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MOOC Monetization Changes and Completion Rates

Are Learners from Countries of Different Development Status Equally Affected?

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Massive Open Online Courses (MOOCs) offer online courses at low cost for anyone with an internet access. At its early days, the MOOC movement raised the flag of democratizing education, but soon enough, this utopian idea collided with the need to find sustainable business models. Moving from open access to a new financially sustainable certification and monetization policy in December 2015 we aim at this change-point and observe the completion rates before and after this monetary change. In this study we investigate the impact of the change on learners from countries of different development status. Our findings suggest that this change has lowered the completion rates among learners from developing countries, increasing gaps that already existed between global learners from countries of low and high development status. This suggests that more inclusive monetization policies may help MOOCs benefits to spread more equally among global learners.

1 Introduction

Massive Open Online Courses (MOOCs) offer online learning opportunities of specific subjects and are characterized by targeting the masses and by being open. While "open" may carry many meanings, we focus on one: being open to everyone with a computer and internet access [7]. This is in line with the United Nations Sustainable Development Goal number 4 (SDG4): "inclusive and equitable quality education [...] for all" [2].

However, in December 2015 edX announced that it will no longer offer free certificates[3]. We use this policy change as a temporal pivot for comparing its effect on completion rates (acquiring a certificate) on MITx MOOCs offered on edX.

Many MOOC platforms monetize by offering paid-for certificates and credentials. Defying the interpretation of open as free, MOOCs today experiment with various monetization models and monetize appeal to the audience of vocational training and employability-related skills-learning-MOOCs [7]. An interesting approach testing the effects of monetizing MOOCs is done in [6] looking at a large scale empirical setting of time, courses and learners, and examining MOOCs with learners that are diverse in their means to acquire a certificate. The results were inconclusive, and a free certificate increased the completion rate in one case but decreased it in the other. Another large-scale analysis of the effect of paying on engagement is [3], who showed a moderate increase in engagement of paying versus nonpaying learners. Engagement and course completion are not independent and positively associated.

We focus our attention on two groups of MOOC learners: a) non-native English speakers from developed countries; b) non-native English speakers from developing countries. Learners' demographics are inferred from the modal IP address from which the learners accessed the MOOC [9]. To measure the effect, we analyze the course completion odds ratio – a ratio of the completion proportions – among learners from the two groups and use it to define completion bias: the lesser odds to complete a course for learners from developing countries. Completion bias in MOOCs was observed in several studies, i.e. [1], and in this work we want to analyze if the policy change had an effect on this issue.

The change posed a modest financial barrier on the acquisition of a certificate. This action can make an impact going in three directions on the completion bias: a) decrease the completion bias due to increase in the motivation of learners to complete the course facilitated by the sunk cost fallacy [3]); b) increase the completion bias by posing a modest barrier which can be perceived as an unsurpassable obstacle to a learner from a developing country [6]; or c) have no effect at all, either by cancelling effects in opposing directions or by being indeed modest and insignificant.

1.1 Research Questions

To assess whether there is an impact to the change, and to shed some light on its nature, we define the following research questions (RQs):

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[3]https://blog.edx.org/news-about-edx-certificates

RQ1: Do we observe completion bias in course runs before the change?

RQ2: Is there a difference between the mean completion bias before and after the change?

RQ3: Is there a different impact of the change on the completion bias between different courses and accounting for runs of the same course?

2 Methods

Empirical setting: We look at all MITx edX course runs that were offered on the platform between 2014 and 2018, and satisfy the statistical assumptions regarding sample cell size, having all cell counts larger than five (a cell contains the number of learners that satisfy the conditions, e.g. non-native English speakers from a developing country that completed the course). This amounts to a total of 135 course runs of 83 different courses and 1.5 million viewers – i.e. users who accessed any of the course materials at least once. Under these conditions the log function of the completion bias is distributed normally and qualifies for the statistical methods used in this analysis.

Measuring bias: We use the completion odds ratio by development status to conceptualize bias in MOOCs. The odds are odds to complete a MOOC and the ratio is between learners belonging to one of the two following groups: a) learners accessing the course using an IP address associated with a developed country; b) learners accessing the course using an IP address associated with a developing country. To focus on development and control for language, course viewers who accessed the course using an IP address associated with a native English country are omitted from the analysis. We refer to native speakers as ones whose modal IP is assigned to one of the following countries: United States of America, Australia, Canada, Ireland, New-Zealand, United-Kingdom, Trinidad, and Tobago[4]. All native English-speaking countries are marked as high development status.

