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Contents

What Drives Enrollment in Massive Open Online Courses?

Evidences from a French MOOC Platform

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The goal of this paper is to study the demand factors driving enrollment in massive open online courses. Using course level data from a French MOOC platform, we study the course, teacher and institution related characteristics that influence the enrollment decision of students, in a setting where enrollment is open to all students without administrative barriers. Coverage from social and traditional media done around the course is a key driver. In addition, the language of instruction and the (estimated) amount of work needed to complete the course also have a significant impact. The data also suggests that the presence of same-side externalities is limited. Finally, preferences of national and of international students tend to differ on several dimensions.

1 Introduction

Massive open online courses platforms provide to higher education institutions a place where they can interact with students by providing them online courses. To date, various platforms have enrolled several million students, numbers which are rarely heard in the higher education context. They offer an unusual setting to understand the behavior of students with respect to various aspects of their learning decisions in an online context.

Economically-speaking, one key peculiarity of MOOCs is that they can be defined as global public goods [12]. Thanks to online technology that limits congestion, the "consumption" of the course by one student does not negatively impact the "consumption" possibility of other students. Courses are designed such that feedbacks to students throughout their learning experience take place via automatically- or peer-graded assessments or via interactive *Q&A* video sessions [17]. Hence, MOOCs have the property of being non-rival in consumption. They are also non-excludable for two reasons. First, digitization eliminates the issue of capacity constraint prevalent in traditional higher education programs due to the limited physical size of classrooms. As a consequence, enrolling an additional student online has a marginal cost equal to zero. Second, MOOC platforms have committed to remain open, as attested by the second "O" of the MOOC acronym.[1] Courses can be accessed free of charge and students may not be excluded from them following a selection procedure.

Hence, it is not just because they take place online and that they are free that set MOOCs apart from traditional programs. Openness is also a defining feature, as translated in the student allocation mechanism to courses. Traditional programs are relying on two-sided allocation technologies. Students do not only have to apply to enroll a program but they also have to be accepted by the school side. This last stage takes place in various forms, sometimes in a decentralized way or via a procedure common to various programs (see for example [1]). To be accepted, students might be required to pass some (centralized) exam or to fulfill some more or less specific criteria. Instead, MOOCs use a one-sided allocation mechanism, where students can unilaterally decide to enroll or not. In addition, educational programs are unbundled and the student's enrollment decision takes place on a course per course base.

The goal of this paper is to study three issues. First, the determinants of enrollment in courses organized online and open to anyone for free and without administrative requirements are analyzed. Thank to this analysis, we are able to know more about why some of these global public goods attract more beneficiaries than others. Second, we look at whether the preferences of French and international students differ, as in this setting they are not discriminated by administrative procedures or by the distance that separates them from the institution providing the course. Finally, the timing of the launch of the first run of the course and its impact on enrollment is analyzed. For this purpose, we analyze, by the mean of a multivariate regression approach, course level enrollment data from FUN (for France Université Numérique), a French MOOC platform, using data covering all the MOOCs launched during its first four years of existence.

First of all, we find that (social and traditional) media coverage of the MOOC is a key driver of enrollment for both national and international students. This result suggests the importance of well-designed media campaigns organized by the institution providing the MOOC in order to inform potential students as a way to increase enrollment. Second, course related factors tend to have an impact on enrollment but factors related to the teacher of the MOOC or to his/her host institution have a more limited influence. Among others, the instructional language,

[1] Over the recent years, some platforms like Edx and Coursera have limited the access to some of the content of their courses (quizzes, access to forum, certificate of completion, etc.). However, there still remains some content open to all users, without paying.

the possibility to pay to obtain a certificate of completion and the expected amount of work required to finish the course all have a positive and significant impact on enrollment. French students tend to differ from international ones on several dimensions. For example, they prefer courses taught in French, while international students rather enroll courses taught by scholars from foreign institutions. Finally, this analysis does not confirm the existence of (positive or negative) same-side externalities, as enrollment is not impacted by the launch of other courses at the same time.

After a presentation of the literature in section 2, the methodology used is presented in section 3. The results of the empirical analysis are presented in section 4. section 5 concludes.

2 Literature Review

Distance education has recently made a comeback under the spotlight of the economics literature, thanks mostly to the emergence of MOOCs (see [4, 6], for reviews of the phenomenon). Two questions have been central in the literature so far. The first concerns whether online educational programs provide a good alternative to their brick-and-mortar version in terms of student learning outcomes [3]. The second analyzes the reasons why higher education institutions decide to innovate by organizing online programs [5].

There is a large literature in the field of economics of education studying the factors driving enrollment decision in non-compulsory tertiary education which is more closely related to the research question of this paper. A first strand of the literature has analyzed the demand for higher education programs by looking at the role of fees and of financial aid (see for example [11]). Others as reviewed in Ehrenberg [7] have rather looked at the role of proximity between students and the higher education institutions using gravity models. How students are allocated to higher education institutions and questions related to the impact of the application procedure on enrollment is a question that has also recently attracted a lot of attention. One key feature of this setting is that neither the tuition expenditure, nor the transport cost nor the selection procedure plays a role in determining the students' demand as courses are free, take place online and are open to all after the few clicks required to log in.

Hence, this paper is closely linked to the literature analyzing the demand for online educational programs. For example, Ortagus and Yang [15] study the impact of decreasing state funding on the enrollment of students in online programs provided by U.S. public universities. In another work, Goodman, Melkers, and Pallais [8] study whether providing in parallel an online and an in-class version of a program can boost the enrollment in the latter. These two works have the peculiarity that, despite taking place online, students need to be selected to attend the program and to pay a tuition fee. Closer to us, Tong and Li [19] evaluate the factors impacting the demand for Massive Open Online Courses using cross-sectional data of OECD countries and China. Due to the absence of aggregate enrollment data at the country level, they construct indices using various sources from the internet to proxy the evolving demand for MOOCs. They observe that the quality of the broadband connection and the level of unemployment are key drivers of this demand.

One key distinguishing feature of this approach is that we are looking at the demand for online courses, using course level data rather than usual program or institution level data, as courses are offered in an unbundled format.[2] Hence, we can look at other additional factors related to the course and his/her teacher. To our knowledge, there are few papers with access to this kind of proprietary data.[3] Hansen and Reich [9] and Ruiperez-Valiente, Halawa, Slama, and Reich [18] are notable exceptions. Using data from 68 MOOCs launched by Harvard and MIT, Hansen and Reich [9] study the background characteristics of enrollees and their influences on student dropout. They find that student's socioeconomic status play a central role in explaining gaps in educational outcomes. Ruiperez-Valiente, Halawa, Slama, and Reich [18] analyze and compare data from Edx, a U.S. MOOC platform jointly launched by Harvard and MIT, and Edraak, a MOOC platform targeting students located in Arab countries, to study whether student's preferences differ from one platform to the other. The authors observe that younger and less educated learners tend to enroll the Edraak platform. These papers have in common that they focus on correlations linked with the enrollment of students. Using a multiple regression analysis, we aim at obtaining more robust measures of controlled correlations by taking into consideration the presence of various omitted variables, i.e. variables both related to our dependent and independent variables, that would lead to otherwise biased estimates. In addition, we do not focus on a sample of courses provided by some institutions on a MOOC platform but on all the courses provided on the platform during its first years of existence.

[2] Remark that enrollment must not be confused with a learning outcome, it is a required step to pursue a training on a MOOC platform. Hence, it can be seen as a key signal of the student's willingness to learn, even if many of them are only there to sample a part of the course.

[3] Using course level data from brick-and-mortar courses, Budish and Cantillon study the course allocation mechanism in place in Harvard where a draft mechanism allocates students to seats available due to the limited capacities of classes. This analysis departs from this approach as in this setting there is no limitation and no administrative barrier to the number of students enrolling the MOOC. Hence, there is no need to develop a market design for this allocation problem.

3 Methodology

3.1 Context

This empirical analysis is based on proprietary data from FUN, a French MOOC platform. This platform was launched jointly by a consortium of French universities and the French government. It is built upon the Open Edx software. As of 2020, it has enrolled in total more than 6 million students in its various courses. The data is organized at the course-level. Courses aired first online from January 2014, the launch of the platform, to November 2017 are included in this sample. Only data about the first run of the course taught is considered. In total, the final sample includes 284 different courses. This information is completed by data gathered from each of the course webpages available on the FUN platform and various additional sources such as Scopus, the Shanghai University's Academic Ranking of World Universities (better known as the Shanghai ranking) and the Europresse database. Descriptive statistics are shown in Table 1.

3.2 Measures

The main dependent variable is total enrollment. It is the number of students who have subscribed to the first organized run of the course. As pictured on Figure 1, we observe that the distribution is skewed to the right. In addition to be also able to interpret the coefficients, this variable is log transformed. Next, data about the origin of the students is used, i.e. whether they are French or international students. This information is collected via FUN, when subscribing to the platform. Unfortunately, only a minority of students mention this information. National and international enrollments are extrapolated assuming that they form the same share of the student course attendance as the one that has filled in this question of the survey.

Independent variables are grouped into four separate categories: Course, teacher, institution related and other factors. The topic of the course is considered in this analysis by the mean of four binary variables: *Mgmt and law*, *humanities*, *STEM* and *health*, the last being the reference category. They are included as the popularity of the course is likely to be related to the topic being presented. If instead the course categories are refined in 10 categories, the results remain the same. *Sequel* is the number of times the course was taught, whether with similar or additional content but with the same course title. This variable is similar to the one used in the economic literature on movies [13]. A higher value can be interpreted as a measure available *ex-post* of the success of the MOOC, as if the teaching team

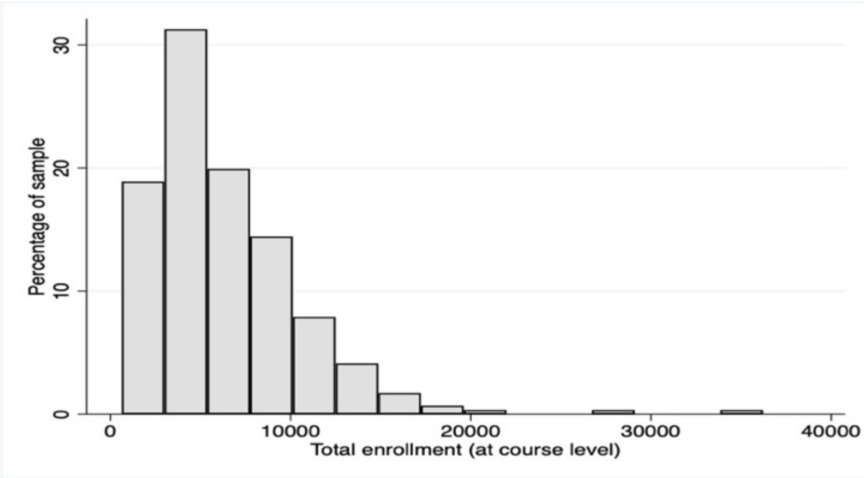

Figure 1: Distribution of the total enrollment of students MOOCs

had a bad MOOC experience they would not organize additional sequels.[4] *Work* is the estimated amount of hours needed to fulfill the course requirement, as advertised on the course webpage. This variable can be seen as a proxy of the depth of the course. *Prerequisite* is a binary variable whether an informally required prerequisite is stated on the course webpage, even if there is whatsoever no control of their fulfillments at the enrollment stage. As they can put off some students from enrolling, it is likely to drive down enrollment. The presence of a *paid certificate*, represented via a binary variable in this analysis, can attract some students, as they might think that some employers value this information signal on their CV. Only 5% of the courses provide this possibility. *Grading* is a binary equal to one if the course grading system is based on more than multiple choice questions. Using problem sets or essays graded by fellow students or valuing the participation to forum discussions can be seen as a proxy of the teachers' pedagogical investment, which can be valued by students at the time of their enrollment decision. *French* is a binary whether the course is taught in French. As more than three fourth of the students are French and 94% of the courses are taught in French, it can be expected to have a positive coefficient.

[4] Remark that this variable can potentially be interpreted as a bad control as the decision to put up a sequel can depend on the success of the initial course, as measured by enrollment figures. However, not including this variable in this model does not impact the quality of these results.

Tenured teacher is a first teacher-related factor included in the model.[5] It is a binary variable equal to one if the main teacher of the course is a full or an associate professor from a higher education institution. *MOOC experience* is a binary equal to one if the main teacher of the MOOC has had beforehand an experience teaching a MOOC. It is the case for one fourth of the courses provided on FUN. *MOOC experience* can be seen as a proxy of the experience of the teacher with this format of learning practice. As obtained via Scopus, *H-index* is a measure of the reputation within the scientific community of the teacher of the course. This variable can be seen as a way to test whether "superstar" researchers are more able to cater students to enroll their courses. The Hirsch index is defined as the number of publications x that have ever been cited at least x times.

Four institution-related independent variables are also included. *University* and *Grande Ecole* are two binary variables, the latter being French public higher education institutions traditionally allowed to select students based on their abilities at the entrance of their traditional programs. Note that the reference category is an heterogeneous group of private higher institutions, not-for-profit organizations, government and administrative bodies. As 4% of the courses are provided by institutions based outside of France, we control for this with a binary called *foreign institution*. Finally, we control for the international prestige of the institution using its ranking in the Shanghai University's Academic Ranking of World Universities. *Ranking* is the ranking of the year 2018 and, to facilitate the interpretation of the sign of the parameter, we subtract the rank of the institution from 1000, which corresponds to the last ranked institution. We also take the log of ranking. This variable will allow us to test whether MOOCs hosted by prestigious institutions tend to enroll more students.

In addition, we control for two variables related with the communication campaigns made around the course: *Twitter* and *Media coverage*. The first is a binary variable whether there is a Twitter profile associated with the course in order to communicate about it. The second variable measures the number of times the course was mentioned on the Europresse database, a database covering most French and international newspapers and magazines.[6] As it is highly skewed, we take the logarithm of the number of times the course was mentioned, plus one unit due to the presence of zeros. We also include a monthly time trend in order to take into consideration the increasing affiliation of students across the first

[5]For these factors, we take into account the main teacher of the course, identified as the person in charge of it. If not explicitly assigned on the course webpage of the FUN platform, the one cited on the top of the list is taken into consideration and, if this list is in alphabetical order, we take the first appearing in the trailer of the MOOC.

[6]If we instead use appearances in Google News, we end up with a variable that is highly correlated with the one we use. We also obtain very similar results using this source to proxy the media exposure of the MOOC.

47 months of the existence of the MOOC platform. Finally, we study the impact of the timing of the course launch on enrollment using two approaches. First, we consider monthly binary variables, using the month of November as a reference category as it is the one with the highest number of course launched. Then we control for the number of courses launched on the platform with a three-month window around the course considered. This approach will help characterize the same-side/within group externality on the content-provider side of the platform. If this externality is negative, it means that course compete one with another while if it is positive, launching a course at the same time as other courses is a good thing for your own enrollment. We define in three different ways the number of courses: the total number of MOOCs, the number of MOOCs on the same theme and the number of MOOCs taught in the same discipline. FUN does not play an editorial role in selecting the courses aired on its platform and it takes at best 6 to 12 months to repurpose a course to the MOOC format [10]). Hence, the decision to launch a course is as good as exogenous from the starting time of other courses. Summary statistics are presented in Table 1.

Table 1: Summary statistics

N = 284	Mean	Standard Deviation	Min	Max
Dependent variables:				
Total enrollment	6 397.10	4 205.76	629.00	36 217
National enrollment	4 446.21	3 194.71	361.15	27 592
International enrollment	1 950.89	1 485.69	127.18	9 607
Course related independent variables:				
Humanities	0.24	0.43	0	1
Mgmt and law	0.24	0.43	0	1
STEM	0.42	0.49	0	1
Health	0.10	0.30	0	1
Sequel	2.41	1.46	1	11
Work	17.75	9.20	1.5	59.5
Prerequesite	0.52	0.50	0	1
Paid certificate	0.05	0.22	0	1
Grading	0.24	0.43	0	1
French	0.94	0.24	0	1
Teacher related independent variables:				
Tenured teacher	0.70	0.46	0	1
MOOC experience	0.25	0.44	0	1
H-index	9.10	13.45	0	82

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Summary statistics (cont.)

N = 284	Mean	Standard Deviation	Min	Max
Institution related independent variables:				
University	0.48	0.50	0	1
Grande Ecole	0.31	0.46	0	1
Foreign Institution	0.04	0.20	0	1
Ranking (log)	2.32	3.09	0	6.87
Twitter	0.39	0.49	0	1
Media coverage (log)	0.63	0.80	0	3.58
Monthly time-trend	27.17	13.24	1	47
# of MOOCs (total)	22.47	7.74	1	36
# of MOOCs (theme)	3.23	1.74	1	8
# of MOOCs (discipline)	7.25	4.17	1	19

3.3 Proposed Approach

For this multiple regression analysis, Ordinary Least Square (OLS) estimators are computed on this sample of 284 courses using the software STATA. Due to the skewness of the enrollment data and the presence of outliers, we apply a log transformation of this dependent variables. Multicollinearity leads to unstable and unreliable estimates. However, the computation of the Variance Inflation Factor (VIF) values show no reason to suspect it is an issue in our analysis. We present heteroskedasticity-robust standard errors. Overall, these coefficients should be analyzed with caution, as controlled correlations rather than causal implications.

4 Results

In order to analyze these results, we proceed in two steps. First, we will analyze the drivers of total enrollment, as shown in regression (1) in Table 2. Second, we will look at whether the factors affecting the enrollment of French students differ from the ones of international students, as respectively shown in regression (2) and (3). Finally, in regression (4) to (9) shown in Table 3, we study the issue of the timing of the launch of the course.

Table 2: Results (1): The drivers of total, national and international enrollment

Dependent variable:	(1)	(2)	(3)
Enrollment	Total	National	International
Mgmt and law	−0.035 (0.1)	−0.027 (0.111)	−0.104 (0.113)
STEM	0.034 (0.088)	−0.016 (0.095)	0.076 (0.096)
Health	−0.156 (0.136)	−0.161 (0.142)	−0.111 (0.144)
Sequel	−0.016 (0.025)	−0.013 (0.027)	−0.01 (0.029)
Work	0.012*** (0.004)	0.012*** (0.004)	0.011** (0.006)
Prerequesite	−0.034 (0.07)	−0.104 (0.075)	0.094 (0.081)
Paid certificate	0.334** (0.15)	0.327** (0.164)	0.366** (0.155)
Grading	−0.044 (0.083)	−0.087 (0.091)	0.023 (0.091)
French	0.304* (0.161)	0.59*** (0.187)	−0.114 (0.167)
Tenured teacher	0.096 (0.083)	0.093 (0.088)	0.14 (0.093)
MOOC experience	0.025 (0.079)	0.005 (0.086)	0.055 (0.086)
H-index	−0.01*** (0.003)	−0.01*** (0.003)	−0.011*** (0.003)
University	−0.098 (0.113)	−0.158 (0.119)	0.009 (0.13)
Grande Ecole	−0.04 (0.105)	−0.117 (0.111)	0.092 (0.127)
Foreign Institution	0.254 (0.156)	0.322** (0.161)	0.11 (0.167)
Ranking	0.013 (0.013)	0.026* (0.013)	−0.007 (0.014)

Continued on next page...

Results (1): The drivers of total, national and international enrollment (cont.)

Twitter	0.177***	0.174**	0.227***
	(0.068)	(0.074)	(0.077)
Media coverage	0.235***	0.281***	0.171***
	(0.041)	(0.045)	(0.047)
Monthly time trend	−0.001	−0.001	0
	(0.003)	(0.003)	(0.003)
Constant	7.966***	7.342***	6.984***
	(0.241)	(0.273)	(0.254)
N	284	284	284
Adj. R^2	0.272	0.326	0.167

Statistical significance: * p < 0.1; ** p < 0.05 ; *** p < 0.01
Heteroskedasticity robust standard-errors in brackets

Concerning course-related characteristics, we first observe that the theme of the course does not have an influence on students' enrollment. Courses requiring more *work* hours from students in order to fulfill the course requirements tend to attract more students. The likely reason is that these courses provide more content and are better organized compared to others due to their length. Having the option to obtain a *paid certificate* is valued by students, as they attract on average 33% more students. If this creates few additional burdens to the MOOC provider, this option can be a fruitful way to attract more students and create revenue sources. Even if the coefficient is only marginally significant, teaching a course in *French*, instead of another language, helps increase enrollment as well, as they attract 30% more students, all else equal. Hence, the platform predominantly cater students willing to follow courses in French.

Only one teacher-related factor has a significant influence on student enrollment: *H-index*. Surprisingly, it has a negative sign. While the distribution of enrollment pictured in Figure 1 highlights the presence of superstar courses, as already mentioned by Acemoglu, Laibson, and List, this result emphasizes the fact that the reward in enrollment numbers of online education is not captured by the same persons as the ones in the research context.

Institutional factors have no significant impact on enrollment. However, both *Twitter* and *media coverage* have a positive and significant influence on enrollment. These results point towards the importance of putting up a media campaign in parallel to setting up of the course as a way to alleviate potential informational asymmetries on the students' side.

Based on regression (2) and (3), it will now be possible to answer the second research question: Do national and international students differ in their enrollment decision? While the number of *work* hours of the course, *paid certificate*, *H-index* and the two communication factors influence significantly the two student populations, two factors tend to highlight differences in the preferences of national and international students. First, having the course taught in *French* drives more national students towards subscribing but this is not true for international students. Hence, international students are not attracted by the fact that the platform offers French courses. Second, we observe that *foreign* institutions attract on average more international students. One potential explanation is that courses cater students from the local and national environment of the institution sponsoring the course as they are likely to be better informed about their existence.

Interestingly as well, the model is better able to explain the decision of national than of international students, with respectively a R^2 of 0.33 and 0.17. Hence, other factors not accounted for are likely key drivers of international student enrollment. This is another sign that the two student crowds tend to differ in their preferences to enroll in a specific MOOC. There are two possible explanations behind these observations: (1) national and international students have different profiles and (2) there are different motives behind their enrollment decision. Unfortunately, more detailed data would be needed to make further claims on this topic, more precisely, data about the students' socioeconomic background and about their course completion.

One final point relates to the timing of the course launch, both concerning the other MOOCs being provided at the same time on the platform and the month when the course starts. The fact that the presence of other successful courses at the same time on the platform could impact enrollment relates to the existence of same-side externalities, also known as direct or within-group network effects. They can be negative, meaning that competition from additional courses organized at the same time drives down enrollment. Negative externalities are more likely in the presence of congestion, for example when users face a limited amount of time and have to give up an option when choosing another one. Compared with traditional courses, positive externalities are more likely online as the "consumption" of the course is more flexible, as it can be done on demand at the preferred time rather than at a predefined time slot [16]. Knowledge about these externalities is not only important for the course providers for their release decision, even if it is unlikely that they can anticipate the courses launched by other higher education institutions. It is also key for the MOOC platform and the MOOC market, as negative externalities contribute to facilitate the coexistence of several platforms and positive externalities create concentration forces leading to a limited number of platforms in the market. It is also more likely in this setting as we only look at the enrollment decision, which takes a very limited amount of time, compared with course completion for example. From regression (4) to (6) of Table 3, we consider three definitions of the number of courses: the total, the amount taught within the same theme and within the same discipline. # *of MOOCs* is only significant when considering the total amount of courses provided and it is positive. Based on this result, it is complex to precise further the shape of this externality, except by saying that they are less likely to be negative.

Table 3: Results (2): The drivers of total enrollment and the timing of the course launch

Dependent variable	(4)	(5)	(6)	(7)	(8)	(9)
Total enrollment				–0.005		
# of MOOCs	0.009**			(0.006)		
(total)	(0.004)				0.007	
# of MOOCs		0.023			(0.022)	
(theme)		(0.023)				–0.012
# of MOOCs			0.006			(0.012)
(discipline)			(0.01)			
Constant	7.852***	7.943***	7.946***	8.494***	9.321***	8.435***
	(0.249)	(0.249)	(0.251)	(0.296)	(0.26)	(0.249)
Monthly time trend	–0.004	–0.001	–0.001			
	(0.003)	(0.003)	(0.003)			
Month fixed effects	NO	NO	NO	YES	YES	YES
All indep. Variables	YES	YES	YES	YES	YES	YES
N	284	284	284	284	284	284
Adj R^2	0.279	0.275	0.272	0.429	0.427	0.43

Statistical significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$
Heteroskedasticity robust standard-errors in brackets

So far, we have considered a monthly time trend. In regression (7) to (9), we instead consider monthly binary variables, for the month when the course started. We observe that courses launched in April tend to attract significantly more students, and those in June and September significantly less students. In Figure 2, where the month fixed effects are pictured when national and international students are considered separately, we see that national and international students have similar preferences except in April, June and December.

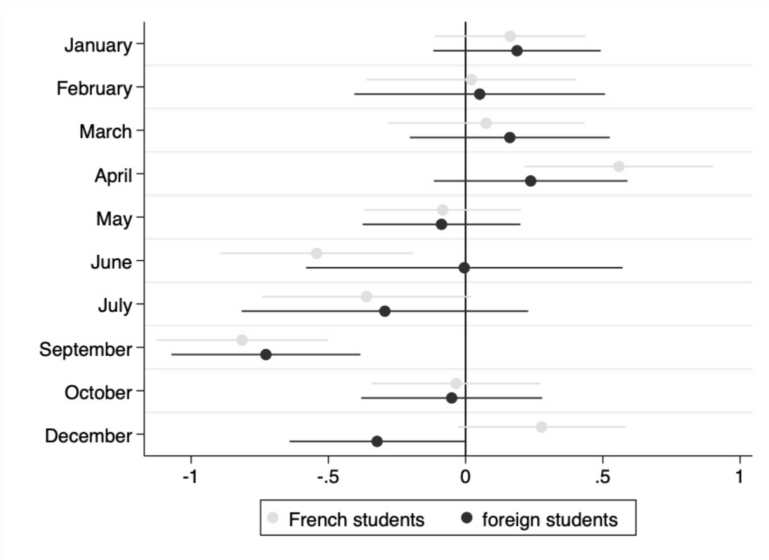

Figure 2: Month fixed effects for model (7) for national/international students

5 Conclusion

Taking advantage of the open access to students of online courses, without tuition fee nor a selection procedure to enroll, this paper analyzes what can explain the differences in enrollment numbers of online courses provided on a French MOOC platform. The results reveal that course-level factors are key, such as the amount of study time needed to fulfill the coursework, the instructional language and the possibility to pay to obtain a certificate of completion. The data analysis shows that communicating about the course on social media and in the traditional press helps decrease informational asymmetries and further on improves enrollment. We also observe several differences in the preferences of national and international students concerning the language of instruction and the starting time of the course. Finally, there is little evidence of the presence of same-side externalities between the courses launched on the FUN platform.

These results suggest two implications related to the scale-up of MOOC platforms and the timing of courses. First, if MOOC platforms want to attract more students, we have shown that one key factor is to be pro-active in the media. How precisely these media campaigns should be organized remains an open question. For example, recent data from the U.S.-based platform Coursera suggests the central role of marketing expenses, as 37% of their total revenues are concerning marketing and sales expenses [14]. However, it is unclear whether this approach should be pursued by the FUN platform as well to be able to scale-up further. Second, from our results concerning the timing of courses, we have that it is more important to consider when to launch a course than to think about whether other, potentially competing, online courses will be aired first at the same time.

Despite the relatively large sample of courses considered, any extrapolation should be done cautiously. The methodology used is suited to understand the key factors behind the course demand but is not adequate to make predictions. In addition, coefficients have to be interpreted as controlled correlations rather than causal impact. Finally, it is important to have in mind that enrollment is not by definition a learning outcome. However, it is still a key measure of the intention to learn, as this step is necessary to further pursue an online learning experience on the MOOC platform.

6 Acknowledgement

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MOOC-Based Online Instruction

A Case Study in Teacher Education

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If taking a flipped learning approach, MOOC content can be used for online pre-class instruction. After which students can put the knowledge they gained from the MOOC into practice either synchronously or asynchronously. This study examined one such, asynchronous, course in teacher education. The course ran with 40 students over 13 weeks from February to May 2020. A case study approach was followed using mixed methods to assess the efficacy of the course. Quantitative data was gathered on achievement of learning outcomes, online engagement, and satisfaction. Qualitative data was gathered via student interviews from which a thematic analysis was undertaken. From a combined analysis of the data, three themes emerged as pertinent to course efficacy: quality and quantity of communication and collaboration; suitability of the MOOC; and significance for career development.

1 Introduction

In March 2020, when COVID-19 hit, universities were forced to move online rapidly and at scale. However, creating online courses is time and cost intensive. To overcome this, many institutions started to use pre-existing massive open online courses (MOOCs) as they provided ready-made, quality materials on which universities could base their existing courses by adding online lessons. This was supported by companies, such as edX, who offered thousands of courses free to universities when campuses started to close. While this provided a temporary solution, effective learning with such MOOCs will only take place if they are carefully planned and underpinned by pedagogical learning philosophies [10] that encourage learning, engagement, and student satisfaction [14] and are adapted to suit local conditions for learning [18]. However, there is currently limited research into how MOOCs can be effectively incorporated into university settings in this way [18]. The current study investigates the effectiveness of one such systematically planned MOOC-based course following a flipped approach as a part of MEF

University's micro-credential program. MEF came up with the micro-credential program in order to better orient itself with the changing paradigm in education, the digital age [16], and to address the needs in the higher education sector. To embrace the digital age paradigm shift, MEF University realized that it is vital to recognize "informal learning" and that "learning is a continual process, lasting for a lifetime" [16, page 1] as well as to give learners more autonomy and choice over their learning journeys. Tackling the needs of the higher education sector was the other reason behind MEF's micro-credential program. "Employers are no longer able to differentiate between the quality of degrees from different institutions, and [...] the specific skill sets that graduates have obtained." [15, page 109]. Incorporating micro-credentials allowed for the informal learning that MEF students were already taking part in to be formally recognized, in return making students more employable. MEF University's micro-credential program is as follows: Students are given the opportunity to design their own elective course modules based on existing modules on online platforms such as edX. To do this, students come together into groups, discuss their needs, and investigate existing courses. They then put a proposal to their faculty mentor and, on approval, pursue the online course of their choice. The purpose of this research is to investigate the efficacy of the design and implementation of one of these courses, Flipped Learning in Education, from the perspective of the students and the instructor.

2 Literature Review

MOOCs bring many positives, such as benefiting future careers, [12], gaining motivation through completion certificates (Hew and Chung, 2014), and effectively meeting users' learning goals [4]. Originally, cMOOCs, driven by connectivism, were designed to offer free, open access education to a massive number of learners. These provided a highly learner-centered learning experience as learners shared and built their knowledge collectively. Later, extension MOOCs (xMOOCs) appeared, following "behaviorism, cognitivist, and (social) constructivism learning theories" whereby "learning objectives (were) pre-defined by teachers who impart(ed) their knowledge through short video lectures [...] followed by simple e-assessment tasks" [19, page 311]. However, these are instructor-centered and have limited peer-assessment and peer-communication. More recently, blended MOOCs (bMOOCs) have appeared, with both online and in-class instruction, which can motivate students, increase commitment to the course [19], and reduce frustration learners feel if unable to ask and answer questions in real time; this also leads to increased course completion, and provides an online community of learners [8].

Also, as tutor support is provided and learning is paced, there are less issues with student self-motivation due to bulk learning [2].

Regarding university courses developed from existing MOOCs or online materials, three studies emerged from the literature. Kloos, Munoz-Merino, Alario-Hoyos, Ayres, and Fernandez-Panadero [11] had their students work from home on MOOCs prior to class, then attend one on-campus class and one lab per week for problem-solving and reinforcing understanding. Assessment was project based. Their results show "a positive reaction from the vast majority of students, who appreciate the practical focus of the courses, leaving more time during face-to-face sessions to solve doubts or problems" [11, page 969]. However, challenges included getting students to complete the online activities before classes, and a high workload for instructors due to material preparation, course refinement, and grading high numbers of project-based assessments. Munoz-Merino, Ruiperez-Valiente, Kloos, Auger, Briz, Castro, and Santalla used Khan Academy videos as pre-class content for a remedial physics course, after which students practiced concepts in face-to-face classes; their findings show that, when using online materials, student satisfaction, grades, and levels of interaction with the online content were high and "activity distribution for the different topics and types of activities was appropriate" [13, page 2]. Hung, Chih-Yuan Sun, and Liu [9] investigated the effect of MOOC-based flipped classrooms on learning motivation and learning outcomes, using surveys to gauge student motivation, a semi-structured open questionnaire to understand students' feelings, and a quantitative test of learning achievements. Their results show that flipped learning, when integrated with MOOCs and game-based learning, can enhance students' learning motivation and outcomes.

Flipped learning involves instructors creating pre-class materials, such as videos and quizzes, that students access online prior to class. Then, class time involves learning activities in which students apply knowledge with the assistance of the teacher or peers. Traditionally, flipped lessons took place face-to-face in classrooms on campus. However, as recently there has been an emergence of online flipped learning with lessons taking place in virtual classrooms, some discussion as to the difference between traditional and online flipped learning has surfaced. Honeycutt and Glova [7] believe the key to flipped learning is not the difference between what happens in class versus out of class, but a focus on "what students are doing to construct knowledge, connect with others, and engage in higher levels of critical thinking and analysis" (para. 10). They recommend instructors find technological tools that allow them to adapt strategies they use in face-to-face classes to engage with their students in the online environment. Swart and MacLeod [17] concur; they took the principles of traditional flipped learning and applied them to a traditional and an online course in analytics. Their results suggest the principles in traditional flipped learning are transferable to online flipped courses, yielding student satisfaction equivalent to traditional flipped courses. DeVita, Lanier, Parker, Boersma, and Hicks also believe the traditional flipped approach can be used with online flipped courses; however, they opine that "applied learning strategies that require active engagement, critical reflection, and collaboration with peers and other stakeholders are especially meaningful [...] in online flipped courses, (as) they help compensate for the physical and virtual distances that exist between students and faculty" [3, page 146]. To underpin flipped learning with pedagogical learning philosophies that encourage effective teaching and learning, in 2018, the Academy for Active Learning Arts and Sciences (ALAAS) developed the Global Elements for Effective Flipped Learning (GEEFL) [15]. This consists of 187 elements, grouped into 12 families (Figure 1), which we reference throughout this paper. For example, (Pb P-5) refers to the family Planning for Flipped Learning, and to element five, Plan Using Bloom's.

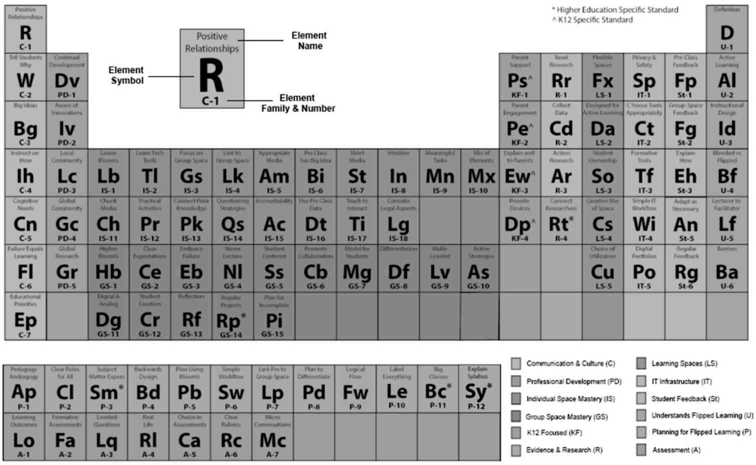

Figure 1: The global elements of effective flipped learning

3 Research Context and Course Design

After the system was announced, a group of Faculty of Education students expressed an interest in taking a Flipped Learning Global Initiative (FLGI) MOOC: *Flipped Learning 3.0 Certification Level* – I (n.d.) and, on its release in March 2020, the *Rapid Transition to Online Learning (RTOL)* (n.d.). One of the authors was allocated as an instructor to design learning outcomes, an end-of-semester project, and a course curriculum from the MOOC content. The course was titled Flipped Learning in Education Elective. When designing the course, first, the instructor took the course overview of the Flipped Learning 3.0 MOOC, considered the content, reflected on local needs [18], developed learning outcomes that follow Bloom's taxonomy (Pb P-5) with a focus on higher levels of thinking and analysis [7], and included strategies that involve active engagement [3]. Second, she designed assessments in line with the learning outcomes (Lo A-1). For the end-of-course performance task, a Backwards Design approach was followed (Bd P-4), that mirrored real life (Rl A-4) whereby students had to use and apply information and skills they had gained [3], while working individually [17] and being supported by a clear rubric (Rc A-6). For the task, students were expected to choose a skill (e.g. cooking, animation), imagine a situation where they may need to teach that skill, and develop a flipped lesson to teach it. Peer-evaluation was included [17] and self-evaluation to get the students to critically reflect on their development [3]. Table 1 shows the assessment structure. The instructor had planned for students to teach their flipped lessons on campus; however, this had to be cancelled due to campus closures. Therefore, the assessment weighting was readjusted. Third, units were developed with a simple (Sw P-6), logical (Fw P-9) workflow, with paced learning [2]. Fourth, the instructor designed the IT infrastructure, using appropriate systems and tools (Ct IT-2) to support active learning (Da LS-2), which included the FLGI MOOCs, a learning management system (LMS), a virtual meeting space, and communication and collaboration tools. These were accessed via the university LMS. The details of the IT Infrastructure used are given in the results section (Table 3).

4 Research Methodology

The purpose of this study was to investigate the efficacy of a MOOC-based flipped online course from the perspective of the students and instructor. The course ran with 40 students over 13 weeks from February to May 2020. To evaluate efficacy, the following three indicators were used: student achievement of learning outcomes [9], engagement with online materials [13], and satisfaction [11, 13]. The following research question guided data collection "*How effective was the Flipped Learning in Education course regarding student achievement of learning outcomes; engagement with online systems, tools and materials; and satisfaction?*" This research follows a case study methodology, with mixed methods. Quantitative data for achievement of learning outcomes was gathered by taking grades for each assessment from the LMS grade center, following [9]. For engagement with the online systems, tools and materials, data were collected from the LMS, FLGI MOOCs, the virtual meeting space, and

Table 1: Assessment structure

Bloom's	Learning Outcomes	Area	Detail	%	Rubric
Remember & Understand	Define flipped learning (FL)	MOOC Certification	Flipped Learning 3.0	15	N/A
			RTOL Course	5	N/A
Apply & Analyze	Illustrate what makes a good FL lesson	Synchronous Online Lesson	Pre-class Quiz	5	N/A
			Participation Online	5	N/A
Create	Design a FL lesson	End-of-course Performance Task	Design a Flipped Lesson Plan	25	Yes
	Produce an effective pre-class video		Create a Pre-class Video	10	Yes
	Create online materials		Create Online Materials	10	Yes
	Teach a flipped lesson		Teach your Lesson	—	—
Evaluate	Evaluate the effectiveness of flipped lessons	Peer and Self-evaluations	Evaluate a Peer's Video	5	Yes
			Evaluate a Peer's Online Materials	5	Yes
			Evaluate Your Own Lesson	5	Yes

communication and collaboration tools, following [13]. For satisfaction, an anonymous questionnaire with 23 questions, (1 strongly disagree – 4 strongly agree) was sent at the end of semester via Google Forms, following [13]. The qualitative data was used to get a more complete explanation of indicators under investigation. Four students were interviewed by a research assistant in 30-minute, individual, semi-structured interviews with open-ended questions, recorded, transcribed and anonymized. This was done via a virtual office on Blackboard Collaborate for data collection via interviews, and LiquidText software was used for data analysis which was conducted following Braun and Clarke's [1] thematic analysis. Following Griffiths, Chingos, Mulhern, and Spies's suggestion that instructor interviews may be used as a legitimate instrument for data collection, the course instructor was interviewed by one of the authors through written communication with open-ended questions via email.

5 Results and Findings

To answer the research question "How effective was the Flipped Learning in Education course regarding student achievement of learning outcomes; engagement with online systems, tools and materials; and satisfaction?" the researchers looked at the results for each of the three indicators, then interpreted them with the use of the qualitative data. The student satisfaction survey was completed by eight students, and four took part in the semi-structured interviews. The combined data analysis revealed three overarching themes which we think are vital when creating bMOOCs from existing xMOOCs: quality and quantity of communication and collaboration, significance for career development, and suitability of the MOOC. Tables 2 and 3, and Figure 2 present the results of the three indicators: learning outcomes; engagement with online systems, tools and materials; and satisfaction, respectively. The rest of the results are presented under the overarching themes that were determined as a result of the combined data analysis.

