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A Tale of Two MOOCs: Analyzing Long-Term Course Dynamics

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Abstract: This paper discusses the evolution of learning engagement patterns and learners' profiles across sequential iterations in two MOOCs. Both courses were relatively stable over time from the demographic point of view, with punctual but notable variations. In both cases, registrants who completed the course tended to decrease in proportions over time as the proportion of bystanders increased, but they were nevertheless responsible for most of the course activity in terms of video consumption or quiz submission. We observed that the statistical associations between engagement in the course and learners' demographic variables were more acute in specific tracks, suggesting that the impact of sociocultural and socioeconomic variables on engagement patterns strongly depends on the context of the course.

Introduction

One of the most striking consequences of Massive Open Online Courses (MOOCs) openness (Daniel 2012) is undoubtedly the high heterogeneity of their registrants, whether we think in terms of socioeconomic status, sociocultural background, motivations, or behaviors (Ho et al. 2014). Their engagement patterns are as heterogeneous as their profiles, and the monolithic distinction between completers and dropouts is not necessarily appropriate to describe the diversity of situations (Kizilcec et al. 2013). Most of the time, a large proportion of registrants could still represent a significant part of the course activity despite the fact that they do not complete the course. While these questions have attracted considerable attention from researchers and practitioners lately, few studies have focused on the long-term evolutions of these learning engagement patterns in a given course (Anderson et al. 2014, Ho et al. 2014). Increasing attention is laid on the relationships between these engagement patterns, intentions (Campbell et al. 2014), or sociodemographic variables (Guo et al. 2014, Ho et al. 2014).

These questions are relevant to both course designers who would like to understand ongoing dynamics and wish to adapt course design accordingly (Grünewald et al. 2013), and to researchers who want to capture ongoing trends at a more global scale. In both cases, even comprehensive studies based on large numbers of MOOCs are limited by numerous confounding effects, as long as they rely solely on different courses. Indeed the comparison of MOOC dynamics is made difficult by the high heterogeneity in course structure and content, despite the multiplication of comprehensive studies (Adamopoulos 2013, Ho et al. 2014). In this paper, we analyzed two MOOCs that have been organized at least thrice, in an attempt to address the question of the evolution of learners' profiles and course dynamics over time. To what extent have engagement patterns and registrants profiles evolved across iterations, and most importantly, how has the relationship between learners' behavior and profiles evolved over time?

Courses description

The case studies we analyzed in this paper are a five weeks long entrepreneurship course called *Effectuation* (Professor Philippe Silberzahn, EMLYON Business School), which will thereafter be referred to as MOOC1, and a four weeks long project management course, *ABC de la Gestion de Projet* (Rémi Bachelet, Ecole Centrale Lille), which will thereafter referred to as MOOC2. Both were hosted by a MOOC agency which used the open source LMS Canvas from Instructure, with the notable exception of the first iteration of MOOC2, which was organized on Canvas.net, a different portal based on the same technology. Some data on video consumption were missing in this first edition of MOOC2. In the case of MOOC1, it was necessary to submit a peer evaluated mid-term assignment and to pass an exam to earn the certificate. In both courses, new course material including quizzes and half a dozen of short videos was made available every week. In MOOC2, two certificates were proposed, which both relied on quizzes and an exam. To get the advanced certificate, participants were required to submit weekly assignments; learners' artefacts were peer assessed. In both cases, variations among iterations were minor and were not reported in this paper. In MOOC2, survey design evolved after the second iteration and some questions were deleted or modified; some data are therefore missing. Course designers estimated that completing the course required fifteen to twenty-five hours for MOOC1, five to ten hours and thirty to forty hours for the basic and the advanced certificate of MOOC2, respectively.

Available Data

Student activity reports, gradebooks and survey responses were downloaded from the platform. Regarding video consumption, we used a proxy as we considered that the video had been viewed when the page where it was embedded was opened, regardless of the number of times this page was loaded. We manually removed from subsequent analyses the videos that were not part of the course strictly speaking, such as weekly introductions or tutorials. The global activity of the course was defined from the video perspective as the total number of views, without taking into account multiple views, and from the quiz perspective as the total number of submissions, without taking into account multiple submissions.