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[4]https://www.sheffield.ac.uk/international/english-speaking-countries

Completion odds is an equivalent measure of a learning achievement that is commonly used in MOOC research, defined as the completers-to-viewers ratio [4]. For convenience we specifically formulate these measures:

$$\text{completion rate} = \frac{\text{number of completers}}{\text{number of viewers}};$$

$$\text{completion odds} = \frac{\text{number of completers}}{\text{number of viewers} - \text{number of completers}}$$

Development is measured by "Human Development Index" (HDI) from the United Nations on a continuous scale [0,1], with a cutoff value 0.7 for defining a developing status below it and developed above, as is done in [5].

The data of learners studying in a MOOC have a unique dependence structure. Our observations are the MOOCs themselves, and the data of each MOOC are a preprocessed analysis of the completion proportions of learners in the MOOC. These MOOCs data include runs of the same or different courses. Different runs of the same course cannot be considered independent, simply because it is the same course, typically with similar or slightly modified content and structure. Hence, for comparisons between courses, we included only the first run of each course (for courses with several runs). We do however point out that focusing on first runs may have other implications since these runs tend to have higher enrollments, and more techno-pedagogic issues that are discovered only once the course is aired for the first time. These two issues are irrelevant to the statistical dependence matter yet should be considered in future research that uses similar methods.

The dataset of each RQ is as follows: RQ1) all course runs of MITx before the change, running in 2014 and 2015; RQ2) two datasets are used here: dataset a) all the MOOC runs offered by MITx from 2014 to 2018; and dataset b) only the first run of each of the MOOCs in dataset a); and RQ3) all the MOOC runs from 2014–2015 and their additional runs from 2016–2018. The entire course list for RQ1 and RQ3 is provided in Table 1 using **bold** and regular type, respectively.

3 Results

We look at all the MOOCs offered by MITx on edX before the change to establish the nature of the completion bias. The impact is first examined before the change to provide a baseline (RQ1). Then, assuming that all MOOC runs are independent observations due to the different learner's population, we examine the effect of the change on the mean value of the odds-ratio taking all the runs into account

Table 1: Course runs list of MITx collection offered on edX

Course Name	Course ID	Runs
Introduction to Biology – The Secret of Life	7.00x	**2014T2***
Introduction to Computer Science and Programming Using Python	6.00.1x	**2014T2**, **2014T3**, **2015T1**, **2015T2**, **2015T3**, 2016T1, 2016T2, 2016T3, 2017T1, 2017T2
Circuits and Electronics	6.002x.6x	**2015T1**
Advanced Introductory Classical Mechanics	8.MechCx	**2015T1**, **2015T2**, 2016T1
Mechanics ReView	8.MReVx	**2014T2**
Supply Chain and Logistics Fundamentals	CTL.SC1x	**2014T3**, **2015T2**, 2016T1, 2017T1, 2017T2
Supply Chain Design	CTL.SC2x	**2015T3**, 2016T2, 2017T1, 2017T3, 2018T1, 2018T3
* Bolded runs are before the change.		

(RQ2 dataset a). We also address the lack of true independence between MOOC runs and examine the change using only the first runs of the offered MOOC (RQ2 dataset b). Lastly, addressing the unique dependence structure in the data we look on runs of the same MOOCs and use analysis of variance to explore the impact of the change on these courses (RQ3).

RQ1: Do We Observe Completion Bias in Course Runs before the Change?

RQ1 data consist of 13 MOOCs offered on edX in 2014–2015 that present achievements of 336,108 viewers. Data of 2013 runs were not included in the analysis mainly due to data inconsistency and validity issues. The complete MOOC list is provided in Table 1 in the Methods section (the bolded runs).

The 13 runs were available and valid for the analysis of completion bias. We answer *yes* to RQ1 with a 95% confidence interval for the mean completion odds ratio on the platform of [1.37, 1.7] and with a mean value of 1.53 that is significantly different than 1, $t(12) = 8.69$, $p < .001$.

Based on these findings, we conclude that i) the development status and the completion odds are statistically dependent; and ii) the mean odds of a learner

from a developing country to complete a MOOC is 65% of the completion odds of a learner from a developed country on average and at most 73% with confidence of 95%. These results are qualitatively in line with previous findings [8].

RQ2: Is There a Difference between the Mean Completion Bias before and after the Change?

RQ2 data include the 13 courses examined on RQ1 and an addition of 122 more course runs of either completely new courses or of courses in their second or greater run (the full dataset, marked by a). A sum of 1,452,511 course viewers is analyzed. For the first run analysis, a subset of the above 135 courses is taken (dataset b), the MOOCs first runs, 7 before the change and 76 after, encompassing 699,673 viewers.