Table 2: Breakdown of grades

Learning Outcomes	Assessment	Number of Students Completed	Weight	Average Class Grade
Define flipped learning (FL)	Flipped 3.0	40	15.00%	15.00%
	RTOL	40	5.00%	5.00%
Illustrate what makes a good FL lesson	Pre-class quiz	36	5.00%	3.67%
	Participation online class	33	5.00%	4.13%
Design a FL lesson	A flipped lesson plan	39	25.00%	18.46%
Evaluate the effectiveness of flipped lessons	Peer-evaluation of video	38	5.00%	4.63%
	Peer-evaluation of FL materials	37	5.00%	4.48%
	Self-evaluation	37	15.00%	10.86%
Produce an effective pre-class video	Create a video	38	10.00%	5.83%
Create online materials	Create online materials	40	10.00%	8.18%

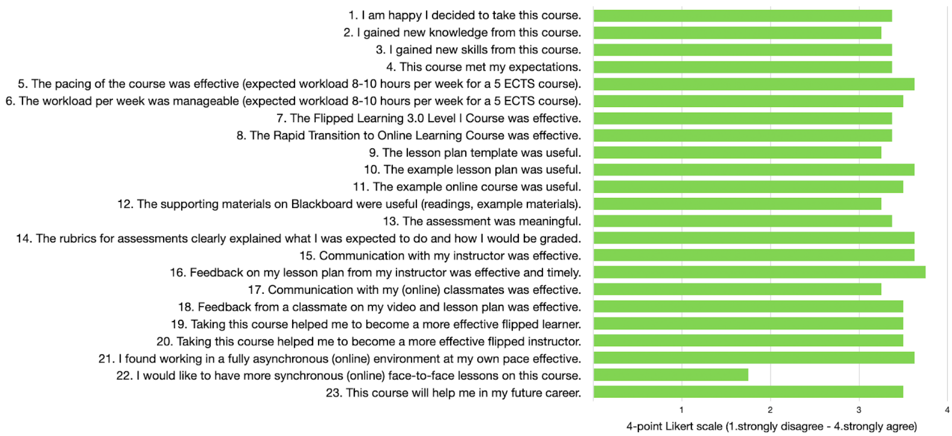

Figure 2: Student satisfaction survey results

Table 3: Engagement with online systems

System	Tool	Graded	Data
MOOCs	Flipped learning 3.0 certification	Yes	100% of students completed
	Rapid transposition to online learning	Yes	100% of students completed
LSM – blackboard learn	Announcement	No	37 announcements in 14 weeks
	Discussion board	No	Not used
	Example lesson plan & Template	No	Data was unavailable on LMS due to timeout
	Additional Readings and Activities	No	Data was unavailable on LMS due to timeout
	Interactive tools	No	Data was unavailable on LMS from third party apps
	Online quiz (for a pre-class quiz)	Yes	36/40 completed with an average grade of 88.4%
	Wikis (for peer-feedback)	Yes	75 entries out of possible 40
	Assignments (for the performance task)	Yes	37 assignments out of possible 40
Virtual Meeting Space – Blackboard Collaborate	Virtual Office	No	Not requested/used
	Virtual classroom – Initial Meeting (Optional meeting space for students)	No	Data was unavailable on LMS
	Virtual classroom – Online Lesson	Yes	33 students
	Student chat room (Session left open during the course)	No	Not used
Communication and Collaboration Tools – G Suite	Emails	No	Around 200 emails over the semester
	Docs and slides (used during the online lesson)	Yes	33 students participated

5.1 Quality and Quantity of Communication and Collaboration

Regarding engagement with online systems, tools and materials, via the LMS, 37 announcements were sent over 14 weeks. One reason for so many announcements at the start was due to students having issues registering to the MOOCs. This could be resolved by having an initial meeting in which students register to the MOOC, which, as Hrastinski [8] opines, would reduce the frustration learners feel when they are unable to ask and answer questions in real time. With the discussion board, in line with Swart and MacLeod [17], the aim was for students to have a place to pose and answer questions. However, it was not used. The instructor noted that she had not set it up in a structured way: *"I simply left it open for students to pose questions if they wished" (Instructor).* One student had a suggestion for improvement: *"This could be developed by adding a feature [...] to discuss [...] with the whole class. If it was mandatory [...] everybody would have to use it" (Student Three).* For quality communication to take place, however, careful consideration needs to go into its purpose and set up. Regarding the virtual office, the instructor had provided the option to offer counselling in line with [17]. However, students opted not to use this, and, in the interviews, all the students expressed that this was because they were happy to communicate via email. The instructor had also set up a virtual chat room to encourage students to work together synchronously, in line with [17]. However, this, too, was not used. The students preferred to use existing modes of communication: *"When I asked the students how they were communicating with each other, some commented that they were using things like WhatsApp to chat with their close friend groups" (Instructor).* However, when it came to using the virtual classroom, 33 students attended. One commented: *"We did one of our classes live [...] I had never seen her live before [...] I think a student knowing their teacher is a good thing [...] I wish she could come to us at least once earlier" (Student Four)*. The instructor commented: *"The first live meeting was not successful, as I had not set up a specific enough task for the students. The second was more effective, as I set clear expectations, assessed it, and prepared online group work using Google Docs and Slides [...] From this I learnt that synchronous meetings must have specific tasks and goals that are shared with the students in advance" (Instructor).* This links in with Honeycutt and Glova's [7] recommendations that instructors find technological tools that allow them to adapt strategies they use in face-to-face classes to engage with their students.

In the satisfaction survey, one hundred percent of students gave a positive response for "Feedback on my lesson plan from my instructor was effective and timely". This was supported by the interviews: *"I had good, descriptive feedback [...]. We communicated very efficiently. (My instructor) gave me feedback on my mistakes and answered my questions" (Student One)*; *"When we asked questions over email, we got rapid answers. Our teacher always [...] (addressed) every detail" (Student Two).* This supports Conjin, Beemt, and Cuijpers's [2] opinion that dedicated tutor support is highly important. All the respondents also said "The example lesson plan was useful", and 87.5% said "The lesson plan template/example online course was useful". The instructor concurred: *"I believe most of the students were successful as they had been provided with a lesson planning template, example lesson plan, and example online materials [...] I believe it gave them the structure required to make effective flipped lessons" (Instructor)*. These results support the GEEFL recommendation that instructors should give clear directions on how students should approach the learning (Ih C-4). Another area of high student satisfaction was peer-evaluation: 75% of respondents were satisfied with the peer-feedback. This was supported in the interviews: *"Commenting on our classmates' plans was really beneficial" (Student One)*; *"Because [...] we assessed the lesson plans of a classmate (and) offered feedback [...] we learned about the mistakes other people made as well as getting feedback from classmates on our own work" (Student Two)*; *"Seeing how other students perceived it and did things is very educational in my opinion" (Student Three)*. These results support Swart and MacLeod's [17] recommendation that instructors encourage students to work together asynchronously to give feedback on each other's work as well as DeVita, Lanier, Parker, Boersma, and Hicks's [3] recommendation that strategies are applied that involve active engagement and critical reflection. Another aspect with high satisfaction was the asynchronous environment. Eighty-seven percent said *"Working in a fully asynchronous environment at my own pace was effective"* and 75% expressed they did not want an increase in synchronous lessons. However, the instructor had some concerns: *"For students who are autonomous and want to move ahead at their own pace, this is a better environment. But, for students that struggle with their time-management, this is more challenging" (Instructor).* This echoes Milligan and Littlejohn [12], who worry students may lack self-motivation if there is not enough dedicated tutor support. For example, in the current course, one area where students needed more tutor support was creating videos; for this outcome, there was a low average grade of 53% even though the overall video grades were good. The low average was due to three students not creating a video. The instructor believes this might be due to fear of using new technologies and, in future iterations, will provide more support in this area.

5.2 Significance for Career Development

Thirty-six students out of 40 passed, making the pass rate for the course 90%. The average grade was 83.57%, meaning achievement of learning outcomes was successful. This was also seen in the student satisfaction survey. 87.5% of respondents said *"Taking this course helped me become a more effective flipped learner/instructor"*. This supports Hung, Chih-Yuan Sun, and Liu [9] that MOOC-based flipped learning can enhance students' learning motivation and outcomes. For MOOC certification, all 40 students completed both MOOCs. All participants said they were motivated by the certificate. This supports Hew and Chung [6] that students are motivated by completion certificates. Students were also happy with the end-of-course task. 87.5% said *"it was meaningful".* There were also references in the interviews regarding how this course could assist the students in their future careers: *"This course helped me learn new information and apply and experience what I learnt. The assessment helped me learn valuable information I will use in the future when I am a" teacher* (Student One); *"It provided me with good things that can help my career. I'm someone who thinks flipped learning is a really" effective method. It saves on so much class time and this is used more effectively (Student Two); "I want to apply it in my own work and aim to be a flipped teacher." (Student Three); "When job hunting, I plan to say 'I'm a teacher who knows flipped learning'. I plan to market myself using (this)" (Student Four).* This supports Milligan and Littlejohn [12] that MOOCs can benefit participants' future careers, and Gamage, Perera, and Fernando's [4] opinion that MOOCs are effective in meeting users' learning goals.

5.3 Suitability of the MOOC

There is evidence from the student interviews that some students fully engaged with the certification MOOCs: *"I didn't know that those two certificate programs I did were this intense before engaging with them. By that I mean how fully formed they are" (Student Four).* However, as one student pointed out, gaining the certificate was relatively easy: *"At the end of the units [...], there were tests (which) could be taken an infinite number of times [...] There is no risk of getting a bad grade [...] You could just get back to the video needed to answer a particular question" (Student Two).* While the tests in the Flipped Learning Level I MOOC are, in fact, designed to encourage students to go back and watch the videos again if they have not understood, as Student Two identified, it was possible for students to simply click through, get incorrect answers, and still get the certificate. In this case, the grading in the Flipped Level I MOOC may not be suited to the purpose intended by the instructor. This could be overcome by moving MOOC quizzes to the LMS. For "design a flipped learning lesson" outcome, grades were much lower than for other assessments. The instructor put forward a suggestion as to why this was the case: *"The least successful students did not complete the FLGI MOOCs before writing their lesson plans. They should have registered on 10th February, but four students sent mails at the end of April about this, meaning they attempted to create their flipped lessons without participating in the online instruction" (Instructor).* This supports Kloos, Munoz-Merino, Alario-Hoyos, Ayres, and Fernandez-Panadero's warning that getting students to complete the online activities before classes is challenging. In addition, for these students, as observed by [2], bulk learning instead of paced learning had a negative effect on their success. The instructor had tried to avoid this by designing the course, following [13] so that it had an appropriate activity distribution for the topics and activities, and by pacing learning, following [2] by adding recommended start dates to each unit. However, these were guidelines only. Students were only held accountable for completing the assessments by the set deadlines.

6 Discussion

The results indicate that high student achievement and satisfaction can be achieved by using xMOOCs as the content for a university course. However, the results also indicate that utilizing xMOOCs for an online course requires a lot of attention in how the students will engage with the materials and each other via the online systems, and how and when materials should be accessed, areas in which the current course needs to be improved on. Drawing on the three themes that were developed, the authors put forward the following framework and guiding questions for the development of effective xMOOC-based online courses (Figure 3).

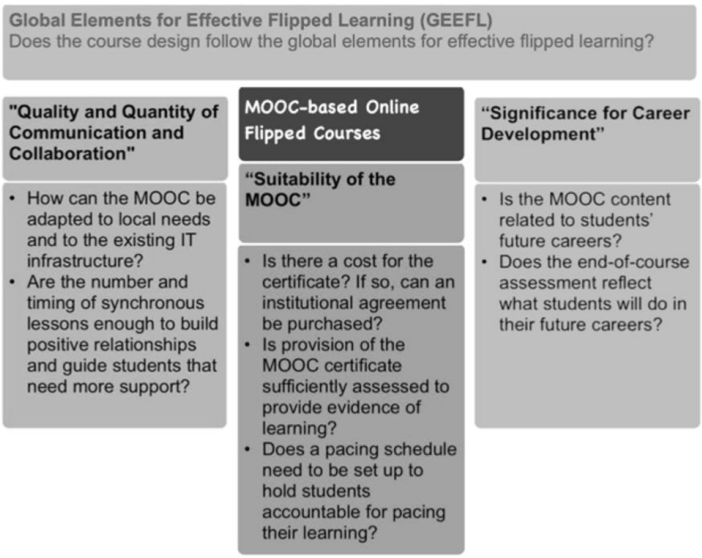

Figure 3: Framework for the development of MOOC-based flipped courses

"Quality and quantity of communication and collaboration" is critical to keep students engaged with the instructor and their classmates and for learning to take place online. For this to happen, the MOOC must be adapted to local needs. It should also link in with the existing university IT infrastructure. Moreover, a synchronous lesson at the start of the course should be held to build a positive relationship between the instructor and students and to ensure students have registered to the MOOC. In terms of "Significance for career development", quantitative data also showed students found the MOOC relevant for their future careers. One of the reasons may be that the students, all faculty-of-education teacher candidates, had specifically chosen the FLGI MOOC to support their future careers. The system used at our institution supports this, as it is the students that choose the MOOC. Moreover, the content of the MOOC proved suitable for this. Another reason for this came out in the interviews; the students found the performance task relevant, which, using backwards design, had asked them to design a lesson originating from a real-life problem, in which they had to apply the information and skills they had gained in an authentic way. Thus, for significance for career development, not only is the MOOC content important, but it is also imperative that there is an authentic assessment task that supports students' future careers. "Suitability of the MOOC" emerged as a critical factor for pacing learning and motivating students. However, if a freemium version is used, the certificate may not be available for students, which may diminish student motivation to complete the MOOC. One way around this may be for universities to get an institutional agreement with xMOOC providers and incorporate the cost into tuition fees. This is an additional expense at a time when many universities are facing a funding crisis. However, if universities require ready-made materials to keep their education online during the pandemic, the expense is worthwhile. In fact, in January 2021, this is exactly what MEF University did when it signed institutional agreements with LinkedIn Learning and edX. MEF was also the first university in the world to integrate edX into its learning management system, Blackboard. The second issue with freemium xMOOCs is there is no way the instructor can check if students have completed the activities. This can be circumvented by the instructor creating graded quizzes about the MOOC content on the university LMS. This overcomes the lack of evidence of learning from the MOOC, as well as holding students accountable, and may also support less autonomous learners who need more structured pacing, but is time intensive for the instructor.

7 Conclusion

From the results, we believe the MOOC-based Flipped Learning in Education course, mostly conducted during the emergency campus closures, was effective for student achievement of learning outcomes and satisfaction. Yet, there is room for improvement regarding engagement with online systems. From the findings, the authors put forward a framework and guiding questions for the development of effective MOOC-based online courses. We believe this evidence-based framework is useful not only for institutions and teachers that are already considering developing courses from existing xMOOCs but also for institutions that need to rapidly transition to online learning. Furthermore, we believe that such a course design for universities can benefit their students' career development by integrating micro-credentials into the curriculum, fostering learner choice and autonomy, and bringing flexibility in delivering quality instruction in times of uncertainty.

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Hybrid MOOCs Enabling Global Collaboration Between Learners

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The COVID-19 pandemic has accelerated the pace of digital transformation, which has forced people to quickly adapt to working and collaborating online. Learning in digital environments has without a doubt gained increased significance during this rather unique time and, therefore, Massive Open Online Courses (MOOCs) have more potential to attract a wider target audience. This has also brought about more possibilities for global collaboration among learners as learning is not limited to physical spaces.

Despite the wide interest in MOOCs, there is a need for further research on the global collaboration potential they offer. The aim of this paper is to adopt an action research approach to study how a hybrid MOOC design enables learners' global collaboration. During the years 2019–2020 together with an international consortium called Corship (Corporate Edupreneurship) we jointly designed, created and implemented a hybrid model MOOC, called the "Co-innovation Journey for Startups and Corporates". It was targeted towards startup entrepreneurs, corporate representatives and higher education students and it was funded by the EU.

The MOOC started with 2,438 enrolled learners and the completion rate for the first four weeks was 29.7%. Out of these 208 learners enrolled for the last two weeks, which in turn had a completion rate of 58%. These figures were clearly above the general average for MOOCs.

According to our findings, we argue that a hybrid MOOC design may foster global collaboration within a learning community even beyond the course boundaries. The course included four weeks of independent learning, an xMOOC part, and two weeks of collaborative learning, a cMOOC part. The xMOOC part supported learners in creating a shared knowledge base, which enhanced the collaborative learning when entering the cMOOC part of the course.

1 Introduction

For better or for worse, the outbreak of COVID-19 pandemic has initiated a sudden transformation of the long-predicted trends related to work and study online [4]. As a result, people have had to adapt quickly to collaborating online. On the bright side, global collaboration is no longer limited to merely physical spaces, but the question remains to what extent may all aspects of a successful collaboration be achieved by purely online means. Furthermore, this new era has increased the need for online learning opportunities as many learners are seeking to develop their competences. MOOCs are open online courses offered free-of-charge to anyone from anywhere in the world [7]. Given the easy access, they have potential to attract a wide target audience, especially during this new era.

The two main types of MOOCs are called xMOOCs and cMOOCs and their pedagogical designs are very different from one another. The first generation of MOOCs, cMOOCs, are based on connectivist theory and are focused on social learning [10], where learners' creativity, autonomy, and networking are encouraged, and learners are expected to enrich the course's content [17] by using different digital platforms and technology. The second generation of MOOCs, xMOOCs have a behaviorist approach, i.e. they are focused on knowledge duplication, where students are required to master what they are taught [17] and the majority of content is created and presented by instructors only [16]. xMOOCs, are designed to be scalable, standardized and they promote centralized knowledge production, where communication is mainly one-sided. Due to the nature of xMOOCs, they are not suited to foster collaboration on their own. Therefore, we assume that a hybrid model combining elements from both xMOOCs and cMOOCs is better suited to enhance collaboration.

The concept of hybrid MOOCs may be understood in various ways according to prior research. It may be used to describe a "learning initiative, strategy or model that integrates MOOCs and MOOC-related technologies into a traditional curriculum" ([15]. In this paper, however, referring to [8, 11] we define hybrid MOOCs as purely online MOOCs, which combine elements from both xMOOC and cMOOC models.

During the years 2019–2020 we jointly designed, created and implemented a hybrid model MOOC, "Co-innovation Journey for Startups and Corporates", with an international consortium, called Corship (Corporate Edupreneurship), consisting of higher education institutions, corporate and startup associations across several European countries. The course was focused on entrepreneurship and, more specifically, on startup-corporate collaboration.

Referring to the need to increase understanding of how to enhance collaboration among global learners and how a hybrid model MOOC may respond to that need, we have investigated the above-mentioned MOOC from these perspectives. Thus, the research question of this paper is: How does a hybrid MOOC design enable learners' global collaboration?

2 Learning Communities in MOOCs

Prior research has widely recognized that one of the most negative aspects of MOOCs is that they suffer from rather low completion rates [7, 1]. According to various studies [2, 12], the average completion rate is less than 10%, which emphasizes the difficulty for MOOCs to keep learners engaged and active. According to [5] one of main factors affecting course quality and completion rates is the lack of interaction between instructors and learners. Due to the limited possibilities for this interaction when teaching masses, peer support plays an essential role in the learning [14]. Therefore, it may be worthwhile to invest efforts in building a community among learners, which may support learners to be more engaged, respect each other and achieve better performance [19] and help build confidence and stimulate active participation [13].

West and Williams [18] suggest that no one definition of learning community exists but they can be described from the participants' point of view. They argue that, in order for participants to form a learning community, they need to sense they have access with one another, a relationship with other learners (sense of belonging, interdependence, trust and faith in the purpose of the community), a shared vision or shared practices. Furthermore, a learning community should be a place where people feel comfortable, trusted, and valued [14]. Therefore, a learning community helps to enhance collaboration. Prior research demonstrates that learning communities built in MOOCs may even continue to grow independently after and beyond MOOC boundaries via social media and networks [10].

3 Methodology

This research addresses how a hybrid MOOC enables global collaboration. Our focus is on the learners' actions and the emerging learning community within the MOOC in question. Therefore, action research is an appropriate approach since it is suitable for research settings, which describe or unfold a series of actions taking place over a period of time in a community or group [9]. Furthermore, characteristic features for action research include the participation of the researchers, interaction and involvement as well as proximity to the research object [9, 6]. We planned and designed the MOOC iteratively as a collaborative effort among seven European partner organizations[3] representing viewpoints from startups, corporations and higher education. The researchers of this paper were responsible for the design and implementation of the cMOOC part, and contributed to the design of the xMOOC part. They had access to all other materials and were closely involved in the whole process and therefore, they were able to observe the entire process: planning, implementation and further evaluation.

Figure 1 highlights the action points of this research and the data that was collected and analyzed during each of the action points.

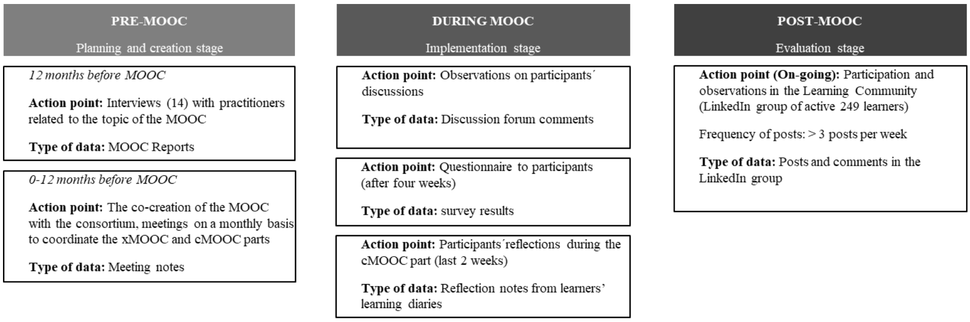

Figure 1: Action points of the research and data collection

The data was collected and analyzed during the following stages: pre-MOOC (planning), MOOC (implementation) and post-MOOC (further evaluation) periods. The timeframe for the planning of the MOOC was around 12 months before it was launched in April 2020. Before the planning started, the members of the consortium wrote research reports to lay a foundation for the contents. During the planning stage, the MOOC was designed in iterative cycles involving practitioner feedback and constant mutual feedback among members of different working groups. Each partner organization was responsible for a certain week, however the whole consortium planned and co-created the contents together. This process was carefully documented.

The implementation of the MOOC automatically created a large quantity of data through the participation. Typically, action research focuses on what practitioners do rather than what they say they do [3]. In addition, the participants were

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involved in voluminous discussions in the forums of the MOOC platform and participant reflections were also collected. The participants in the MOOC – like the creators of the MOOC – represented startups, corporates and higher education institutions. After the MOOC ended, the learning community was maintained through a LinkedIn group.

Action research is based on practical problem solving and systemizing that experience to research [9]. The analysis is based on the systematic categorization of the building blocks related to both parts, xMOOC and cMOOC. The results are indicated in the findings (see Table 1: Hybrid MOOC design "Co-Innovation Journey for Startups and Corporates").

4 Results

In Table 1, we present the design of the hybrid model MOOC, "Co-innovation Journey for Startups and Corporates". Learners who completed the first four weeks, were able to register separately for the last two weeks of the course. During the first four weeks learners created a shared knowledge base, which enhanced the collaborative learning in a team task during the last two weeks.

The MOOC was free and open for anyone to take, but was targeted towards startup entrepreneurs, corporate representatives and higher education students. Next a brief overview of the learners that took part in the MOOC will be presented.

4.1 Description of Learners

In Figure 2, we present the number of learners during the different stages of the MOOC. Learners had the option of completing only the xMOOC part of the course or continue to also complete the cMOOC part. Those learners, who wished to complete both parts of the MOOC, had to register separately for each part. The cMOOC part of the course was only available to the learners, who completed the xMOOC part.

As shown in Figure 2, a total of 2,438 learners enrolled for the xMOOC part of the course, i.e. the first four weeks. Out of those 1,609 (66%) started the course by being active on the platform, the rest of them remained inactive and did not complete any of the tasks. A total of 728 learners completed all the tasks during the first four weeks, the xMOOC part, which is around 30% of the 2,438 enrolled learners.

Out of the 728 learners, who completed the xMOOC part of the MOOC, a total of 208 learners enrolled for the cMOOC part of the MOOC, which consisted of a team task and self-reflections. These learners were divided into 41 teams, each consisting

Table 1: Hybrid MOOC design "Co-Innovation journey for startups and corporates"

	XMOOC PART DESIGN (WEEKS 1–4)	CMOOC PART DESIGN (WEEKS 5–6)
Main focus	Scalability	Community and connection
Learning focus	Theory and concepts	Experience, application and reflections
Participants	Open for all, main focus group: higher education students, corporate representatives and startup entrepreneurs	Learners who completed the first four weeks of the MOOC
Type of learning	Individual learning	Collaborative learning in teams
Workload	~6h/week (25–30h) = 1 ECTS	~15h (25–30h) = 1 ECTS
Communication	Limited, mainly discussion forum for questions/feedback	Open discussion in a team's own collaboration space (Collab Space), group work outside the MOOC platform (Jitzi, WhatsApp, LinkedIn, Zoom), and discussion forum for questions and feedback
Main learning outcome	Understanding theories and tools related to startup-corporate collaboration	Apply the theory and tools in teamwork
Contents	High-quality video material, articles and other reading materials, short quizzes, final exam	Some high-quality video material, startup-corporate collaboration cases, Co-Innovation Builder
Assessment	Automatic grading	Peer assessment
Role of teacher	Content creator, expert and moderator	Facilitator from outside the teamwork Moderator with strong focus on technological problem solving during the course

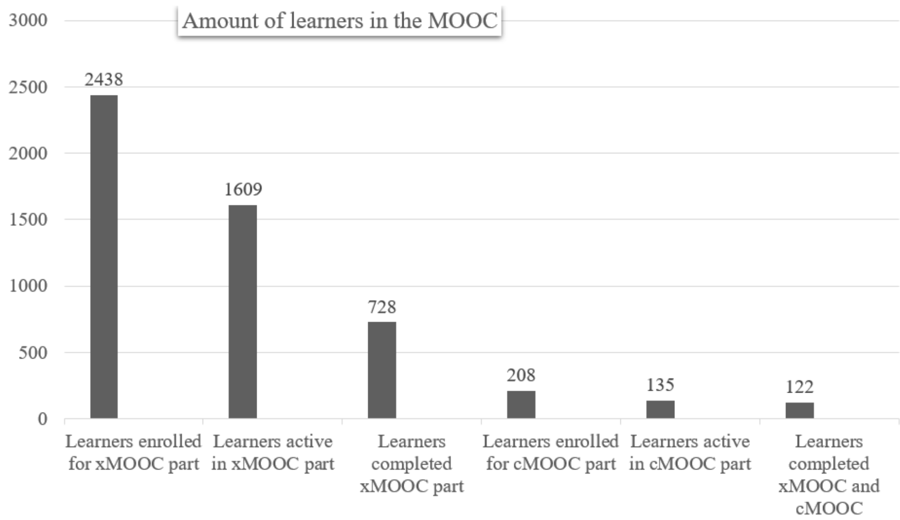

Figure 2: Number of learners in the different stages of the MOOC

of 4–5 learners. Because the drop-out rates in MOOCs have been typically rather high as stated in prior research [7, 1], we assumed that some of the team members would drop out at some stage of the team task. Taking that into consideration, we decided to build teams of at least 4 people. Out of the 208 enrolled learners for the cMOOC part, a total of 135 learners were active, contributed to the team work and submitted their final work in the platform. By the end of the MOOC, 122 out of those 135 learners received a passing grade for the full course (xMOOC + cMOOC), which constituted 58% of the learners enrolled for both parts of the course (N = 208). Only two of the teams did not submit anything and stayed inactive until the end of the course.

The average age of learners that took actively part in both the xMOOC and cMOOC parts of the course (N = 135), was 37, ranging from 21 to 60. A total of 88 (65%) were male and 46 (34%) were female. The majority of learners were in employed and had professional backgrounds in business either working in a startup or a corporate. Only 3 of them were merely higher education students and were not currently working. As learners shared similar goals and an interest in startup-corporate collaboration, they were motivated to learn and network with one another. Furthermore, the vast majority of them, 130 (96%), stated that they had prior experience of working remotely alone and as part of a team. A few of the learners mentioned that due to Covid-19 they had had to learn how to work remotely both independently and in teams, because they did not have experience from before.

The nationality of learners that took actively part in both the xMOOC and cMOOC parts of the course (N = 135), are shown in Figure 3. The majority of learners were from Germany (51), Austria (14) and India (10).

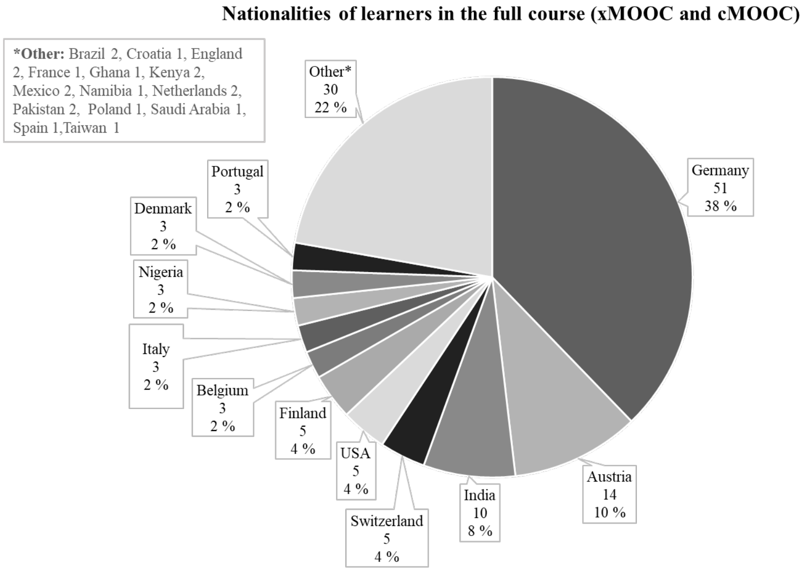

Figure 3: Nationalities of active learners in the full course (xMOOC + cMOOC)

As Figure 3 presents, the hybrid MOOC attracted learners across the globe. The MOOC was built in the mooc.house platform, which is German. We believe that played a key role in attracting so many German learners as the MOOC was marketed to other existing MOOC course participants via the platform. The consortium consisted of members from the EU (Austria, Belgium, Finland, Germany, Poland and Portugal), which also explains why so many learners were from these countries and from the EU region as marketing of the course was done mainly to existing audiences of each institution.

4.2 xMOOC – Independent Study Phase

The xMOOC part of the course was focused on knowledge acquisition about startup-corporate collaboration. Learners studied theories, were introduced to collaboration tools and acquired practical knowledge of startup-corporate collaboration. They had access to high-quality videos and articles, and there were opportunities to share ideas and opinions with one another in different discussion forums on the course platform. Learners took short quizzes to test their knowledge of the subject matter, and at the end of the four weeks, learners took a final exam, which was compulsory to take in order to receive a grade.

Due to the large number of participants in the xMOOC part, we as educators needed to preplan and create a standardized and automated, scalable learning design. Furthermore, we moderated discussion forums to remove learning barriers, for example, by answering questions and encouraging learners to share ideas about the topics. The xMOOC part was essential for learners to create a shared knowledge base before entering the cMOOC part of the course. This was evident in the learners' reflections:

"Yes, as a team we were able to identify any issues that were discussed in earlier weeks (1–4) because we kept going back to some of the materials to read again or re-confirm what we had learned." (MOOC participant's reflection note)

"It was so great the preparation, all the team working together in the assignment, allow us to know the best skills of each one. Yes, here was where we review the most the content for 1–4 weeks and the group debates allow us to integrate the concepts more." (MOOC participant's reflection note)

4.3 cMOOC – Collaborative Learning Phase

The overall objective of the cMOOC part of the course was to deepen learners' understanding about co-innovation between startups and corporates by encouraging them to collaborate in a simulated startup-corporate collaboration case. Because most of the learners had prior work experience working in startups or corporates, the niche study theme on co-innovation between startups and corporates motivated learners to participate in the cMOOC part. Learners were asked to register separately for the team task (the cMOOC part) after completing the first four weeks of the course (the xMOOC part) and teams of 4–6 persons were formed on the basis of the following:

- their time commitment for the team task (1–2h, 3–4h or 5–6h/week)
- time zone of the participants

- the role they wished to take (startup/corporate): each team had to have both roles represented and each member could choose their own role
- having at least one person who wanted to lead the team included in each team
- gender: having both female and male participants in each team

Furthermore, five teams were formed on the basis of having the lowest performance in the xMOOC part, because it was suspected that they would drop-out. The teams were formed with a Team Builder tool that helped form versatile teams with the chosen parametrics.

The cMOOC part included real-life startup-corporate collaboration cases, weekly task instructions, a set of collaboration tools and self-reflection tasks. The final outcomes made by the teams were assessed by other teams and all teams assessed the performance of their own members.

We paid strong attention to clarity when creating the course contents and instructions, as well as, with our communication with the learners. Due to the large number of learners, we saw that modifying them later during the course could have caused a lot of difficulties and confusion. Furthermore, together with the consortium we created a digital tool, called the "Co-Innovation Builder", to support teamwork. The tool was seen as essential, especially, since the educators had limited possibilities to support the teams. It also helped teams to create strategies and solutions for the team task. This was strongly evident in the majority of learners' reflections:

"Co-Innovation Builder is a great tool to collaborate and share our views with different perspective yet keeping us focused on what we need to put in our agenda while discussing." (MOOC participant's reflection note)

The MOOC learning environment required learners to take responsibility for initiating, organizing and managing team work autonomously. In most teams, learners collaborated actively by giving feedback, clarified misunderstandings, shared experiences and made decisions together. Furthermore, according to the learners' reflections they recognized the benefits of collaborative learning over individual learning.

"Working as a team definitely was an added advantage in identifying issues that were discussed in earlier weeks (1–4), and recognizing and challenging the gaps in our knowledge while helping the team to fill them [collaborative tool, Co-Innovation Builder, elements] was a plus that cannot be replaced if doing the work individually." (MOOC participant's reflection note)

Team members' diverse cultural backgrounds, experiences, perspectives and prior knowledge were used as 'raw material' in social knowledge construction.

"What I considered really interesting is the fact that each of the team members have a different background, no-one is coming from the same industry." (MOOC participant's reflection note)

At times the diverse backgrounds also posed challenges according to learners' reflections:

"We had some communication issues due to the language and culture (e.g. Greeks say 'ne ne ne' but it means 'yes')."(MOOC participant's reflection note)

The broader knowledge base allowed each member to benefit from collaboration by constructing individual knowledge and developing cognitive (thinking, problem solving and decision making) and affective (feelings) aspects of learning. Having the same interest with peers, a sense of community, willingness to share and mutual trust were key elements in building a learning community, which was evident in a survey conducted after the first four weeks of the course. We received responses from 148 learners. They were asked the reasons for why they shared experiences and thoughts with peers. They had an option to choose a maximum of 3 reasons, and the majority of them answered as follows:

- same interest as peers (N = 91)
- sense of community (N = 86)
- pure willingness to share (N = 78)
- mutual trust (N = 42)

Some learners even took a step toward a sustainable learning community, when they created a LinkedIn group for course members during the course. The LinkedIn community is still sustained and active today. It was evident from the learner's comments that they wish to sustain the networks:

"I have connected with some participants from different parts of the world and hope to keep this professional network going and support each other's initiatives; have also learned about some resources that will help along the journey, and, partnerships around common work that I'd like to pursue." (MOOC participant's discussion forum comment)

We argue that a hybrid MOOC design may foster global collaboration within a learning community even beyond the course boundaries. As one of the MOOC focus group participants called it "by connecting the different minds from all over the world".

Some weak points were detected in the hybrid model. Building the MOOC together with an international consortium took a lot of time and resources, because there were many people involved in the process. The cMOOC part required a rather extensive amount of time for solving problems, communicating clearly, answering to discussion forums and sending constant reminders. The xMOOC part required more time in the content creation, but the implementation was mainly automated. The MOOC also required us as educators to take a different role than in a traditional classroom setting shifting the responsibility for learning to learners to a greater extent. The interaction between learners and educators was rather limited due to the large number of learners. Therefore, educators were not able to support learners, who needed more guidance as strongly as in a classroom setting.

5 Discussion and Conclusion

Overall, these results indicate that the majority of global learners, who completed the hybrid model MOOC, were committed to collaborating and had an active role in knowledge construction with the most recent knowledge from the field. Moreover, the learners contributed to further development of startup-corporate collaboration. Our results are in line with prior research, which has indicated that building a learning community supports collaborative learning [19] and that a learning community may continue to grow independently after the MOOC, for example, via social media [10]. It was surprising for us that the learners took an active role in building a learning community beyond course boundaries and saw the MOOC being merely the starting point for bringing together people enthusiastic about co-innovation between startups and corporates. One year after the course, it is evident that the movement triggered by the MOOC appears to be steady. We argue that the MOOC had novelty value in starting this movement.

Furthermore, the completion rates were above the general average (less than 10%) for MOOCs [2, 12]. There are several possible explanations for this unexpectedly high completion rate, such as, the background of learners or timing of the course. However, we argue that the hybrid model may have had the strongest impact. Most of the inactive learners dropped out during the independent xMOOC part, and, thus, they did not compromise the completion of the cMOOC part for the more active learners. We argue that a hybrid model MOOC design with first a xMOOC part and then a cMOOC part to be the decisive factor for this. Moreover, the results show that the design of the hybrid MOOC enhanced the collaborative learning. Mainly because it supported learners to first create a shared knowledge base, which was fundamental for the collaboration.

Our results revealed the importance of building a learning community for collaborative learning and how creating a shared knowledge base was an essential first element for doing so. The results also demonstrate that communication technologies, such as social networks, allow new global collaboration possibilities beyond the facilitated learning that should be further researched. The results also highlight the potential disadvantages of a hybrid MOOC. It is not easily scalable due to the cMOOC part, which requires educators to be active during the implementation.

In addition, creating a hybrid MOOC, especially with a consortium consisting of many people, required a lot of time and resources to build it. It also required learners to take more responsibility for their own learning.

Because our research was focused on one MOOC and a rather focused group of learners, the findings may not be generalized as such to all MOOCs. Therefore, we purpose that further research should be undertaken in collaborative learning and building learning communities in hybrid model MOOCs. The practical implications of this research contribute to the need in sharing best practices of how to enhance collaborative learning in MOOCs and building learning communities.

6 Acknowledgement

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Long-Term Effects of Short-Term Intervention Using MOOCs for Developing Cambodian Undergraduate Research Skills

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Developing highly skilled researchers is essential to accelerate the economic progress of developing countries such as Cambodia in South East Asia. While there is continuing research investigating Cambodia's potential to cultivate such a workforce, the circumstances of undergraduate students in public provincial universities do not receive ample attention. This is crucial as numerous multinational corporations are participating via foreign direct investments in special economic zones at the border provinces and need talented human resources in Cambodia as well as in neighboring Southeast Asian countries such as Thailand and Vietnam. Student's research capability growth starts with one's belief in their capacity to use the necessary information tools and their potential to succeed in research. In this research paper, we look at how such beliefs, specifically research self-efficacy and information literacy, can be developed through a short-term intervention that uses MOOCs and assess their long-term effects. Our previous research has shown that short-term training intervention has immediate positive effects on the undergraduate students' self-efficacies in Cambodian public provincial universities. In this paper, we present the follow-up study results conducted sixteen months after the said short-term training intervention. Results reveal that from follow-up evaluations that while student's self-efficacies were significantly higher than before the short-term intervention was completed, they were lower than immediately after the intervention. Thus, while perfunctory interventions such as merely introducing the students to MOOCs and other relevant research tools over as little as three weeks can have significant positive effects, efforts must be made to sustain the benefits gained. This implication is essential to developing countries such as Cambodia that need low-cost solutions with immediate positive results in developing human resources to conduct research, particularly in areas far from more developed capital cities.

1 Introduction

Due to the genocide of the Khmer Rouge (1975–1979), Cambodia's higher education system has suffered because it was followed by continuous civil war, political conflicts, social insecurity, and very unstable economic reform [7]. By the early 1990s, Cambodia switched to a free-market economy, so higher education gained importance and played a role as the key to human resource development.

Cambodia issued its first policy on research in the education system in 2010 [13]. Different sectors collaborated to promote the culture of research in Cambodia by investing funds so that the Ministry of Education, Youth, and Sport (MoEYS) would benefit. The World Bank provided USD 90 million to Cambodia to improve higher education and research quality between 2015 and 2025 and promote cultural research and capacity [34]. This is separate from the USD 23 million funding provided by the World Bank to MoEYS from 2011 to 2015. The World Bank funding was to support teaching, management, and research at Higher Education Institutions [HEIs] through the Higher Education Quality and Capacity Improvement Project [HEQCIP] programs [24]. Cambodia has continued to earn support for its educational institutions even during the COVID-19 pandemic. For instance, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) has supported the strengthening of digital and distance learning in Cambodia when learners were forced to study online due to the educational institution lockdowns [31]. These higher education improvement efforts are expected to aid in moving the country's developing economy forward as the country attracts international investment.