Participants were asked to fill in a survey at the beginning of the course; response rates ranged from 40 % to 60 % of enrollees. IP addresses were not collected; all available data on countries of residence come from these surveys; the Human Development Index of these countries were retrieved from U.N data (U.N. 2012). In both courses, the students who could gain credits by completing the course were excluded from our analyses since they were not strictly speaking following a self-directed learning approach. They represented a significant contingent in the case of MOOC2. Participants were categorized based on their level of engagement: those who obtained a certificate were called “completers”, those who submitted at least one quiz or assignment but did not complete the course were referred to as “disengaging learners”; those who did not submit any quiz or assignment were referred to as “auditing learners” if they had viewed at least 10% of available course videos, and bystanders (Anderson et al. 2014) if their fell below this threshold. We admit that the term “disengaging” is somehow debatable since submitting a quiz is not a strong engagement, but as was demonstrated in this paper and other reports (Ho et al. 2014), it is more engaging than just watching a video. Anonymized data was analyzed with the open source statistical software R 2.12.

Results

Evolution of learners profiles across iterations

The proportions of the different categories of learners evolved significantly over time (Table 1, Table 2). For instance, in the case of the MOOC1, the number of registrants decreased from 8,996 in the first iteration to 4,236 in the third one. The proportion of completers decreased from 27% to 20%, while bystanders increased from 42% to 50% of registrants; auditing and disengaging learners were stable around 7% and 25%, respectively (Table 2).

Table 1: Course demographics. Note that the percentages we reported were valid for survey respondents only.

%	MOOC1 V1	MOOC1 V2	MOOC1 V3	MOOC2 V1	MOOC2 V2	MOOC2 V3	MOOC2 V4
Women	40	36	35	32	36	39	42
Men	60	64	65	68	65	61	58
Lower management positions	10	9	11	13	17	16	16
Higher management positions	38	45	49	52	48	52	40
Jobseeker	12	12	14	14	11	14	15
Students	26	18	11	14	15	11	18
Others	14	16	15	7	9	7	11
HDI Low	13	10	10	24	22	19	18
HDI Intermediate	8	6	7	9	11	12	9
HDI Very High	79	84	83	67	67	69	73
Below 2h	56	52	52	25	31		
Between 2 to 4h	35	38	39	40	36		
Above 4h	9	10	9	35	33		
It is my first MOOC	73	70	48	91	87	92	82
I had completed at least a MOOC prior to registration	20	21	37		7	2	
I had registered in at least a MOOC but completed none	6	9	14	9	6	6	18

In the case of MOOC2, the number of registrants increased from 3,495 in the first iteration to 14,835 in the fourth iteration (Table 2). The proportion of “basic certificate earners”, “advanced certificate earners” and disengaging

learners decreased from 26 to 12%, 13 to 2%, and 35 to 23%, respectively. In the same amount of time, the proportion of auditing learners and of bystanders increased from 3 to 10% and 24 to 52%, respectively. Differences in participants categories between iterations were all statistically significant according to chi-square tests (p-value <0.001).

Table 2 Learners profiles across iterations. We represented the absolute numbers and the corresponding proportions in parenthesis; these percentages were computed relatively to the total number of registrants.

	MOOC1 V1	MOOC1 V2	MOOC1 V3	MOOC2 V1	MOOC2 V2	MOOC2 V3	MOOC2 V4
Enrollees	8996	4078	4236	3495	10268	12055	14835
Bystanders	3735	1805	2130	831	4823	5763	7781
(%)	(41.5)	(44.3)	(50.3)	(23.8)	(47.0)	(47.8)	(52.5)
Auditing registrants	587	302	311	97	131	254	1442
(%)	(6.5)	(7.4)	(7.3)	(2.8)	(1.3)	(2.1)	(9.7)
Disengaging	2219	1068	957	1235	2512	3846	3440
(%)	(24.7)	(26.2)	(22.6)	(35.3)	(24.5)	(31.9)	(23.2)
Completers (Basic)	2455	903	838	894	2195	1725	1831
(%)	(27.3)	(22.1)	(19.8)	(25.6)	(21.4)	(14.3)	(12.3)
Completers (Adv.)				438	607	467	341
(%)				(12.5)	(5.9)	(3.9)	(2.3)
Initial survey respondents	5385	2205	1693	2250	5257	7129	7008
(%)	(59.9)	(54.1)	(40.0)	(64.4)	(51.2)	(59.1)	(47.2)
Starting date	Nov. 2013	Apr. 2014	Nov. 2014	Mar. 2013	Oct. 2013	Mar. 2014	Nov. 2014