After establishing a baseline for the completion bias, we move to evaluate the impact of the change in the certification policy. Based on the entire dataset of available and valid MOOC runs we answer *yes, there is a difference, but...* to RQ2, and find that from a mean completion bias of 1.53 before the change to mean completion bias of 1.71 after. However, this difference is not statistically significant $(t(31.31) = 1.86, p = .072)$, hence the difference is descriptive in nature and provides insights only on the sample data. The values of the completion bias in all MITx edX MOOC runs (dataset a) are displayed in Figure 1 below, until the change in lighter color, and after the change, in darker color. In the figure, zero reflects completion odds that are identical in the two groups, and positive values reflect greater completion odds of learners from developed countries.

The insignificance result might be due to lack of treatment of the complex dependency structure described in the Methods section above. Thus, we validate the above result with a more fine-grained analysis, that compensates for this lack of independence by focusing on the first run of each course, dataset b. Establishing a baseline using only first runs, prior to the change there are seven courses with mean completion odds ratio of $M = 1.5$, $SD = 0.26$ statistically different than 1, $t(6) = 5.97$, $p < .001$. After the change started 76 MOOCs are offered for the first time with mean odds ratio of $M = 1.9$, $SD = 0.87$. This difference in the means of the distributions of before and after the change was found insignificant as well, with $t(18.17) = 1.85$, $p = .08$.

Based on these analyses, we conclude that the increase in the completion bias before and after the change is statistically insignificant.
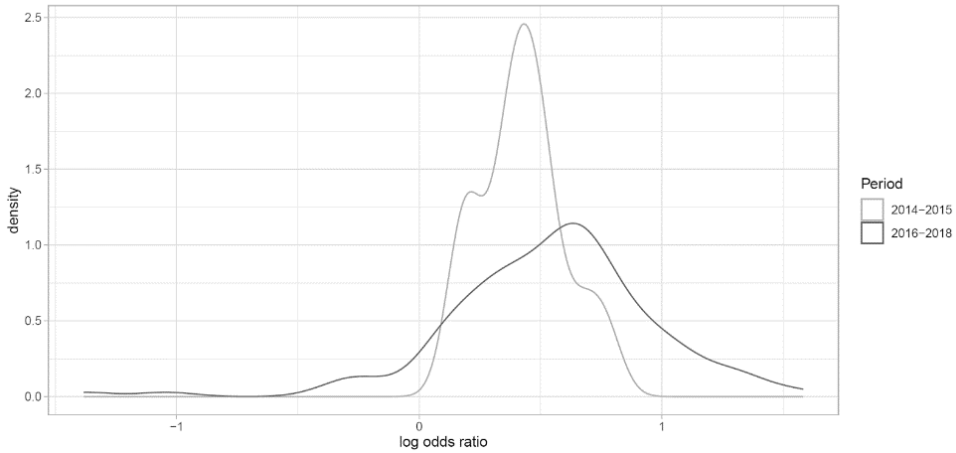
Figure 1: Distribution of completion bias in MITx MOOCs before and after the change

RQ3: Is There a Different Impact of the Change on the Completion Bias between Different Courses and Accounting for Runs of the Same Course?

Last, we focus our attention to courses offered before and after the change of policy, and ask what was the effect of the policy on the completion bias of these courses. A total of 27 course runs were analyzed for this question, detailed in Table 1, Methods section. The sum of viewers whose achievements are analyzed in this question is 659,497.

We located four MOOCs on edX MITx collection that were offered before and after the change: 6.00.1, 8.MechCx, CTL.SC1x, and CTL.SC2x. In addition to these, three more courses were offered only before the change: 6.002x.6x, 7.00x.2, 8.MReVx, and are included in the analysis for completeness and do not change the significance or meaning of the results. Different impact in courses means that the changes in the values of the odds ratio are different between different courses and before and after the change. The interaction of course and change should also be significant.

To analyze the effect, we conducted a two-way analysis of variance (2-way ANOVA) of the completion bias by course name and the change modeled as an indicator function for the change. This analysis reveals that only the change itself is significant in explaining the variability of the odds ratio with $F(1, 16) = 10.32$,

p < .001. The effects of the course and interaction between the factors are non-significant, with p > .26.