Multinational companies have been moving manufacturing operations to South East Asia (SEA), for example, through Cambodia's special economic zones (SEZ) due to the rising labor costs experienced in China and to avoid trade frictions between China and the United States [22]. In particular, Japanese companies have been actively moving their operations to South East Asia (SEA) since the 2008 financial crisis [35]. In recent years, Japanese companies have started looking not just for low-skilled labor in SEA but also for highly skilled workers. Thus, they have been looking to hire local university undergraduate and graduate degree holders [18]. Japanese companies need human resources capable of high-skill activities such as problem-solving, which requires a researcher's mindset. However, academic research capacity remains a shortcoming for Cambodia, especially in the provinces. About 80 % of the universities in Cambodia have been established within just 15 years; thus, the quality of education, especially research skills, remain in the critical stage [32]. Additionally, faculty members at provincial universities are not as experienced in conducting research as their city-based counterparts [13]. Several of these SEZs are in international border facing provinces, as shown in

Figure 1. Thus, the provincial Cambodian talent is not just competing with their city counterparts but also with their neighbors, such as the Thai and the Vietnamese. In 2020, Thailand and Vietnam were ranked 67th and 96th respectively out of 132 countries by INSEAD in terms of global talent competitiveness; Cambodia, on the other hand, was ranked 117th [20].

To have a competitive edge, Cambodians in the provinces should have the research competency required by the SEZ investors. Additionally, they should be equipped with autonomous learning skills to enable them to quickly pick-up new skills as demands continuously change. Research and information literacy self-efficacies are essential attributes to conducting research and autonomous learning. Universities educate students that then work in society upon graduation. Their skills then form the foundation of the research capability of a nation. Thus, it is crucial to understand the self-efficacies of undergraduate students, especially in developing countries. While many researchers have investigated undergraduate students' self-efficacies in various geographical regions, Cambodian provincial universities' circumstances remain understudied.

Aside from being an individual's belief in his ability or capability to complete a specific task [4], self-efficacy is also seen as a person's ability to control a challenging task using their beliefs with their practices [23]. Self-efficacy, however, is not the same as competency; students who have high research self-efficacy do not necessarily have high research ability since the research environment – resources, mentoring, and motivation, among others – also matter [16]. Nevertheless, high research self-efficacy was found to be highly correlated to positive research attitude, which can serve as a starting point for future researchers [19]. Individuals who have high perceived self-efficacy believe that they will be successful, and they will continue to endeavor until finishing the task [10]. High research self-efficacy has been connected to future research involvement and higher research productivity in many studies conducted [21, 5, 14]. The gains from high research self-efficacy can be expected to be further magnified when combined with information literacy self-efficacy.

One of the most cited definitions of information literacy is the one given by the American Library Association in 1989. Information literacy is the set of abilities required by individuals for recognition when information is needed. They can locate, evaluate, and effectively use the information necessary [2]. Information literacy self-efficacy can be an individual's judgment of their own ability to access information, evaluate and use this information effectively [3, 17]. From here, we can see the relevance between information literacy self-efficacy and autonomous learning, where students are expected to control and regulate their own learning.

Students often gain those autonomous learning skills they need as part of their growth in tertiary education. However, progress is sometimes slow, and they have difficulty understanding some of the basic tenets of information literacy.

Figure 1: Special economic zones in Cambodia

In that sense, they need a repertoire of evaluative strategies [6] to become better researchers. It will become increasingly important to teach students the skills they need to be better users of information. Data and information can be freely published and accessed on the internet; this presents students with a unique challenge that students twenty years ago did not have to deal with. Processing information that is not professionally vetted will require students to use potentially new critical thinking skills. The more students and educators know how to assess and use information, the better off they will produce their original research outside the classroom.

2 Related Work

To better understand the current circumstances, we conducted a cross-sectional study at three public provincial universities in Cambodia from February to March 2018 [29]. The Research Self-Efficacy (RSE) survey by Phillips and Russell [25] was administered to 1,009 undergraduate students from different faculties to assess their research self-efficacy. The information literacy self-efficacy of the same group of students was measured using the information literacy self-efficacy skills (ILSES) survey by Kurbanoglu, Akkoyunlu, and Umay [17]. The findings indicated that the undergraduate students at the provincial universities in Cambodia exhibited low confidence in research and information literacy. Both the RSE and ILSES were localized to the native language Khmer and Cambodian context (i.e. combined items which are conceptually similar in Cambodia). The questionnaires were delivered as five-point Likert scales.

A training intervention was administered to 461 undergraduate students at three public provincial universities in Cambodia between August to October 2018 to address the deficiency in the said self-efficacies [27, 28]. The participants were pooled from the respondents in the original study. The participants answered the same sets of questionnaires before and after the intervention. The training lasted three weeks and was 60 hours in total covering topics such as using statistical analysis software, Massive Open Online Courses (MOOCs), and referencing software. Typically, training interventions address the concerns directly: in our case, research self-efficacy and information literacy self-efficacy. However, through the analysis of the cross-sectional study results, we learned that the current infrastructure in these universities – from the facilities, curricula, and even teacher training – was lacking. Interventions directed at the target self-efficacies may work. However, the students may not have the chance to cultivate their knowledge and transform their self-efficacies to quality research outputs. We decided to design the interventions to cover the more practical topics and investigate if these indirect, yet pragmatic, approaches can have positive results.

While knowing how to use statistical and reference management software have direct usage in research, the benefit of being exposed to MOOCs is not as straightforward but can be profound. Because MOOCs are typically self-directed learning experiences, they promote self-regulated learning skills [1]. Independent learning can come in handy in research projects as it is expected for researchers to find gaps in their knowledge that they must quickly fill. Some learners additionally require the structure provided by courses to assess if their learning has been enough. During the training intervention, the learners attended MOOCs on edX for three days (four hours per day, thus 12 hours in total). They were given the freedom to choose courses on English language, academic writing, research methodologies, and statistics. The goal was simply to familiarize the learners with the learning format. The students were taught how to create accounts, choose courses, and navigate the edX platform. They were also required to at least complete a quiz and the researcher was available throughout the training to provide support. The decision whether to complete the MOOCs they enrolled in is left to the students. Trainings for using statistical software and reference management software were done for eight and four days, respectively.

The use of MOOCs not just for academic purposes but also for professional and capacity building is not new. In January 2021, the online course aggregator Class Central has listed more than 300 courses specific to career development [8]. Recognized institutions in the region such as the Asian Development Bank (ADB) have developed several MOOCs intended for capacity building of government employees in developing countries within the region [26]. And while the creation of MOOCs is not yet widespread in Cambodia, several Cambodian universities had been embracing the use of MOOCs. With the onset of the COVID-19 pandemic, Cambodian universities have promoted MOOCs such as through the Erasmus+FRIENDS Project MOOC [11]. Another notable example is the Institute of Technology of Cambodia's efforts to use MOOCs both in English and in their native language Khmer even before the pandemic has started [15].

The result indicates that short-term training is an effective means to promote information literacy and research self-efficacies among students. This result is not surprising: it is known that providing educational activities such as short-term training interventions can help raise self-efficacy beliefs [4]. What remains to be understood is how effective is the said intervention. Will the students sustain their gained self-efficacies until they are given a chance to demonstrate their research skills later in their career? We addressed these questions through a follow-up study detailed in this paper.

3 Methodology

After one year and four months, we conducted a follow-up survey at two public provincial universities in Cambodia. We randomly selected 60 students from each university from the same pool of 461 respondents during the training intervention (or the post-test), with the added criteria of coming from the best and worst performing universities during the pre-test and post-test for practical purposes. As mentioned previously, the post-test students were pooled from the 1009 respondents during the cross-sectional study (or the pre-test). Of the 120 students contacted, 95 students responded. After data processing, 87 responses were deemed to be complete for further analysis.

This research study adopted a mixed method approach to respond to each research question. Descriptive statistics such as the minimum, maximum, and mean scores of each research self-efficacy and information literacy self-efficacy items on each test (pre-test, post-test, and follow-up) were calculated. A paired samples t-test was used for the pre-test, post-test, and follow-up surveys of each of the 87 respondents to determine research self-efficacy and information literacy self-efficacy over time. The data were analyzed using the Statistical Package for Social Sciences (SPSS). An alpha value (α) of .05 (level of significance) was used for each statistical analysis. Cohen's d was used for calculating the effect sizes, which were typically interpreted as small for values between 0.2 to 0.5, medium for values from 0.5 to 0.8, or large for values greater than or equal to 0.8 [9]. Randomly selected students were invited for unstructured interviews to probe on their views about potential research careers in the future.

4 Results and Discussion

The RSE and the ILSES items are grouped into factors using the pre-test results with principal component analysis (PCA). The subsequent studies for post-test and follow-up are presented here according to these computed factors for brevity. The RSE resulted in four factors which we consequently labeled as research design skills, practical research skills, quantitative and computer skills, and writing a paper for a journal publication. The ILSES, on the other hand, resulted in three factors, which we labeled as information literacy skills for research production, information handling skills, and skills in using library resources.

Figure 2 shows that the respondents' research self-efficacy levels during the pre-test and the follow-up were under the median score of 3 for the five-point Likert scale. The overall research self-efficacy mean scores are higher during the post-test and follow-up than the pre-test. Statistical analysis with the follow-up data also showed a significant difference with the pre-test scores. These findings indicate that while the participants became more accepting of research self-efficacy from the post-test due to the IT training intervention, their attitudes had become less confident on research one year and four months after the intervention. The levels are still better in comparison to the pre-test. Thus, even though the training intervention is only short-term, its impact remains on their research self-efficacy.

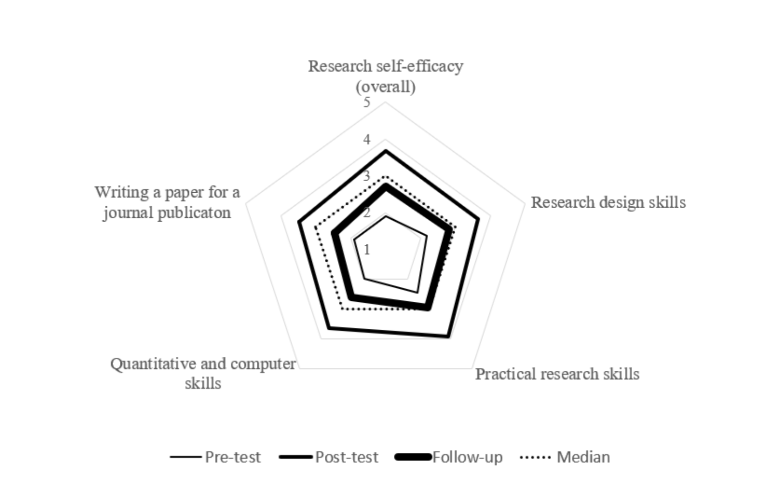

Figure 2: Mean scores for pre-test, post-test, and follow-up on research self-efficacy

Figure 3 shows that respondents' overall information self-efficacy levels during the pre-test and follow-up survey results were under the median score of 3 for the Likert scale. We also noticed that the pre-test scores are the lowest for all factors, while the post-test is the highest. The result for information literacy self-efficacy is thus, like that of the research self-efficacy. This means that doing just one intervention is better than none, but it is not enough to sustain a long-term effect after one year and 4 months.

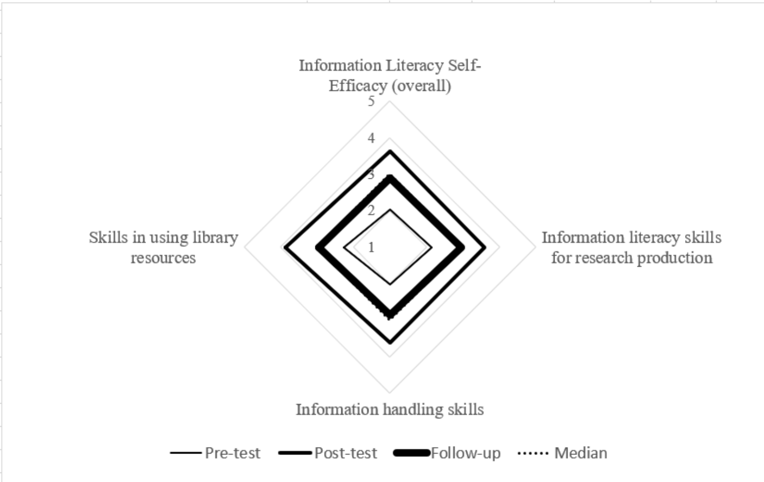

Figure 3: Mean scores for pre-test, post-test, and follow-up on information literacy self-efficacy

Table 1 shows the mean score differences between follow-up assessment and pre-test on subscales of research self-efficacy. The observation revealed a significant mean difference between follow-up and pre-test on overall research self-efficacy ($t = 11.07$, $df = 86$, $p = .000$) with a mean score difference of 0.81 in value. Effect sizes of these differences were also large and found to be 1.279, .916, 1.006, 1.070, and 1.187 for each factor, respectively.

Table 2 shows the mean score differences between follow-up assessment and pre-test regarding subscales of information literacy self-efficacy. It is observed that the mean difference between follow-up assessment and pre-test students regarding overall information literacy self-efficacy ($t = 10.68$, $df = 86$, $p = .000$) was remarkable with a value of .88. The high effect sizes of these differences were also observed to be .990, .998, .699, and 1.145 for each factor, respectively.

Table 1: Comparison of research self-efficacy scores during pre-test and follow-up

Factor	Pre-test		Follow-up		Paired samples test		Effect size
	Mean	SD	Mean	SD	t	Sig.	
Research design skills	1.93	0.61	2.81	0.41	11.93	0.000	1.279
Practical research skills	2.2	0.70	2.96	0.53	8.55	0.000	0.916
Quantitative and computer skills	1.81	0.61	2.6	0.46	9.38	0.000	1.006
Writing a paper for a journal publication	1.64	0.64	2.47	0.49	9.98	0.000	1.070
Research self-efficacy	**1.90**	**.58**	**2.71**	**0.40**	**11.07**	**.000**	**1.187**

Table 2: Comparison of information literacy self-efficacy scores during pre-test and follow-up

Factor	Pre-test		Follow-up		Paired samples test		Effect size
	Mean	SD	Mean	SD	t	Sig.	
Information literacy skills for research production	2.14	0.76	2.95	0.54	9.24	0.000	0.990
Information handling skills	2.03	0.72	2.86	0.57	9.31	0.000	0.998
Skills in using library resources	2.26	0.89	2.96	0.55	6.52	0.000	0.699
Information literacy self-efficacy	**2.02**	**.70**	**2.9**	**0.49**	**10.68**	**.000**	**1.145**

From these results, we learn that the students are better off with short-term training intervention than without it even in the long run. However, the positive effects can fall apart if no follow-up action is made. When the selected universities' curricula were analyzed, we learned that there is only a single computer-based course offered during the first year, and students can opt-out of the research requirement for graduation by taking comprehensive exams instead. Because research skills and information literacy skills cannot be separated, the number of courses about research and IT in these undergraduate programs should be increased. However, upgrading curricula can be costly both in time and money as it will require a careful reevaluation of the current curricula, consultation with relevant stakeholders, and retraining. This is where introducing the students to MOOCs can have a compounding effect. Multiple research studies have shown that MOOCs can be a game-changer for developing countries. It provides access to high-quality learning materials produced by top institutions in other parts of the world without the time, cost, and location restrictions [33].

The follow-up study also involved informal interviews with the students on what they learned from the short-term intervention and how it has impacted them. The students indicated that through the short-term intervention, they learned how to enroll in MOOCs and conduct basic data entry and analysis. They saw the activity as very practical in improving their research skills which led them to having better understanding of other related concepts such as qualitative approaches. Because of this, they gained confidence in writing a thesis instead of just taking the examination option for graduation. These perceptions support the effectiveness of our approach; with their improved self-efficacies, the students gained confidence in exposing themselves to research activities, which can cascade into skill development through practice.

Undergraduate students should also be directed to activities that develop these skills to positively affect these skills. This can be done by making the research option more palatable to students by enticing the faculty to develop their research skills and let them serve as positive role models. Un and Sok [30] pointed out that only a handful of academics in Cambodia had completed doctoral programs; about the same number of academics did not even hold qualifications at the master's level. Eam's [12] research found that faculty members' research interest in Cambodia was directly related to competence. Students should be provided the skills throughout their entire stay in the university and not just in select years.

5 Conclusion

Cambodia has been setting its sight on using higher education to advance its economy, as evidenced by the attention being given to higher education not just by the Cambodian government but by international bodies such as the World Bank. With the current global job market demands, provincial universities are prime candidates for these developments. Several SEZ that attract multinational companies seeking highly skilled research capable human resources are being built in the provinces. Our previous studies have shown that undergraduate students in the provinces are not well-equipped with research and information literacy self-efficacies. These are essential skills to succeed in conducting research, and this concern can be remedied with a short-term intervention targeting practical skills, one of which is familiarization with MOOCs. The follow-up study discussed in this paper supports our previous studies' results that short-term intervention positively affects both research self-efficacy and information literacy self-efficacy. However, after an extended period, the effect tapers off without follow-up support. Thus, our follow-up study also reinforces our previous recommendations to integrate research and information literacy throughout the undergraduate curriculum (i.e. from the first year to the fourth year).

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MOOCs for Flexible and Lifelong Learning in Higher Education

The Struggle from within Loosely Coupled Organizations?

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In this paper, we take a closer look at the development of Massive Open Online Courses (MOOC) in Norway. We want to contribute to nuancing the image of a sound and sustainable policy for flexible and lifelong learning at national and institutional levels and point to some critical areas of improvement in higher education institutions (HEI). 10 semi-structured qualitative interviews were carried out in the autumn 2020 at ten different HE institutions across Norway. The informants were strategically selected among employees involved in MOOC-technology, MOOC-production and MOOC-support over a period of time stretching from 2010–2020. A main finding is that academics engaged in MOOCs find that their entrepreneurial ideas and results, to a large extent, are overlooked at higher institutional levels, and that progress is frustratingly slow. So far, there seems to be little common understanding of the MOOC-concept and the disruptive and transformative effect that MOOC-technology may have at HEIs. At national levels, digital strategies, funding and digital infrastructure are mainly provided in governmental silos. We suggest that governmental bodies and institutional stake holders pay more attention to entrepreneurial MOOC-initiatives to develop sustainability in *flexible* and *lifelong learning* in HEIs. This involves connecting the generous funding of digital projects to the provision of a national portal and platform for Open Access to education. To facilitate sustainable lifelong learning in and across HEIs, more quality control to enhance the legitimacy of MOOC certificates and micro-credentials is also a necessary measure.

1 Introduction

In Norway, the interest in Massive Open Online Courses (MOOC) in higher education (HE) emerged as a consequence of global trends in open online education around 2010. Early on, digital educational enthusiasts Krokan [18], Haugsbakken and Langseth [11], and Hjeltnes and Horgen [13] embarked on independent learning journeys out of self-motivation, followed by national government bodies, as well as leaders in higher education institutions, who outlined digital strategies and guidelines [23, page 5] and funded a series of MOOC-related projects [16].

Some ten years later, Tømte, Laterza, and Pinheiro [27] reviewed national research literature and strategic documents on MOOCs and found that the MOOC-concept is still contested in Scandinavia. Their findings are linked to different perspectives and tensions among academic, administrative and ICT staff at institutional levels and to some extent government involvement and engagement with MOOCs at HEIs. As compared to the rest of the world, they find that Scandinavian MOOCs have developed at their own pace within different national and local contexts. One effect is more attention to teaching and learning, with some spill-over effects on campus-based programs. Tømte, Laterza, and Pinheiro [27] also describe Norway as the only Scandinavian country that has provided a national strategy and systematically funded MOOC-initiatives in HEIs. Nevertheless, and despite a series of Norwegian governmental initiatives related to digitalization strategies and project funding, we are concerned about the adoption of the MOOC-concept at both governmental and institutional levels. A part of this concern relates to how stakeholders in Norwegian higher education institutions (HEI) have understood and acted upon the MOOC-concept.

In this article, we will define the MOOC-concept close to its original description and later international development [15]. By these definitions, *MOOCs* are online courses provided by HEIs on an open EdTech platform and made available in large numbers. Anybody irrespective of their geographical location can register and get access to the content and receive a certificate or some form of formal accreditation after completing a course. *All* content – instructions, learning objectives, learning materials, tasks and assessment – is designed and completed prior to the course start. The course content is mainly delivered asynchronously with automated feedback. Course adjustments resulting from direct feedback from students and from data collected on the digital platform, happen in between course runs. Thus, we exclude blended learning from the definition. *Blended learning* is usually understood as online courses offered to registered students on more closed learning management systems (LMS) and with some content synchronously delivered online (e.g. Zoom, Teams) and on campus.

Obviously, we do recognise the spill-over effect from MOOCs to blended learning and traditional courses and vice versa. Providers of one type of course have a lot to learn from suppliers of the other (e.g. pedagogy and multimedia production). MOOCs can also be seamlessly integrated in campus programs or function as supplemental learning for students [14]. However, the point that we want to make is that there are two logics at play [12]. The concept of logics is generally referred to as broader cultural beliefs, values and rules that structure cognition and guide decision-making in a field [1]. One logic is the traditional (closed LMS for campus-based learning) model and the other logic is the transformative (open MOOC-platform for online learning) model. The latter will likely impact strategic, pedagogical, judicial and financial decision making in HE education in future. A rapidly and ever-changing society and work life with a continuous demand for new skills and competencies will gradually focus less on defined diplomas and rather start to appreciate initiatives that focus on bite-size learning on-demand and just-in-time [9].

In their research, Tømte, Laterza, and Pinheiro [27] identified a top-down model with sustainable centralized funding in the governance of MOOCs in Norway. We want to nuance this picture aiming to understand the conditions for a successful outcome of MOOC-initiatives in Norwegian organizations in light of flexible and lifelong learning.

2 Research Focus

An overall issue in this research pertains to how Norwegian HEIs will be able to handle digital transformation to meet competition and societal demands for flexible and lifelong learning for all. The authors of this article have been heavily involved in developing the MOOC-concept at institutional, national and global levels at one HE institution in Norway. With this follows the risk of a certain bias that we are aware of. Nevertheless, we also believe that we can contribute to painting a more detailed picture of how entrepreneurs in the field experience obstacles to and benefits from this digital shift.

Our main research question in this article is: *What are the current conditions for MOOCs in Norway?* Sub-questions also governing the research are: *What conditions may impede the outcome of successful MOOC-initiatives at HEIs in Norway? and How can Norwegian stakeholders facilitate successful MOOC-initiatives in HEIs?* To answer these this end, we have interviewed entrepreneurs, here understood as employees that take an active and divergent role in developing the MOOC-concept, at ten different HEIs in Norway. Their experience in the MOOC area is the backbone in this research.

3 Theoretical Guidelines

In general, HE systems comprise several levels of governance, procedures and implementations where a number of institutions represent the operational level. In Scandinavia, most institutions are public and funded by the government. As such, they are also governed and overseen by the ministry of education. Nevertheless, universities are traditionally bottom-up institutions where academic personnel with a discipline-based identity and expertise are the core personnel. They possess the specialized knowledge that the production in the organization depend on. Usually, when essential knowledge is predominantly situated at the bottom of the hierarchy, we also find organizations with a high degree of local governance and *room for manoeuvre* [24].

Over the years, the institutions have also added administrative staff. In Norway, for instance, they are a growing part of the hired personnel dealing mostly with executive tasks, strategies and support. This also means that the autonomy of faculties (academic personnel) has decreased as the logic of *new public management* (NPM) has replaced the previously non-hierarchical and autonomous institutions. Along with this development, new digital technologies and stakeholders outside the universities, e.g. work life, other educational institutions or governmental officials start to place new demands. Contemporary research has tried to unpack these implications in more specific or concrete terms.

To better grasp the complex dynamics and nuance the conditions for MOOC innovation in Norwegian HEIs, as described in [27], we turn to New Institutionalism Theory in organizational analysis for inspiration. New Institutionalism Theory serves as a theoretical framework to guide the research questions and three categories developed in the data analysis. Sociologists Meye and Rowan [21] argued early on that organizations adopt rational and technical procedures as a means to gain *legitimacy* among other organizations, with the consequence that the instruments intended for enhancing organizational performances develop into *rationalized myths*. In other words, the adoption of rational and technical procedures is merely *superficial* and serve little or no purpose internally in organizational life. Adoption of rational procedures are more of a symbolic display in a championship for legitimacy with other organizations. In fact, this aspect creates the very common conception that organizations have a dual face; on the one hand, organizations portray themselves as effective and rational, while, on the other hand, internal organizational structures intended to be efficient are rather vast and ineffective. Scripted logics for how things are supposed to be done, lead to a variety of *loose coupling* of components that operate under their own agenda or possess separate, overlapping, and contractional institutional logics. Organizational theorists describe *loosely coupled systems* as an effect of high levels of autonomy which is especially prevalent in educational institutions [28, 29]. Different levels and branches of the organization are only loosely connected and what goes on in one subdivision does not necessarily influence the arrangements in others, which has both positive and negative implications. The notion of loose couplings also denotes a lack of compliance between formal structures, i.e. goals, decisions, plans and lines of authority, on the one hand, and work processes and results on the other [24].

Moreover, it is precisely within these loosely coupled systems that MOOC *entrepreneurs* intend to perform acts of digital transformation or innovative pedagogy. *Digital transformation* is widely used to describe the transformational or disruptive implications of digital technologies in institutions and business [22], and more specifically, to indicate how existing HEIs may need to transform themselves to succeed in the emerging digital world [17].

Instead, we observe that educators share experiences described in research on institutional entrepreneurs. Although institutional entrepreneurs have been defined as change agents, the research points out that the field position of institutional entrepreneurs can be impeded by the power of larger institutional arrangements such as the institutional logics of stakeholder or other competing organizational structures [28, 29].

Nevertheless, loose couplings establish a room for manoeuvre where institutional entrepreneurs can operate. Institutional Entrepreneurship (IE) was first introduced by DiMaggio [6] to describe actors, who initiate changes that contribute to transforming existing and creating new institutions. This is different from notions describing how institutions influence actors' behaviour in a top-down approach. Battilana, Leca, and Boxenbaum [2] propose "a conceptual account that views institutional entrepreneurs as change agents who initiate divergent changes, that is, changes that break the institutional status quo in a field of activity and thereby possibly contribute to transforming existing institutions or creating new ones." [2, page 67]. The concept of institutional entrepreneurship contributes to understanding the rapid change that digital technologies has brought about worldwide, and the role of actors and action in the creation, diffusion, and stabilization of digital transformation in HEIs. MOOC entrepreneurs might, for instance, argue for a particular form of online education that does not correspond with institutional logics of campus pedagogy.

4 Method

This study was based on ten individual semi-structured interviews with academics from ten different HEIs across Norway in the autumn 2020. The basic idea behind the study was to gather open-ended data inspired by an inductive approach and Grounded theory [3, 26]. A main idea in this line of methodology is to build on the content of the informants' responses to elicit new theories and insights. The interviews allowed us to explore similarities and differences across these institutions and explore their uniqueness at internal, external and strategic levels.

To find the informants, we selected academic personnel based on an *information-oriented strategy*, that is, we wanted to find the informants who could provide us with as much information as possible regarding the various MOOC initiatives. To this end, we selected ten institutions based on their active role in the development of MOOCs in Norway. We asked leading personnel to put us in contact with the actual informants. A main criterion for selection of informants was that these informants should have been engaged in MOOC-technology, production and support over a longer period, preferably stretching from 2010 to 2020. The participants finally selected (N = 10), were both male (N = 9) and female (N = 1).

The interviews lasted about 60–70 minutes each. Because of long distances and potentially high travel costs, we carried out the interviews online, on ZOOM. Each interview was taped and subsequently transcribed with consent from the interviewees. The individual contributions have been anonymised in the process.

After the interviews, we coded the data in NVivo and developed categories based on the informants' statements. The purpose of these categories was to structure the rather large material. The next step was to implement a variation of the *constant comparative method* [10, 5], to compare the informants' accounts and to paint a picture of the different initiatives, their similarities and differences throughout the institutions. Throughout the analysis, a particular focus was on the research questions listed above. The research project has been approved by the National Centre for the Handling of Research Data in Norway (NSD).

5 Preliminary Findings and Discussion

The findings in this study will be presented in three overreaching categories: 1) *MOOC-activities in pockets of innovation* 2) *internal conditions for digital transformation* and 3) *national contributions to digital transformation*.

5.1 MOOC-Activities in Pockets of Innovation

The informants described entrepreneurial roles and actions taken in the development of *online courses* in all the ten institutions. When asked to describe their source of inspiration, most informants pointed *abroad*, for example to Stephen Downes and George Siemens, who in 2008 made a connectivist MOOC to take advantage of web 2.0 technologies and social media to engage learners in more informal learning contexts. They also pointed to Connectivism [25], which is described as an emerging theory for the digital age. Informants also reported being inspired by various pedagogical designs and business models mainly formed by the EdTech industry and by leading HEIs, such as MIT, Harvard, Stanford and the Open University. The informants described themselves as among the first to take a serious interest in the MOOC-concept around 2012–2014. The timing also coincided with the white paper MOOCs for Norway [23] that created enthusiasm among the informants as expressed by one of them:

It (MOOC-initiatives) coincided well with the report (MOOCs for Norway [23]) and OK, now something is brewing here, and something is happening [...] Driven by curiosity then. (HEI-1)

When asked about their affiliation, the informants reported being initially *located* in very different fields – spanning from the university library to technological support units for the LMS and in academic positions in their institutions. Interestingly, none of our informants located their initiatives in the IT-department. Some described an early interest in Open-Source technologies, others in Open Access to education (MOOCS) and a few also explored the possibilities of joining global MOOC-platforms, such as Coursera and FutureLearn in their institutions. We can distinguish three typologies of inspirational sources:

- *Global MOOCs* – Some informants were inspired by study visits to e.g. EPFL, MIT or Stanford or they participated in research projects involving international partners that sparked the interest and motivation to produce their first MOOCs on for example FutureLearn and Moodle in English with a global reach.
- *National MOOCs* – Other informants networked with other interested parties in their organization to establish the MOOC-infrastructure and pilot their first MOOC on Open Canvas and Open edX in Norwegian for national reach.
- *Online courses* – Many informants reported on developing closed online or blended courses with a somewhat more regional reach and with more synchronous and teacher supported learning activities on the existing learning Management system (LMS), usually Canvas. The latter is, however, of less interest in this study, due to the more traditional approach that seems to better fit the existing organizational arrangements.

To illustrate the level of interest and activity in these initiatives, we refer to one informant, who reported that their global MOOCs provided on FutureLearn attracted some 35,000 learners, and that their national MOOCs provided on the institutional Open edX platform attracted some 25,000 learners in 3 years. The overall picture in the interviews is that there are tangible results coming out of these pockets of innovation. By *pockets of innovation*, we think of independent local groups of innovators or early adopters, who explore their room for manoeuvre to test new concepts and ideas. These ideas concur strongly with the entrepreneurs' values and beliefs about education and institutional practices, but are only loosely coupled to organizational goals, strategies, existing practices and leadership mindsets. Academic freedom exists as long as these pockets of innovation operate independently. When faced with institutional arrangements (cf. New Public Management), the same freedom has a downside, which may lead to alienation and burn out, as the professional standards of excellence are measured against measurable standards based on a different logic [20].

Following the initial MOOC-hype, informants described how the HEIs, to a variable extent, organized and anchored the entrepreneurial MOOC-activities in the organization. We found three typologies:

- *Random initiatives* – informants reported on ad-hoc initiatives and external funding (cf. DIKU).
- *Project management* – informants reported that they were supported by their institution in internally funded projects.
- *Reorganization* – informants described the way they had been reorganized to establish a support unit involving MOOC-production, where an existing unit typically expanded and assimilated MOOC-production in their activities.

While project management is a common strategy in New Public Management, reorganization is a strategy intended to remove physical barriers to strengthen collaboration across institutional silos. A central component in these arrangements is trust [20]. As there are few elements of control involved, the overall picture is that of a journey from random initiatives to more formally established practices at different paces in separate pockets of innovation with variable proportions of trust attached to them.

The MOOC went up and then it went down a bit, so you think it is dead, I think it is not dead, but that you have now come to the next step. That it's not just about MOOC alone, to make these courses and stuff, but it's come to the next phase now then, to use this for something bigger, to do something new that I think the universities are completely dependent on taking in. This is an example of something that comes in from the side that challenges the university structure and the discussion that we have to take, the first thing is to make the university understand that this is something you have to decide on now, because something comes later. To attack the problem before it has become a problem then. (HEI-1)

Despite this, a main finding is that regardless of the way these MOOC-initiatives are organized and funded, they are often placed on the "back shelf" and their legitimacy is still loosely embedded in strategy and policy documents at higher institutional levels and in the broader set of academic cultures at lower institutional levels. In the various MOOC-initiatives, positive feedback on project proposals resulting in external funding and prizes are common, as long-term outcomes seem to be non-existent.

We conclude that the conditions for MOOCs in Norway are difficult. Sensemaking and translation of the MOOC-concept is currently taking place in Scandinavia [27] and is lagging behind international trends and development [19]. Considering the massive development of MOOCs worldwide and the massively growing competitive market for lifelong learning reported in [4], this should obviously be an area of interest to HEIs in Norway.

5.2 Internal Conditions for Transformation in HEIs

When asked about conditions that impede the outcome of successful MOOC-initiatives in the organization, most informants reported that they struggle to disseminate their ideas and products outside their teamed and self-motivated pockets of innovation. For example, while external funding of their projects was most welcome, informants felt that many leaders allocated limited *time* to be informed about progress and results in their MOOC-initiatives. This also applied to locally funded projects. Moreover, many informants experienced that leaders possessed an *insufficient vocabulary* to understand and discuss the logics of MOOCs and possible implications for the HEI in a broader perspective in the limited time available.

There is a decoupling of some formal processes [...] And then the institution wants the money and the activity and then they (leaders) sign (the contract), but they do not really mean it. Or, they do mean it, ideally speaking, but they do not really understand what the consequences of these decisions (MOOC projects) really are. But, committing the organization in the long-run or committing to spreading something to more people, well, it is not that easy. (HEI-5)

Informants repeatedly describe the dissemination of their results in negative ways: *It has not been successful considering the HEI as a whole, we do not succeed in getting the message out. (HEI-7).* For example, and to illustrate the complexity in the point that the informants are making, we found that their activities are mainly located across organizational charts and horizontally aligned, as opposed to online and ordinary campus courses on LMS that are generally organized in pre-existing programs and where course collaboration takes place in more local arrangements following established practices. We found that the MOOCs are produced in teams, often consisting of complementary competences involving *technical, multimodal (video)* and *pedagogical* support and a range of *expert subject knowledge.* They team together from both inside and outside the institution for a certain period of time, generally lasting from a few months to a year, to reach a common educational goal, often with a *multi-purpose potential* in and across HEIs.

The informants also reported that most academics contributing with their expert subject knowledge were very enthusiastic in their first MOOC, spending a lot of time on a more voluntary basis, while they were more reluctant to take on the work without support in terms of allocated time and recognition from their leaders in their second MOOC.

But it has probably more to it with time, resources and means to do it. I think a stopper might be that educators will not get any special credit for doing so either. [. . .] Maybe more what do you get for it? Why should we do that? Because it's about priorities in the end, so that yes, [. . .] there is something that just does not function quite well there yet, and it is in a way a responsibility that lies throughout the chain there. (HEI-1)

Moreover, when asked about systematic development and research on their activities, informants reported that there is limited research documenting these MOOC-initiatives. With some exceptions, they described research as not an issue in the support units (e.g. administrative positions with no allocated time for research) and that academics with research time, to a lesser degree, seem to carry out research on their MOOCs. Something, which is also confirmed by [27], where one institution was responsible for nearly half the eleven refereed articles on MOOC by Norwegian authors.

An overall preliminary interpretation of the data coming out of the interviews is that the informants seem to struggle to translate their technological and pedagogical ideas into a more administrative and bureaucratic language to make themselves understood and thereby strengthening their position in the institution. Our findings suggest a weak competence in their role as *translators* in the organization [8], which in institutional entrepreneurship theory refers to how entrepreneurs battle with more powerful organizational actors [2] and are often left powerless. Further research is needed to establish whether this is due to predominantly *silent knowledge* and *limited research capacity* on their own practice to back their arguments, and to what extent leading stakeholders have developed a vocabulary to enter into a discussion on MOOC-initiatives. However, MOOC-actors seem to be impatient, they may fail to understand the slow speed of change and the resilience it takes for indirect impact to manifest itself in inconsistent relations between organizational levels [24].

5.3 National Conditions for Institutional Change in HEIs

We also asked the informants about and how national stakeholders facilitated MOOC-initiatives in their HEI. The informants described no *coherent* national strategy to support institutions and academics who provide flexible and lifelong

learning on MOOCs in HE. One response describes the general attitude to national support:
I am not impressed by the visionary level on government speeches and documents. [...] Most innovation and inspiration, and also the visionary ideas happen at grassroot levels. (HEI-3)

The informants described the government bodies as mostly peripheral, as only one government body seemed to play a more active and supportive role. For example, while the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (DIKU) provided funding for transformative open online course production, the Norwegian directorate for ICT and joint services in Higher Education and Research (UNIT) provided minimal, but crucial support for the local Open EdX developers in our study. Our informants made no reference to The Norwegian Agency for Quality in Education (NOKUT) in terms of the many questions related to open online education, quality enhancement and legal affairs in the area of MOOCs, certificates, transfer credits and micro-credentials etc. that the MOOC-initiatives entailed. So far, we would like to add that the government has not yet come up with a sustainable financial model for flexible and lifelong learning, that attracts national MOOC-offerings in HEIs (cf. principle of free education).

To further support the argument, our informants referred to the ad-hoc provision of two MOOC-platforms – Open edX and Open Canvas, and a portal – mooc.no, which came about upon request from individual entrepreneurs in HEIs and was graciously supported, with minimal maintenance and upgrading, by individual stakeholders in UNIT around 2013–2014. Our informants report that the support is still mainly funded by the institutions at minimal cost:

There are limitations on the side of UNIT, actually. The Open EdX-installation is not a priority there, in any case. (HEI-7)

In the few institutions that provide national MOOCs for flexible and lifelong learning in Norwegian, our informants described the platform technology as developed in projects and centre-based pockets of innovation characterized with a somewhat loose institutional anchoring and legitimacy. The Open edX entrepreneurs, who networked and pushed for national action, described their efforts as not successful, others reported on a gap in the organizational arrangements for national MOOCs. Our findings suggest that the white paper MOOC for Norway [23], seems to have made little difference at governmental levels so far.

An overall picture in the interviews is that there are pockets of innovation ready to support technological infrastructure for MOOCs and MOOC-projects located in governmental bodies. However, the lack of a national coherent strategy for MOOCs may well explain why we found that nationally funded online courses tend to run on closed LMSs where participants must register as qualified students at bachelor's or master's degree level to get access to course content. Moreover, since there is no coherent, reliable and legitimized national technological infrastructure – portal and platform – in place, we argue that it is challenging for flexible and lifelong learners to know what courses are available.

To sum up, we see different *logics* at play [1] also behind digitalization initiatives at government levels in HE. The logic seems mainly campus centred. Nevertheless, *loose couplings* [24] seem to go all the way up to governmental levels and also exist among the different governmental branches. At these levels, pockets of innovation exist, but tend to be overseen, as many initiatives become invisible. The MOOC-field seems decoupled from formal structures and established policy and practice, with implications for HEIs.

6 Consequences for Flexible and Lifelong Learning

Acknowledging that strategic decision making in HE is a question of logics, value and judgement, our findings suggest that strategic decisions regarding MOOC-initiatives are, with some exceptions, not sufficiently informed at managerial levels. One informant expresses his/her concerns in the following way:

The challenge probably lies in the fact that they (the MOOC-actors) have too little contact with the ownership level, for instance the vice-rector level. Because if the strategic competence is to be affected and begin to work, [...] as a basis for making the important strategic choices, one must have a certain minimum of contact with top management level, and we have probably not had that until now. [...] One does not have good enough contact with, I would say, quite innovative programs and projects such as [mentions project]. (HEI-3).

Inspired by Paulsen [24], we suggest the existence of an asymmetrical distribution of *critical knowledge* regarding MOOCs at the different institutional levels. This applies in particular to the complex and rapidly emerging EdTech-based landscape. Consequently, entrepreneurial pockets of innovation tend to stay encapsuled for longer periods of time, as no-, slow- or perhaps ill-informed strategic decisions are made. Unclear strategies at government levels only contribute to the complexity of strategic decision making in HEIs. Considering that hundreds of millions of NOK have already been spent on funding online courses, results from these initiatives can contribute to inform decisions regarding digitalization of HEIs.