Course activity and engagement patterns

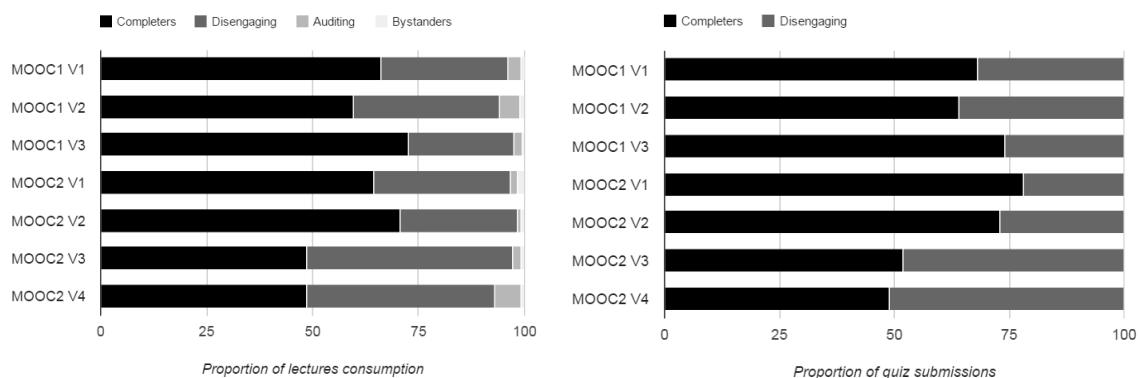


Figure 1. Proportion of the course activity for the different categories of learners (Completers, Disengaging and Auditing learners, or Bystanders) from the video consumption (Left) or the quiz submission (Right) perspectives

We then measured the share that the different categories of learners represented in the course activity. From the video consumption perspective, across all iterations of both MOOCs, bystanders and auditing learners represented a maximum of 1.5 and 6.2% of the course activity, respectively (Figure 1). Disengaging learners and completers represented up to 49%, and 73% of the course activity, respectively. Additionally, completers represented up to 74 and 78% of quiz submissions, in MOOC1 and MOOC2, respectively.

We then analyzed engagement patterns at a finer scale, for both disengaging and auditing learners (Figure 2). We focused on the proportions of videos that had been viewed and of the quizzes that had been submitted rather than on the last week or last day participants were active, and used deciles to fall in the conditions of validity of survival analyses. By doing so we wanted to avoid considering as similar, the participants who had watched all of the course videos and those who started the course on the last week but watched only a handful of videos. We reported the results in Figure 2 for MOOC1 only, since the results were very similar for MOOC2.

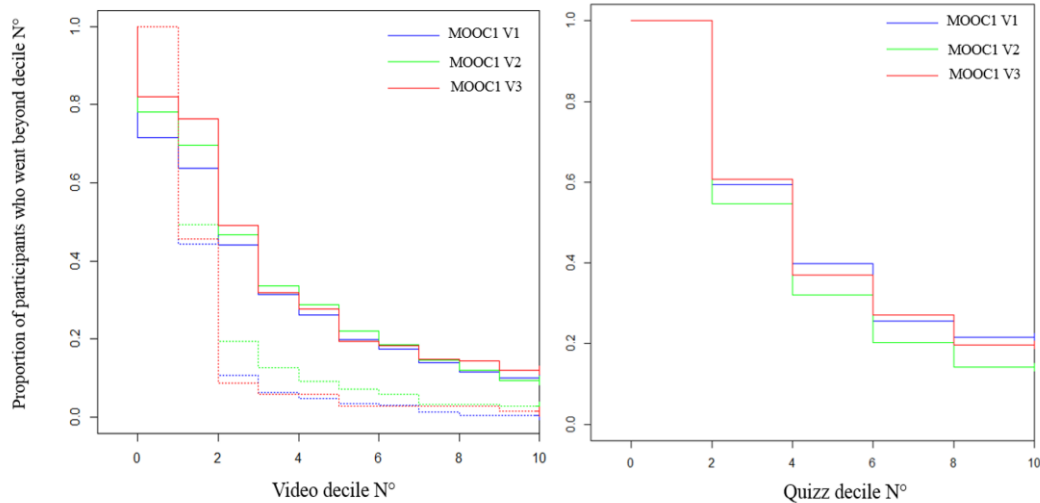


Figure 2. Video consumption (Left) and quiz submission (Right) behaviors in the three editions of MOOC1. Regarding video consumption behaviors, a distinction was made between disengaging learners who had submitted at least a quiz (plain lines) and auditing learners who had not submitted any quiz (dotted lines).