The interaction plot in Figure 2 reveals descriptive information on the mean completion odds ratios of the courses before and after the change.
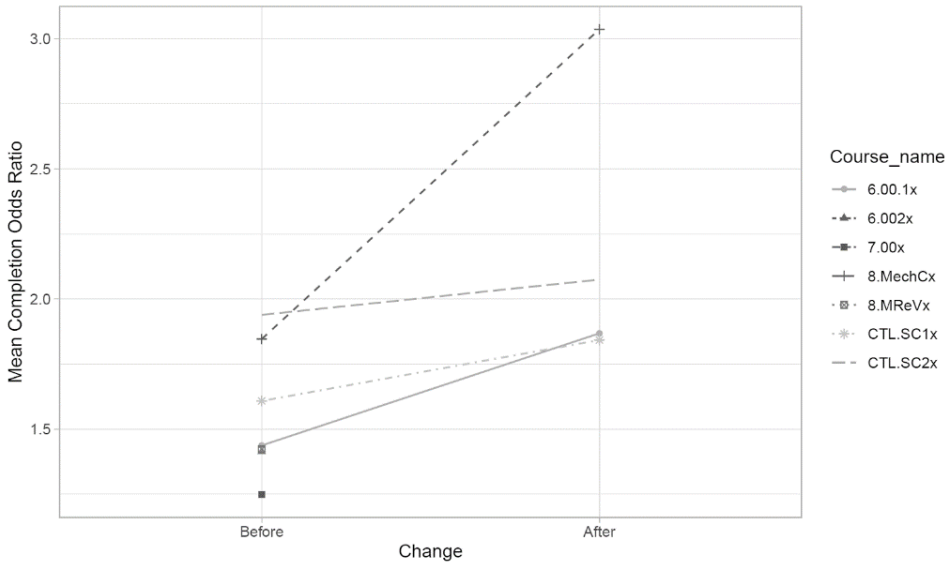

Figure 2: Interaction plot of completion odds ratio

We can clearly see the effect of the change on the four courses. For this purpose, we also looked at the values of the odds ratio over the years which are plotted in Figure 3. Qualitatively, we can see different change patterns in all the courses we examined. An overall growth in the odds ratio values is observed within each course along the years and trimesters.

To conclude, the analysis of RQ3 reveals that the change of certification policy is associated with an increase in the completion bias among learners from developing countries, meaning that their chances to complete the course decreased.
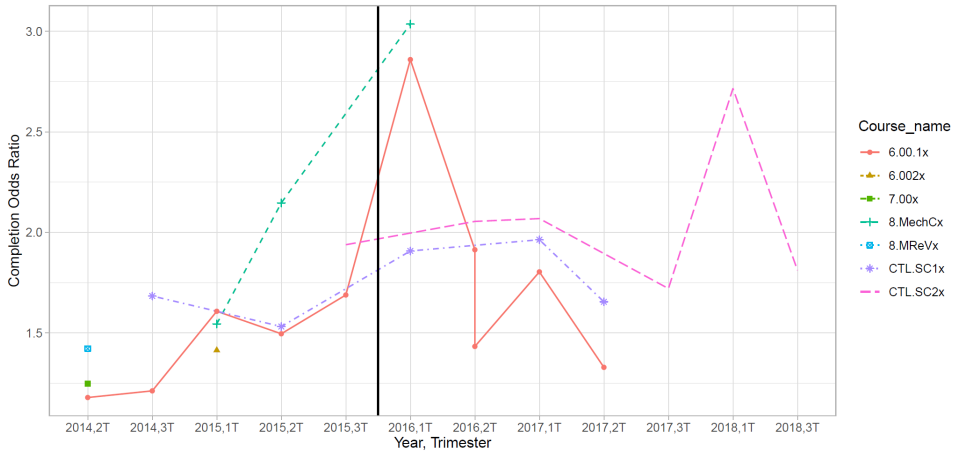
Figure 3: Completion odds ratio of consecutive runs

Summary of findings

Although there is inherently a completion bias present in learning in MOOCs, raising financial barriers has worsened the situation for learners from developing countries. Their chances to complete a MOOC are lower after the change. This effect is statistically insignificant in the entire dataset and in a partial dataset created to compensate for the dependence structure. In these courses, a significant increase in the completion bias is observed in all the courses being examined. The small number of courses (4) that are valid as input to this question can be considered important in explaining the lack of significance observed on the full dataset.

4 Conclusion

This research aimed to assess the impact of a monetary change cancelling free certificates on the MOOC platform edX in December 2015 on learners from developed and developing countries. This impact is assessed by examining the MOOC runs' completion odds for MITx courses. The research literature is inconclusive on this topic and our results help to clarify the situation to some extent. Indeed, we see that after the change of policy, the likelihood of learners from developing countries

to complete a MOOC decreased, compared to learners from developed countries, increasing a gap that was already significant before the change.

Combining these results with those of [6], we may suggest that if MOOC providers wish that the benefits of MOOCs would spread more evenly among global learners and to follow the path indicated by SDG4, a differential pricing and monetization policy may contribute to narrowing this observed gap leading to more inclusive online learning and instruction. As a methodological contribution, this research suggests a simple, yet powerful statistical methodology for comparing completion rates. Especially, the completion bias that this research defines may be used as a proxy for the level of "democratization" of MOOCs.

5 Acknowledgement

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