Academic teachers and leaders are not a homogenous group, and there are blurring boundaries. Our findings are consistent with findings from in HE research in the UK [30]. Here, the researchers found that also many academic teachers are reluctant and less motivated to adopt digital technology as there is limited evidence to show that technology has a positive impact. This relates to module and course evaluations, as well as consequences on their career development.

Zhou, Wolstencroft, and Milecka-Forrest [30] also found that many managers in the UK believe that *digital technologies* can increase course recognition, prepare students for future careers and create a student friendly environment. The main difference between Norway and the UK seems to be the leaders' motivation for direct involvement in innovation projects.

With reference to the two different logics at play in Norwegian HEIs, our informants display a certain scepticism regarding leaders' beliefs in MOOCs as tools for *flexible* and *lifelong learning*. Except from strategy and policy documents, we found no research and little evidence regarding academic managers' motivation to introduce and support digital technology in HEIs in Norway. For example, in one external evaluation at one HEI, managers came across as generally uninformed about the current MOOC activities in their organization. Rather MOOC-entrepreneurs were encouraged to contribute to digital "low threshold" support at grassroot level [7]. Designing the digital experience around current university structures rather than focusing on contemporary digital alternatives and the needs of the end-user, could lead to organisations that are resistant to change.

7 Conclusion

In this article, we addressed the following research question: *What are the current conditions for MOOCs in Norway?* We found that MOOC-entrepreneurs operate in *pockets of innovation* in HEIs. They are located in different organizational fields. Thus, they operate in teamed networks across institutional silos, with some, but limited, external support from governmental bodies, in terms of project funding and technological infrastructure. The internal conditions for these MOOC-entrepreneurs are challenging, as their struggle for power and legitimacy, meaning their ideas and results, tends to be overlooked by important stakeholders in the institution.

In sum, our findings suggest that, on the one hand, there is a need of *translator* competence among MOOC-entrepreneurs to facilitate *critical knowledge* among important stakeholders in HE. On the other hand, there is a need for stakeholders to allocate time and attention to these pockets of innovation for digital transformation (flexible and lifelong learning) to move HEIs forward. We found two *logics* at play, that of traditional on campus and that of innovative online education (MOOCs). In Norway, like in most countries facing digital change, exploring how MOOCs, micro-credentials and everything it entails, can develop in competition with more formal and established educational logics, has assumed a greater urgency.

The study is qualitative and reports on findings from 10 semi-structured interviews with MOOC-entrepreneurs in Norwegian HEIs. Our findings introduce and shed light on the notion of *pockets of innovation*, which are collegial groups testing out the MOOC-concept loosely coupled from the organization's normal structures and practices. We have presented and discussed our findings in light of New Institutionalism and Institutional Entrepreneurship, focusing on MOOC-entrepreneurs, who can initiate changes that contribute to transforming existing and creating new institutions.

With this article we hope to contribute to an emerging educational field that has not yet yielded much research in Norway. Hence, we hope that we can contribute to shaping policy, inform practice and inspire further research from a Norwegian perspective. Our underlying motivation is that we believe that MOOCs are disruptive, not only because of digitalization within the traditional existing framework – blended learning, but mainly because MOOC-initiatives prepare the ground for a new concept of flexible and lifelong learning. Our findings invite further research, especially in the field of critical knowledge about digital transformation.

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TransPipe

A Pipeline for Automated Transcription and Translation of Videos

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Online learning environments, such as Massive Open Online Courses (MOOCs), often rely on videos as a major component to convey knowledge. However, these videos exclude potential participants who do not understand the lecturer's language, regardless of whether that is due to language unfamiliarity or aural handicaps. Subtitles and/or interactive transcripts solve this issue, ease navigation based on the content, and enable indexing and retrieval by search engines. Although there are several automated speech-to-text converters and translation tools, their quality varies and the process of integrating them can be quite tedious. Thus, in practice, many videos on MOOC platforms only receive subtitles after the course is already finished (if at all) due to a lack of resources. This work describes an approach to tackle this issue by providing a dedicated tool, which is closing this gap between MOOC platforms and transcription and translation tools and offering a simple workflow that can easily be handled by users with a less technical background. The proposed method is designed and evaluated by qualitative interviews with three major MOOC providers.

1 Introduction

Massive Open Online Courses (MOOCs) have set out to disrupt, revolutionize, and democratize the educational world starting about ten years ago. However, neither have predictions come true that universities will become obsolete within a few years nor has everybody in the world the same access to high-quality education. This leads many critics to the conclusion that MOOCs have failed altogether. On the other hand, the number of MOOC platforms, course providers, and participants all over the world is still growing. Particularly, the current pandemic boosted the participant numbers in so far unknown heights. We are one of Europe's oldest and largest MOOC platform providers. We are operating the platform for our own purposes but are also providing further instances of the platform for customers and partners often with different needs and purposes.

The common factor that unites all platform instances independent of their purpose and motivation: they heavily rely on videos as a major component to convey knowledge. Videos as learning material, however, exclude aurally handicapped participants and those who do not understand the lecturer's language. Both groups can be easily included by adding subtitles and/or interactive transcripts to the videos. Interactive transcripts, furthermore, come with additional advantages. They provide an additional option to navigate within a video and they enable search engines to include the videos' contents into their search results.

Creating multilingual subtitles for MOOC videos requires two steps: 1) the spoken words within a video need to be transformed to written text, so-called transcripts, and 2) these transcripts need to be translated into the required target languages. Tool support for both processes exists for several years. Speech-to-text software extracts the spoken word into text, enriched with timestamps so that these texts can be synchronously displayed with the video stream. This generally works well for lecturers who speak English fairly with neither dialect nor accent. The stronger the dialect or accent, the more effort is required to manually correct these texts. If the original language is not English, the quality of automated transcripts is often too low to be used, thus requiring manual transcription. Furthermore, the transcript has to be translated if subtitles in other languages are desired. In this case, a high quality of the transcript is even more important as errors would be transferred to translations. Similar to transcriptions, quality control and manual fixes are often necessary, even though the quality of AI-based translation has improved significantly within the last years – at least for some languages. Even assuming the best-case scenario, creating multilingual subtitles so far is still a quite time-consuming and tedious process. First, the video needs to be retrieved from the video hosting platform and passed to the transcription tool. The transcription itself takes some time, and once it's done, the transcript needs to be quality-checked and possibly improved. The transcript then needs to be downloaded and uploaded to the translation tool, processed, downloaded again, quality-checked, improved, and uploaded again to the platform.

These separate steps often have to be completed by different people. Many of them need access to different tools, which creates new challenges: security risks, possible loss of data, additional costs, etc. Furthermore, the transcripts and translations often have a particular format and character encoding, which tends to be messed up when people with a non-technical background are involved, e.g. by opening text files in word processors rather than text editors. In the worst-case scenario, several more manual steps are involved, such as a manual peer review. Finally, the workflow to create these subtitles greatly differs between the different platform instances, as the quality requirements to publish these subtitles differ a lot from partner to partner. For example, some partners directly publish machine-generated transcripts and ask the participants to contribute by improving them, others would not publish any text until it is perfect in all supported languages. Complicating matters, the time between video recording and course start is often very limited. Studio capacities and particularly the available time of the lecturers often result in just-in-time video production. Therefore, a very streamlined transcription and translation workflow is required to enable adding subtitles before a course starts. Currently, many videos on our partner platforms are still missing subtitles or the subtitles are only added once the course is completed.

We have, therefore, set out to create an application that closes this gap and provides an end-to-end workflow to add subtitled videos to the courses of our platform partners. Hence, it has to connect the dots between the different transcription and translation services. Our application needs to be configurable to allow combinations of different service providers. Finally, it has to fulfill the different requirements and reflect the different workflows of our platform partners. The goal is to simplify the transcription and translation process to allow the platform providers to add transcripts and translations to more videos, to speed-up the process so that transcripts and translations can be added earlier than previously so that subtitles are available before the course has started. This enables the platform partners to offer a better platform experience to their participants with fewer accessibility issues and the option to address an internationally broader audience.

We conducted extensive interviews with our platform partners to learn about their particular needs, requirements, and workflows. We talked to our service providers to learn about their future plans and ways to integrate their services into our application. From here, we will refer to this application by the name "TransPipe", which stands for transcription and translation pipeline.

2 Related Work

Automated transcription and translation to enhance online learning videos, with subtitles or interactive transcripts has been an elementary part of several research projects in the recent past. A system to create such automated transcripts was designed as a part of the *transLectures* project (2011–2014). The project focused on improving the transcription quality by adapting from the speakers' previous lectures and adding the speakers' slides as additional input. The system supported human supervision by highlighting those parts where the system had little confidence in its results. The results were field-tested on the *VideoLectures.net* platform [5, 8].

One of transLectures' partners, the Universidad Politécnica de Valencia (UPV) took the results further and formed the *Machine Learning and Language Processing Group (MLLP)*. MLLP claims that their automated speech recognition (ASR) and machine translation (MT) systems are among the most competitive at an international level [9]. MLLP also operates *poliTrans* a commercial tool allowing customers to create automated transcripts and translations for their videos[1]. The tool also features a user interface to manually correct the machine's mistakes. The MLLP Group contributed to several other projects and published several papers in the area of automated speech recognition and machine translation [11, 3, 10, 7, 16].

One of these projects, the *European Multiple MOOC Aggregator (EMMA)* (2014–2016) aimed to showcase excellent innovative teaching methodologies on a large-scale multi-lingual MOOC platform. Since 2019, the platform receives additional funding to host (mostly English-only) courses in the content of another project: *ASSET (A Holistic and Scalable Solution for Research, Innovation and Education in Energy Transition)* [4]. To access the older multi-lingual courses, you have to create an account and sign in. Still only very few courses are really multi-lingual. Often only the written texts are translated. Video subtitles are rare and often only exist in one language. Sometimes the videos are completely missing when the user switches to another language. These observations are based on random samples on the platform[2]. There might be better examples, but they indicate that multilinguality was at least not achieved on a broader level. Further random samples on VideoLectures.net revealed that there as well subtitled videos are rather the exception than the rule.

The *TraMOOC* project (2015–2018) aimed to reduce language barriers in MOOCs by developing a high-quality translation tool for all types of texts used in MOOCs including video subtitles. The machine translation engine was provided mainly by the University of Edinburgh [15, 12, 14, 13]. During this project, openHPI served as one of the field test platforms. The openHPI platform's video player was extended to support the display of subtitles and interactive transcripts in multiple languages. The translation engine is marketed by one of the members of the consortium[3] under the name of *translexy*[4]. Although the transcription and translation quality were generally perceived quite well by course participants and instructors, until today, the field test is the only course that offers subtitles in all supported languages.

The main reason for this is the missing support for integrated end-to-end-workflows including automated transcription, manual quality assurance, automated translation, further quality insurance, and an option to upload the subtitles

[1] https://politrans.upv.es/
[2] https://platform.europeanmoocs.eu/
[3] Knowledge4All Foundation [5]
[4] https://www.k4all.org/project/translexy/

to the platform. The transcripts generated by *poliTrans* are all lowercase and lack punctuation. *TraMOOC* translates the subtitles time-stamped chunk by chunk, these chunks are often not even complete sentences and, therefore, deteriorate the translation quality. One solution to these issues is the method developed by Che et al. to add punctuation and upper-case letters to the transcripts, and to merge the chunks into a proper text that can be translated in context [2].

Transcription and translation engines are available by many academic and commercial providers. Next to the already mentioned *poliTrans* and *translexy*, the commercial players such as *Google Translate*, *Amazon's Media Insight Engine* (AWS MIE), or *DeepL* are well known. Each of the existing tools does a good job in what it does. However, none of the tools does the job completely on its own. Often several tools need to be combined. Some platform partners might be contractually bound to certain providers or company guidelines prohibit a platform partner to work with a certain provider. The workflows also might differ depending on the course's original language: English generally works quite well, non-native speakers, however, might have a bad effect on the transcript quality due to their accents. Automated transcripts for German videos are much worse[5]. In total, this results in a heavy workload for the teaching teams, which only a few can afford. We, therefore, offer this now as a service to the teaching teams. Still, the process is time-consuming, error-prone, and tedious. To address this, we decided to work on a configurable, flexible tool to simplify and support this process.

3 Requirements Analysis

We analyzed the requirements of three of our platform partners with the user-centered Design Thinking approach [6]. Consistent with this approach, we started by interviewing the process owners of our platform partners, who are the potential users of our application. We gathered detailed insights about their individual workflows to create, translate, and provide subtitles for videos in MOOCs. More specifically, we asked about the different stages in their process, the providers used during each stage, and how they integrated different tools.

We summarized the challenges the users faced during their workflow and our derived requirements in Business Process Management Diagrams. Based on these findings, we developed strategies to solve the various challenges the users faced in their current workflows. In line with the Design Thinking approach, we im-

[5]We quick-checked for literature to confirm this statement but only found more general papers addressing issues with under-resourced languages, e.g. [1]. For now, this statement is, therefore, only based on our experience concerning the quality of automatically generated German transcripts.

plemented wireframe prototypes to verify our ideas in a subsequent round of interviews with our users. We incorporated the feedback during the second round of interviews for the final prototype described in section 4. In the following, we show the results of both rounds of interviews with our project partners.

3.1 Partner A

In this section, we summarize our findings from interviews with the digital innovation department of our Partner A (see Figure 1). Their workflow for video transcription and translation has three kinds of participants: administrators responsible for coordination, volunteers for processing transcripts and translations, and linguistic experts responsible for quality assurance.

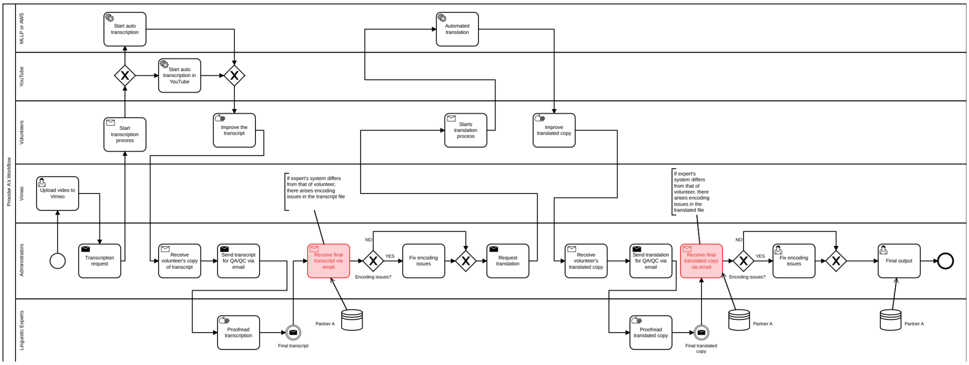

Figure 1: Process model diagram of our partner A's workflow for the transcription and translation task. Best viewed digitally with zoom.

The process starts with the administrator uploading the given video to the Vimeo platform. They then delegate the transcription task to one of their volunteers. The volunteer uses the video transcription service from either MLLP or YouTube to automatically generate the initial transcript from the video. Then, they download the machine-generated transcript to manually improve and proof-read it. Upon completion, they send the transcript to their respective supervisors. Afterward, experts are commissioned to perform quality assurance on the volunteer's copy of the transcript. The finalized copy is sent back to the administration. Next, the final transcription is sent to volunteers for translation into the required target languages. They use the *DeepL* service to translate the transcript automatically and later improve it where necessary. Subsequently, the translated copy is sent back to the supervisor who then contacts the linguistic experts to perform quality assurance. Finally, the experts send the translations to the administrators, who publish both the original transcription and the desired translations on the platform.

During this process, there is no shared environment for editing subtitle files (neither for transcripts nor their translations). Instead, emails are used for communication and file exchange between the participants. Since files are edited locally, different operating systems used in different regions sometimes result in encoding errors between the different participants. If such errors occur, the transcripts and/or translations need further examination and reformatting before proceeding to the next step. This issue can cause delays which could easily be solved with a common editing platform. Furthermore, the most recent version of subtitles is not always clear to administrators, which sometimes leads to more manual effort to determine the correct files.

As described above, our Partner A's process has some points that lead to delays and manual effort. In summary, we identified the following process issues:

1. status of the videos is unclear to the participants and needs to be tracked manually by the supervisors
2. the most recent version of subtitles is unclear due to a lack of a versioning system for subtitles
3. several process participants collaborate in the creation process of subtitles but there is no role-based system to control the process
4. files are shared via email causing delays and accessibility issues
5. local file editing frequently leads to encoding and formatting issues in the transcripts (and translations)

3.2 Partner B

In a similar manner, we present our findings from interviews with our Partner B in the following (see Figure 2).

Their process starts with student assistants searching for the given video on Vimeo. The video is then temporarily set to be publicly available so that the MLLP service can be used to generate the transcription automatically. After the transcription is finished, they reset the video in Vimeo to private and download the generated subtitles. After manually improving the transcript, they send it to the production team for publishing. Furthermore, the student assistants use the *DeepL* translation service to improve the MLLP translations and hand them over to the production team for publishing. An intermediate manual improvement of

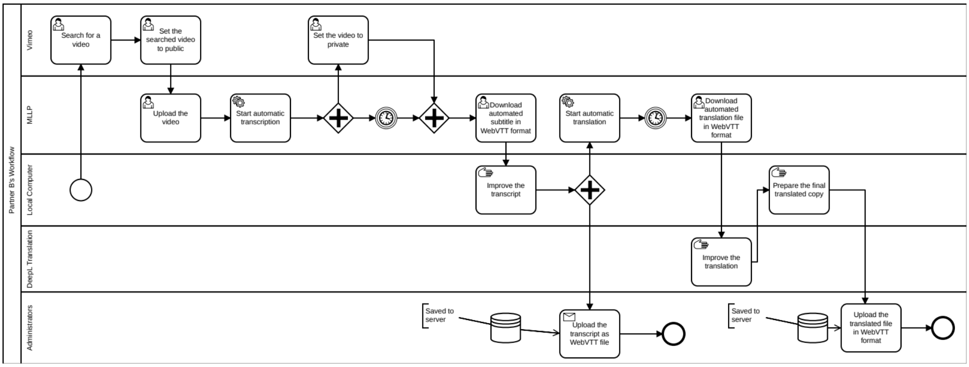

Figure 2: Process model diagram of our partner B's workflow for the transcription and translation task. Best viewed digitally with zoom.

the translations sometimes is done between this, but it lacks accuracy or is entirely skipped if the student assistants do not speak the target language.

Similar to the process of Partner A (but less frequent), encoding issues can occur and delay the process (in subsection 3.1). There is no quality assurance by linguistic experts, but an external agency is commissioned to create manually made, high-quality transcripts for videos in German (due to the lack of automatic tools with reasonable quality as mentioned in the previous section). The quality of these transcripts is superior to automatically generated ones used for videos recorded in other languages, e.g. English.

In summary, we identified the following process issues:

1. no common file management or sharing system creates communication overhead
2. manual work to use multiple, different applications for transcription and translation
3. several process participants collaborate in the creation process of subtitles but there is no role-based system to control the process
4. reverting to previous versions of subtitles is impossible due to a lack of a versioning system for subtitles
5. local file editing frequently leads to encoding and formatting issues in the transcripts (and translations)

3.3 Partner C

Finally, we interviewed the process owners of our Partner C (see Figure 3).

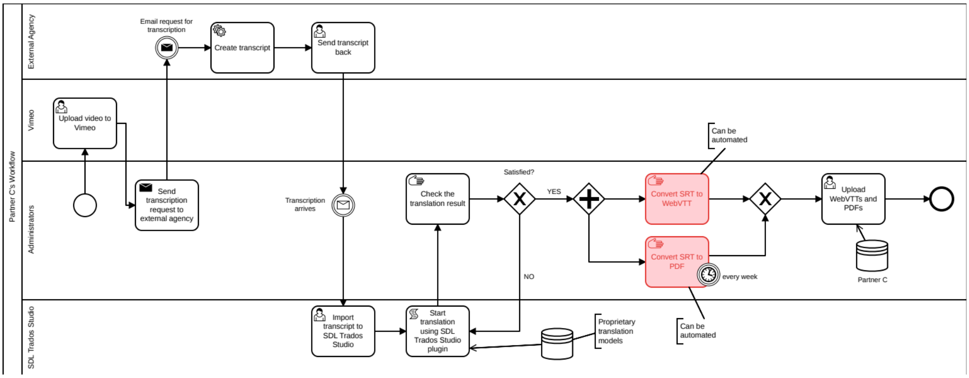

Figure 3: Process model diagram of partner C's workflow for the transcription and translation task. Best viewed digitally with zoom.

The process begins with the administrators uploading a given video to Vimeo. They employ a third-party agency to create a high-quality transcript. Once the file is ready, the agency hands it over to the administrators where the transcript is imported into a proprietary software for high-quality and efficient translation. Upon completion, the translated files are inspected for accuracy. If the administrators are satisfied, they convert the transcript and its translated copies into the SRT format. The SRT files are converted into PDF documents to generate weekly PDFs for each course week. Finally, those subtitle files are published. During these steps, files are transferred via email between the agency and the administrators.

In summary, we identified the following issues:

1. considerable manual effort is needed to generate a weekly course overview and the subtitle summary and for file conversion
2. files are shared via email which needs manual intervention and causes delays
3. subtitles need to be uploaded to the platform manually

3.4 Derivation of Requirements

The process model diagrams in the previous sections show the complex and manual processes involved in creating transcripts and translations for courses on our partners' platforms. While the partners share a common goal of adding subtitles to their videos within MOOCs, the involved parties (volunteers, student assistants, and external agencies) and the quality requirements (ranging from no improvements to a review by linguistic experts), differ. Using this understanding of the process, we formulate the following eight requirements needed for our solution to serve the needs of the end-users (we briefly refer to the corresponding issues of our partners with the identifier followed by the issue number, e.g. B2 is the second issue of partner B):

R1: Common Environment. Requirement for a common environment where all project participants collaborate as a basis for requirements R2, R3, and R6.

R2: Status Overview. Requirement for an accessible overview page to list all the available courses and their status (A1).

R3: Shared Editing Platform. Requirement for a single shared platform on which the subtitle files (for transcriptions and translations) can be edited (A4, A5, B1, B5, C2).

R4: Versioning. Requirement for a versioning system of subtitles (A2, B4).

R5: Roles and Permissions. Requirement for a platform where different users can have different permissions to edit subtitles (A3, B3).

R6: Service Integration. Requirement to integrate different external services into one platform to remove the necessity to switch between different platforms (B2).

R7: Summary Generation. Requirement to provide an automatically generated summary of the subtitles for a course week for download (C1).

R8: Subtitle Publishing. Requirement for an option to publish the edited subtitles directly on the corresponding MOOC platform (C3).

We created several wireframe prototypes for each platform partner and validated the prototypes with the individual process owners. Afterward, we merged the prototypes into one generalized version by mapping the single process steps of the first prototypes into one process that fits all identified requirements, which is described in the following section.

4 TransPipe Prototype

This section describes how we translated the derived requirements from the wireframes into a prototype which we call "TransPipe". *TransPipe* integrates into our MOOC system with external machine learning systems for transcription and translation. This results in a single shared platform to manage the generation, editing, and quality assurance of subtitles for all of our MOOC platform partners. At the same time, *TransPipe* must be highly configurable to choose the preferred transcription and translation services and should provide extensibility for new services.

The generalized pipeline for a given video consists of the following steps: (1) generating an initial automatic transcription, (2) improving the transcription (optionally followed by quality assurance), (3) generating an initial automatic translation of subtitles for each target language, and (4) improving the translated subtitles (again with optional quality assurance). The integration into our MOOC system allows us to trigger this process directly by fetching a video from the corresponding MOOC platform and publishing the final transcribed or translated subtitle files.

The prototype mainly consists of the following views (web pages): a course overview, a course details page, a course section overview, and a video details page showing the available subtitles for the video, to fulfill the requirements R1 (Common Environment), R2 (Status Overview), and R4 (Versioning). Furthermore, a page is needed to modify and review transcripts, and another page to modify translations for steps (2) and (4) of the pipeline, fulfilling requirement R3 (Shared Editing Platform). These pages consist of a side-by-side view of the input video and a text editor for the transcript (see Figure 4). For the translation tasks, two text areas are shown, which contain the original transcription and the current translation, respectively.

We integrated the external machine learning services used by our partners for the automatic generation steps (1) and (3) of the pipeline to fulfill requirement R6 (Service Integration). Each step is configurable, i.e. different services can be offered to the users of our platform partners, who can then choose the service to use. Automatic status updates on these externally running services ensure the status is up to date in our system and can be viewed by the users. Furthermore, finished subtitle files (either containing a transcription or its translations) are downloaded to our system once ready and can subsequently be edited. Even though the initial prototype included mock-up buttons for requirements R7 (Summary Generation) and R8 (Subtitle Publishing), the actual implementation was missing at the time of evaluation. Similarly, the requirement R5 (Roles and Permissions) was mocked for the evaluation interviews.

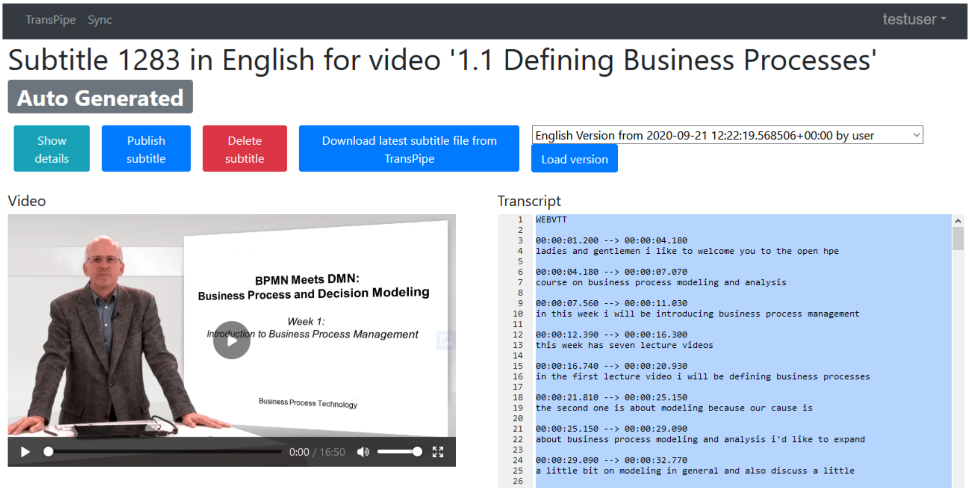

Figure 4: The prototype page displaying subtitle details coupled with a text editor and video player for checking and editing transcripts

5 Evaluation

Throughout the development of *TransPipe*, we regularly collected feedback from the different MOOC providers involved in the project. Our goal was to create a first working version to showcase the possibilities of an automated pipeline for transcription and translation. We based our prototypical implementation on the unified design described in section 4 and used it to evaluate the intended workflow with our partners in qualitative, unstructured interviews. While the MOOC providers valued the possibility to streamline the rather manual process of creating subtitles by replacing most steps with *TransPipe*, they provided additional feedback on the desired integration of their workflows.

Most importantly, the MOOC providers wished to have user roles better represented in *TransPipe*. Most have specialized staff for different languages or optionally request an additional review from language experts before subtitles are published. Due to the prototypical implementation, these roles were not yet supported nor was the status of subtitles fully reflected in the system. Supervisors also criticized the missing visualization of progress and a lack of required information to decide which courses or videos need attention for a timely release.

The technical integration of the transcription and translation services along with the MOOC platform fulfilled most of the requirements outlined in section 3. A new technical challenge discovered with the working prototype was our partners' request to combine multiple services for a single video. When the initial translation was performed with another provider, a slightly modified input is required for the services. Similarly, we did not add dedicated support for custom terminology to *TransPipe* so far. While the providers generally use all previously created terms, users can add new entries for the custom terminology only through the website of the service. We plan to add both features upon request in a later stage.

5.1 Workflow Improvements

The most criticized part of the prototype was the user navigation which resembled the initial wireframes but did not sufficiently support our partners' workflow. Based on the collected feedback and the initial prototype, we iteratively created a workflow-based design. It defines seven different states for each subtitle file ranging from *not available* through *auto-generated*, *manually edited*, *in review*, *changes requested*, *approved* to *published*. If a language expert decides not to approve a subtitle but rather rejects it, the requested changes can be described with a textual comment. Each workflow step requires a user to have an appropriate role that administrators can assign to users at any time to reflect customer demands.

A new course overview page lists all videos of a MOOC ordered by their position with the lecturer's oral language and the desired translation languages in separate columns of a table. Each cell indicates the current state for the given language and video combination and thus allows checking the progress of a course with a glimpse. Representatives from our partners stated that the chosen visualization eliminates the need for another project tracking solution or additional synchronization across the involved staff. If desired, users can execute bulk actions on several languages or videos simultaneously.

We also tightened the coupling to the MOOC platform by making *TransPipe* the default editor for subtitle changes. A deep linking between the course or specific videos allows easier editing of subtitle files in *TransPipe's* two-pane view with built-in versioning. By disabling editing features on the MOOC platforms, we prevent possible merge conflicts.

5.2 Future Work

With the current implementation of *TransPipe*, we were able to resolve many of the initial shortcomings and show the feasibility of building a pipeline. While our application includes the required steps to automate the processes as much as possible, the correction of machine-created subtitles is still unsophisticated with a simple text editor. Hence, we plan to integrate an advanced subtitle editor that optionally synchronizes with the video and allows a more user-friendly change in timestamps as we have for now. Doing so will also require additional syntax checks and editing support for the used WebVTT file format to prevent illegal changes.

Some transcription and translation services, such as AWS Media Insights Engine, provide advanced machine learning features, e.g. maintaining a custom terminology to improve future subtitle generation based on previous corrections. In the current status of *TransPipe*, no information about edits is shared with the original service rendering this feature almost useless without manual maintenance of the custom terminology. However, the open architecture and the availability of dedicated APIs by the providers make it possible to integrate support for these as well. Depending on the specific service, we will investigate how to offer support for advanced machine learning features within *TransPipe* or how to extend our application with other providers.

In addition to publishing transcripts and translation for videos, course administrators can use the generated subtitles to create a written summary of the video lecture. Hence, MOOC participants can use them when watching the video is not possible or desired and thus value them in various situations. By adding a PDF export functionality of the subtitles (without time information) to *TransPipe*, we can fulfill the learners' request for written information without increasing the workload for teaching teams or platform providers. Therefore, we plan to add an export job and extend the MOOC platform integration so that *TransPipe* users can automatically attach the PDFs to the course. Finally, we will revalidate our assumptions and the prototype with our partners and adjust the system where necessary.

6 Conclusion

In this work, we discussed a solution on how to reduce the effort of creating subtitles in the hopes of improving the accessibility of MOOC course videos for foreign or handicapped participants. Having subtitles in different languages also leads to other beneficial effects, e.g. indexing and retrieval by search engines and improved navigation within videos.

To reach an effective solution, we conducted interviews with three major MOOC providers, which are platform partners using our MOOC system. We presented our findings of their particular needs, requirements, and workflows and designed our *TransPipe* prototype to solve the challenges found. The main aspects tackled are communication issues and delays, reducing the need for manual effort and intervention in the process, and providing a sufficiently general, yet configurable platform to be suitable for all MOOC providers.

Although, we were not able to quantitatively determine the effectiveness, e.g. the share of videos with correctly (translated) subtitles, the evaluation through qualitative interviews showed the potential and usefulness of *TransPipe*. However, they also revealed opportunities for future improvements, and we expect this process of gathering feedback and adapting the current application to the future plans of our platform partners to be continued in the future.

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Integrating Community Teaching in MOOCs

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The MITx MicroMasters Program in Supply Chain Management (SCM) is a Massive Open Online Course (MOOC) based program that aims to impart quantitative and qualitative knowledge to SCM enthusiasts all around the world. The program that started in 2014 with just one course, now offers 5 courses and one final proctored exam, which allows a learner to gain a MicroMasters credential upon completion. While the courses are delivered in the form of pre-recorded videos by the faculty members of Massachusetts Institute of Technology (MIT), the questions and comments posted by learners in discussion forums are addressed by a group of Community Teaching Assistants (CTAs) who volunteer for this role. The MITx staff carefully selects CTAs for each run of the individual courses as they take on a co-facilitator's role in the program. This paper highlights the importance of community teaching, discusses the profile of CTAs involved with the program, their recruitment, training, tasks and responsibilities, engagement, and rewarding process. In the end we also share a few recommendations based on the lessons learned in community teaching during the last five years of running more than 45 MOOC courses, that could help other MOOC teams deliver a high-touch experience.

1 Introduction

The MITx MicroMasters in SCM is a global program having more than 400,000 unique learners from 190 countries. The program comprises of 5 supply chain courses, SC0x – Supply Chain Analytics, SC1x – Supply Chain Fundamentals, SC2x – Supply Chain Design, SC3x – Supply Chain Dynamics, SC4x – Supply Chain Technology and Systems, and a proctored CFx – Comprehensive Final Exam[1]. One of the main policies of the program is to educate the world, free of cost, by making the material available on edX platform for learners to audit the course. Students

[1] https://micromasters.mit.edu/scm/

can enroll in a course as per schedule and either take it up at their own pace (SC0x), or follow the instructor, by going through weekly released materials (SC1x to SC4x). This program also allows students to gain a certificate for the individual courses by paying a nominal fee. These students, called the verified learners, can move ahead by completing all 5 courses to take up the CFx. The students who successfully pass all the courses and the CFx (score $\geq$ 60%), earn a MicroMasters in SCM credential. The MITx MicroMasters in SCM team has awarded more than 40,000 verified certificates and currently has 2,640 credential holders as a part of its community. The course materials are delivered in the form of short videos, quick questions, and practice problems. These are open to all learners. The graded assignments, mid-term and final exam are the ones exclusively available to the verified learners along with supplemental course materials, and access to live events conducted during each run.

While the Course Lead and Teaching Assistant (referred to as the course staff from this point onwards) of each of the courses are responsible for managing the learners enrolled in that particular run, they are assisted by a group of CTAs. The course staff invites verified learners to volunteer for this role, and then carefully selects potential candidates based on certain criteria from the pool of applications. With an average number of 16,300 enrolled learners in each course run, the course staff comprising a maximum of 2 people face what Wiley and Edwards [8] described as a "teacher bandwidth" issue, when analyzing the scalability of the traditional model of teachers supporting learners in an online environment. As the one-on-one interaction becomes almost infeasible under this scenario, CTAs are a key to connect learners and staff, guaranteeing that all learners receive the support and answers they request. The edX platform provides discussion forums, which are open to all, to foster interactions among learners. Learners requiring clarification on topics discussed in the videos or practice problems, post their questions in the forums. The CTAs play a crucial role in clearing the doubts of the learners by providing additional explanations or examples or debugging their approach to quick questions/practice problems. They also engage in discussions with the learners on topics that are complementary to the course materials to keep learners motivated and interested in the course.

Garrison [1] created a Community of Inquiry framework, defining the Social Presence, Cognitive Presence and Teaching presence as prerequisites of higher and successful educational experience. The CTAs enhance a teacher's presence when they contribute to the community teaching activity along with the course staff. Being from diverse backgrounds, the CTAs bring fresh perspective from their own experience either while engaging with learners or while suggesting improvements in the course material, which is lauded and encouraged by the MITx staff. The CTAs are trained to support the learners not only by means of direct instruction when required, but also to guide learners by building on their understanding of the lecture topics, stimulating the discussion, and challenging their assumptions, to enrich and improve the learners' knowledge construction throughout the course.

2 Methodology

Over 95% of the CTAs recruited for a particular run, have taken the course before as learners. As such, their basic demographic details, such as nationality, age, and education background are available as a part of a sign-up survey conducted by edX. We used the survey results to create general insights on the profile of CTAs. To dive deeper into assessing their motivation behind volunteering for this role, the challenges they face, the benefits they seek, and other details, we conducted an anonymous experience survey among our CTAs. It included multiple choices, ranking options, and open-ended questions. Finally, the course leads' insights in CTA recruitment, training, engagement, tasks, and responsibilities were considered to put our analysis together.

3 Profile of Community Teaching Assistants

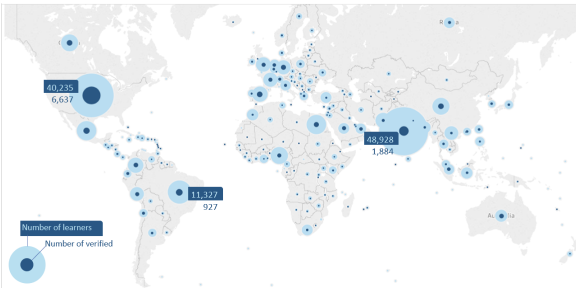

Figure 1: Representation of global community of learners (self-declaration by learners)

The global reach of the MITx MicroMasters in SCM calls for a global set of CTAs as well. From the year 2016 to January 2021, the program has worked with 179 CTAs from 49 countries across 6 continents. As shown in Figure 2 in comparison to Figure 1, the countries from where CTAs volunteered/were recruited is proportional to the countries from where learners originated. At any point in the year, there are more than 60 CTAs engaged in total across the courses.

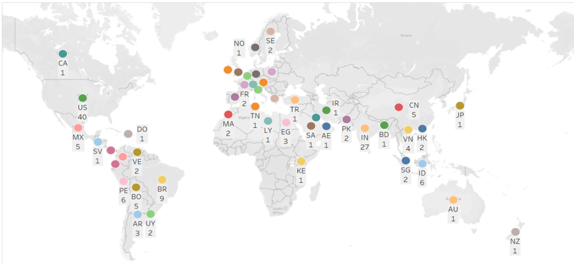

Figure 2: Representation of global community of CTAs (as reported by 176 CTAs)

A higher percentage of CTAs have a bachelor's degree with the next higher set having an additional master's degree. A small portion of this group also had just a high school degree when they on-boarded the community teaching journey as shown in Figure 3. The ones with a degree and job experience, add value to the course by using examples from their career and learning journey when they assist learners in the course. For the ones who are in the process of obtaining a degree or have just completed school, the CTA experience adds value to them as they get to learn from varied students enrolled in the course, while assisting the same learners with the knowledge they gained from the course material.

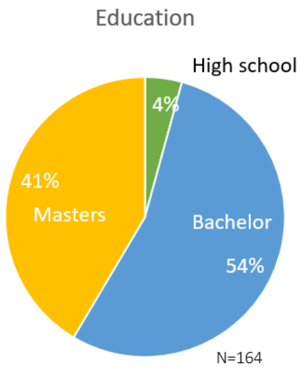

Figure 3: Educational background of CTAs

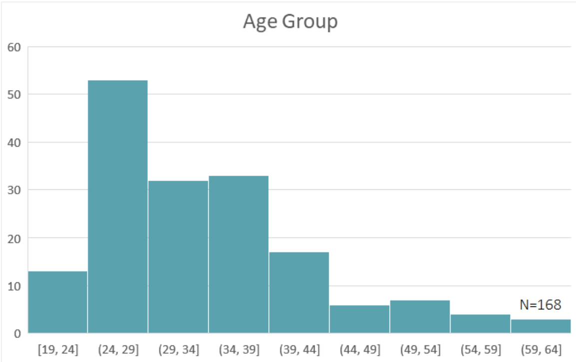

Figure 4: Age group of CTAs

A big part of the CTA group belongs to the age group of > 24 and ≤ 29 years with a close following by those belonging to the 29–39 age group as shown in Figure 4. It was not surprising to note that this trend followed that of the learners as observed by us over the years.

4 Motivation, Benefits and Challenges behind CTA'ing

From the short experience survey that we circulated among our CTA group, it was heartening to see that the first and the foremost reason why CTAs were motivated to volunteer for this role was to give back to the community. This outcome connects with previous research studies done by Northrup [3], and by Sadera [5], who reported a strong correlation between interaction and engagement among learners, and a sense of community belonging to being successful in online learning. Being former learners, CTAs have seen the value in community learning and the positive impact that a teaching role creates in furthering the understanding of concepts. Smith [7], found through their research that peer discussion boosts the entire group's understanding of any concept, even in cases where none of the learners discussing the topic know the right answer. The added advantage in this program's structure is that almost all the CTAs hired for a course run know the content already and having a strong backing from the staff, as such, they are confident to jump into the discussion forums to do their bit for the community.

Other important reasons which motivated CTAs to volunteer, was to stay connected to the staff and thus the program, and also to learn from others' (learners and CTAs) perspective as shown in Figure 5.