As far as video consumption was concerned, we could observe a clear distinction between disengaging learners who had submitted at least a quiz and auditing learners (Figure 2 Left). Across all three iterations, a maximum of 2.9% of auditing learners and a minimum of 9.4% of learners who had submitted a quiz or more watched all available course videos; the median survival time were the first decile for auditing learners, and the second decile for disengaging learners. Among auditing learners, the sharpest decline occurred between the first and the second decile, which is likely to correspond to the middle of the first week of the course. It suggests that almost all auditing learners, and most disengaging learners did not go beyond the first week. The differences in video consumption behaviors between disengaging and auditing learners were statistically significant in the three iterations of the course according to the survival analyses we carried out (Table 3).

Table 3: Differences in video consumption behavior between auditing and disengaging learners in the three iterations of MOOC1. *coef* stands for coefficient of the log-rank test, H.R stands for Hazard Ratio. The higher the coefficient, the lesser the amount of videos that have been viewed by auditing learners compared to disengaging ones.

	coef.	H.R.	se(coef.)	p-value
MOOC1 V1	0.58	1.78	0.06	$< 2.0 \cdot 10^{-16}$
MOOC1 V2	0.51	1.66	0.08	$2.0 \cdot 10^{-10}$
MOOC1 V3	0.84	2.33	0.14	$4.7 \cdot 10^{-10}$

We carried out log-rank tests to identify most impacting factors with regards to video consumption behaviors within these different categories of learners. Regarding auditing learners, we failed to detect any impacting factor; however, across all three iterations, we detected consistent differences between disengaging learners from more developed countries and those from least developed countries; the hazard ratios were equal to 0.40 (p-value $< 10^{-16}$), 0.53 (p-value = $3.9 \cdot 10^{-5}$), and 0.45 (p-value = $3.9 \cdot 10^{-5}$), for the first, second and third iteration, respectively. It suggests that disengaging learners from least developed countries tended to disengage more than twice faster than disengaging learners from more developed countries. As far as quizzes were concerned, around half of the disengaging learners who had submitted a quiz submitted at least another one (Figure 2 Right). The proportion of disengaging learners who did all quizzes ranged from 14 to 21%. In contrary to video consumption, we failed to detect any consistently impacting factor through survival analyses.

Identifying factors associated with course completion

In a previous analysis of the first iteration of MOOC2 (Cisel 2014), we had shown that completers differed significantly from auditing participants by their socio-economic status, and by the HDI of their country of residence, among other parameters. We first studied the evolutions of socioeconomic and sociocultural characteristics of survey respondents across the different iterations of the two MOOCs (Table 1) and

then focused on the relationship between learners' profiles and their engagement in the course in order to identify the most impacting factors. We reported the odd-ratios of the corresponding logistic regression in Table 4.

Table 4: Identification of factors influencing course completion in the different iterations of MOOC1 and MOOC2. Numbers represent odd-ratios (O.R) of a logistic regression. For instance, an O.R of 2 means that the completion rate for this category was twice the completion rate of the reference (Ref). In MOOC2, a distinction was made between the two certificates (Ba. : Basic certificate, Adv. : Advanced certificate). p-value < 0.05 : *, p-value < 0.01 : **, p-value < 0.001 : ***

	MOOC1			MOOC2 V1		MOOC2 V2		MOOC2 V3		MOOC2 V4	
	V1	V2	V3	Ba.	Adv.	Ba.	Adv.	Ba.	Adv.	Ba.	Adv.
Women		Ref.									
Men	1.11	0.98	0.99	0.91	1.02	0.95	1.07	0.99	1.32*	0.93	1.50***
Low management positions		Ref.									
Higher management positions	0.99	0.87	1.66*	1.01	1.50*	0.87	1.97***	0.95	1.23	1.10	1.75*
Jobseeker	0.98	0.77	1.54	1.07	1.42	0.79*	1.47*	1.11	1.69*	1.04	2.38***
Students	1.25*	0.71	2.33***	1.26	0.97	1.06	1.22	0.68**	0.28**	1.19	1.09
Others	0.76	0.73	1.68*	0.93	1.31	0.83	1.22	0.79	0.90	0.89	1.44
HDI Low		Ref.									
HDI Intermediate	0.85	0.87	0.68	0.67*	1.72*	1.24	1.75**	1.12	2.08*	1.40*	0.76
HDI Very High	1.22*	1.57	0.61*	1.24	3.43***	1.95***	3.19***	2.76***	4.89***	2.06***	1.83**
Belowe 2h		Ref.									
Between 2 to 4h	1.51***	1.48***	1.76***	1.38**	3.93***	1.16	2.46***				
Above 4h	1.75***	1.54**	2.02***	1.37*	12.7***	1.15	7.56***				
It is my first MOOC		Ref.									
I had completed at least a MOOC prior to registration	0.96	0.97	0.62***			0.54***	1.24	1.32	1.32		
I had registered in at least a MOOC but completed none	0.60***	0.62**	0.45***			0.70*	0.89	0.56***	0.70		

