MOOC designers is to build courses based on evidence drawn from data. Further research on MOOCs and

cooperation between MOOC designers and researchers will be needed to face the challenges of the next generation of courses.

## Acknowledgements

The author wishes to address his grateful thoughts to Rémi Bachelet and the rest of the MOOC team for the hard work that they carried out and for giving access to the data, Instructure for hosting the course, and Unow, the start-up that took part in the design and the implementation of the course. Thanks are also due to the MOOC participants who helped correcting the spelling of this paper, Rohit Arora, Frédérique Géneaux, and Caroline Raro for helping with the translation of the paper into English. I wish to thank Eric Bruillard, my PhD supervisor, and

Mehdi Khaneboubi, assistant professor in educational studies, for their helpful remarks and feedback. This research was reported to the Commission Nationale Informatique et Liberté (CNIL), the French institution in charge of online privacy (ticket 1691291).

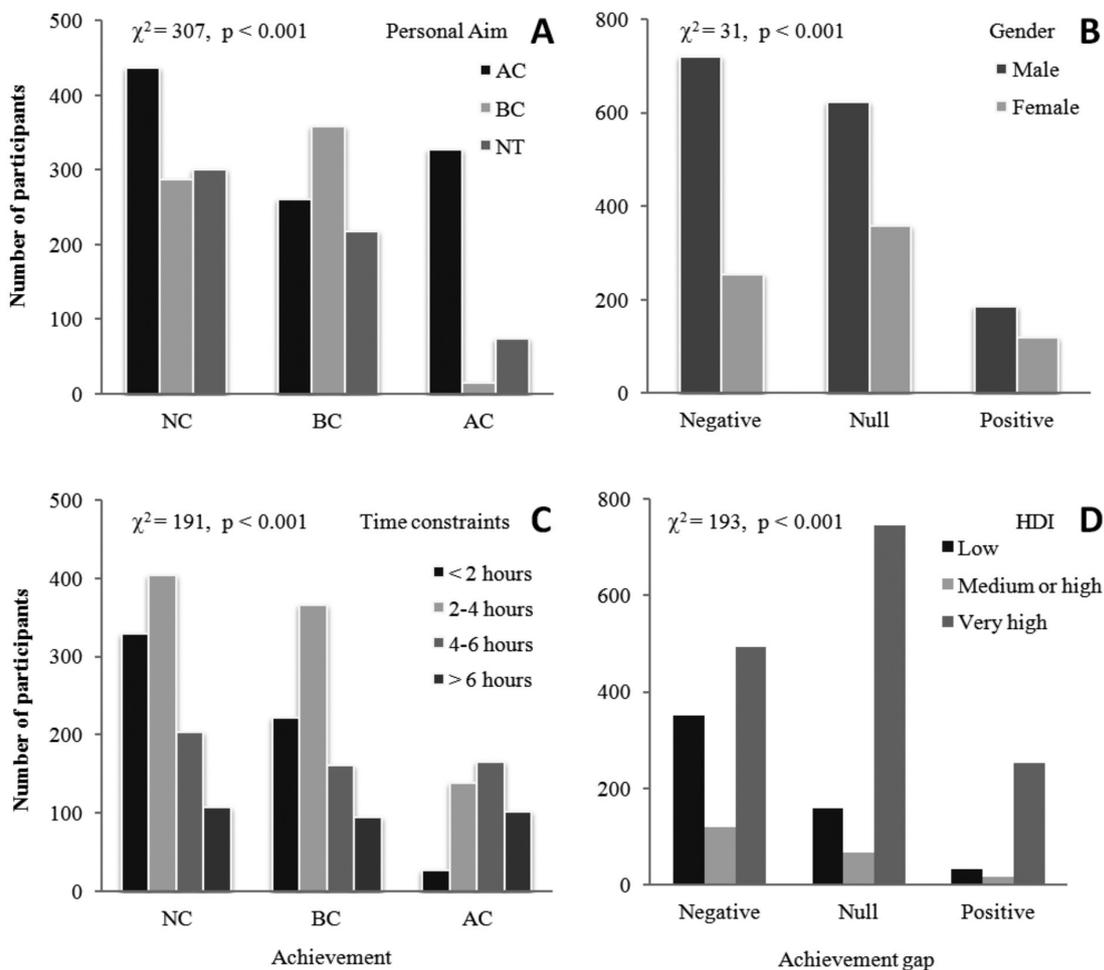


Figure 1 Understanding completion levels. NC : Non Completer, BC : Basic Certificate, AC: Advanced Certificate. Numbers represent chi-square test statistics. A. Personal aims and achievement, NT : No target or unsure B. Achievement gap and Gender C. Achievement and number of hours participants intended to spend weekly on the course when they filled in the survey D. Achievement gap and Human Development Index.

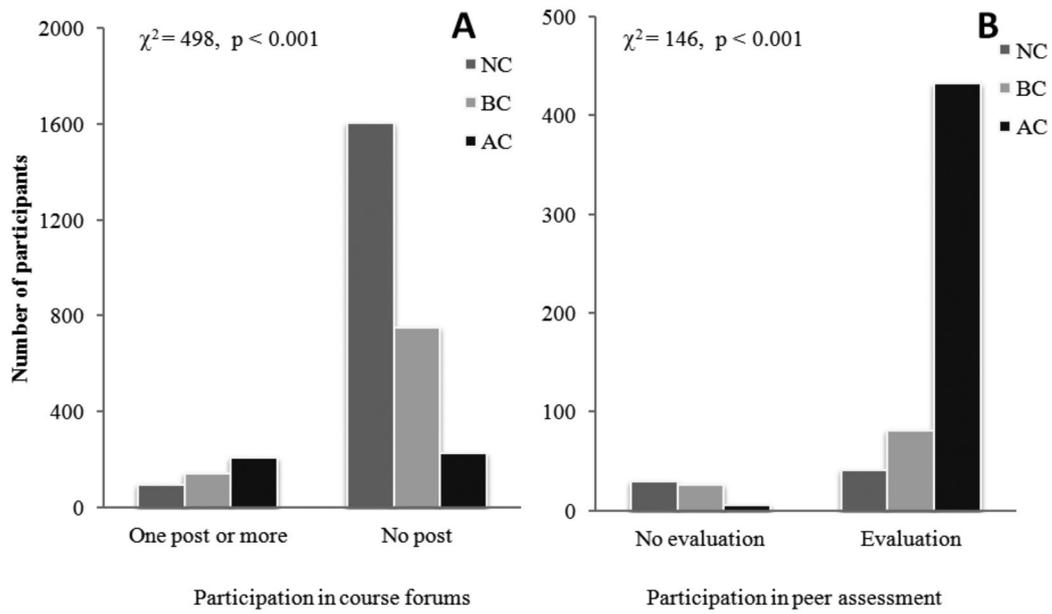


Figure 2 Simple indicators associated with completion levels. NC : Non Completer, BC : Basic Certificate, AC: Advanced Certificate. Numbers represent chi-square test statistics. A. Participation in course forums and completion levels B. Participation in the peer evaluation process and achievement, among participants who submitted at least one assessment.

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### Edition and production

Name of the publication: eLearning Papers  
ISSN: 1887-1542  
Publisher: elearningeuropa.info  
Edited by: P.A.U. Education, S.L.  
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Internet: [www.openeducationeuropa.eu/en/elearning\\_papers](http://www.openeducationeuropa.eu/en/elearning_papers)



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