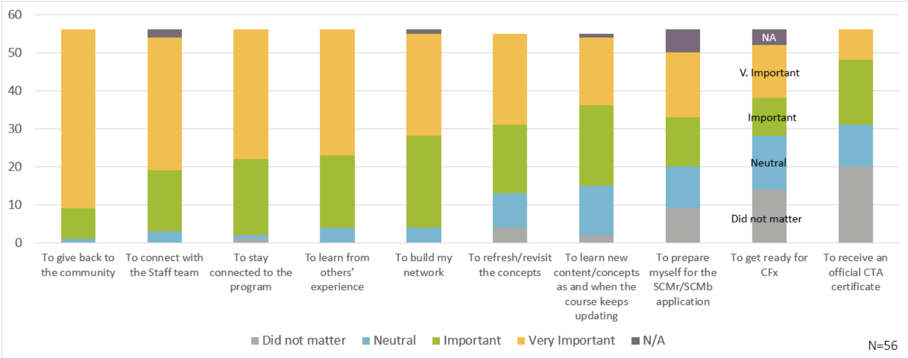

Figure 5: Motivation behind taking up a CTA's role

Building a network with like-minded individuals was the biggest benefit observed by CTAs followed by staying connected with the course content, and learning new concepts as introduced time to time in the courses. For some of them, the CTA role boosted their resume while for others it helped them prepare for the CFx exam, as visualized in Figure 6 below.

A single challenge which was almost agreed upon by all CTAs was finding a balance between their regular job, volunteering for this role, and spending time with their family as shown in Figure 7.

Some of the memorable moments/best experiences shared by CTAs revolved around them being appreciated by the staff, thanked by the learners for their contributions to the program, and the weekly interactions with the course staff and other CTAs where they learned from each other's work experience and shared their views on different topics related to the course.

5 CTA Recruitment Process

The CTA recruitment and onboarding process started in the year 2016 with just 21 CTAs. This family has grown to a total of 179 (as of January 2021) over the years, as indicated in Figure 8. The growth in recruitment was relatively steep in the initial few years to cater to the increasing volume of learners enrolling in the program, which was expanding to include more Supply Chain (SCx) courses. Before the year 2016, only two SCx courses were active. By 2017, a full-fledged MicroMasters program was in place with over 212,000 learners enrolled in one or more courses. Community teaching assistants thus became necessary to assist the existing two-member team of Course Lead and Teaching Assistant.

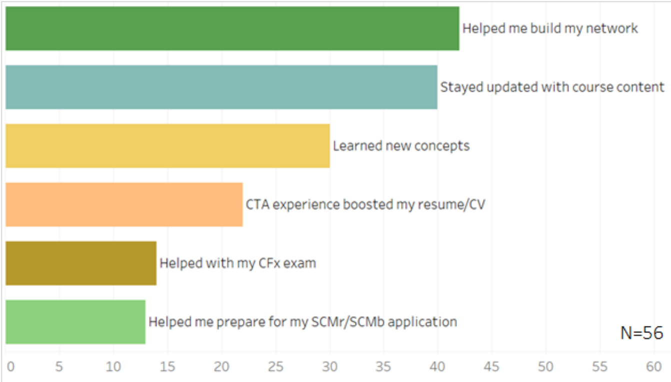

Figure 6: Benefits in a CTA role

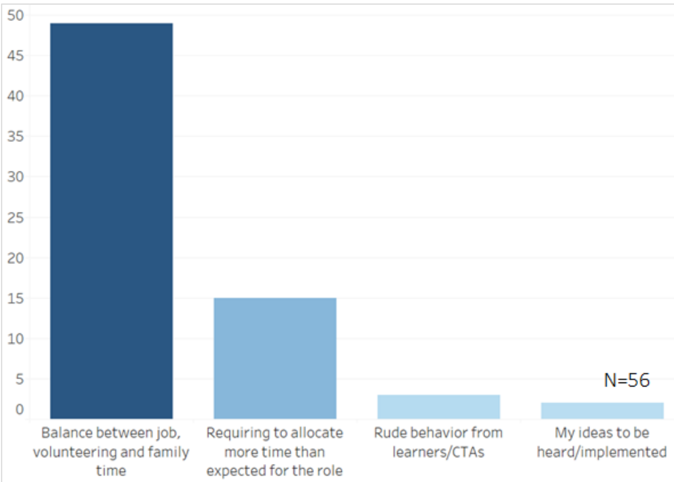

Figure 7: Challenges faced in a CTA role

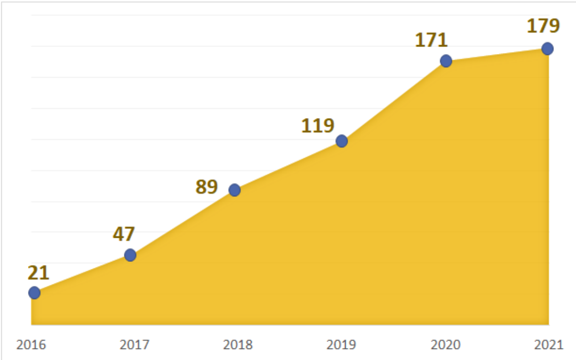

Figure 8: Cumulative growth in the number of CTAs

There are two routes by which a CTA group is created for every run of a course – recruiting fresh candidates and/or inviting existing CTAs. A digital form which asks for the candidate's name, edX username, number of courses taken, their respective scores, and motivation statement to become a CTA is circulated at the end of each course run. After keeping the form open for a short period of time and two weeks before the release of a course run, the course staff evaluates each application and short lists potential candidates. The selection is done based on their performance in the courses, their motivation to be a CTA, and their overall behavior, language and tone of communication with other learners and staff by checking the discussion forums (in which the candidates were learners) and the emails sent to respective courses' help email IDs. An invitation email is sent to all potential candidates seeking confirmation on acceptance of role. Occasionally, if the Course Lead identifies a verified learner, enrolled in a run of a course, has an outstanding performance in previous courses, the learner is invited to join the CTA group while taking the course. This allows for the course team to fix minor bugs in the regular material which could be identified by such CTAs taking the course. However, these CTAs will not be allowed to view any assessment material in advance to be fair to all learners.

Among the existing group of CTAs, an invitation is extended to those who have been performing well in terms of engagement with learners, staff, and suggesting ideas actively to improve the course. Also, those CTAs who express their interest to volunteer, are invited as well based on the capacity of CTA roles available. For every run, at least a ratio of 1 CTA per 100 verified learners is tried to be maintained by observing the initial enrollment trend.

There is no restriction placed on the number of courses a CTA needs to complete in order to apply. As such, in the experience survey result as shown in Figure 9, we noticed that most of them had completed at least 2 courses before they applied. Figure 10 indicates that the maximum number of times a particular CTA has volunteered for this role is between 1 to 3 times while 28 of them volunteered for 4 to 6 course runs.

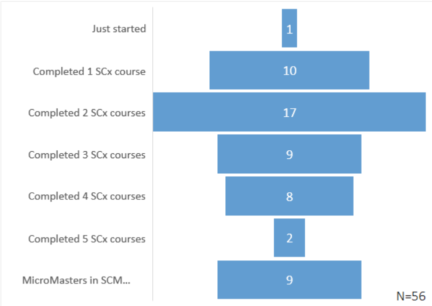

Figure 9: SCx status during application

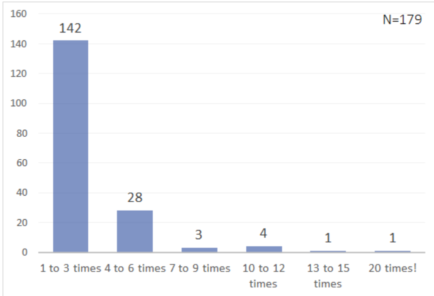

Figure 10: Number of times each CTA has volunteered for the role

6 CTA Training Process

Knowing that the CTAs are selected considering their performance in SCx courses and their motivation (among other factors as detailed in section 5), the course team does not focus on technical training on the course content, but on the principles and values that should guide them through the journey of assisting in the course. The staff employs CTAs who have completed the course with an average grade above 80%, and only 1 learner is occasionally allowed to be a CTA while taking the course if the learner scored well beyond average in other courses. This shows that the CTAs are well-versed with the material and would rarely require guidance from the course staff on course content.

Existing literature indicates that TAs should encourage collaboration and promote the creation of collective knowledge, trying to avoid direct replies. Additionally, it highlights the importance of a single instructional approach between the Course Lead and the TAs when interacting with the community of learners. This is especially considered just as fundamental as having the technical knowledge to answer the learner's questions [4]. This is one of the main aspects in our CTA training process.

The CTA training is performed during the initial kick-off meeting and reinforced every week. The training includes:

1. The MITx MicroMasters in SCM mission: To educate all learners equally without differentiating between verified or audit learners, and to be polite and respectful towards all learners. The CTA are also made aware of the expected level of commitment and the purpose of their volunteering effort. The CTAs' alignment to the team mission is reflected in their posts in the forums, on how they address the questions, feedback, and comments they receive from the learners. This is observed by the staff regularly during initial weeks after a course run opens.

2. Criteria to differentiate the Learning and Assessment processes: Understanding the difference between which posts aim to enhance the learning experience, opening the doors of engagement and collaboration with other learners, and which posts are about rigorous assessments that should be reported to the course staff immediately for honor code violation.

3. Details on their tasks: Tasks expected to be deployed by a CTA are communicated during the kickoff meeting. Subsequent weekly meetings are conducted to ensure the duties are being carried out as expected.

4. Communication paths: The Course Leads create a common group with CTAs on a social-media platform to stay connected during the run of a course. This group is used for sharing urgent issues seeking attention of the staff. The staff also uses this medium to share updates with the CTA group.

7 CTA Tasks & Responsibilities

The main role of a CTA is to address the concerns and issues of all learners – audit or verified through the discussion forums on edX platform. In the forums, the CTAs are asked to:

1. Look for unanswered "questions" related to the practice material and answer them to the point of not giving away the solutions, but to suggest an approach for the learners to arrive at the right answer. The CTAs are also expected to clarify content related questions to the best of their ability. The staff steps in to assist CTAs as and when necessary, and also to keep a watch on the forums to ensure discussions are civil.

2. Foster conversations by answering the "discussions" post, to encourage learners to think of application of course materials or to discuss on topics related to the given material.

3. Redirect learners to similar posts that have been answered before, mark questions/discussions as "answered" once done so that the other CTAs do not spend time in resolving the same doubt, and actively up-vote the right answers that could either be posted by another learner or a CTA.

4. Report inappropriate/honor-code violating posts (related to graded assignments, mid-term and final exam) to the staff immediately.

5. Improve the learner's experience in the platform by supporting and encouraging them with positive feedback and sharing their knowledge from the industry besides strictly academic content. The relevance of this task was highlighted by Nicol and Macfarlane-Dick [2] whose findings show that supportive and encouraging feedback (which they define as "anything that might strengthen the student's capacity to self-regulate their own performance") improves the results of learners in higher education. Similar conclusions were achieved in online environments by Northrup [3] who found that conversation and collaboration in online learning, including peer interaction and receiving feedback, are highly rated by learners as important to their success.

In addition to the tasks related to the discussion forum, a CTA is also expected to:

1. Report high-impact bugs that could affect learners' capability in taking the course in the predefined structure.

2. Report low to medium impacting bugs in a debug sheet for the course staff to fix before releasing the next run.

3. Participate in weekly meetings hosted by the Course Lead to share feedback on the course material released so far, report any concerns seen by learners, and update the course staff on mini-projects related to course improvement.

A subset of the CTA group is also given an opportunity to beta-test new graded assignments, mid-terms, and final exams before they are released. They are made to sign a Non-Disclosure Agreement (NDA) before they are involved in this process. The beta testing process helps in ensuring that the problem statements are precise as they are being checked by CTAs with diverse backgrounds, the platform settings are working properly, the questions have no ambiguities, and that the assessment is fair. It is important to highlight that the beta tester is a completely different role from that of a CTA. CTAs are set in the platform as Community TA/discussion moderators, while beta testers are included in the platform as Beta Testers.

8 CTA Engagement Process

The SCx courses are designed with the mission of raising the knowledge of SCM professionals across the globe, educating the world for free, and providing a credential to qualified students at a minimum cost. Being a program available globally, the feeling of belonging to such a diverse community of learners is reinforced regularly in lectures, live events, podcasts, presentations, practice problems that are created for the course, and in weekly communications. Interaction is encouraged not only for academic learning purposes but also for networking, and even for personal growth through cultural exchanges. The sense of creating an impact on such a dynamic community, having received support themselves from others, cultivates a need for CTAs to give back to it. This feature, that was highlighted in our findings in section 4 (Figure 5), is the greatest source of engagement driving our CTAs.

On the staff side, the team is responsible for keeping the CTA group motivated and engaged throughout the 12–13 weeks of each course run to count on their continued support in assisting the learners in the forums. Building motivation in online courses, as described by Salmon [6], implies giving the learners, and in this case, the CTAs, activities that make being part of the team worth their time and effort, including short-term goals so that they are able to see the impact of their participation materializing.

A weekly meeting of 30–45 minutes is conducted by the course staff where the CTAs are updated on the learner enrollment statistics, upcoming materials, and any new content/problems to watch out for, live events they could be a part of, and so on. Every Course Lead has used either a formal or an informal method of discussion with the CTAs and both methods have proven to work just as well as the other. The common factor between both is to provide an opportunity for CTAs to share their feedback on the progress of the course so far, any new ideas they wish to share towards course improvement in the form of additional recitations, practice problems, clarification notes, correction of errors, etc. It is important for the staff to acknowledge their points and work in the direction of their recommendations when possible. If infeasible, the staff provides them clarifications to show that their feedback is valued, and their ideas are heard and considered. It is always necessary to respect and appreciate the hard work they put in this volunteering work. Engagement is observed here through a 2-way communication system that helps to build trust in each other, in which both parties, the course staff and the CTAs share information that is not necessarily privileged about the course, but the one that is usually not shared at a learner's level.

In addition to the engagement activities mentioned above, the CTAs are welcomed to help in researching on new content that would be added to the course before it is opened to learners at large. To let them know how special and valued they are for the staff, they are invited to conferences and seminars hosted by MIT CTL and other external events that Course Leads take part in.

As learning from others' experience and building their own network is highly valued by our CTAs when they volunteer, they are also encouraged to share their SCM work experiences in short sessions of 15–20 mins during the weekly meetings. Another engagement method used by the course staff is to share challenges observed in the industry or the application of new techniques in the field to discuss together. This could eventually lead to its addition as a post in the discussion forums due to its relevance, expanding the discussion to more learners and newer perspectives.

CTAs find it rewarding to engage with the staff on mini projects which are outside their scope to improve the course hands-on. Some of the mini-projects have been Virtual Machine preparation, documentation, and implementation to help learners avoid issues with new software installation, creating downloadable solutions for practice problems in various formats, formula sheet in the form of a "cheat sheet" or "one-pager" for easy access to equations and formulae across courses, guiding documents on how to post in the discussion forums, and a post describing methods to debug a spreadsheet solver. These projects along with many more have received appreciation from learners, who are made aware of the CTAs' participation as the course staff acknowledges them by name when publishing the project outputs in the course platform.

9 CTA Rewarding Process

At the end of a course run, which is after the completion of final exam and declaration of overall course grades, an evaluation of CTA performance is done by the course staff. The number of responses given by CTAs in the discussion forums, their level of engagement with the staff, and their interest in improving the course by providing new ideas and suggestions, are some of the factors taken into account during this evaluation. Based on the results, a "Certificate of Excellence" is awarded digitally to each deserving CTA. The staff also highlights the name of active CTAs by acknowledging them at the end of the course newsletter to thank them for the efforts they put in voluntarily.

Due to the importance of this role, and the kind of value add it brings, a "CTA appreciation event" is conducted twice a year to bring the entire community together, to thank them for their continued support, to hear out their ideas in enhancing a CTA's experience, and to update them on the improvements planned for the courses while also taking their suggestions for the same.

10 Conclusion

Through the research we conducted and after running a community teaching inclusive program for more than five years in massive, open and online courses, we conclude that CTAs play an instrumental role in delivering a high-touch experience in these courses. They are the vigilant eyes in the discussion forums, clarifying learners' doubts almost the very same day, and ever ready to report any wrongdoings or issues to the staff.

The CTA is a volunteer position (unpaid), thus their commitment to the program is one of the key features we make note of during recruitment. This was well reflected in the results of the experience survey we conducted. The top motivation behind CTAs taking up this role was found to be to give back to the community. This sense of belonging to a community and the fact that the CTAs are thankful for what they get through the program, is the main driver for them to sign-up for a CTA role.

We recommend course teams to invest time in managing and engaging with their group of CTAs. It is important to listen to them and take actions based on their feedback. Most of them are full-time working professionals trying to find balance between their regular job and CTA'ing, and that is why it is important not to push them beyond their availability, allow them to be flexible in their CTA timings, and always hear them out. Actively take feedback and provide a response either by working on their recommendation or giving an explanation to CTAs if it is an infeasible action. The CTAs and the course staff trust in each other's work, so as and when necessary, it is crucial to support CTAs in the discussion forums in unpleasant circumstances where learners could be frustrated with the course material or with the way an answer is given by a CTA. Having weekly meetings and open channels of communication with CTAs allows regular connect to clarify doubts or concerns that they may have. This should be one of the course team's utmost priorities when managing a team of CTAs.

Finally, reward and appreciation is another key aspect for the program to be successful. The MITx MicroMasters in SCM team has seen the importance of community teaching through years of engaging with enthusiastic volunteers and observing the quality of their support in the forums. The response from learners either in the forums or in the end of course survey is a testimony to the fact that community teaching does add value beyond the course material.

For future work, we consider including CTA interviews and further expand on staff's and learner's feedback regarding the impact CTAs create in the learning journey. We strongly believe that this additional information will reinforce the positive influence of community teaching in online learning environments.

11 Acknowledgement

We would like to thank Dr. Chris Caplice, Director of this program, for inspiring and encouraging the community teaching initiative. We are also grateful to Dr. Alexis Bateman, Dr. Inma Borrella and Dr. David Correll, Course Leads of this program, who were kind to share their experience with the CTAs which helped put this paper together. We cannot thank enough, the group of wonderful CTAs of this program, who are ever ready to lend us a hand in managing the course runs, for participating in the experience survey and sharing their unbiased opinions on course improvement ideas. Finally, we want to thank the three anonymous reviewers who provided valuable feedback and insightful comments to improve our paper.

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A MOOC-Based Computer Science Program for Middle School

Results, Challenges, and the Covid-19 Effect

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In an attempt to pave the way for more extensive Computer Science Education (CSE) coverage in K-12, this research developed and made a preliminary evaluation of a blended-learning Introduction to CS program based on an academic MOOC. Using an academic MOOC that is pedagogically effective and engaging, such a program may provide teachers with disciplinary scaffolds and allow them to focus their attention on enhancing students' learning experience and nurturing critical 21st-century skills such as self-regulated learning. As we demonstrate, this enabled us to introduce an academic level course to middle-school students.

In this research, we developed the principals and initial version of such a program, targeting ninth-graders in science-track classes who learn CS as part of their standard curriculum. We found that the middle-schoolers who participated in the program achieved academic results on par with undergraduate students taking this MOOC for academic credit. Participating students also developed a more accurate perception of the essence of CS as a scientific discipline.

The unplanned school closure due to the COVID19 pandemic outbreak challenged the research but underlined the advantages of such a MOOC-based blended learning program above classic pedagogy in times of global or local crises that lead to school closure. While most of the science track classes seem to stop learning CS almost entirely, and the end-of-year MoE exam was discarded, the program's classes smoothly moved to remote learning mode, and students continued to study at a pace similar to that experienced before the school shut down.

1 Introduction

There is a growing realization that K-12 Computer Science Education (CSE) should evolve from a subject for a fortunate few to an opportunity for all [9]. However, attempts to broaden CSE face significant challenges such as acute lack of teachers [15] and equality issues related to gender and socioeconomic differences [8, 10].

In this research, we performed a preliminary evaluation of a suggested solution for this multi-facet challenge: A Blended-Learning (BL) program based on an existing academic "Introduction to Computer Science" Massive Online Open Course (MOOC). Ideally, the academic MOOC will substantiate the required disciplinary depth, enabling the teacher to focus on blending and orchestrating online and offline activities and mentoring and enhancing students' learning. As part of the professional development and training for delivering the program, the teachers would receive a collection of suggested offline class activities, exams, program delivery planners, and guidance on optimizing the program's facilitation. We refer to this collection as Teacher's Toolkit. By building the program around an appropriate academic MOOC, we provide new-coming teachers with disciplinary scaffolds, creating a scalable introductory CS program while increasing the disciplinary depth. By that, this program aims to address the challenge of the acute lack of CS teachers.

Regarding equality, such a program could spread more easily to schools from low socioeconomic environments, which typically have less access to CS teachers. Additionally, facilitating such a program as an obligatory course in middle-school will also reach an adequate female participation rate. Thus, such a solution has the potential of also mitigating the equality issues mentioned above. Economic-wise, such a program leverages the massive investments in academic MOOCs to the benefit of K-12 education.

This research aimed to be a preliminary evaluation of such a solution. We focused on ninth-graders in science-track classes, chose an appropriate academic MOOC, and then developed the program's principles and initial version. Our main goal was to study whether students who participated in the program can develop a meaningful understanding of core CS ideas and a more accurate perception of the nature of CS. Specifically, our research is guided by the following research questions (RQs):

1. Do students who completed the program achieve the disciplinary learning goals, as defined by the course developers (RQ1)?

2. What is the relationship between participation in the program and changes in students' perceptions of the discipline of computing (RQ2)?

To study these questions, we piloted the program in two classes. The original research design included a control group consisted of ninth-grade classes in this track, which also learn the same MOOC in a BL setting, yet with no pre-designed program (students who learn the MOOC in-class hours with the teacher present for assistance). An additional control group consisted of classes who learn the standard MoE CS curriculum for ninth-grade. However, the transfer to remote learning due to the COVID-19 pandemic severely affected these classes, and eventually, they stopped learning. While this limited our ability to follow a comparative research design as was planned, it emphasized the teacher's critical role in the program and shed light on the importance of developing programs that can flexibly switch between physical and remote learning.

The rest of the paper is organized as follows. Following a short Background in section 2, we describe the program design in section 3. In section 4, we describe the Research Methodology, and in section 5, we describe the Results, followed by a Discussion and Conclusions in Sections 6 and 7, respectively.

2 Background

MOOC-Based Blended Learning Programs

In many cases, the MOOC used in blended-learning programs is pre-designed to be used as the online part of a blended learning program, sometimes referred to as Blended MOOCs or bMOOCs [1]. For example, Rayyan, Fredericks, Colvin, Liu., Teodorescu, Barrantes, Pawl, Seaton, and Pritchard [13] described such design and development of a blended learning program for introductory physics at Massachusetts Institute of Technology (MIT), where a dedicated MOOC was developed as part of the program development. In the context of K-12, a bMOOC-based program that is closely related to our study is that of Grover, Pea, and Cooper [7]. Grover, Pea, and Cooper designed a blended learning program to prepare and motivate middle school learners for future engagement with algorithmic problem-solving. They created a dedicated MOOC as part of the program design and development. The goal was to design a MOOC that encodes both the content and the pedagogical content knowledge (PCK) to enable a non-CS teacher to facilitate blended learning delivery of the program. They reported encouraging results, with students meeting the desired learning goals.

The above examples of MOOC-based BL programs created a *tailored* MOOC as part of the program development. However, designing and producing a dedicated MOOC requires significant resources and is time-consuming [11]. With the explosion of available academic MOOCs, it makes more sense to locate an adequate existing MOOC. Previous research on MOOC-Based blended learning was mainly conducted in the context of higher education [2, 1, 13, 5]. Perez-Sanagustin, Hilliger, Alario-Hoyos, Kloos, and Rayyan [12] proposed the H-MOOC framework, which details indicators to measure the impact of hybrid initiatives at higher education in which locally produced and third-party MOOCs are reused and integrated into traditional courses.

But academic MOOCs usually target undergraduate level and may not be adequate for middle school students. This rationale led HarvardX to adapt its renowned Introduction to CS MOOC, CS50, for high school students [3]. In this research, our goal was to evaluate whether, through a careful design of a blended learning program, an *existing academic* MOOC may be leveraged, as is, for creating a meaningful learning experience for middle school students.

The MOOC

The MOOC we chose for the program is First Steps in Computer Science and Programming in Python [4]. It is an intro to CS elective course for undergraduates who are not majoring in CS. The course was developed by Prof. Benny Chor and Dr. Amir Rubinstein, two highly experienced CS scientists and educators from Tel Aviv University School of Computer Science. The course production and digital pedagogy guidance were done by TAU Online: Tel Aviv University Innovative Learning Center[1].

We chose an academic course because of its disciplinary depth, which is felt throughout the course. Non-academic MOOCs that we considered were more of python coding courses. Additionally, we hoped that the ninth-grade students' successful learning of an actual academic course would provide them with an added benefit of self-efficacy for academic studies.

We chose the specific course because of its content, pedagogy, and production quality. The first third of the course almost entirely overlaps the CS curriculum for eighth & ninth-grade science track classes in Isreal. The second half of the course extends the MoE CS curriculum. It illustrates the versatility of CS by providing an initial hands-on exposure to a selection of four advanced topics in CS: encryption, error detection & correction (communication), image representation & processing, and complexity of computations. Overall, we found that the MOOC content gives a balanced and friendly, yet meaningful, introduction to computer science as a discipline and computational thinking and python programming.

Above all, we gave extra care for choosing a highly engaging course. This MOOC immediately stood out as such.

[1]The course team, and its university, were not involved in this research, except for providing the end-of-course exam and statistics on the results of the undergraduates who took this course for credit.

3 Program Design

The BL program targets ninth-grade class in a science track and assumes a gross class time of 90 minutes a week. Due to setup time related to getting all students on computers in the lab, the result is a net time of 60–70 minutes a week. The program also assumes additional off-class study (homework) of 30–45 minutes a week. The offline parts, e.g. class activities, discourse, and direct teaching, consume approximately 35% of class time on average. The rest of the class time and the weekly off-class study time are dedicated to self-learning from the MOOC and other digital resources.

Learning Goals

The program inherits the disciplinary learning goals of the academic MOOC and extends them. The MOOC makes an Introduction to CS and Programming Fundamentals with the python programming language. Following successful completion of the MOOC, students should:

- Understand and write short programs in python using the fundamentals of programming such as variables, operators, conditional execution, iterative execution, and functions.
- Understand and use basic data types, strings, lists, and two-dimensional lists.
- Understand the notion of algorithm complexity, error correction, encryption, picture representation, picture manipulation, problems with no efficient solution, computational graphs, and artificial intelligence.

In addition to the MOOC's learning goals, the program also defines a goal of constructing a more accurate perception of CS as a problem-solving discipline that uses the computer as a tool to solve real-world problems in diverse fields. This is opposed to conventional naïve notions that are computer-centric (CS is about making/fixing/studying computers) or programming-centric (CS == programming) [7, 14].

The program also aims to develop self-learning skills that leverage up-to-date digital resources. In addition to MOOCs, the program seeks to expose the students to self-learning through engaging popular science podcasts, documentaries, and YouTube channels.

Lastly, the program aims to encourage and develop social/peer learning practices as learning strategies.

Redefining the Teacher's and the Students' Roles

Building the BL program around an academic MOOC, we had the opportunity and need to redefine the teacher's and the students' roles. In a classic school pedagogy, one of the teacher's primary responsibilities is to drive the students' cognitive learning process. This process is usually conducted via a series of actions and reactions to build the motivation for a new concept, concept introduction, connecting to previously learned concepts, concept illustration, exercising the new concept, providing feedback on students' performance, etc. An effective academic MOOC will usually perform such a series of actions (see for example [5]). Specifically, the MOOC chosen for this program is doing an excellent job at it. Our program design urges the teacher to embrace that and delegate a significant part of driving the cognitive learning process to the MOOC. That should enable the teacher to dedicate more attention to more meta-level and social aspects and focus on fostering self-learning, collaboration, and communication – crucial 21st-century skills that typically (at least from our experience) receive less attention in CS classes of this program. Towards that end, we were obliged to define what we believe should be the ideal new roles and class dynamics between the teacher, the students, and the MOOC.

The Ideal Interplay between the Students, the MOOC, and the Teacher

The Community of Inquiry (CoI) framework [6] aims to create a meaningful learning experience by developing three interdependent presences – social, cognitive, and teaching. Inspired by this framework, we treated the cognitive presence, teaching presence, and social presence as three pillars for the educational experience; Pillars that construct the ideal roles and interplay between the three entities of the BL program: the students, the MOOC, and the teacher (Figure 1).

As the name "MOOC-based" suggests, the design assumes that the MOOC is anchoring the Cognitive Presence while the teacher only enhances it. The teacher carries the Teaching Presence pillar. The teacher is also responsible for igniting a prolific Social Presence. However, the teacher should not attempt to carry most of the weight of maintaining a productive social climate. Through the teacher's leadership for setting appropriate class norms, the social presence pillar should eventually be assumed by the students.

We use the terms Pillar to convey that the responsibilities for the presences are not dichotomic. Beyond its assigned presence (teaching, cognitive, or social), each entity (teacher, MOOC, or students) is also responsible for enhancing the other two presences. To that end, each student is a teacher, and the students also enhance

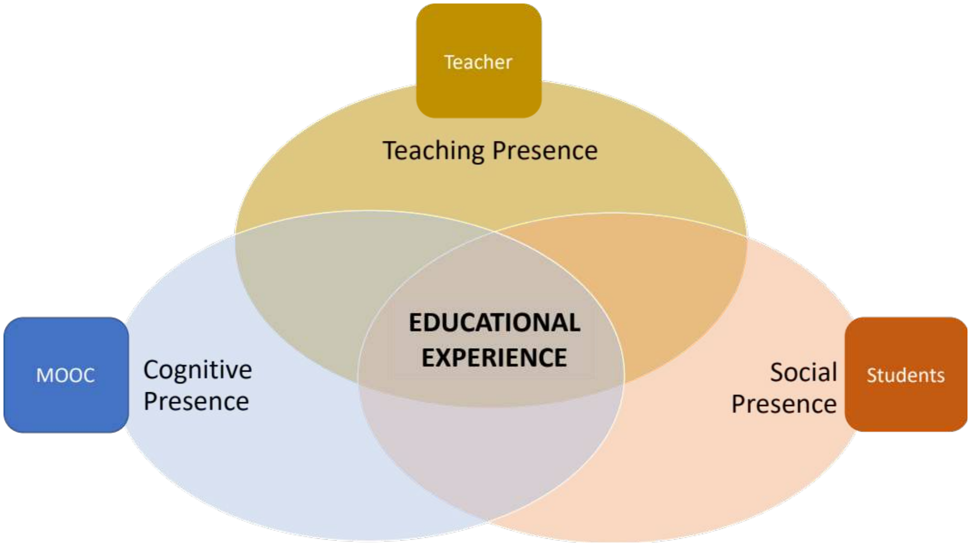

Figure 1: Interplay between the students, the MOOC, and the teacher – inspired by the CoI framework

the cognitive presence. The teacher has a crucial role in supporting the social climate and a key role in augmenting the cognitive presence. Lastly, the MOOC also organizes the learning process and may even facilitate discussion, for example, by posting a non-trivial open question to be answered on the MOOC's forum.

We envisioned the roles and dynamics portrayed here as the ideal dynamics for the program facilitation. These new roles for the teacher and the students are very different from those assumed in conventional pedagogy. The teacher should not expect or be expected to teach. In this new role, the teacher's primary responsibility is to build and maintain high motivation for learning the subject matter and create learning opportunities for the students. He/she is also responsible for nurturing students' skills that will enable them to cease those learning opportunities. On the same token, students should not turn to the teacher as the first resource for questions on the subject matter. In their new role, students should first discuss with their peers and seek advice there.

It is implausible that these roles and interplay would settle by themselves. The teacher's responsibility is to drive the classroom to this state through purposeful actions and reactions taking place mainly in the first three months of the program. To develop this mindset, teachers will have to go through proper training and be provided with a pre-designed learning program that includes various class activities, tools, and advice for effective facilitation. Alongside this research, we have developed a 'Teacher's Toolkit' for the program consisting of all the offline class activities, other online learning resources such as specific podcast chapters, popular science programs, and YouTube science teaching channels. The toolkit also includes several midterm formative assessment exams, a tool for planning the program facilitation along the year, and advice on optimizing the program's delivery.

4 Methodology

The research population consists of ninth graders from science track classes. The research sample includes 55 students from two classes located in two public schools from urban cities classified as middle- to high middle-class economic status. The lead researcher taught one of these classes and mentored the other teacher on facilitating the learning program. Figure 2 illustrates the research design

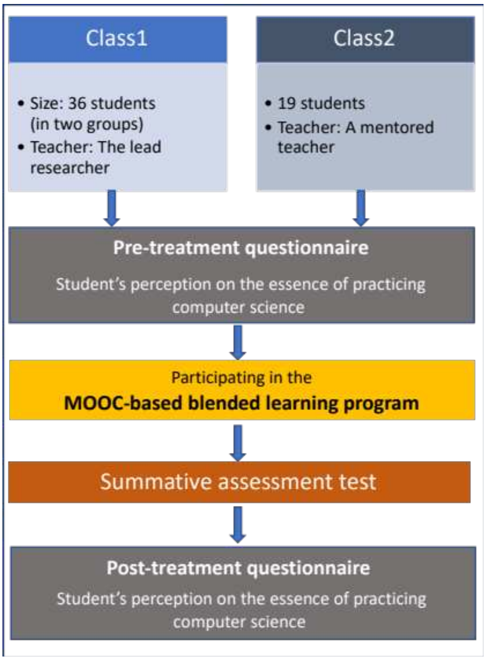

Figure 2: Graphical illustration of research design

The Summative Assessment Exam (RQ1)

To assess the achievement of the disciplinary learning goals, we administered the same pencil-and-paper summative exam given by the university to undergraduates who take this MOOC for credit (provided to us by the course team). This exam serves two purposes. First, it enables us to evaluate whether the program students meet the learning goals defined by the course team. We recall that meeting these goals award the undergrads academic credit. Second, it enables us to compare the achievement of the program's students to those of the university students.

Given at the end of each semester, the university's summative exam for the course followed the same structure (but not the same items) across all test dates: 25 multiple-choice questions; three questions per each of the eight units of the MOOC, plus another general question. The questions are designed to measure conceptual understanding of the course material on different levels.

Perceptions of the Discipline of Computing (RQ2)

To study the influence on student perceptions, the students answered a questionnaire at the beginning of the school year (pre) and again at the end of the school year (post). The part of the questionnaire that refers to students' perception of the discipline of computing includes the following question (translated):

Professor Noga Alon from Tel Aviv University is a world-renowned and one of the country's most respected computer scientists. Out of the list of items below, what can be assumed that professor Alon can do well, even if it is not necessarily what he does? Mark up to 4 items (you may mark less than 4):

1. *Design a computer*
2. *Fix a computer*
3. *Play computer games*
4. ***Code in some computer language (e.g. Java, Python, C#)***
5. *Install the Windows operating system on a computer*
6. *Build mobile apps.*
7. *Build a computer*
8. ***Cooperate with other computer scientists***
9. ***Use the computer as a tool for problem-solving***
10. *Build a website*

This question is a variation of the open-ended question "What does a computer scientist do?" used by Grover, Pea, and Cooper [7]. However, we found it more appropriate to use a closed-form rather than an open-ended one for our purposes. Out of the ten choices, three (marked bold) are correct, and seven are distractors. The distractors represent common misperceptions identified by Grover, Pea, and Cooper [7]. as common among middle-school students in the US. These are "CS is about computers" (1,2,7), "CS is about coding" (6, 10), and "CS is about IT" (5).

5 Findings

Achievement of Disciplinary Learning Goals (RQ1)

	Program (n=53)	University (n=221)
Median	84.0	88.0
Average	79.2	83.2
Std. Dev	18.8	17.4

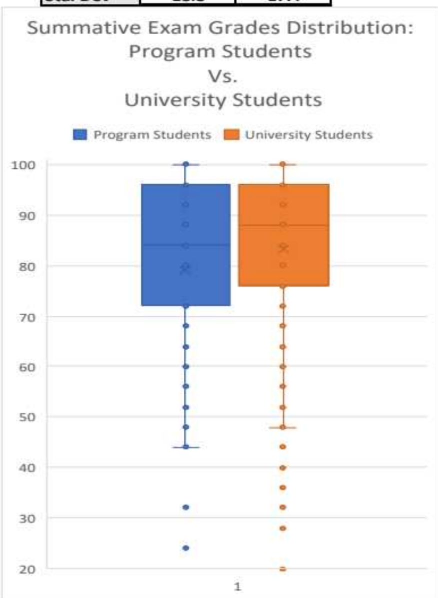

Figure 3: Summative exam grades distribution

At the end of the blended learning program, the students took the summative test given to Tel-Aviv University's undergraduates upon completing the MOOC. Undergraduates who are non-CS majors can take this MOOC and receive credit after taking the exam on-campus and achieving a passing grade (60). Using this criterion, 83% (44 out of 53) of the participating middle-schoolers met these academic standards defined by the course team.

We also compared the program students' achievements to those of the university undergrad students (Figure 3). The participating middle-schoolers achieved a median score of 84 and an average score of 79.2 (std. dev: 18.8). In the recent three semesters, this exam was given at the university. Overall, N = 221 undergrad students took this test, with a median score of 88 and an average score of 83 (std. dev: 17). To compare this distribution to that of the program participants, we first checked the assumption of equal variances using an F-test. The F-test p.value = .22, so we accepted the null hypothesis that the variance is similar among the groups. We, therefore, may use the appropriate t-test. The t-test results in p.value = .14; hence we accepted the null hypothesis and concluded that it appears as if these two sets of results are coming from the same distribution.

To conclude the results regarding our first research question, we found that the vast majority of students who participated in the program met the academic standards defined for the course. Their achievements were on par with the university students taking this course for credit.

Changes in Students' Perceptions of the Discipline of Computing (RQ2)

In the pre/post questionnaire, the students were given a list of ten tasks and were asked to mark up to four that he/she believes that a computer scientist should master. Three tasks in the list reflect a good understanding of CS as a scientific discipline, while the rest are related to common misperceptions of the essence of CS.

To assess the effects on students' perceptions, we calculated the proportion per task. That is the number of students who selected the specific task divided by the total amount of students who answered the questionnaire. A two-sample proportion test per task in the list compared the pre-test results to those in the post and indicated if the change was statistically significant.

Figure 4 illustrates the change in proportions for the three tasks reflecting a good understanding of the essence of practicing CS. All three tasks show an increase in proportions. The task "program in some computer language" was chosen by 96% of the students on the pre-test, so there was very little room for increase. However, the other two tasks, "use the computer as a tool for problem-solving"

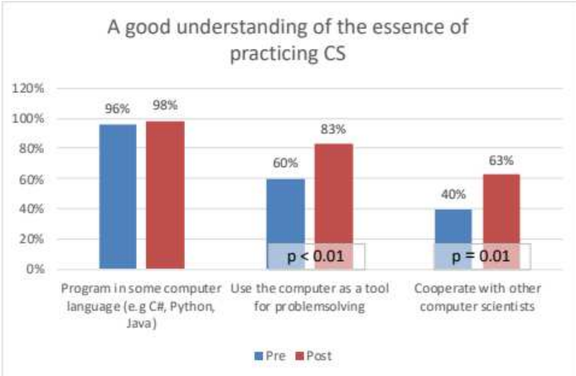

Figure 4: Changes in proportions in tasks reflecting a good understanding of practicing CS

and "cooperate with other computer scientists", were less trivial for the students before the program. These two tasks show a very significant increase in the post questionnaire. In contrast, all other tasks related to common misperception showed a decrease in the post-test (see Figure 5), though not always significant.

To conclude, regarding our second research question, we found that the students who participated in the program tended to develop a more accurate perception of the essence of CS as a scientific discipline.

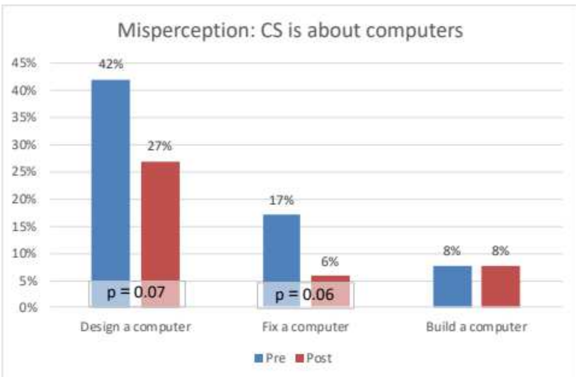

Figure 5: Changes in proportions in tasks reflecting a good understanding of practicing CS

6 Discussion

This research explored a way of harnessing existing academic MOOCs for the benefit of CSE in K-12, and specifically, on middle school students. To achieve these goals, we selected an appropriate academic MOOC and carefully designed a system of scaffolds around it in the form of a blended-learning program. Scaffolds were planted for the students and the teacher. We piloted the program in two scientific track ninth-grade classes. Our findings demonstrate that ninth-graders who participated in the BL program successfully completed the academic MOOC, achieving summative assessment scores on par with undergrads taking this MOOC for credit and developing a more accurate perception of the essence of CS as a scientific discipline. Following is a discussion on each of these findings.