Some characteristics evolved significantly over time. For instance, we observed that over the three iterations of MOOC1, the proportion of students decreased from 26% to 11%, and that the proportion of participants who had not followed a MOOC prior to the course decreased from 73% to 48% (Table 1). There were also significant differences among the two courses regarding the amount of time that participants were willing to invest in the course. Only 10% of the respondents of MOOC1, at most, were willing to invest more than four hours a week, whereas they were at least 36% in MOOC2. This parameter was strongly associated with completion rates, especially for the advanced certificate of MOOC2. In the second iteration of MOOC2, completion rates were up to twelve times higher among those who wanted to invest more than four hours a week than among those who declared they were willing to invest less than two hours a week. They were also usually lower among respondents that had followed a MOOC prior to the course, but without completing it. We failed to detect consistent trends regarding socioeconomic status, except for MOOC2 advanced certificate, where respondents with higher management positions and job seekers tended to perform better. Additionally, respondents from more developed countries usually showed higher completion rates more than those from least developed countries in MOOC2, a trend that we could not detect in MOOC1.

Discussion

The two MOOCs followed strikingly different trajectories in terms of numbers of registrants; contrary to MOOC1, the number of registrants of MOOC2 increased sharply, especially over the first iterations. Quantitative and qualitative differences among courses' potential audiences may be responsible for such differences. A management course with no prerequisites may target a larger audience than an entrepreneurship course. Consequently, the pool of potential learners may remain larger for a longer time than in the case of a more specialized course. However, comparisons with other courses in the same situation should be done to validate this hypothesis; indeed, other processes such as marketing around the courses could be at stake, as the professors in charge suggested, communication strategies differed significantly across iterations.

From the learning engagement perspective, certification rates tended to decrease as was observed in Introduction to Solid State Chemistry (Ho et al. 2014). In the management course (MOOC2), the core of most engaged participants slightly decreased as the number of enrollees was increasing. This relative decline in the advanced track was striking, with a six-fold decrease in the proportion of advanced certificate earners. We believe

that the first iteration of a course attracts proportionally more engaged participants than following iterations, maybe because people eager to learn a topic are rather proactive; it is likely that these learners are aware of the launch of the course from the first iteration and consequently register sooner than less motivated learners; consequently, their share decreases across iterations.

In both courses, the proportion of bystanders rose over time, a trend that was also observed in the Probabilistic Graph Model course (Anderson et al. 2014). At a global level, the proportion of early-adopters, likely to be motivated participants, has logically decreased as MOOCs were expanding their audiences. At the same time, we observed a sharp increase in the proportion of registrants who had already completed at least one MOOC prior to registering to the courses. However, the impact of this experience on engagement in the course is not clear. One may expect that participants with more experience in online learning are more likely to complete the course, but we generally observed quite the opposite. We believe that sampling behaviors that were detected within courses (Kizilcec et al. 2013) are probably transposable at a larger scale, and that a significant proportion of learners register to more courses than they can afford to follow given their time constraints. Given the sampling bias, this proportion is likely to be way higher than what was reported in the course statistics; indeed, these learners are probably among bystanders, a category of learner that is unlikely to respond to our surveys and that we consequently do not know very well.