High Achievements of Academic Goals

The well-validated Community-of-Inquiry framework inspired our systematic approach for re-imagining and designing the teacher's role in such a program. The MOOC was anchoring the cognitive presence while the teacher landed the teaching presence, enhanced the cognitive perspectives, and ignited a prolific social climate.

At the core of the teaching presence, the program gave the teacher tools to organize and drive the learning process. These were manifested through the weekly recommendations on units to learn, followed by opening the next class meeting with a discourse or activities related to these units' topics. Yet, the principal pace-setters milestones were the four pre-scheduled assessments spread throughout the program. Some students abused the liberty of learning at the time and place of their convenience for procrastination. However, an approaching assessment motivated them to close the gap and align with the rest of the class.

The program also provides the teacher with tools and advice to ignite and nurture an open and collaborative social climate. As these social norms evolved, we witnessed interactions where learners progressively render/employ scaffolds to/from their peers. Eventually, these peer scaffolds solved practically every cognitive and technical issue related to the MOOC's academics.

Lastly, at the overlap of the teaching and cognitive presences, the program provided tools and guidelines to instill purpose, inspire, and empower. Class group activities and the discourse around the popular science materials inspired many of the students in the class. We frequently got positive feedback and requests for more of these. We believe that all these played a crucial role in assisting the ninth-graders in completing the academic MOOC and successfully achieving its academic goals.

Student Perceptions of Computer Science

As we demonstrated in the findings on student perceptions, the students who participated in the program developed a more accurate perception of the nature of CS as a scientific discipline that its essence is computing (rather than IT-related skills). We believe that the choice of building the program around an academic MOOC, delivered by "real" scientists (as opposed, for example, to a general coding MOOC), served a great deal in supporting students in constructing a better perception of the essence of CS as a discipline. The developers and instructors of the MOOC are two CS scientists who are also deeply involved in CSE. Their disciplinary language and argumentation manifest that CS is about problem-solving through computational thinking, with coding as one part of the process of solving a computational problem using a computer. This difference became evident when we compared this academic MOOC with a Python coding MOOC, developed and served by experienced python developers.

The Implications of the COVID-19 Shutdown: Change of Research Plan and New Insights

Initially, this research was designed as a comparative study. Aside from the two treatment classes analyzed here, we followed four additional ninth-grade science classes as a control group. One of these four learned the same MOOC in a classroom, yet with no pre-designed program (in a format that can be described as online learning in-class hours with the teacher present for assistance). The other three studied the standard MoE CS ninth-grade CS program.

In the middle of the year, all schools were shut down due to the COVID19 pandemic outbreak. In the two pilot classes, only the program facilitation shifted to Zoom, and the MOOC learning continued asynchronously between the weekly Zoom sessions. However, none of the control group classes succeeded in switching to distant learning. In these classes, CS studies decayed to a complete halt a few weeks into the school closure. The closure thus affected the research design. However, it also underlined the advantage of such a BL program in building student agency and also the flexibility of such a program to operate in different learning conditions.

The classes that followed (pre-shutdown) conventional teaching failed to switch to remote learning simply because the teachers were unprepared, with no digital resources and no experience in teaching CS remotely. Regarding the class that followed the "online learning in class hours format, we believe that the lack of teaching presence, as defined by our program, was a significant factor explaining this class" failure to switch to remote learning, eventually failing to complete the

MOOC (in fact, course data shows that it actually lagged behind the experiment classes also before the school shutdown). We believe that this underlines the value of a pre-designed BL program and the redesign of teacher role to provide meaningful teaching presence in blended learning courses, even if they base most of the cognitive aspects of the content delivery on digital resources.

Limitations

Significant parts of the program were developed as the program's pilot unfolded. That includes many off-MOOC materials and activities, and more importantly, insights into effective program facilitation. As a result, the program facilitation was not uniform throughout the year, nor between the two classes. This is expected, given that this is just the first iteration of development and implementation. However, it also made clear that the program can be improved if we allow it further iterations. Hence, we treat the satisfying results as a lower bound of what such a program could achieve. Also, the results are based on a small sample (two classes) and a non-comparative design.

Future Research

Aside from further developing the program, we believe that the main challenge is studying the program's scalability, primarily whether it can be delivered effectively by new-coming CS teachers and even by non-CS teachers.

7 Summary and Conclusion

In an attempt to pave the way for more extensive coverage of meaningful CSE in K-12, this research developed and made a preliminary evaluation of a potential solution – a Blended-Learning Introduction to CS program based on an existing academic MOOC. For this purpose, we developed the principals and initial version of such a program, targeting ninth-graders in science-track classes. Our goals were evaluating the success of this program on two aspects: meaningful learning of core CS ideas and developing an accurate perception of the discipline of computing. The former was evaluated using the same end-of-course exam given to undergraduate students who take the course for credit. The latter was measured using a questionnaire that was developed for this purpose by combining and adapting standard instruments.

The program was piloted in two classes. Overall, we found that the middle-schoolers who participated in the program achieved academic results on par with undergrads taking this MOOC for academic credit. Participating students also developed a more accurate perception of the essence of CS as a discipline.

Scalability was a primary design goal of the program. Yet, testing and studying the program's ability to scale remains a question for further research. The successful transition of the pilot classes to remote learning, especially when contrasted with the control classes who fail to do so, underlined the program's ability to operate on different learning conditions while highlighting the centrality of the teaching presence.

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Fostering Women to STEM MOOCs

The FOSTWOM Toolkit

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In the context of the *Fostering Women to STEM MOOCs* (FOSTWOM) project, we present here the general ideas of a gender balance Toolkit, i.e. a collection of recommendations and resources for instructional designers, visual designers, and teaching staff to apply while designing and preparing storyboards for MOOCs and their visual components, so that future STEM online courses have a greater chance to be more inclusive and gender-balanced. Overall, The FOSTWOM project intends to use the inclusive potential of Massive Open Online Courses to propose STEM subjects free of stereotyping assumptions on gender abilities. Moreover, the consortium is interested in attracting girls and young women to science and technology careers, through accessible online content, which can include role models' interviews, relevant real-world situations, and strong conceptual frameworks.

1 Introduction

The *Fostering Women to STEM MOOCs* (FOSTWOM) project (FOSTWOM – Connecting Women & STEM) is a three-year initiative approved for funding under the European Commission's Erasmus+ Projects. The project is coordinated by UPV, Universitat Politècnica de València, and the other partners are IST, Instituto Superior Técnico, CNAM, Conservatoire National des Arts et Métiers, KTH Royal Institute of Technology, METID , Politecnico di Milano, and two high schools, Colégio Amor de Deus (Cascais, Portugal), and I.I.S. Benedetto Castelli (Brescia, Italy). The FOSTWOM project intends to use the inclusive potential of Massive Open Online Courses (MOOCs) to propose STEM subjects free of stereotyping assumptions on gender abilities. Moreover, the consortium is interested in attracting girls and young women to science and technology careers, through accessible online content, which can include role models' interviews, relevant real-world situations, and strong conceptual frameworks. We consider that the usage of good practices in videos and online courses' design can give that sense of belonging that female students seek when entering STEM areas and encourage a new generation of women and girl scientists [12].

Universities and workplaces have made enormous progress in terms of gender equality[5] in the past fifty years. Even historically male fields as business, law and medicine have greatly improved gender-balanced recruitment, and retention. Science, Technology, Engineering and Mathematics (STEM) areas have had less success in recruiting and retaining women in a gender-balanced way [6]. Women are still largely under-represented in these areas [27]). Globally, less than 30% of the world's STEM researchers are women [5]. Why are there so few women working as scientists and engineers, in particular in the digital fields, as only 18% of ICT European specialists are women[6]?

According to the European Schoolnet, STEM skills are becoming an increasingly important part for basic literacy in today's knowledge economy, since they are requested in order to ensure the citizens' confidence, knowledge and competences to participate actively in an increasingly complex scientific and technological world [11, 10]. However, the percentage of young women studying in computer sciences (CS) by 2018 in EU is around 24%[7], of which only 60% go on to work in the digital sector (EU Commission Report, 2018). With this framework, European policies are demanding to build capacities and develop innovative ways of connecting STEM to society, namely among young people intending to attract them to STEM subjects in secondary and higher education and related careers [10]. Moreover, it is also known that there are multiple disparities in participation in STEM education across regions, cultures and gender in Europe which are blocking the full involvement and the empowerment of all citizens and talents.

Education, gender equality and reduced inequalities are an integral part of the 2030 Agenda for Sustainable Development, adopted by the United Nations General Assembly in 2015[8], as distinct Sustainable Development Goals (SDGs) but also as catalysts for the achievement of all other SDGs. STEM underpins the 2030 Agenda

[5]See definition by the European Institute for Gender Equality, https://eige.europa.eu/gender-mainstreaming/concepts-and-definitions.

[6]https://ec.europa.eu/digital-single-market/en/women-digital-0.

[7]The numbers of female students in CS by 2018 in the UK and Brazil, for instance, are lowers, being respectively 19% and 11% https://www.stemwomen.co.uk/blog/2021/01/women-in-stem-percentages-of-women-in-stem-statistics; https://ec.europa.eu/digital-single-market/en/women-digital-0.

[8]https://en.unesco.org/sustainabledevelopmentgoals.

for Sustainable Development, and STEM education can provide learners with the knowledge, skills, attitudes and behaviours required for inclusive and sustainable societies. Women and girls have the same/equal right as boys and men to know how STEM can be used to make a difference in the world.

Thus, special attention must be paid to science education of girls and young women, since their voices, expertise and creativity are crucial elements for sustainable development progress. However, they are being held back by discrimination, biases, social norms and expectations that influence the quality of education they receive. Although scientific studies show that there are no significant differences between boys' and girls' brains that are relevant to learning or education [9, 26], this misconception is still widespread in society, leading to boys' abilities in Maths and science being supported while discouraging girls who study these subjects/discouraging girls from studying these subjects [21, 14]. With this context in mind, FOSTWOM intends to use the inclusive potential of MOOCs [18, 25] to propose STEM subjects free of stereotyping assumptions on gender differences in abilities. Moreover, the consortium is interested in fostering young women's participation in science and technology, through accessible online content with relevant real-world applications within strong conceptual frameworks.

The motivation behind this project is based on the project team members' experiences on an everyday basis while teaching in STEM Higher Education Institutions (HEI), designing and producing MOOCs, and also applying MOOCs in blended learning methodologies. We know from experience that a lot of students are using MOOCs in flipped classroom strategies within UPV, IST and POLIMI's curricula [7, 13, 25, 22].

Based on the results and the analysis of data from previous research [12], and the project teams' own experiences, we propose some recommendations for filling the gap, and in particular, we advance several conclusions that we consider to be the important actions to take into account while building a gender balance Toolkit and the project's MOOCs. By a gender balance Toolkit, we mean a collection of recommendations and resources for instructional designers and teaching staff to apply while designing and preparing MOOC content, so that future MOOCs have a greater chance to be more inclusive and gender balanced. The FOSTWOM Toolkit has be disseminated through conferences[9], the project's trainings and is still open for contributions on the website (can be accessed through FOSTWOM Toolkit (https://fostwom.eu/?page_id=2170)).

[9]It has been presented and discussed in sessions of Open Education Week 2020, Open Education Week 2021 (https://www.openeducationweek.org).

2 Gender Balance Toolkit

A MOOC, in our definition and practice[10], is an online course aimed at unlimited participation and open access via the web and nowadays it often includes validated academic content designed and produced by faculty members and MOOC teams located at Universities. Within the FOSTWOM consortium, almost all HEI partners are MOOC producers with online courses designed in a multidisciplinary collaboration between teaching staff and the development team. Content experts, instructional designers, graphic designers and video editors, ideate and design the STEM content according to the pedagogical-scientific model of each online course [23].

It is our responsibility as MOOC developers and designers to promote gender equality and provide better opportunities for MOOC participants to access high-quality content in a gender-balanced environment. In addition, the virtual classroom offered by MOOCs may provide a more comfortable learning space for many female students [19] and the free and easy access to the online courses provided by universities may be providing opportunities for female participants to take STEM courses, especially females from less gender-egalitarian and less economically developed countries [6].

2.1 Key Principles

The FOSTWOM Toolkit does not seek to judge a MOOC and give it the status of "good" or "bad" or say this is right or this is wrong. Rather, it seeks to raise awareness around gender balance indicators and to get people to reflect, to use their critical sense and to be able to design MOOCs' content in a more inclusive way, so that the content of the MOOCs reach more people (and, specifically for STEM MOOCs, to reach more girls) who want to learn. The Toolkit will also provide practical examples of what gender-biased and gender-discriminatory communication is and how to avoid it. The guidelines that are include in it are still an on-going process: in the first stage we defined the key guidelines according to the conclusions of the project's needs analysis [12]; in the second stage, based on our experience as MOOC teams and producers, we defined the stakeholders to be addressed in the guidelines; and presently the toolkit is a work-in-progress tool under evaluation by the MOOC teams that are producing the FOSTWOM's online courses and the MOOC community, at large.

[10] According to Wiki's definition this will be a close definition of a xMOOC.

During our previous research that constituted the needs evaluation analysis [12], we were able to identify several principles to fostering young women into science and technology education and careers [16][11], specifically through MOOCs.

For making awareness of gender stereotypes in STEM content and activities, we shall avoid female invisibility in STEM subjects and STEM MOOCs, in particular, help girls to recognise their relevant skills, use a discourse that value growth, not "born talents"; also use of inclusive MOOC graphic design that do not resonate exclusively with male participants, and other key online activities for building self-confidence and career aspirations [16]. More specifically, thinking on the identified stakeholders the FOSTWOM Toolkit should provide tools to:

- Make women working in the STEM subjects, researchers and other role models more visible;
- Make women involved in STEM MOOCs, female teachers, professors and lecturers more visible;
- Avoid gender stereotypes in STEM content and activities;
- Use inclusive graphic design: images, colours, avatars and videos, that break gender norms and are not aimed solely at male participants;
- Use real-life applications of relevant content for STEM careers, which include both women and men;
- Design assessment and learning activities in a gender-conscious way;
- Make visible the diversity and variety of competencies (both soft and hard skills), experiences, perspectives and representations needed among practitioners in the STEM area;
- Promote a gender equality discourse that highlights and problematizes women's under-representation in STEM, and points to the consequences it may have for problem formulation (e.g. risk of lack of a broad user perspective), product design, research, innovation, etc.

Then, as MOOC producers, thinking practically on a toolkit that could help to design and evaluate gender balance in online courses, we have identified the following MOOC stakeholders: content experts, MOOCs' team development members, participants/students. Finally, not only in analysing existing STEM MOOCs so that they can raise their awareness on biases, but also in helping them to contribute to future STEM MOOCs free of gender stereotypes.

[11] See also Microsoft Action Guide in https://www.microsoft.com/en-us/corporate-responsibility/skills-employability/girls-stem-computer-science

2.2 Toolkit for Whom?

The checklist within the Toolkit can be used by any person or institution that wants to develop MOOC content with gender balance or check if the offered MOOCs respect gender balance. We expect the Toolkit to be especially useful to institutions wanting to create an institutional policy of gender balance in their MOOCs and online learning production. Institutions willing to do so will find in the FOSTWOM Toolkit a great starting point in devising their own policies.

If you were considering designing and developing a MOOC that incorporates gender balance, we recommend reading the guidance before beginning this process. If your question is to what extent a given MOOC has a comprehensive gender balance level, then you could use the checklist tool. The FOSTWOM Toolkit can be found at our website https://fostwom.eu/?page_id=2170. It is presently, and during the all period of the project, open to comments and suggestions from the public: the aim is to collect feedback to be analysed before every new release during the project lifecycle. At the end of the project, the Toolkit will be released with a CC license so that anyone can adopt and adapt it to their own scenario. The role you play in the creation and development of the MOOC is also an essential element in the identification of the approaches you should consider. Next, we describe different points of view when addressing the task of defining the content, images and videos of a MOOC.

Content Experts

The autonomy of the content expert may vary widely according to the approach defined by the MOOC team, or the production process followed by the HEI. In general, MOOCs provide a natural environment for a constructive alignment of teaching and learning with more students enrolling from a wider diversity of background [4, 24]. In STEM areas this is also the case, since STEM MOOCs enrolees range from "surface learners" (only concerned with memorization of definitions) to "deep learners" (engaged in understanding and ultimately changing as a person), having in between "strategic learners" (who aim for good grades with minimal effort) [20]. FOSTWOM project aims for the "deep learners", not forgetting that we want to have among them a significant group of female students [12].

A good answer for dealing with the challenge of current diversity of students, in particular female students, is therefore the theory of constructive alignment, which is based on aligning the principle of students' learning by doing with the teacher's goal of obtaining significant learning outcomes from teaching [3]. This principle of alignment can also be found in the Universal Design for Learning

(UDL) Guidelines[12], which is a tool used in the implementation of UDL, a general framework to improve and optimize teaching and learning based on scientific insights into how humans learn, involving as many people as possible in the process. Both methods underline a discourse that value growth over "born talent", consider a diversity of approaches over "lecturing", and are capable of foster online activities for building self-confidence based on experimentation.

On the other hand, besides applying a constructive alignment of content, learning methodology and assessment activities, the teacher must adopt the role of a facilitator of learning [15]. Not only because the learning process is linked to sharing personal and common experiences with students, but also because students in a MOOC lack, even more than in face-to-face classes, the sense of self-monitoring and self-regulation which can lead to poor learning outcomes [15]. Since the development of all these competences is a challenging goal for the majority of content experts, those with higher levels of communications skills along with expertise in the field would be perfect candidates for being the advocates of a gender balance discourse in STEM subjects [12].

Visual Designers

The role of the visual designer of the MOOCs may not be evident for people who are not involved in the creation and development of courses. Since online learning has to be prepared to be performed in a variety of platforms, a professional task needs to be done. In addition, they can create better graphical representation for concepts based on creative briefs through artwork and layouts for digital projects.

The communication between content experts and visual designers, often facilitated by the instructional designer assigned to the MOOC project, is crucial for avoiding misunderstandings as regards to gender biased, stereotypical, images and/or videos. Besides, the visual designer should be aware of the importance of selecting or creating gender-balanced situations.

The main tasks of the visual designer usually include:

- Ask questions to the content expert(s) in order to catch the spirit of the MOOC (or course) project and – when possible – propose gender-balance oriented solutions to each choice to be made from a visual perspective;
- Accompany the content expert, with the support of the instructional designer, in choosing an appropriate graphic coordinated image for the course, also in consistency with any already existing elements; it is beneficial to have a gender-conscious perspective throughout the process of designing logos, colours and

[12] See more details in https://udlguidelines.cast.org.

fonts to avoid the graphics contributing to stereotypical gender markings of the subject;

- Provide suggestions and examples for the graphic and video elements to be creatively designed from a diversity perspective;
- Read carefully all storyboards provided by the content expert from a visual perspective, in order to verify if the balance between spoken text and images and keywords is effective in videos, attractive to a heterogeneous audience;
- Provide suggestions and alternatives whenever possible if there is a lack of (not only gender related) balance in the storyboard.
- Receive graphic elements from the content expert and provide alternatives consistent with the intended learning outcomes in order to improve the final product, as far as possible, using image stock libraries in a gender-aware way.

Instructional Designers

Instructional designers create effective, engaging learning experiences, working side by side with content experts and visual designers. Their role is to coordinate the efforts provided by all professionals involved so that the final result is as effective and pleasant as possible, according to all elements and variables considered. They draw on best practices from education, design, educational psychology, pedagogy theories, systems theory, and creative writing to provide learning experiences for multiple and diverse target users.

While trainers or teachers deliver instruction to a live audience, instructional designers work behind the scenes. The instructional designer role determines how the learning experiences and materials should be created so that learners achieve the expected learning outcomes. Usually, they are responsible or involved in tasks related to the (re)definition of courses, or even the development of entire new courses. The elaboration of new training materials and curricula, such as teaching manuals, tutorials and student guides, is also one of their main responsibilities. Overall, the instructional designer may be the person in charge of controlling characteristics of the course that cannot be controlled by the content expert.

The following are tasks usually tackled, among others, by instructional designers when involved in MOOC design and production (FOSTWOM elaboration starting from [17]):

- Assist faculty in discovering methods of improving their instructional design skills with and without technology;
- Guide content experts in designing their courses with the support of innovative learning methodologies so that the design works for all participants;

- Guide content experts in understanding the opportunities and challenges related to the MOOC platform in use also in terms of accessibility for a heterogeneous student body;
- Coordinate the dialogue between the content expert and the visual designer in order to support both of them in finding the most effective solutions to accompany learners in their path, also from a gender balance perspective;
- Support the visual designer in making choices around images and video elements (or already existing content) when parts of them – in addition to graphics – need an improvement, also when related to gender balance;
- Design and choose/adapt templates for key documents to be used by content experts: storyboards, exercises, short explanations, instructions, etc.
- Keep track of the design process and support the content expert in monitoring the consistency between the intended learning outcomes and the content of the MOOC, including assessment, during the whole process.

Thanks to the FOSTWOM Toolkit, we hope the Instructional designer can effectively support the content expert also in taking constantly into account all the gender balance variables that can be considered along the way.

Other Roles

There are more roles involved in the successful development of a MOOC, namely Teaching assistants, Mentors/community manager, System Administrators. Since they are of key importance in the development of MOOCs, we want to stress the importance of considering gender balance in MOOC production since the beginning.

For all these roles it is important to have in mind that they should be inclusive to both genders in all communications. Gender-aware language considerations are a must. A good reference for this is the Toolkit on gender sensitive communication from the European Institute for Gender Equality [8].

2.3 Evaluating the Toolkit

In summary, the Toolkit will provide a useful set of tools for online courses considering gender balance during its design and development. We think developing inclusive and stereotypes-free MOOCs about STEM subjects that can attract and support girls and young women to study and work in these fields. Furthermore, we hope that the use of this Toolkit promotes gender-equality training and can help all genders to recognize situations of gender inequality in careers soon enough to correct them or implement alternative solutions.

The FOSTWOM Toolkit has been already disseminated through conferences and the project's webinars and website. We count to include the most relevant comments from the audience of those conferences, webinars and trainings into the final version of the Toolkit. Moreover, we are currently producing a MOOC targeted at teaching staff, instructional and graphic designers. This MOOC will include awareness of gender-balanced STEM content and activities, will give examples that help to analyse former MOOC practices through the lens of inclusion, as well as instructions on how to use the FOSTWOM Toolkit. Naturally, all the examples come from our MOOC experience, but the final version will be released with an open licence so it can be reused and adapted to different cultures and also to different MOOC production processes.

Since the purpose of evaluating FOSTWOM Toolkit is primarily to improve and to develop, the focus will be on qualitative methods for evaluation where opinions and views can emerge continuously during the process in dialogue with stakeholders and reference groups. [1, 2]. In a longer time perspective to see what benefit and what effects it can have in the long run, we will report both on the spontaneous individual feedbacks, informal conversations, and on the answers to focus groups interviews applied to MOOCs' partners teams and other MOOCs teams willing to use the Toolkit.

3 Conclusion

FOSTWOM Toolkit (see https://fostwom.eu/?page_id=2170) is designed to be easy to apply in everyday usage. In order to fulfil that requirement, we recognize that the different roles in the MOOC production process may have a limited scope in what they may do. Thus, we have built two different checklists: one for content experts and another for visual designers. Instructional designers are expected to use both, together, and keep under control the consistency between the two.

In applying FOSTWOM Toolkit checklists, follow the main principles. REFLECTION from a gender and diversity perspective is the guiding principle. It is a process (learning new skills and professional development) that requires time. A good starting point is to go through the checklist, preferably together with other people involved in MOOCs, to get started thinking and reflecting on how inequality affects teaching and learning in your specific teaching subject. Sensitive contexts may require an inclusive approach as the one proposed in the Universal Design for Learning (UDL) Guidelines[13], taking into account different perspectives. Local culture and language are important. Consider how this checklist applies to your culture and specific language issues, but also consider that MOOCs may be used by anyone in the world.

Finally, do not look at single items, but at the overall result of having a better gender-balanced MOOC. All questions should be written affirmatively, so that all respondents understand the content easily. Consider also adopting the Toolkit and adapting it to your own institutional scenario: it will be released with an open license to allow anyone to do it.

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The MOOC-CEDIA Observatory

Study of the Current Situation of MOOCs and Recommendations To Improve Their Adoption in Ecuadorian Universities

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In the last few years, an important amount of Massive Open Online Courses (MOOCS) has been made available to the worldwide community, mainly by European and North American universities (i.e. United States). Since its emergence, the adoption of these educational resources has been widely studied by several research groups and universities with the aim of understanding their evolution and impact in educational models, through the time. In the case of Latin America, data from the MOOC-UC Observatory (updated until 2018) shows that, the adoption of these courses by universities in the region has been slow and heterogeneous. In the specific case of Ecuador, although some data is available, there is lack of information regarding the construction, publication and/or adoption of such courses by universities in the country. Moreover, there are not updated studies designed to identify and analyze the barriers and factors affecting the adoption of MOOCs in the country. The aim of this work is to present the MOOC-CEDIA Observatory, a web platform that offers interactive visualizations on the adoption of MOOCs in Ecuador. The main results of the study show that: (1) until 2020 there have been 99 MOOCs in Ecuador, (2) the domains of MOOCs are mostly related to applied sciences, social sciences and natural sciences, with the humanities being the least covered, (3) Open edX and Moodle are the most widely used platforms to deploy such courses. It is expected that the conclusions drawn from this analysis, will allow the design of recommendations aimed to promote the creation and use of quality MOOCs in Ecuador and help institutions to chart the route for their adoption, both for internal use by their community but also by society in general.

1 Introduction

Massive Open Online Courses (MOOCs) are a global phenomenon that is transforming teaching and making researchers reason about new ways to support the teaching/learning process in Higher Education Institutions (HEIs). Since Dave Cormier coined the term MOOC in 2008, these courses have become the catalyst for changing the traditional teaching/learning model of universities. Since then, universities have launched into an unbridled career of mass networked course production. Until November 2020, more than 16,300 MOOCs were registered worldwide involving around 180 million students, according to the MOOCs Class Central Global Observatory [10].

The adoption of MOOCs in different regions of the world has been quite heterogeneous [5, 9]. Most MOOCs are produced in Europe and the United States while only a small proportion are produced in Latin America. For instance, it can be seen in a report prepared in early 2016 [8] that the incorporation of MOOCs in Latin America HEIs has been very slow and cumbersome; the rate of production of MOOCs has been between 4 and 5 times smaller than their peers in Europe. However, in Latin America, the great takeoff of MOOCs began in 2015. The rise of the initiative and the increase in the number of MOOCs was mainly given to three reasons: (1) the alliance of Latin American universities with platforms such as Coursera, MiríadaX and edX; (2) the dissemination and development of Latin American MOOC platforms such as Telescopio (Guatemala) or Veduca (Brazil) which promoted the dissemination of such courses, and (3) the dissemination of the MOOC-Maker project, co-financed by the Erasmus+ program of the European Union, and whose objective was to create a network between European and Latin American IES to improve the relevance, quality and access to teaching-learning programs through the implementation of quality MOOCs [1].

According to the data published by the MOOC-UC Observatory for Latin America [8], until 2018, more than 929 MOOCs were produced in Latin America, being Mexico (341 MOOCs) and Brazil (239 MOOCs) the countries that lead the production of such courses. In the specific case of Ecuador, 2014 was the year in which the first MOOC course initiatives were registered in the country. The Private Technical University of Loja and the University of Cuenca pioneering such initiatives [13]. According to the MOOC-UC observatory, a total of 26 MOOCs were registered in 2016 and in 2018 a total of 37 MOOCs [8], making evident the slow growth of MOOCs in the country in 2 years (just 11 MOOCs) if compared to other countries in the region (such as Mexico that went from 157 MOOCs in 2016 to 341 MOOCs in 2018 or Brazil that went from 110 MOOCs in 2016 to 239 courses in 2018).

Currently there is no report providing an overview and specific state of the art of MOOCs in Ecuador. Information is needed on the current state of the MOOCs initiative in Ecuadorian HEIs. Moreover, an analysis of the factors and barriers that have limited the growth of this initiative in the country is needed. In order to better understand the current situation of MOOCs in Ecuador, it has been proposed to build the MOOC-CEDIA Observatory (CEDIA stands for The Ecuadorian Research Development Consortium and the Academy), an interactive web platform that presents a global view on the state of MOOC's initiatives in Ecuador. Based in the first data gathered in MOOC-CEDIA observatory, several recommendations are proposed to improve the adoption of MOOCs in Ecuadorian HEIs.

This article is structured into 6 sections in addition to the introduction. Section two describes the context of the study, section three describes the methodology used to conduct it; section four introduces the MOOC-CEDIA observatory, section five presents the analysis of the first data gathered by the observatory; section six presents some recommendations to improve the adoption of MOOCs by Ecuadorian HEIs. Finally, section seven includes an outline of the main findings of the study.

2 Context of the Study

The Ecuadorian Research Development Consortium and the Academy (CEDIA) was established in 2002 by a group of Ecuadorian universities, with the purpose of creating the national node of the global academic network and improving the conditions of provision of the Internet to member institutions. CEDIA is a private non-profit corporation and currently brings together 44 universities (73% of the total of the HEIs), 12 technology institutes and 36 colleges. The organization provides its members with a broad portfolio of services, without neglecting its original technological vocation. The organization has evolved to become a fundamental pillar of support to Ecuador's HEIs system. Over time, CEDIA's service portfolio has been internationalized to the point that, researchers from more than 20 countries collaborate with Ecuadorian researchers on various projects funded by the institution. In addition to offering its members more than 90 continuing education courses per year, CEDIA operates and maintains in its infrastructure the LMS platform of 24 institutions, an open access learning object platform and the MOOC platform available to all its members. CEDIA is continuously assessing global trends in the digitization of education, to get ahead of the provision of services relevant to its members. That is why the present study and the first version of MOOC-CEDIA Observatory (an interactive web platform), are considered a very relevant asset by the organization.

The MOOC-CEDIA Observatory aims to become a reference to support decision-making in the design of effective recommendations around MOOCs in Ecuador.

This observatory presents data of MOOC initiatives through 2020. This development, as well as the data collection, is part of CEDIA's MOOCs – Phase 1 project, whose main purpose is to build capabilities to produce MOOCs in Ecuadorian HEIs, as well as to conduct research around the initiatives that are developed. The data presented at the observatory were collected through a detailed review of the initiatives developed at each of the universities in Ecuador. This study conducts an HEIs comparison exercise that lightens and helps to better understand the specific situation in each institution over the past 4 years. The results of this report are expected to help advance and gain a global view and a greater understanding of the current state of MOOC initiatives. In the context of this study, a number of research questions arise, focusing on HEIs, government institutions, networks and corporations:

- *RQ1. How many MOOCs are developed by HEIs or other institutions in Ecuador?*
- *RQ2. Which universities/institutions produce MOOCs and represent national leaders in the field in the benchmarks?*
- *RQ3. What are the main characteristics of MOOCs in Ecuador's HEIs (topic, duration, dedication required by the student?*
- *RQ4. Which platforms are most commonly used for MOOCs deployment?*

3 Methodology

This section presents the methodology followed for data collection and analysis, as well as the methodology followed for defining metrics and visualizations for web platform development [8]. The web platform displays interactively and intuitively the number of MOOCs developed in Ecuador, which universities or institutions produce MOOCs, the kind of topics and the platforms used to deploy the courses. This article focuses on the data collection process and the explanation of the metrics used to display on the web platform, but no technical details will be given about its implementation.

3.1 Data Collection Analysis

The search methodology is structured in 3 phases (Figure 1): (1) selection of the sources of information and definition of the search strategies to be carried out; (2) collection, registration and review of the data collected; and (3) evaluation of the results and main conclusions. Each phase is detailed below.

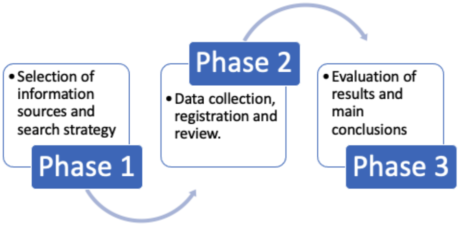

Figure 1: Data collection and analysis strategy

Phase 1: Selecting Sources of Information and Search Strategy

This work has leveraged different sources of existing information. First, and in order to delimit the search field, lists of HEIs from Ecuador were obtained, as well as a selected list of the most significant MOOC platforms for this study. Second, the sources of information and searches for the collection of MOOCs data in Ecuador were selected.

HEIs list and MOOC platforms:

- The list of universities analyzed was extracted from the list of HEIs members of CEDIA (44 of the 60 institutions active in Ecuador) and complementary we use the list of the web portal called "Altillo.com". This portal maintains a complete and up-to-date list of Latin American universities, including both traditional and online universities. This study considered only Ecuadorian HEIs.
- The MOOC Platforms list consists of 4 different platforms. Coursera and edX, world-leading American MOOCs platforms; and MiríadaX which was included in the list as the platform that hosts the most courses in Spanish. MOOC platforms implemented in Ecuador such as Open edX (implemented by CEDIA, Universidad de Cuenca and ESPOL) were also added to the list.

Sources of information for data collection and search strategy:

- Web portals of each University. A thorough search was conducted on the web portals of each of the selected universities. This search was carried out from the search engine of each university, and web scraping techniques were used to be able to map the courses offered by each university.
- MOOC platforms. Many of today's MOOC platforms have search engines that allow you to filter courses by university name or by authors. The search on

the different platforms was done by name of the university (from the list of selected universities) and selecting the country as Ecuador.

- Google. This search engine was included in order to find information related to MOOCs in Ecuador that may have been mentioned in different online media. To systematize the search, a set of keywords that were crossed with the name Ecuador and the selected universities were defined. The keywords used are: MOOC, MOOCs, Massive Open Online Course, Massively Open Online Course, Massive Course, Free Online Course, Free Online Course(s), Open Course/s.

Phase 2: Data Collection, Registration and Review

The data collection was carried out by 7 researchers. In order to homogenize results, each of the researchers involved was provided with a manual[5] with instructions on how to perform searches. Also, a shared document in a Google Spreadsheet for data registration was provided. The data was reviewed to remove redundant information and supplement the missing information.

Phase 3: Evaluation of the Results and Main Conclusions

Data analysis was performed with Excel and Tableau on the 153 MOOCs selected in the validation phase (MOOC, SPOC, NOOC). The process that was performed to analyze the recorded data and answer the different research questions (defined in section 2) are described in section 5. For the development of the web platform was followed the SCRUM methodology was followed, to support agile and iterative development. The main phases of this methodology are: (1) development, (2) closure, (3) review and (4) adjustment. These phases form an iterative development cycle. The design of the web platform was conducted following the principles of Vogel [11], functionality of the application, navigation (easy to recover and easy to navigate the contents), mechanisms of interaction and satisfaction of users who use the web application.

3.2 Defining Metrics and Visualizations

This section describes the metrics used for data analysis and visualizations. In order to analyze the number of MOOCs produced at each University, we started by differentiating a MOOC from a SPOC and a NOOC. It should be noted that in this

[5]Instruction manual provided to researchers for systematic search: https://www.dropbox.com/s/acrzq9kpbo8hfo6/Manual-Investigadores-vfinal-blind.pdf?dl=0

study we take as a reference the definition of MOOC proposed in the HOME & OpenupEd project [2]: *"MOOCs are courses designed for a massive number of students, accessible by anyone from anywhere as long as they have an internet connection, without restrictions of access by grade, and that are offered only online through a MOOC platform, periodically or continuously"*. On the other hand, SPOCs are *"courses that use the same methodology and platforms as MOOCs but privately with access control. They are generally used as a complement to face-to-face teaching through what is known as blended learning. Being a controlled environment, you can add special functionalities that don't make sense in an open and massive course"* [3]. While NOOCs are a new concept, although it is not yet recognized by the scientific community, but they are similar or equivalent to Learning Objects implemented in a MOOC platform.

We accounted the total number of MOOCs, SPOCs and NOOCs produced in Ecuador. The web platform MOOC-CEDIA presents this information through a map that divides Ecuador into its provinces. In addition, a ranking of the 9 universities and/or institutions with the highest MOOC production was performed. This ranking is presented in an ordered bar chart from highest to lowest; it can be filtered according to the type of institution (public, private or other). The analysis seeks to learn which learning domains the courses are aimed at. The domain classification follows the domain taxonomy proposed by Wu [12]. It includes the following domains: Humanities, which includes history, language, linguistics, literature, arts; Social sciences, which includes areas related to economics and sociology; Natural sciences, including areas of chemistry, physics, biology; Formal sciences, including mathematics, statistics and computer science and related; professional and/or applied sciences, including areas such as engineering, law, health, among others; Transversal, courses where cross-cutting skills such as teamwork, time management, productivity, among others are worked.

4 Description of the MOOC-CEDIA Observatory

This section describes the MOOC-CEDIA Observatory web platform, developed to provide different visualizations that help analyze the current situation of MOOCs initiatives in Ecuador. Currently the web platform is hosted on the CEDIA server (https://www.cedia.edu.ec/en/) and can be accessed from the site https://observatoriomoocs.cedia.edu.ec/ (see Figure 2). From the web platform, researchers have the possibility to interact with the visualizations and filter the information to be displayed, helping in the analysis of the data of interest for the researcher. In all the visualizations, data can be filtered by year. Depending on the analysis, data can be visualized in different levels of detail; for instance, this is the case of demographic data which can be filtered by province. Currently, only the 2020 data is available. To keep the observatory up to date, an annual update of the data collected is planned. In this way, we will be able to track and analyze the evolution in terms of the adoption of MOOC in Ecuador.

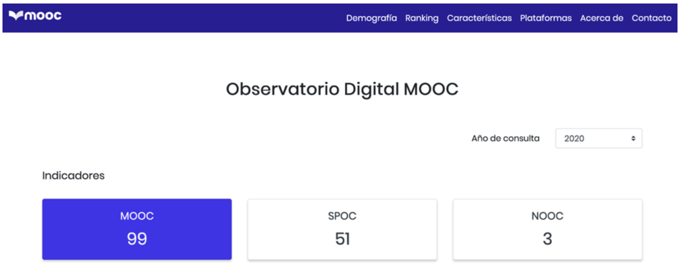

Figure 2: Observatory MOOC-CEDIA

5 Results: Ecuadorian Higher Institutions Adoption

This section presents the main results of the adoption of MOOCs in Ecuador, based on the visualizations offered by the MOOC-CEDIA observatory. The results have been organized to answer the research questions proposed in section 2: (1) an overview of MOOCs in Ecuador; (2) the characteristics of the courses; and (3) the technological platforms used for their implementation.

5.1 Overview of MOOCs in Ecuador

This section addresses the first two research questions:

- *RQ1. How many MOOCs are developed in HEIs or other institutions in Ecuador?*
- *RQ2. Which universities/institutions produce MOOCs and represent national leaders and benchmarks?*

R1. Until October of 2020, a total of 99 MOOCs were registered, 51 SPOCs and 3 NOOCs, were the 14.2% (N = 9) of Ecuador's institutions (7 HEIs, 1 corporation and 1 network) are MOOCs producers, the 10% (N = 7) of HEIs develop SPOCs and the 1.4% (N = 1) develop NOOCs.

R2. Universities with the highest production of MOOCs are the Private Technical University of Loja – UTPL (N = 50), the National Polytechnic School – EPN (N = 22), followed by the MOOCs repository of CEDIA (N = 11) and the Network of Financial Development Institutions (not a HEI) (N = 6).

R3. Universities with the highest production of SPOCs are the Polytechnic School of the Litoral – ESPOL (N = 32), the Universidad de Especialidades Espíritu Santo – UEES (N = 6), the Pontifical Catholic University of Ecuador – PUCE (N = 5) and the Universidad Católica Santiago de Guayaquil – UCSG (N = 5).

R4. From the 99 registered MOOCs, most have been produced by Private Universities (N = 54), followed by the Public University (N = 29) and finally CEDIA's MOOCs repository (N = 11).

R5. From the 51 registered SPOCs, most have been produced by Public Universities (N = 34), followed by the Private University (N = 17).

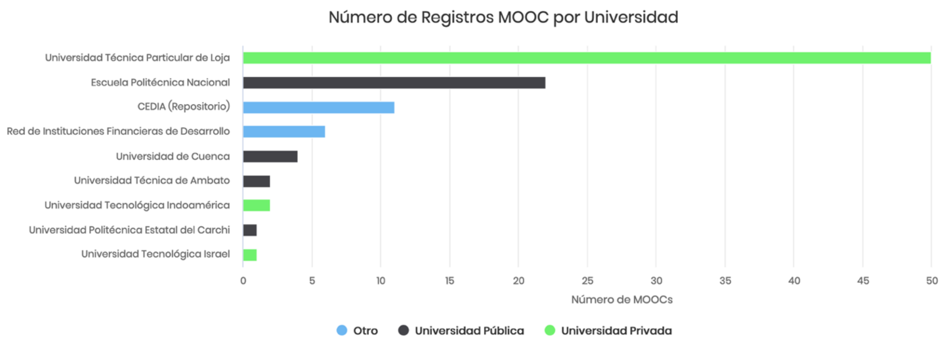

Figure 3: Ranking of institutions with MOOC

5.2 Characteristics of the MOOCs in Ecuador

This section addresses the following research question:

- *RQ3. What are the main characteristics of MOOCs in Ecuador's HEIs (topic, duration, dedication required by the student?*

R1. Available MOOCs cover domains related to professionalization and/or applied sciences (41.41%, N = 41), social sciences (20.20%, N = 20) and natural sciences

(17.17%, N = 17). The area of humanities and cross-cutting sciences are the least covered by the offer of MOOCs.

R2. The average dedication required by the student in Ecuadorian IES to review the MOOC is 8 hours per week.

R3. On average, the duration in 41% of the MOOCs in Ecuadorian HEIs is about 6 weeks (N = 37), for 23% of HEIs is about 4 weeks (N = 21), and for 22% of them is 8 weeks (N = 20).

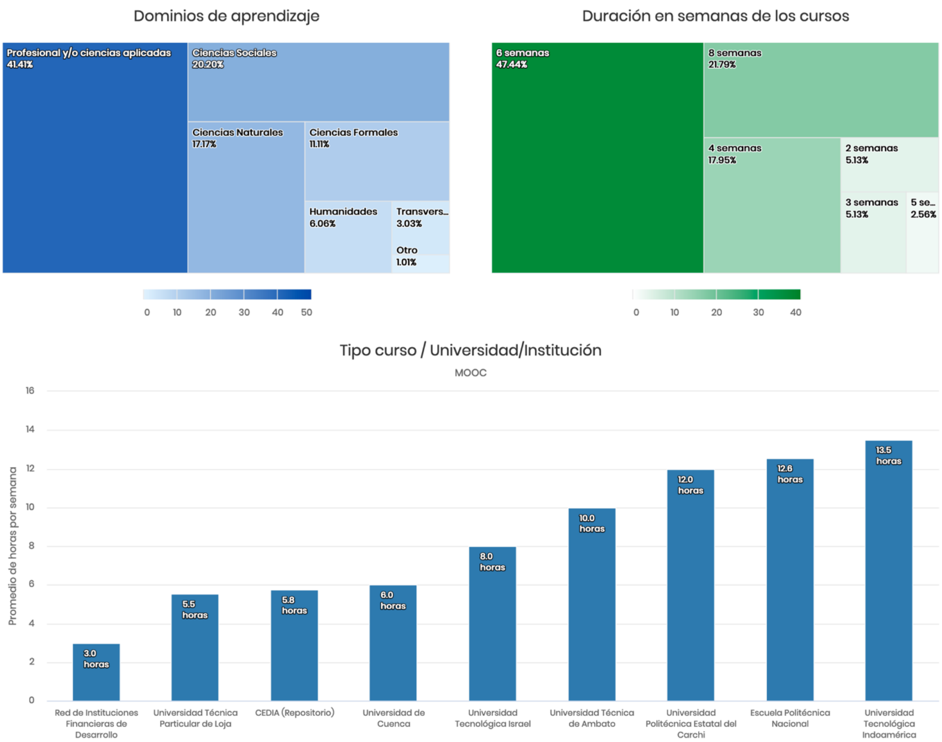

Figure 4: Characteristics of the MOOCs in Ecuadorian HEIs

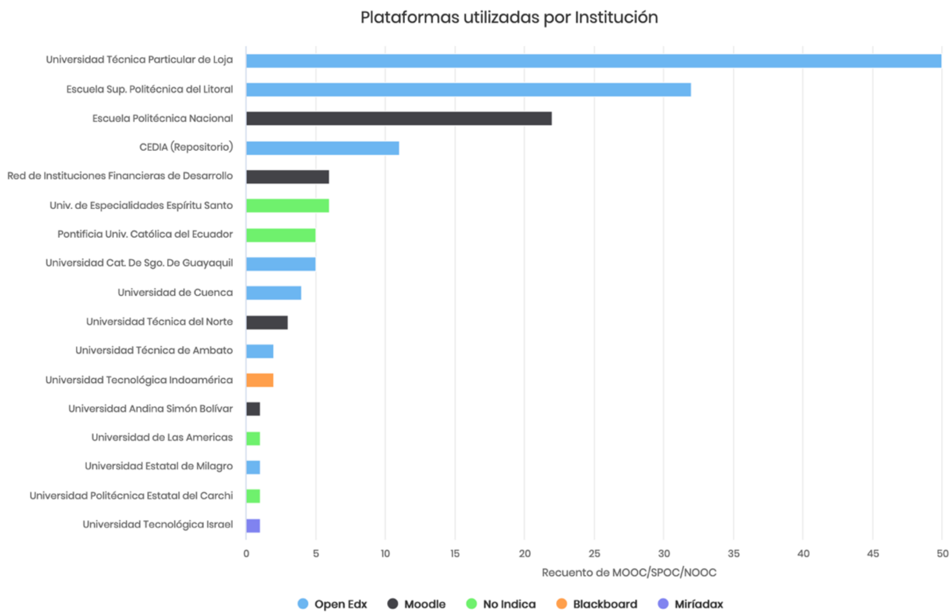

Figure 5: Platforms used to deploy MOOCs in Ecuador

5.3 MOOC Platforms in Ecuador

This section addresses the following research question:

- *RQ4. Which platforms are most commonly used for MOOCs deployment?*

R1. The predominant platforms for MOOCs in Ecuador are Open edX (44.4%, N = 4) and Moodle (22.2%, N = 2).

R2. The use of leading platforms such as Open edX focuses on 4 institutions (UTPL, CEDIA Repository, U. de Cuenca and U. Técnica of Ambato), while the use of Moodle focuses on 2 HEIs (EPN, Network of Financial Development Institutions).

R3. Only 2 Public Universities use Open edX (U. de Cuenca and U. U. Técnica of Ambato) and 1 Public University uses Moodle (EPN), while only 1 private IES (UTPL) uses Open edX.

6 Recommendations to Improve the Adoption of MOOCs in Ecuador

Studies such as those described in [6, 4], reveal that, although open platforms, such as MOOC platforms – for example Open edX (https://open.edx.org), Course-builder (https://code.google.com/p/course-builder) and OpenMOOC (https://openmooc.org/) – are very useful and are considered the solution for distributing and reusing learning material. However, the amount of work, time required for its implementation, and the services they provide, are the main reason for HEIs to give up their adoption against their use. Other works such as [7] have identified barriers that limit access and use of open platforms, including: (1) lack of broadband availability to give visibility to the digital resources (technical); (2) lack of resources to invest in hardware and software required to develop and share MOOCs (economic); (3) lack of competence in the use of these technological inventions and style of communication (social); (4) resistance to sharing and using resources produced by other teachers or other institutions (cultural); (5) lack of knowledge on how to license intellectual property (legal). In addition, these works cite factors of different nature that compromise the usability of platforms and MOOCs, including: (6) conceptual and pedagogical factors (relating to concepts about what is and is not a MOOC, the amount of terminology created to refer to such courses in a different way, and lack of knowledge about the use of these courses in contexts other than virtual); and (7) politicians and organizations (position of the institution and the services involved for the implementation of a MOOC initiative, definition of processes and management of the platform, content and the establishment of metrics to measure impact).

The definition of recommendations to improve the adoption of MOOCs in HEIs, is a process that will require even more study. However, this work is a good start point to be able to explore the real situation in HEIs regarding MOOCs and to be able to define some recommendations in relation to the gaps and factors described in this section (see Table 1). Table 1 shows the direct ("D" relationships, those that are directly described and whose answers have been possible to obtain them through this study) and indirect ("I", those that can be inferred from the answers obtained in this study), identified between the answers to the questions included in this study and, the gaps – factors that affect the adoption of an institutional MOOC initiative. However, the following questions were used to define some early recommendations in relation to bridge the gaps and factors described in this section:

- *Q1. How many and which HEIs have institutional mechanisms for the creation and management of MOOCs (institutional initiative)?*

- *Q2. What kind of infrastructure can HEIs provide to produce MOOCs?*
- *Q3. What are the mechanisms used for the quality assessment of MOOCs?*
- *Q4. What are the methods or guides used to produce MOOCs?*
- *Q5. What platforms are used to deploy MOOCs?*
- *Q6. What training needs do HEIs have, that are relevant to the production of MOOCs in Ecuador?*

Table 1: Relationship between barriers and factors affecting the adoption of MOOCs at HEIs

Barriers and Factors	**Questions**					
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**
1- Technological (relating to the implementation, operation, visibility, use of the MOOC platform and MOOCs).	D	D	I	I	D	I
2- Economic (lack of resources to invest in hardware and software required to develop and share MOOCs)	D	D	I	I	D	I
3- Social (lack of competence in the use of these technical inventions, communication style)	D	I	I	D	D	D
4- Cultural (resistance to sharing and using MOOCs produced by other teachers and other institutions)	D	D	I	D	D	D
5- Legal (derecognize about how to license intellectual property)	D	I	I	I	D	D
6- Conceptual and pedagogical (relating to MOOC, SPOC, NOOC, MOOC platforms and reuse concepts)	D	D	I	I	D	I
7- Political and organizational in nature (as regards the position of the institution and the services involved in the implementation, definition of processes and management of a MOOC initiative and the development of its contents)	D	D	I	I	D	I

From Table 1 we have stablished a set of recommendations to improve the adoption of MOOC initiative in Ecuadorian HEIs. We present the recommendation, explain the type of barrier and the proposal.

Recommendation 1: Delegated and Centralized Management of MOOC Platform

Barriers: Technology and Economics
Proposal: To update CEDIA's centralized national infrastructure platform, so that its administration, implementation, deployment and data analytics services improve the academic visibility of MOOCs produced by different HEIs, adopting common standards (conceptual and pedagogical) at the national level.

Recommendation 2: National Training Plan on the Design, Implementation, and Use of MOOCs

Barrier: Social, conceptual and pedagogical
Proposal: As a recommendation to overcome this barrier, a national training plan (virtual, online or face-to-face) can be designed in the use of technologies for the design of educational content in low-cost MOOC format and design incentive and reward programs for outstanding teachers within the HEIs academic community.

Recommendation 3: MOOC National Conference and Competition

Barrier: Cultural
Proposal: In addition to the existence of a centralized MOOC platform, this barrier can be overcome by the stimulus that would generate a national MOOCs competition, which would seek to promote collaboration between institutions, publication, sharing and reuse of MOOCs produced by the participants, giving visibility to the content generated. This will help HEIs to start sharing good practices, discuss different views, and find technical, technological, conceptual and pedagogical agreements that allow them to move forward in the creation and exploitation of these resources.

Recommendation 4: Support Mechanisms for Quality Validation and Licensing of MOOCs Content

Barrier: Legal
Proposal: This barrier can be overcome with the development of a support service in CEDIA, that includes the review and validation of MOOCs by academic peers after publication on the platform. This will allow the collaborative evolution of the creation of MOOCs, maintaining the intellectual property of both original and evolved versions, together with training on how to license and reuse published MOOCs.

Recommendation 6: National Policies on the Creation, Publication and Use of MOOCs

Barrier: Political and organizational
Proposal: To build the internal capacity in CEDIA service to establish specific guidelines and the necessary monitoring and follow up on the creation, publication and use of MOOCS in its centralized platform. This will allow to analytically evaluate its effectiveness in content management, and to integrate into other global ecosystems, seeking their sustainability over time.

7 Conclusions

In order to better understand the current situation of MOOCs in Ecuador, this study presents the state of the art of ***the adoption of MOOCs in Ecuador and the analysis of barriers and factors that facilitate their adoption.*** This study describes the main objectives and also describes the methodology followed for the survey of the analyzed data presenting the analysis of the data obtained of MOOCs in Ecuador, from the number of MOOCs produced by all the institutions that are part of the study, to the analysis of the universities that have the highest production of this type of courses. Finally, this study presents the barriers as well as the factors that facilitate the adoption of the MOOC initiative in HEIs and establishes several recommendations that will enable this initiative to be carried out at the national level. In general, as main findings we can mention that: (1) until 2020 there have been 99 MOOCs in Ecuador, (2) the domains of MOOCs are mostly related to applied sciences, social sciences and natural sciences, with the humanities being the least covered, (3) Open edX and Moodle are the most widely used platforms to deploy such courses. These results help to identify the barriers and the factors that hinder their adoption. It is expected that the conclusions drawn from this analysis will allow the design of the first recommendations as a strategy aimed to promote the creation and use of quality MOOCs in Ecuador and help other institutions to chart the same route.

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Evaluating OERs in Museum Education Context
A Collaborative Online Experience

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This paper aims to present the results of a higher education experience promoted by the research centres INTELLECT (University of Modena and Reggio Emilia) and CDM (University of Roma Tre), as part of difference master's degrees programme of the academic years 2018/2019, 2019/2020, and 2020/2021. Through different online activities, 37 students attended and evaluated a MOOC on museum education content, such promoting their professionals and transverse skills, such as critical thinking, and developing their knowledge relative to OERs, within culture and heritage education contexts. Moreover, results from the online evaluation activities support the implementation of the MOOC in a collaborative way: during the academic years, evaluation data have been used by researcher to make changes to the course modules, thus realizing a more effective online path from and educational point of view.

1 Introduction

The use of MOOCs and OERS in the field of heritage education has considerably increased in the last decade, especially in the last year due to the spread of the COVID-19 pandemic [2]. One of the reasons why MOOCs are so interesting for museum institutions is the possibility to reach a large number of users, including online, and to promote the communication of artistic and cultural heritage. For example, in 2013 the New York MOMA designed and released a MOOC intended for museum operators and professionals, which was attended by around 17,000 people from all over the world [1, 3]; in 2015, the Museum Studies Centre of the University of Leicester created the "Behind the Scenes at the 21st Century Museum" MOOC, the first example of an online course created with the support of a museum institution, the National Museums Liverpool, thus highlighting the efficacy of such a didactic methodology for the development of content relative to the field of museum and university didactics.

The spread of OERs and MOOCs in the field of museum education imposes the need for educators to engage with such didactic tools and to reach as deep an understanding of this phenomenon as possible, so as to develop their professional knowledge and skills and, at the same time, the transverse skills of analysis, creativity, collaboration and critical evaluation, which are to a greater extent connected to such learning resources. Moreover, the recent Italian ministerial regulations in education, through the "Guidelines for Integrated Digital Education" (2020) and the "Digital School National Plan" (law 170/2015), define as necessary the creation by teachers of educational pathways which employ OERs and which can integrate online content to educational activities according to the learner education needs. Therefore, training courses in this field are pivotal, both for in-training teachers and educators that intend to enter the formal or informal education context, as well as for educators and teachers that are already part of the workforce.

Starting from these assumptions, the Centre for Museum Studies (CDM) based at the Department of Education, University of Roma Tre, designed and implemented a series of online activities for students of the Pedagogical Science degree of the a.y. 2018/2019, 2019/2020 and 2020/2021 in which participants had the opportunity to study the characteristics of OERs, such as MOOCs, in the formal and informal education field, and to discover their potentialities for the promotion of the artistic and cultural heritage, thus developing professional and transverse knowledge and skills in the field of distance learning and museum education, as contents of the course. Moreover, thanks to the support or researcher from the INTELLECT centre (Research centre for Education of Museum Heritage, Wellbeing and Teaching Technology), data from the online evaluation activities, done by students, were analysed in order to obtain useful suggestions for the MOOC implementation, thus realizing a more effective online path from and educational point of view.

2 MOOC Design and First Evaluation Activity

The MOOC "Museum Education: teaching methodologies for the promotion of transverse skills in heritage context" was developed in the academic year 2016/2017 by about 70 students of the bachelor's degree in Educational Science, during the "Museum education and critical technology" blended internship organised by CDM. The 50-hour-long internship, carried out through distance and face-to-face activities, allowed the design and creation of a MOOC in museum education addressed to primary school teachers, educators and museum operators. The MOOC was planned and realized by ten groups of students: each group was assigned a module from the course and it had to create the following OERs:

- lecture notes containing the study materials;
- an introductory video on the topics of the module;
- an assessment test consisting of ten close-ended questions.

The modules of the MOOC were divided into ten different topics; the group number two was not able to complete the requested activities at the end of the blended internship course; therefore, the final MOOC consists of nine modules.

All the materials produced by the students' groups were evaluated through a specific evaluation tool [3]; moreover, the OERs produced were also assessed by the internship tutors, who afterwards appointed group number nine as the best group in the activity.

In September 2018, the MOOC "Museum Education: teaching methodologies for the promotion of transverse skills in heritage context" was reviewed taking into consideration the results of the first evaluation phase. The process of revision was aimed at implementing the contents of the OERs, correcting any mistakes, reviewing the evaluation tests and the video material produced.

The MOOC was modified and implemented, with the final structure as follows:

1. What is a museum;
2. Heritage education and transverse skills development;
3. Museum education methodologies 1: Object-Based Learning;
4. Object-Based Learning at the museum: an example of best practice;
5. Museum education methodologies 2: Digital storytelling;
6. Digital storytelling at the museum: an example of best practice;

In October 2018, the course was uploaded on the CDM Moodle platform (https://centrodidatticamuseale.it/didatticamuseo/), which is completely accessible and free. Starting from the 23th October 2018, students of the Master's Degree in Pedagogical Science had the opportunity to access the platform and begin to study the various modules of the MOOC.

3 Second Evaluation Activity: Aims and Methodology

During the academic years 2018/2019, 2019/2020 and 2020/2021, in total 37 students attended the MOOC "Museum Education: teaching methodologies for the promotion of transversal skills in heritage context" through the CDM Moodle Platform. In addition to studying the lecture notes, watching videos and evaluating the acquired knowledge through an assessment test, students were asked to rate the contents and characteristics of each module (6 modules in total) by using an evaluation tool especially created for the experience. This evaluation activity aimed students to analyse OERs in a critical way, promoting specific professional skills in the field of online education and transverse skills, such us critical thinking and digital skills.

The aims of the students' education experience are the following:

- allowing university students to participate in a MOOC on museum education content;
- allowing students to use a MOOC evaluation tool specifically realized for education activity;
- evaluate the effect of MOOCs and the related evaluation activities in the promotion of students' transverse skills.

4 The Evaluation Tool

The evaluation tool of the MOOC modules, used during the last 3 academic years, was released to stimulate the students' analysis and reflection skills, and their ability to critically evaluate the online educational resources (OERs). The tool was based on previous evaluation tools created for the development of critical thinking through evaluation activities. The main studies taken into account to create the research tool were the works of Wright [6], Yousef, Chatti, Schroeder, and Wosnitza [7], and Poce, Agrusti, and Re [4].

The tool is composed of five questions based on the Likert scale that aim to examine the following indicators [5]:

The first macro-indicator aims to assess the structure of the Sub-MOOC in terms of learning pathway design. The second macro-indicator allows participants to self-assess the transverse competences solicited within the Sub-MOOC under evaluation. The third macro-indicator aims to assess the quality of learning in terms of expectation and clarity of learning instructions. The fourth macro-indicator focuses on the technical aspects of the OERs, such as the sound of the videos

Table 1: Evaluation tool indicators

Macro Indicator	Indicator	Likert scale
Instructional Design Category – Module Organization	Clarity of objectives Self-regulation promotion Practical examples Cultural differences within videos Assessment reports Test consistency	1: Strongly disagree – 5: Strongly agree
Self-evaluation skills promotion	Creativity Innovation Communication Analysis Evaluation Argumentation Metacognition Problem solving Memory Aptitude for research Entrepreneurship	1: No incentive – 5: Maximum incentive
Self-evaluation learning	Expectations in learning Gradualness of learning Clarity of learning path Quality of learning instructions Number of learning instructions Learning contents	1: Strongly disagree – 5: Strongly agree
User Interface and Video Content	Search functions Sound quality Resources complexity Sentences complexity Users engagement	1: Strongly disagree – 5: Strongly agree
Sub-MOOC Content quality	Ease of understanding Ease of memorisation Clarity of content Clarity of the language used. Duration of use. Exhaustiveness of content. Multimedia of content.	1: Minimum Quality – 5: Maximum Quality

and the accessibility of the online resources. The fifth and last macro-indicator allows participants to evaluate the clarity, comprehensiveness and multimedia of the contents in relation to the Sub-MOOC educational objectives.

To access the evaluation questionnaire of each module, the student involved in the online activity had to have previously studied the lecture notes, watched the video and completed the assessment test related to the module evaluated.

5 Evaluation Results

Since the academic year 2018/2019, 37 students (M = 6, F = 31) from the Masters' degree in Pedagogical Sciences have completed the MOOC and the evaluations of each module of the course. The evaluation data on the first macro indicator (Instructional Design Category - Module Organization) are very positive (Figure 1). The average scores assigned to *Assessment reports* and *Test consistency* indicators are quite high: on average, 19 out of 37 students strongly agree with "The level of the evaluation tests is coherent with the learning objectives of the module" statement and give high marks to the quality of evaluation reports provided during module activities. Even the indicators of *Clarity of objectives* and *Self-regulation promotion* also have good ratings: learning objectives are defined quite clearly in the MOOC by 19 students. The presence of practical examples of the use of specific teaching methodologies in the context of artistic and cultural heritage is particularly appreciated by students; moreover, they can be fairly well understood by everyone, regardless of cultural background, by 18 participants out of 37.

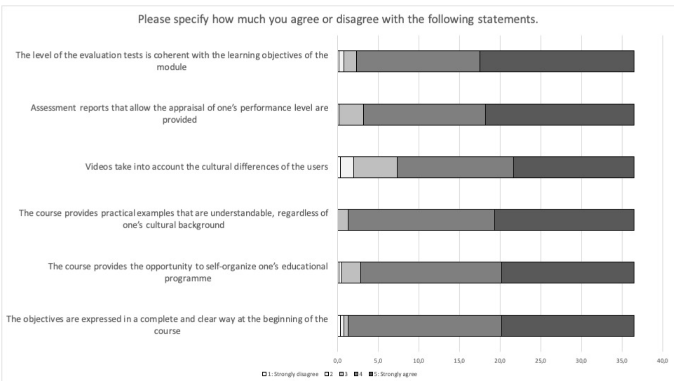

Figure 1: Comparative histogram of the average scores assigned to the instructional design indicator (N = 37)

The macro-indicator *Self-evaluation skills promotion* shows very satisfactory evaluation data for almost all the transverse skills mentioned (Figure 2). The *Evaluation* and *Innovation* skills receive on average the highest scores: 24 students score the innovation competence 5 or 4, while 26 students score the evaluation competence 5 or 4. The achievement of these evaluation results with reference to these skills, ascribable to the construct of Critical Thinking (see *Novelty* and *Critical Evaluation* indicators in Poce, 2017), makes explicit the attainment of the online course's objectives by the students, who self-assess in a very positive manner the promotion of their mental dispositions (Facione, 1990). The *Communication* skills are also evaluated positively: students state that the MOOC activities, especially modules 1 and 2, promoted communication skills, encouraging the acquisition of the specialized language of museum education (st.dev. = 1.20). *Creativity* also achieves quite high evaluation results (on average, score of 4 for 12 students and score of 5 for 10 students), highlighting the students' awareness of the acquisition of new skills and content, one of the priority objectives of the online activity. The lowest self-evaluation scores were given to the *Problem solving*: on average, 11 students assigned the score 3 to this skill. The low perception of the promotion of the *Problem solving* skill could be due to the absence of individual and group activities based on problem solving methodologies in the field of museum and heritage education, and this provides researchers with an important direction for the future implementation of the MOOC. It is important to highlight that some results of the self-assessment of transversal skills are closely related: specifically, *Innovation* skills show a strong positive correlation with *Creativity* skills (r = 0.83) and *Communication* skills (r = 0.83). These data are significant in relation to the educational objectives of the MOOC and provides important information about the educational effectiveness of the learning pathway.

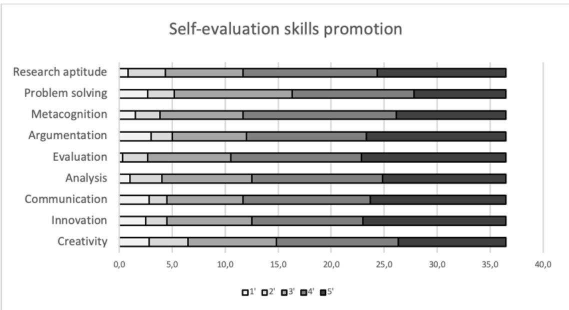

Figure 2: Average of the scores assigned to the modules of the MOOC in terms of "self-evaluation skills promotion" (N = 37)

The results of the learning self-evaluation learning process are also fully satisfactory (Figure 3): students declare that the indications provided are always clear and in line with the objectives of the module (on average, 34 students out of 37) and acquisition of knowledge were almost always gradual (on average, 32 students out of 37), preventing in this way the arising of difficulties due to the excessive complexity of the contents provided. The indications concerning the activities were very clear, obtaining an average of the scores assigned to 5 by 18 students. The evaluation assigned to the indicator *Number of learning instructions* reveals how further implementations must be made about the quantity of contents proposed in the course: on average, 10 students quite or completely agree that more indications regarding online activities would have been needed.

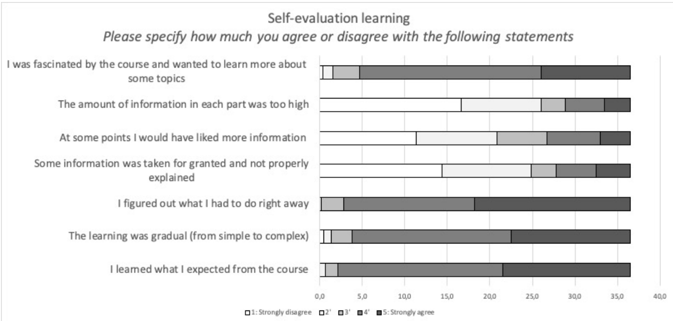

Figure 3: Average of the scores assigned to the modules of the MOOC in terms of "self-evaluation learning" (N = 37)

The User Interface and Video Content macro-indicator presents important evaluation results for the implementation of the MOOC: students declare the need to activate a content search function not only within the text but also in the videos and in the assessment tests, so as to view specific contents more quickly. While the results related to the *sound quality* are quite satisfactory (on average, 20 students assign the maximum score to this indicator), the level of syntactic complexity should be reduced for 15 out of 37 students, in order to facilitate the understanding of the content delivered through different OERs. Generally, the level of complexity of the proposed topic is assessed positively in relation to the MOOC target users (on average, 34 students out of 37 agree with this statement).

The Sub-MOOC Content quality achieved the evaluations with the highest average scores: the lecture notes, videos and evaluation tests are easy to understand and memorise, clear in form and content, exhaustive and with good interactive and multimedia contents for the most of students participating in the MOOC. In general, 23 and 22 out of 37 students give the highest score respectively to the indicators of *Ease of understanding* (St.dev = 0.67) and *Clarity of the content* (St.dev = 0.66)

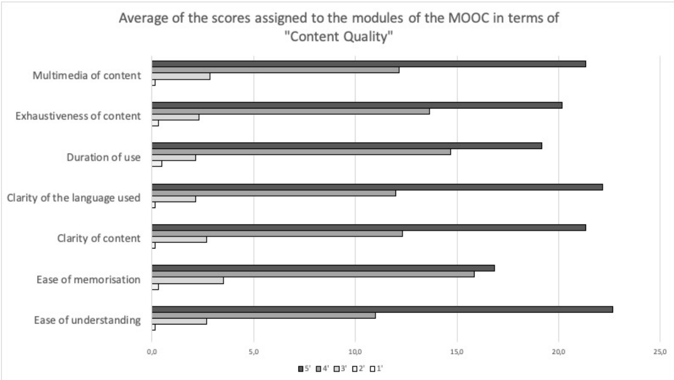

Figure 4: Average of the scores assigned by participants to the "content quality" macroindicator (N = 37)

6 Conclusion

The educational experience presented here proposes an innovative methodology that promotes professional and transverse skills, especially critical thinking, in students of a Master's degree course through online activities. The opportunity to participate in a MOOC on museum education and to evaluate it through a specific evaluation tool has allowed students to deepen their specific knowledge of museum education and to enhance skills and abilities, both those more directly related to teaching and educational activity, such as pedagogical reflection and the evaluation of learning material, and those that can be defined as transversal, such as innovation, creativity, communication and argumentation.

In addition, the designed activities through different academic years allowed the realisation of a MOOC with the collaboration of university students who participated in both the first design and evaluation phase, providing interesting stimuli for the implementation of OERs, such us videos and texts technical implementation or introduction of new type of e-learning activities.

Indeed, the evaluation results of the MOOC modules, suggested by the "evaluators" students, will be used in the second revision phase of the course, starting in 2021, with the aim to enlarge the number of users thanks to the collaboration of the INTELLECT research centre. The small number of students employed in the experience described here imposes the need for a subsequent pilot phase of the MOOC, but it was also necessary to identify the most evident elements that need modification or interventions.

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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):

[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.

[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.

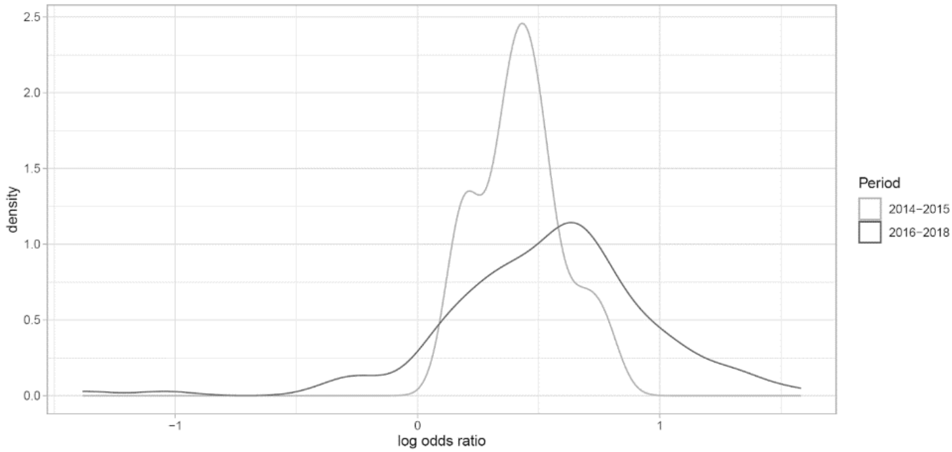

Figure 1: Distribution of completion bias in MITx MOOCs before and after the change

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.

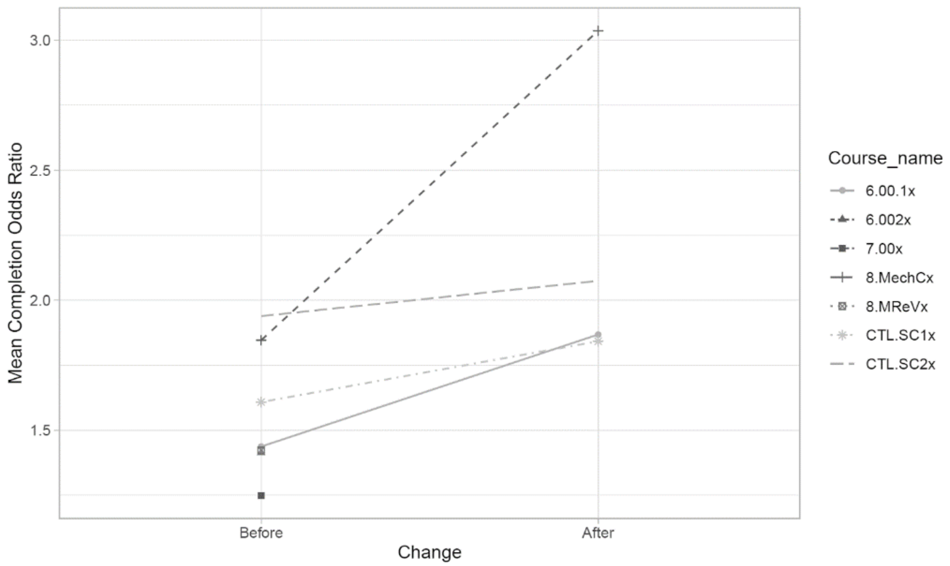

Figure 2: Interaction plot of completion odds ratio

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.

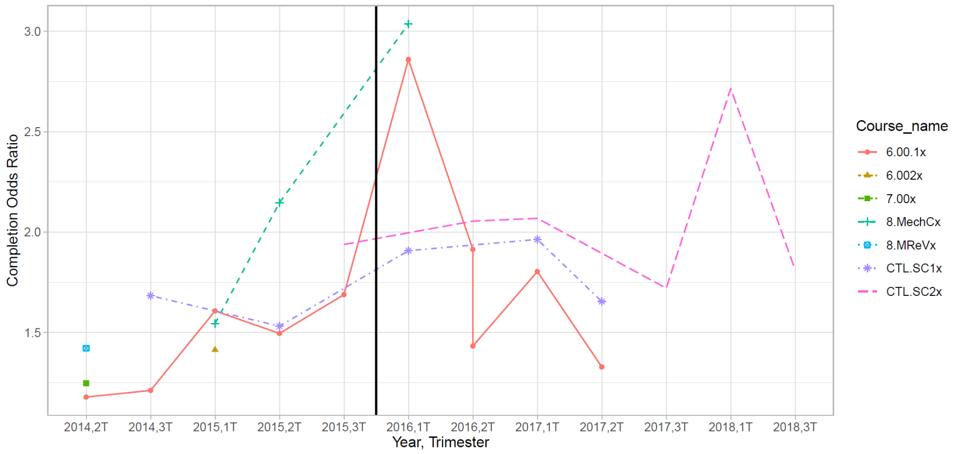

Figure 3: Completion odds ratio of consecutive runs

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.

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Universitat Politècnica de València's Experience with EDX MOOC Initiatives During the Covid Lockdown

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In March 2020, when massive lockdowns started to be enforced around the world to contain the spread of the COVID-19 pandemic, edX launched two initiatives to help students around the world providing free certificates for its courses, RAP, for member institutions and OCE, for any accredited academic institution. In this paper we analyze how Universitat Poltècnica de València contributed with its courses to both initiatives, providing almost 14,000 free certificate codes in total, and how UPV used the RAP initiative as a customer, describing the mechanism used to distribute more than 22,000 codes for free certificates to more than 7,000 UPV community members, what led to the achievement of more than 5,000 free certificates. We also comment the results of a post initiative survey answered by 1,612 UPV members about 3,241 edX courses, in which they communicated a satisfaction of 4,69 over 5 with the initiative.

1 Introduction

As soon as March 11, 2020, when massive lockdowns started to be enforced around the world to contain the spread of the COVID-19 pandemic, edX, the global MOOC platform, mobilized to help its university partners support their students and maintain learning continuity with an initiative called RAP (Remote Access Program) [3]. The initiative saw the creation of an edX-partner community group, where members could access at no cost the courses and programs of any other member. In a few days, more than 60 edX partners from all over the world joined the program, adding 800 courses to deliver blended and independent learning opportunities for students and professional development for faculty and staff through June 30, 2020 [4]. Building on this success, and recognizing the ongoing need of colleges and universities globally, edX took the step of expanding its offerings to provide free course access for any accredited educational institution, and it continues to do so with its OCE (Online Campus Essentials) solution [1]. The courses for this initiative were drawn from the catalogue of courses of the edX partners that decided to participate offering their certificates for free.

Universitat Politècnica de València (UPV) recognized these two initiatives as powerful tools to help during the pandemic, so it offered the certificates of its most in-demand courses to those institutions in need.

At the same time, UPV also saw it as a great opportunity to give access to high quality educational content to its community during the lockdown, so an automated mechanism was created to let its member access the free certificates.

2 Description of Rap and OCE

2.1 How Both Initiatives Worked

For RAP all participating members got access to the program after confirming their participation. For OCE the accredited academic institutions filled a form in a web page and signed an agreement with edX.

EdX emailed csv text files with promotional codes to each customer institution. These codes had to be distributed to users to be redeemed when purchasing the certificates of the courses included in each initiative.

All RAP participating members could ask edX for an unlimited number of codes during the initiative.

The students had to enroll in the courses and use the codes before the end of the initiatives, but they could finish the courses later (if the course ending date was after the end of the initiative). The only condition was that the course was published and open for enrollments during the initiatives.

2.2 Global Impact of the Courses of UPV in the Initiatives

6,057 learners asked for a certificate of UPV's courses in the RAP initiative and 7,750 in the OCE initiative, 13,807 in total. As the initiatives were active for 4 months, this means that they generated almost 3,500 extra verified-certificate enrollments per month, what implies a 3.5-fold increase over the average number of verified certificate enrollments during 2019, that was about 1,000 per month.

Around 27% of the verified certificate enrollments in UPV's courses generated from the initiatives were from UPV members, what demonstrates an interest by UPV's community to get verified certificates from our courses that we had not detected. For the other 73%, edX reported enrollments from 1,844 different institutions and the data we gathered shows that we had enrollments from 17 different countries.

The average completion rate of the courses with the free certificates was 33% (39% if we consider only the Spanish speaking countries).

3 Use of the Initiative by Universitat Politècnica de València

3.1 Code Distribution System

To use RAP initiative as a customer the challenge was to create a system that could distribute thousands of codes with minimum administrative overhead. We decided that the best way to distribute the codes was to create an automatic mechanism, gathering the users' requests through a website that enforced the policy of use and distributing the codes by email.

To avoid the misuse of the codes, we asked edX that the codes created for UPV had to be used in an edX account made with an email from the institution's official email domain. Taking into account that we could ask for an unlimited number of codes, and that the codes could only be used from an edX account made with an institutional email address, the policy that was created was letting users ask for 5 codes per email address, accepting only email addresses from upv.es domain.

The website also included a listing of the institutions that were offering courses in the program and some instructions about how to make an account and how to use codes. It was developed as an open source tool and the code can be downloaded from https://github.com/leosamu/edxcovid19.

Once the system was ready and tested, emails were sent to the different groups of the university community. First an email was sent to staff and faculty, that are smaller groups and, once we checked that the system was working well, an email was sent to the student groups, one school at a time. After one month of the start of the initiative, a reminder email was sent to the different groups.

3.2 Summary of RAP Initiative Use by UPV Community Members

UPV distributed 24,613 codes to 7,712 of its students, faculty and staff, what means that around 22% of its 35,000 community members asked for at least one code. The data provided by edX shows that 15,744 of the codes provided to UPV were redeemed and that 5,202 certificates from different institutions were obtained (a 33% completion rate). It also shows that around 27% of UPV codes were used to get certificates for UPV courses.

Given the success of the UPV courses among the UPV community members and, as edX gives its members the possibility to offer free codes for their courses to their communities, we decided to set up a follow up initiative to distribute codes for UPV courses to UPV members using the same system with a new server.

At the moment of writing this article, 5 months after setting up the new service, 2,116 codes had been sent to UPV students, staff and faculty.

3.3 Post Initiative Survey

At the end of September 2020, almost 3 months after the end of the RAP initiative, a survey was sent to the 7,712 users that had asked for codes during the initiative. The survey was anonymous and was opened for responses until the end of November, when data were collected and analyzed.

1,612 users answered the survey giving their opinion about 3,241 edX courses. 54% of them declared themselves as students, 8% as unemployed, 25% as UPV staff or faculty and 13% of them said they were working outside UPV. They declared that, on average, they have requested 3.8 codes, they had used 3.2 codes, they had obtained 1.8 certificates and where in process of achieving 1.1 certificates more. Their satisfaction with the initiative of codes for free certificates was 4.69 over 5 and their perception of the quality of the courses was, on average, 4.04 over 5. When asked about the usefulness of the MOOCs they had taken for their career the average result was 3.65 over 5 and 97.9% said that they were going to take more MOOCs in the future.

4 Conclusion

The data gathered shows that edX was right, there was a need for quality online learning during the lockdown, and that our courses were well accepted by institutions around the world.

The use of the initiative by the UPV community was a big success, with a third of the community asking for codes, 5,000 certificates awarded and a very high valuation of the initiative by our users, who also consider that the courses are high quality and that they are valuable for their career. It has been so successful that we are continuing it with a new initiative with codes for our own courses.

The system and process we created to distribute the codes to our community have demonstrated to be simple and robust, being able to distribute thousands of codes with minimum human intervention.

We are participating in a new initiative by edX called Open Campus Essentials that gives access to registered academic institutions for free to courses following a subscription model until the end of July 2021 [2]. 16 of the 145 courses included in the catalogue are from UPV. We have also enrolled in this initiative as a customer institution and we are now testing the system to offer this new subscription model to our community.