Despite the fact that they always represented a minority, disengaging learners had a non neglectable share in the course activity by completers were responsible for most of it, from both the video and the quizzes perspectives. Consequently, one should be cautious when comparing different MOOCs or different iterations of a given MOOC from the audience perspective; the mere number of registrants is an unreliable indicator, likely to be driven by fluctuations in the number of bystanders. Even when the number of registrants is important, most of the course activity is actually driven by the core nucleus of highly engaged learners, which represents a rather small proportion of the audience. Indeed, auditing and disengaging learners tend to dropout very quickly, mostly before the end of the first week for the former and before the end of the second week for the latter, a pattern consistent with what was reported by Ho et al (2014), among others. These patterns are likely to be course-dependent. For instance, in a video-intensive MOOC with little or very complicated activities, the proportion of highly engaged auditing learners may be higher than what we observed in our two case studies.

The different categories of participants were relatively stable across iterations from the sociocultural and the socioeconomic perspectives, as was often reported (Ho et al. 2014). In both MOOCs, a significant proportion of learners were already registered in previous iterations of the course (data not shown) and had come back most probably because they had failed to engage as much as they would have liked in the first place. Nevertheless, this proportion always fell below 10% and the phenomenon of multiple registrations is unlikely to be responsible for stability in course demographics. We observed punctual but significant variations in the proportions of students for instance. Since those proportions did not vary in the same directions, it is unlikely that these variations reflected a growing or a decreasing interest of French students for MOOCs. They were probably linked to communication strategies around the course; this illustrates the sensitivity of course demographics to recruitment strategies, especially for MOOCs with a limited audience.

Interestingly, the impact of characteristics such as socioeconomic status or country of residence on completion rates was revealed mainly in the most demanding track of the management course, a result we had already observed in the first iterations of MOOC2 (Cisel 2014, Cisel 2014b). We also detected the influence of geographical origin at finer scales, in video consumption behaviors for instance. Lower completion rates in least developed countries have repeatedly been reported (Ho et al. 2014), which is consistent with our results. Technical issues such as low bandwidth may be at stake, but further investigations would be needed to get a better understanding of this phenomenon. Similarly we should investigate why registrants with higher management positions and jobseekers were relatively more engaged than others in the most demanding tracks. Such a phenomenon could be linked with the nature of the course. An advanced certificate from a practical management course could have more value on the labor market than a certificate from an entrepreneurship course, and therefore constitute a stronger motivation for specific categories of learners.

Finally, the amount of time participants were willing to invest in the course was the best predictor of course completion, especially for the track involving a heavy workload. This result suggests that self-declared data about learners' intentions (Campbell et al. 2014) could be used along with predictive algorithms (Halawa et al. 2014) to enhance our ability to identify potential dropouts. It is indeed important to make the distinction between the different categories of dropouts, and especially voluntary withdrawal, if we are to tailor pedagogical responses accordingly. Interestingly, this parameter was one of the main differences between the two courses, with many more learners in MOOC2 who were willing to invest more than four hours a week in the course. This suggests that certain courses attract learners with higher levels of engagement, or that learners willing to obtain the certificate adapt their time schedule according to their objective, whatever the required workload.

Analyzing the different iterations of a given course could provide valuable insights into the evolutions of MOOCs audience and dynamics on the long-term, at a global level or at the course level. In that purpose, we need to design comprehensive studies focused on these long-term dynamics. In that purpose, standardization

efforts in survey design need to go beyond questions about motivations to register (Schneider & Kizilcec 2014), and should also focus on parameters such as time constraints, MOOC consumption behavior, and most importantly on learners' intentions. Importantly, cross-correlations between survey and log data should be more systematic; common identifiers are often absent from datasets, impeding interesting discoveries.

In response to recurrent criticism against MOOC low completion rates, some major figures have claimed that many registrants benefit from these courses despite the fact that they do not obtain a certificate. This assumption is quite debatable, since exploring a fraction of the available course material is unlikely to bring valuable learning outcomes. Millions of accounts have indeed been created on platforms such as Coursera or edX over the past two years, but it is likely that most of the MOOC movement is driven by a core of a few hundreds thousands of learners. However, even if it seems that this nucleus is mainly composed of educated people from the most developed countries, its characteristics and its evolutions are not known well yet. To what extent is it renewed by the arrival of new learners? Are we witnessing the apparition of professional learners, always following at least a MOOC in one of the many platforms that have appeared lately? Or do these addict learners represent a minority? In order to tackle these issues, increasingly numerous studies on completion rates will not suffice; we need to design comprehensive studies that go beyond the course level and probably beyond the platform level. One should not be blinded by the impressive amount of enrollments; we still need to assess whether we are facing an increasingly global phenomenon, or merely the constitution of a relatively small community or self-regulated learners.

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