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Open Tools and Methods to Support the Development of MOOCs

A Collection of How-tos, Monster Assignment and Kits

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There are a plethora of ways to guide and support people to learn about MOOC (massive open online course) development, from their first interest, sourcing supportive resources, methods and tools to better aid their understanding of the concepts and pedagogical approaches of MOOC design, to becoming a MOOC developer. This contribution highlights tools and methods that are openly available and re-usable under Creative Commons licenses. Our collection builds upon the experiences from three MOOC development and hosting teams with joint experiences of several hundred MOOCs (University of Applied Sciences in Lübeck, Graz University of Technology, University of Glasgow) in three European countries, which are Germany, Austria and the UK. The contribution recommends and shares experiences with short articles and poster for first information sharing a Monster MOOC assignment for beginners, a MOOC canvas for first sketches, the MOOC design kit for details of instructional design and a MOOC for MOOC makers and a MOOC map as introduction into a certain MOOC platform.

1 Introduction: MOOCs and Different Backgrounds for MOOC Development

Open online courses for "masses", or "massive open online courses" [14] have been exponentially growing since 2012, becoming a strategic ambition for many institutions world-wide [10]. In March 2020, Google search data shows a sharp peak for MOOCs during the first COVID-19 pandemic wave (see Figure 1) and thus also shows the potential of open learning programmes, especially when access to traditional formats is or becomes problematic (and this does not only apply during a pandemic).

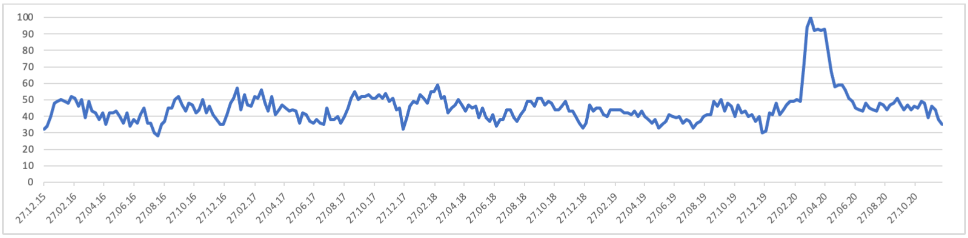

Figure 1: Worldwide searches for the topic "Massive Open Online Course" at Google.com. Source: Own visualisation of data offered by "Google Insights for Search", https://trends.google.com/trends/explore?date=today%205-y&q=%2Fm%2F0gyvy46, 27.12.2020. Note: The representation is shown in relation to the highest level (March 2020, 100 percent)

There is now a vast selection of MOOC platforms in existence, with the prominent suppliers being Coursera, edX, FutureLearn and Udacity. ClassCentral [2] reports that these platforms now service over 180 million learners, from 950 universities and offer 16,500 courses. In this paper we will describe the authors' backgrounds, experiences and developments which are impacting on MOOC growth across several countries.

Since 2014, Graz University of Technology (TU Graz) has been hosting a MOOC platform called iMooX.at (https://imoox.at/). Since then, more than 100 courses have been held with over 60.000 registered users. A special feature of the platform is that all course materials *must* be published under Creative Commons licenses, so that complete courses and materials can be used and modified by others. iMooX.at is thus a platform for courses with open educational resources (OER, see [6]). Another platform enabler is that iMooX can be used for free for all Austrian universities co-financed by a ministry's initiative (iMooX.at, 04/2020–03/2024).

The MOOC story of the University of Applied Sciences in Lübeck (Technische Hochschule Lübeck, TH Lübeck) starts with a first Moodle-based prototype, that was evolved into the MOOC platform "mooin" in 2015 (see [13]). Some years later, the relaunch of oncampus.de (https://www.oncampus.de/), a subsidiary of TH Lübeck responsible for postgraduate study programs, combines both MOOCs and further learning opportunities on the new platform. Next to MOOCs offered directly by TH Lübeck or the oncampus company, externals can offer their courses, too. Therefore, there is a great variety of open online courses: from academic subjects to non-formal education topics like beekeeping, rock'n'roll or youth participation. Many of the open online courses are published under Creative Commons licenses, i.e. MOOCs produced by TH Lübeck.

The University of Glasgow has been developing MOOCs since 2014. To date, they have launched over 35 courses on FutureLearn and one on Coursera (with many more in development), and are regarded as a leader in this area. Furthermore, the University of Glasgow has increased its offerings on these platforms by launching seven micro-credentials and one fully online M. Sc. programme. With over 500,000 enrollments across the portfolio, Glasgow continues to develop MOOCs in key strategic areas to increase access to education. Glasgow has a strong connection in partnering with industry and other universities to co-develop and deliver courses. Examples of this include, working with The Data Lab to produce a course on Data Science for School Teachers, and collaborating with the University of the West Indies to develop a course on the History of Slavery in the British Caribbean.

Therefore, we can build upon the experiences of hosting and supporting the design and delivery of several hundred MOOCs via self-hosted platforms (TH Lübeck, TU Graz) or the University of Glasgow's approach with Coursera and FutureLearn, and courses licensed under Creative Commons (TU Graz, partly TH Lübeck) or not (University of Glasgow).

2 Development of MOOCs and Aim of This Contribution

Collectively we offer diverse perspectives on how to develop MOOCs in different contexts. Our approaches have slightly different purposes, strategies, didactics and a broad variety in disciplines. However, we are united by the need to support the development of MOOCs – for our teachers, our clients and various institutions – in the best possible and professional way. Therefore, we often independently develop and implement resources, methods and tools for developing MOOCs. The challenge is, how can we enable others for MOOC development, provide targeted guidance and support in planning their MOOC projects? In the following, we would like to present resources, methods and tools that we have developed and consider to be fundamental to our approach to MOOC developments.

This paper aims to present a collection of methods to demonstrate the variants of methods and tools that have been created. We restrict ourselves to those examples that are explicitly available under Creative Commons licenses and in the best case under open licenses, so that their re-use is possible without the host institution. This includes translation of the mainly English (and partly German) materials.

Since all the creators who developed the materials agreed to contribute to this paper, we can also highlight experiences with the tools and backgrounds.

3 Selected Tools and Methods

3.1 Overview

Figure 2 gives an overview about the resources, methods and tools that we describe within this contribution. They are ordered in a timeline fashion, from initial discovery to designing and building your first MOOC. A very prominent and often repeated measure is not described further as a tool, but needs to be highlighted: Everyone who is interested in developing a MOOC we highly recommend to take part at one. This serves two important purposes, 1) it allows the designer to become the learner and 2) also to be informed by best practice and generate new ideas for their own pedagogical approach.

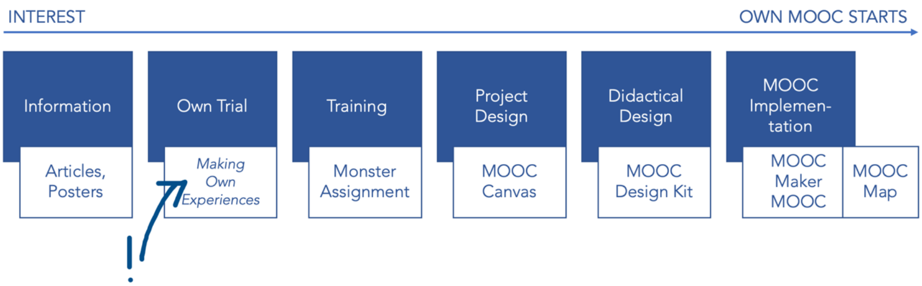

Figure 2: Overview about the potential development from first interest to become a MOOC maker and supportive resources, methods and tools

3.2 How to MOOC – First Insights

We skip introductory texts and information on what MOOCs actually are and directly propose texts and materials that deal with their development or different implementations. The texts are very practically focused.

As a first, we want to share "Ten simple rules for developing a MOOC" by Manallack and Yuriev who shortly emphasize the main steps (similar to our Figure 2). Concerning diverse didactical design many refer to the differentiation of cMOOX (c for connectivistic) as well xMOOX (x for extension). Whereas cMOOXs designs using principles of discussion and even co-design of the course, xMOOXs design are focused on content, especially videos and quizzes to support self-organised learning. Conole [3] emphasizes that there are even more possibilities to classify MOOCs and offers 10 criteria for different MOOC designs. Similarly to [3], Drake, O'Hara, and Seeman [5] share five principles of MOOC design and how it influenced decisions in a case study.

MOOCs are typically, but not always, developed by academics working at universities. Therefore, it might be of interest to see different possibilities to implement existing MOOCs into teaching or develop it as an integrative part. Educators use the affordances of MOOCs to provide their students with different insights into content and as a means to engage with external participants. This is a growing trend with the introduction of major platforms offering Campus-based used for free, resulting in learners being able to take a variety of courses for free, with continued access, without payment. In so-called "pre-MOOCs", for example, the MOOC becomes a prerequisite for participation in a laboratory exercise [1]. In the case of the "Inverse Blended" MOOC, specific measures are taken to ensure that the MOOC is also "in attendance", for example by printing workbooks or organizing meetings of learners [7]. We have identified seven such scenarios that are implemented more frequently [8].

3.3 Own Trial – You Have to MOOC

All agree that colleagues who wish to develop a MOOC should take full part in at least one especially on the platform they will be offering theirs in. There are several overviews and collections of MOOC providers and MOOCs.

- OERu.org (https://oeru.org/) is an offer of the OER foundation and presents online courses on the base of open licensed materials from partner universities (mostly outside of Europe).
- MOOChub.org (https://moochub.org/) is an aggregation service and common project of several MOOC providers from the German speaking landscape, who provides a well open licensed courses (amongst others: iMooX.at, openHPI, oncampus)
- Then there are other lists, which offer overviews and collections of online courses, e.g. Edukatico.org (https://www.edukatico.org/) and Classcentral.com (https://www.classcentral.com/), which includes different providers, but as well fee-based courses.

3.4 The Monster MOOC: A Workshop Design and Assignment for Beginners

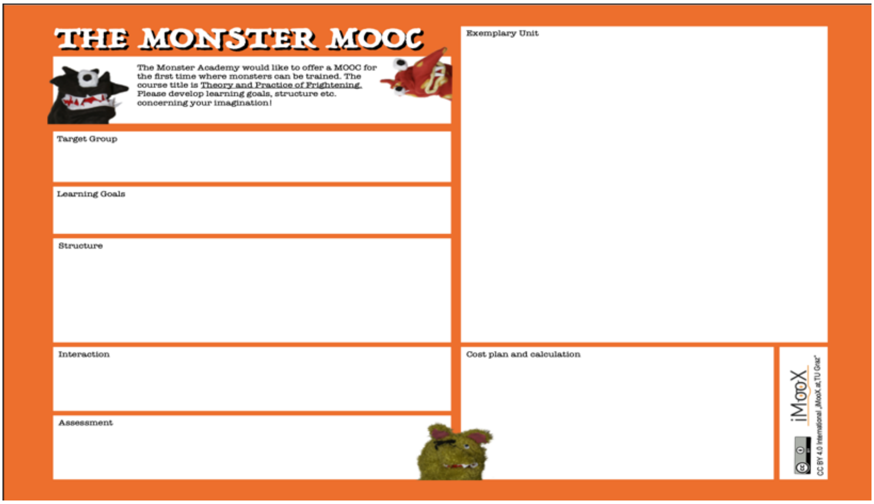

Figure 3: Monster MOOC Assignment in a Workshop. A workshop design including an assignment which is engaging and very helpful to support a first MOOC design in a fun and creative way.
Reference (URL): Schön and Ebner [19]. The Monster MOOC (Template for Group Work). Version 1.0, Zenodo, 27.12.2020, https://zenodo.org/record/4395154
License: CC BY 4.0

Encouraging MOOC design teams to engage in a course and document areas they felt worked and areas they felt didn't work well can be a good way to share a common experience and engage in pedagogical discussion. In this way, at least the multitude of implementation variants with regard to communication, collaboration, action orientation or humor components becomes apparent. In addition to a few theoretical classifications and explanations, we then had the best experience with a very special work assignment: the development of a MOOC for monsters. Here we would like to emphasize: The monsters are very important: Nobody here is really an expert, even if she is a big fan of the Monster Family or has just seen Monster, Inc.: What monsters are exactly and how they could at best give you a fright is mainly up to our imagination.

The assignment for a group task in the MOOC further education is therefore (see [19]: "The Monster Academy would like to offer a MOOC for the first time where monsters can be trained. The course title is 'Theory and Practice of Frightening' Please develop learning goals, structure etc. concerning your imagination!" With the help of pre-structured posters, MOOCs are now sketched, accompanied by giggles and loud laughter, it's just too weird what's happening. And yet: Especially the free thinking and the exchange of ideas in a good atmosphere provides good first sketches and plans, which in turn show in the mutual presentation how different one can design a MOOC. Does the MOOC follow an approach that gradually releases testing into application? Does it concentrate only on theoretical aspects of the topic? Which form of assessment is planned?

Antidotally, positive experiences of staff using Monster assignment have been captured (see [17]).

3.5 Sketching a MOOC Project with the MOOC Canvas (TU Graz)

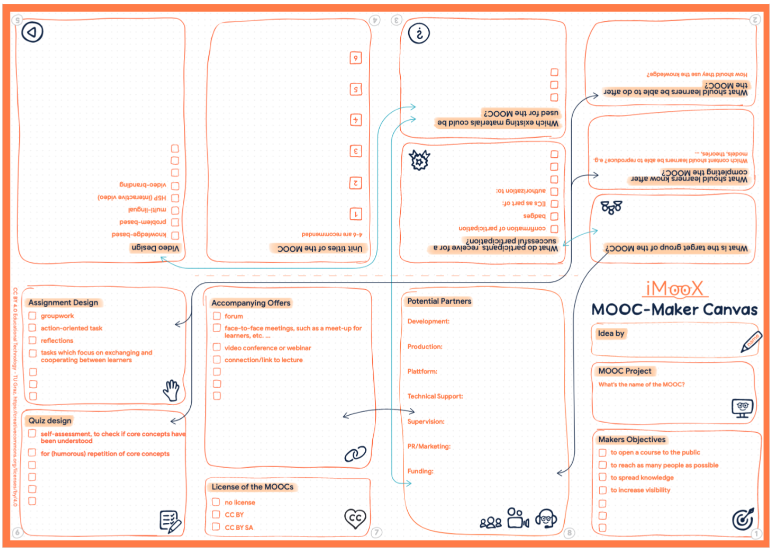

Figure 4: MOOC Canvas. A big print (DIN A3), the canvas can be folded as a booklet and used to sketch a first draft of a MOOC project.
Reference (URL): http://dx.doi.org/10.13140/RG.2.2.28577.22887 ([21])
How-to fold the canvas: https://www.youtube.com/watch?v=MIQO5uurSLc
License: CC BY 4.0

Originally, the term "canvas" was used for completely empty canvases, but especially the openly licensed and widely used business model canvas by Osterwalder and Pigneur [15] has changed this term. Thus, a canvas is often understood to be a template that can be printed and helps to structure developments or plans.

The MOOC Canvas, which the Educational Technology team at TU Graz uses for consultations on MOOC project conception, was first used in 2017 (see [16]). The MOOC Canvas is intended for the early phase of the MOOC project development and is oriented towards important planning activities around the overall MOOC project by considering production up to marketing, cooperation and topics (see [18]. The MOOC Canvas, printed on DIN A3, is first folded to a small booklet, page by page, which gives a big "picture" around the MOOC project. Folding instructions can be found online (https://www.youtube.com/watch?v=MIQO5uurSLc). It starts with a working title and the MOOC organizers' objectives: Why a MOOC? Then target groups and learning goals, a sketch of the units and video, tasks and test design are discussed. A MOOC project, which is strategically implemented, must include good cooperation and partner selection as well as marketing ideas, embedding in other concepts and cooperation partners is also discussed. In the best case the first thoughts for the potential MOOC project are sorted after working through and unfolding the MOOC canvas and further connections visualized by arrows can be discovered. Thus, MOOC's target group is closely connected to possible cooperation partners; existing material could be used etc. Whoever wants to use the canvas is invited to do so – the open license also allows own modifications [21, 20].

3.6 MOOC Design Mapping Framework – The University of Glasgow

Due to the scale of courses Glasgow was producing, across a range of subject disciplines, there was a requirement to provide more focused support for academic staff and streamline learning design support with a framework that allows MOOC design to be a creative and collaborative process. Equally, in doing so allowed the central team to collate and share examples of previous course design best practices with colleagues. Thus, we now have a bank of exemplars to share with colleagues new to the process. What this achieves is a much stronger understanding of how MOOCs are designed and the importance of mapping the learner journey to learning types, ensuring Intended Learning Outcomes (ILOs) are being delivered on.

The MOOC Design Mapping Framework (MDMF) is centered on Laurillard's [11] conversational framework which has been further adapted by the ABC learning design approach by [22]. Glasgow's framework builds upon and expands this approach by using an online collaborative tool, Miro, that allows multiple contributors to design and map MOOC curriculum (central section). Post-it style notes

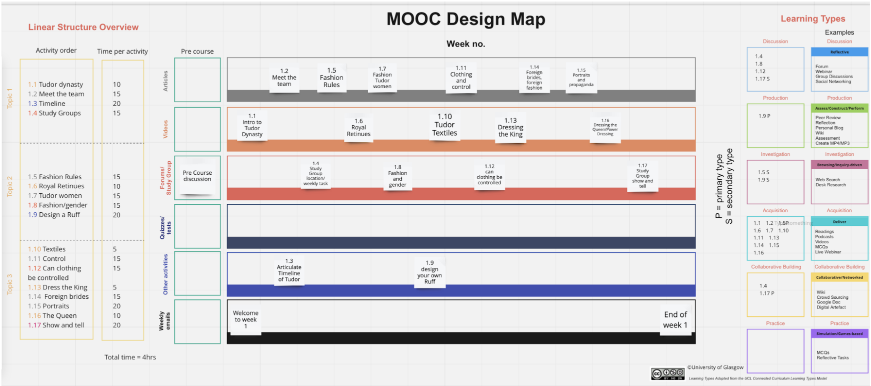

Figure 5: A collaborative approach to MOOC design mapping. Utilising an online tool (Miro) to create a framework which allows MOOC stakeholder to collaboratively build and map out, step by step, MOOC curricula.
Reference (URL): https://www.gla.ac.uk/colleges/socialsciences/staff/learningandteaching/moocdesign/
License: CC BY-NC-SA

are dragged into the desired activity type with enough information captured to explain the step. The activity types have been strongly aligned to the FutureLearn platform pedagogies and tools available to deploy. The completed curriculum map then allows content to be developed with the learner journey fully mapped and aligned to learning types (right hand column) and time to complete each step (left hand column). The framework has been granted a reusable license (CC-BY-NA-SA) allowing other institutions free use to adapt and remix the approach to suit local needs. Empirical research has been conducted into the evaluation of this tool, which explored academic experiences and also those of the learning technologists who supported the design and development of these MOOCs using the framework [9].

3.7 A MOOC for MOOC Makers

Since 2016, it has been possible for external participants to host their MOOCs on oncampus.de (cf. [12]). The platform is based on Moodle, but there are some specifics that MOOC makers need to be familiar with in order to set up a MOOC and implement content and activities. Providing (free) regular training or some other supervised format to empower external MOOC makers was not considered as an efficient practice: If people want to create their own MOOC, it would be rather unpleasant to wait until the next start of a guided tutorial. In addition,

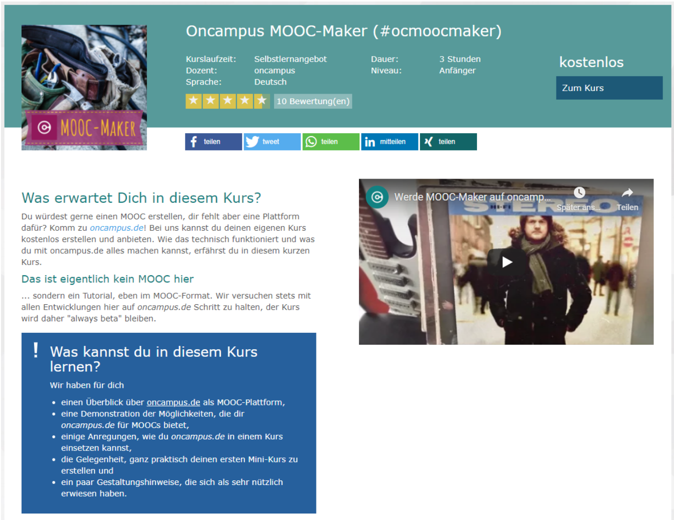

Figure 6: MOOC Maker. A MOOC on how to technically set up an open online course on the oncampus.de platform.
Reference (URL): https://www.oncampus.de/mooinmaker
License: CC BY 4.0

the demand for these courses would vary quite a dramatically: In one term there would be hardly any people interested in an introduction to MOOC making, in another there might be a very high number of interested participants. MOOCs on the other hand are scalable and, if planned accordingly, can be launched at any time. Other platforms like Coursera likewise ended up with this approach (cf. [4]). Another benefit is that participants directly experience for themselves a possible implementation of an online course. In addition, there is of course the opportunity to ask for individual supervised training services.

The MOOC maker MOOC takes approximately 3 hours to complete, whereas it depends very much on whether participants want to create their own course in the meantime and need more time to experiment on their own. The course

- gives an overview of the MOOC platform oncampus.de,
- demonstrates the potential features for MOOCs provided by oncampus.de,
- includes some proposals on how to use oncampus.de for a course,
- provides the practical opportunity to create a first mini-course, and
- shares some basic design instructions that have proven quite useful.

It starts with a brief introduction to the platform, demonstrates possible forms of content and activities, and then provides step-by-step instructions on how to set up and fill a blank course. Participants can ask questions and discuss ideas on implementation options with other MOOC makers in a forum. The MOOC maker MOOC is licensed under CC BY 4.0, so copying is allowed, so is adapting – and in this case it is even required.

To date (January 19th, 2021), 859 participants are enrolled in the course. However, not all of them actually produced a MOOC of their own. 105 externals have requested empty courses so far. Of these, some only did some experimenting, others actually launched multiple courses on the platform (i.e. there are four MOOCs on volleyball training launched by an external MOOC maker).

The tools and methods described in previous sections can be used regardless of which MOOC platform will be used. They are in fact not covered in the MOOC maker course and are therefore needed for the didactic and organisational planning of the course. However, this is no longer the case when it comes to the practical implementation of the MOOC. The functionalities, interfaces and configurations that will be used in the MOOC will need to follow those of the MOOC platform. Although oncampus.de is based on Moodle, it has been heavily customised, so that the MOOC maker MOOC cannot easily be used to explain the implementation of MOOCs on other Moodle-based platforms. Therefore, the MOOC should also be designed in order to enable easy integration or adjustment of new features and updates. Apparently, this is not always feasible in a MOOC that has to include a lot of screenshots and screencasts. Participants therefore also need some acceptance that the current state of the platform may differ slightly from what is shown in the images and videos.

3.8 A MOOC Map as Checklist

At TU Graz, an own MOOC for MOOC makers is under development modelled on the MOOC maker course at the TH Lübeck. At this point, we would like to point out another tool, the MOOC map: MOOC creators receive this map during their individual training and can tick off the central steps of MOOC implementation with a focus on the technical and practical needs. The current version is the third, as we do update the MOOC map according to the feedback of all involved people, so the iMooX support team as well the MOOC makers.

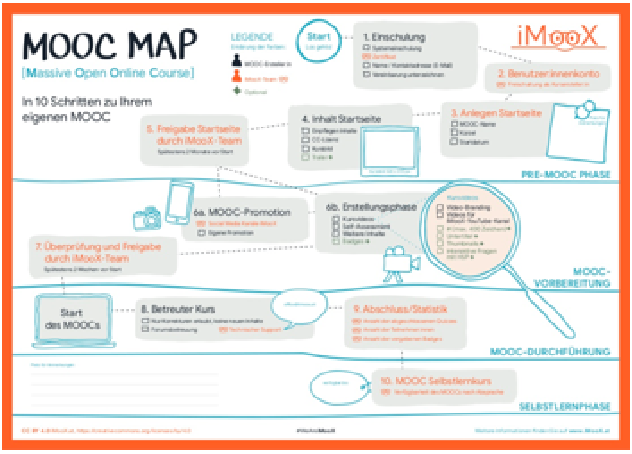

Figure 7: A MOOC map with a to-to list to tick off on the main steps of set-up a MOOC at iMooX platform.
Reference (URL): https://imoox.at/page/creator
License: CC BY 4.0 International

4 Outlook

The authors of this paper contacted one another and collaboratively wrote this contribution. They are aware that other open-source developments do exist but where not located in our searches. In this joint overview, we have tried to collect and present openly accessible and, if possible, openly licensed resources and materials for the development of MOOCs. Practically, we concluded our efforts on the design and development of MOOCs knowing that there are open issues such as marketing, implementation and evaluation that require exploration and consideration when undertaking a MOOC build and launch.

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Confidence Counts
Fostering Online Learning Self-Efficacy with a MOOC

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The increasing reliance on online learning in higher education has been further expedited by the on-going Covid-19 pandemic. Students need to be supported as they adapt to this new learning environment. Research has established that learners with positive online learning self-efficacy beliefs are more likely to persevere and achieve their higher education goals when learning online. In this paper, we explore how MOOC design can contribute to the four sources of self-efficacy beliefs posited by Bandura [4]. Specifically, we will explore, drawing on learner reflections, whether design elements of the MOOC, *The Digital Edge: Essentials for the Online Learner*, provided participants with the necessary mastery experiences, vicarious experiences, verbal persuasion, and affective regulation opportunities, to evaluate and develop their online learning self-efficacy beliefs. Findings from a content analysis of discussion forum posts show that learners referenced three of the four information sources when reflecting on their experience of the MOOC. This paper illustrates the potential of MOOCs as a pedagogical tool for enhancing online learning self-efficacy among students.

1 Introduction

Online and technology-enhanced learning have been gaining increasing importance in higher education and have, to varying degrees, become integral components of curriculum and instruction. This trend accelerated dramatically in 2020 when the Covid-19 pandemic forced higher education institutions across the globe to rely solely on remote teaching and learning. With little to no preparation students all over the world were tasked with starting and continuing their higher education online. These unprecedented circumstances highlighted the importance of supporting students adapt to the challenges and demands of online learning.

Central to the process are student self-efficacy beliefs towards learning online. Online learning self-efficacy refers to one's confidence to perform learning-related tasks successfully in an online environment. This definition of self-efficacy is based on the work of Bandura [3], Bandura [4], and Bandura [1]. Self-efficacy has been shown to be related to human behaviour and pivotal in various valued outcomes. For example, studies have shown that self-efficacy is related to motivation, self-regulatory learning processes, and achievement across a wide range of academic domains and learning contexts [15]. Students with high levels of self-efficacy are often motivated, self-directed, persist in the face of difficulties, and tend to have high goal achievement [2, 8, 12]). This research suggests that in order to improve the success of the pedagogical interventions commonly used by educational institutions to support knowledge and skill development among students, they should focus on the development of students' self-efficacy beliefs.

Massive Open Online Courses (MOOCs) are one avenue through which pedagogical interventions can be offered at scale. Studies have suggested several ways to support self-regulated learning (e.g. [9, 10]) and self-efficacy more specifically [6] through MOOC design. In addition, Rodriguez and Armellini [13] demonstrated using a pre-test/post-test research design that their study skills MOOC was successful in significantly increasing learners' levels of self-reported self-efficacy. In an extension of this work, the current paper focuses on the MOOC, *The Digital Edge: Essentials for the Online Learner*, a pedagogical intervention designed to assist students to learn how to learn online. By drawing on qualitative feedback posted by participants in the course discussion forum, this paper explores how the design and implementation of the MOOC can support learners develop positive self-efficacy beliefs towards online learning.

2 Sources of Self-efficacy

Central to social cognitive theory, Bandura [4] proposed that individuals develop self-efficacy beliefs through a combination of the following: i) enactive mastery experiences, ii) vicarious experiences, iii) verbal persuasion, and iv) physiological and affective sources.

2.1 Enactive Mastery Experiences

An individual's prior experiences with the task at hand, or a similar task, can serve as an indicator of capability. Past successes can build confidence, while failures can weaken it. The difficulty of a task and the amount of effort required also contribute to a person's sense of self-efficacy. Enactive mastery experiences are determined to be the most influential source of efficacy information as they are accomplishments that we have experienced ourselves, for which we have tangible experiential evidence of success [2].

2.2 Vicarious Experiences

Social comparisons allow individuals to perceive their abilities in relation to the successes or failures of others, such as peers and role models. Observing others, with whom they can identify, succeed at a task can provide individuals with a sense of confidence in their own ability to perform similar tasks [2].

2.3 Verbal Persuasion

Verbal persuasion refers to positive encouragement and feedback from others. Realistic affirmations from others can boost self-efficacy perceptions. Verbal persuasion is often considered to be a weaker source of self-efficacy as compliments can often be given loosely without substantiation [2].

2.4 Physiological and Affective Sources

Self-efficacy beliefs or perceptions of ability can also be influenced by our body's physical and emotional reactions to certain situations and tasks. Experiences of anxiety, stress, arousal, fatigue, for example, and their accompanying physical manifestations, can leave a student with a low perception of their ability to persist in a task.

3 Mooc Design and Self-Efficacy

The Digital Edge: Essentials for the Online Learner, is a MOOC offered by Dublin City University (DCU) in collaboration with the Irish Universities Association and DCU's Students Union. The main goal of the MOOC is to support college and university students around the world to learn how to be effective online learners given the challenges facing them as a result of the Covid-19 pandemic.

The course, which is hosted on the FutureLearn platform, is two-weeks long and consists of approximately 3 hours of learning per week. The content is structured around four main themes: Ways of Thinking and Ways of Working (Week 1), Tools for Working and Tools for Thriving (Week 2). The pedagogical design of the MOOC draws on the LifeComp Framework [14], the Learning Compass 2030 [11] and the Conversational Framework [7], which is the underlying pedagogical framework of the FutureLearn platform. A unique aspect of the MOOC is that it was co-designed and -facilitated by experienced online learners. The first iteration of the course was launched in September 2020 with over 7,800 enrolments. Table 1 outlines how the pedagogical strategies in the course were intended to support online learning self-efficacy development.

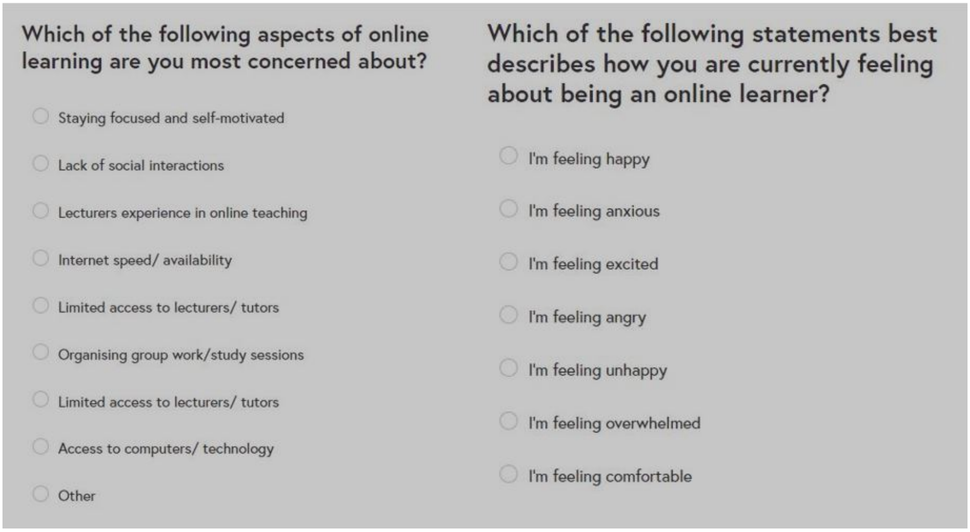

Figure 1: In-course poll examples

4 Analysis of Learner Reflections

A theory driven, deductive content analysis of discussion forum posts was conducted to identify if learners reported on these four information sources when reflecting their experience of the MOOC. Data was obtained from the final step in the MOOC. In this step, learners were encouraged to share their experience and thoughts on the course as a whole. This step contained a total of 353 independent learner comments.

In the first phase of the analysis, 187 posts were coded as containing substantive learner reflections of the course. All other comments (N = 166) were excluded from further analysis because they were either too short or were not a reflection. For instance, many of the excluded comments were simply a “thank you” to the

Table 1: Sources of self-efficacy development in the MOOC

Information Source	Relation to MOOC
Enactive mastery experiences	The MOOC itself was an authentic online learning experience. Participation in an online course can give students tangible evidence that they can learn successfully online. It was expected that the non-formal, low risk nature of the course would encourage participation, even among less experienced learners.
Vicarious experiences	The MOOC was co-designed and -facilitated by students who had prior experience learning online. Participant's vicarious experience was encouraged through the use of real-life examples and testimonials from these students. Testimonials were included in the course content as quoted text and audio clips. Student facilitators were also available for the 2 weeks to answer questions and share their experiences in the discussions forums at the end of each step. Participants were encouraged to ask questions and draw on the knowledge and experience of the student facilitators. By observing the successes of their peers, learners can generate efficacy beliefs that they too can obtain success through persistence and effort.
Verbal persuasion	Positive verbal persuasion was provided through the discussion forums by both the instructors and the student mentors to help participants believe that they can cope with difficult situations when learning online.
Physiological and affective states	Well-being, emotional regulation and co-regulation were key components of the pedagogical framework of this MOOC. Polls incorporated at four points throughout the course encouraged learners to reflect and share how they were feeling about learning online (See Figure 1). The poll format allowed participants to respond anonymously while also being able to see how their peers were feeling.

instructors. Next, a more detailed qualitative analysis was conducted to identify self-efficacy-related appraisals relating to the four sources of self-efficacy. Five coding categories were formulated, one for each of the four sources of self-efficacy and an additional category for other. All 187 comments were coded and assigned to these five categories. The results of this categorisation are presented in Table 2 and Table 3 provides exemplar comments from each category.

Table 2: Classification of learner reflections

Source	**N**	**%**
Enactive mastery experiences	37	20
Vicarious experiences	5	3
Verbal persuasion	0	0
Physiological and affective states	33	17
Other	112	60

The results show that learners referenced three of the four information sources when reflecting on their experience of the MOOC. In particular, the participants reported that the MOOC was a form of enactive mastery experience and that it encouraged positive physiological and affective states. No reflections were classified as referring to "verbal persuasion". This may be because learners usually receive feedback on an individual basis and may not deem it relevant when reflecting on the course as a whole. It may also be the case that the role of feedback is difficult to identify in comments as it could be implied by more general statements such as "the course was encouraging". More research is needed to investigate this further. It is also noteworthy that the majority of the reflections were classified as "other". These comments generally focused on knowledge and skill attainment owing to the course content. While improvements in knowledge and skill may influence one's self-efficacy beliefs, they are difficult to categorise according to Bandura's [4] constructs.

5 Conclusion

Self-efficacy plays an important role in learning success. Thus, online learning self-efficacy constitutes an important area of interest for higher education institutions, particularly in the context of Covid-19, where the majority of teaching and learning is taking place remotely. The current paper contributes to the literature by

Table 3: Examples of learner self-efficacy feedback categorised by source

Enactive mastery experiences	*A great confidence booster in an Unfamiliar environment* – Learner A *This course helped introduce me to what learning online will be like. It has helped me understand it better and I feel more confident now that I have completed the course* – Learner B
Vicarious experiences	*This course was very helpful and encouraging. I thought the reflections by student ambassadors were reassuring and have made me a little bit more confident about the learning that lies ahead.* – Learner C *I feel a lot more comfortable about online learning after finishing it. Seeing other students' opinions and experiences in the comment section also really helped me.* – Learner D
Physiological and affective states	*I am now excited to start studying my course whereas last week I was more anxious.* – Learner E *After completing this course my level of anxiety definitely went down* – Learner F
Other	*This course has been very informative and helpful and i look forward to using the tips I've learned during my online learning.* – Learner G *It gave me plenty of new resources to use that will help with my college experience.* – Learner H

illustrating how MOOC design and implementation can contribute to the sources of self-efficacy beliefs posited by Bandura [4]. Previous research has shown that self-efficacy can be improved as a result of completing a course [5, 13]. However, more qualitative and quantitative research is needed to build on the findings of the current study and explore further the relationship between MOOC design and online learning self-efficacy.

6 Acknowledgement

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CoFeeMOOC-v.2

Designing Contingent Feedback for Massive Open Online Courses

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Providing adequate support to MOOC participants is often a challenging task due to massiveness of the learners' population and the asynchronous communication among peers and MOOC practitioners. This workshop aims at discussing common learners' problems reported in the literature and reflect on designing adequate feedback interventions with the use of learning data. Our aim is three-fold: a) to pinpoint MOOC aspects that impact the planning of feedback, b) to explore the use of learning data in designing feedback strategies, and c) to propose design guidelines for developing and delivering scaffolding interventions for personalized feedback in MOOCs. To do so, we will carry out hands-on activities that aim to involve participants in interpreting learning data and using them to design adaptive feedback. This workshop appeals to researchers, practitioners and MOOC stakeholders who aim to providing contextualized scaffolding. We envision that this workshop will provide insights for bridging the gap between pedagogical theory and practice when it comes to feedback interventions in MOOCs.

1 Introduction

Massive Open Online Courses (MOOCs) are perceived as a form of democratizing education by providing global learning opportunities without geographical and cost constraints [7]. Nevertheless, not all the learners can exploit the learning benefits offered. In MOOC contexts, learners usually face several difficulties related with their learning paths which have been associated with their course retention [1, 11, 12]. The massive nature of MOOCs, the learners' heterogeneity [4] and the asynchronous communication among educators and participants, result in belated attention and timely feedback interventions leading often in learners' disengagement and dropout.

Feedback has a high impact on the learning process, shaping considerably the learners-to-tutor and learners-to-learners interaction [3]. During learning, educators are required to meet students' needs by providing them with the necessary support [13]. In face-to-face learning contexts, educators can follow learners' progress and collect information from various formal and informal sources to understand their students' needs for assistance [8]. Yet, in MOOCs, this direct interaction may be hard to monitor or altogether absent due to massive number of participants. Also, the use of technology introduces additional factors – such as technology failures, need for structured communication and coordination between teachers, learners and peers – that can affect the way we provide feedback.

Designing feedback for MOOCs cannot be addressed as in human-to-human tutoring due to the aforementioned aspects. At the same time, designing scaffolding following intelligent tutoring systems approaches is not appropriate since human factors (such as the role of the teacher and the peers) are important aspects of MOOCs. So far, research focuses on Learning Analytics to identify the students who may need assistant and to assess what kind of feedback is appropriate for their needs. However, empirical research suggests that the Learning Analytics methods used to provide feedback are not based on established pedagogical strategies for instruction [5] and it may hinder learning instead of supporting it [2].

2 Workshop Objective

The current workshop provides a venue to explore, discuss and reflect on the design of feedback interventions in MOOCs following a participatory approach. To design appropriate feedback in MOOCs, we identify three critical points that we will further elaborate during the workshop:

a. To pinpoint the context-specific aspects that come into play regarding scaffolding in MOOCs and to investigate their impact on designing feedback;

b. To explore the role of learning analytics in delivering feedback. For example, how can we employ learning analytics to identify struggling learners in need of scaffolding or to design personalized feedback;

c. To develop guidelines for designing scaffolding and delivering contextualized feedback in MOOCs.

Through real-life scenarios, we will address the aforementioned points and we will demonstrate how to provide personalized interventions designed for massive contexts. In particular, we plan to apply various computational algorithms and visualizations on existing data and attempt to interpret findings based on established educational theories.

2.1 Workshop Relevance with EMOOCS21

This workshop is aligned with the themes of the Experience Track, and with the Research and Policy Tracks directions. More specifically, CoFeeMOOC-v.2 serves as an opportunity for discussion and reflection on the recurrent problems that may appear during the design and the enactment of MOOCs in terms of providing feedback to learners experiencing difficulties. This goal is in alliance with the second and fourth focus of the Experience Track, that is, the incorporation of the pedagogy and LA in MOOC learning designs, respectively. Through hypothetical situations where MOOC learners need help, workshop participants will discuss on how to cope with these problematic situations. We envision that this hands-on approach will deliver insights regarding the design and implementation feedback strategies, the appropriate support mechanisms for different situations and the conceptual or technological tools that could facilitate scaffolding. This workshop aims to contribute to bridging the gap between pedagogical theory and practice when it comes to feedback interventions in MOOCs and to inspiring future research lines.

At the same time, this workshop is in accordance with the current policy needs which ask for new applications of MOOCs for different learning contexts (e.g. K-12, lifelong learning). Recently, MOOCs received a lot of attention due to Covid-19 pandemic, with 2020 to be considered as the "second year of MOOCs" [10]. The pandemic has posed radical challenges in worldwide education shifting learning from the traditional in-person teaching to online settings. Under such circumstances, MOOCs gained a lot of attention as a lifelong learning opportunity for individuals [9], also as a solution for remote learning addressing K12 and university sectors [6]. The high interest that MOOC received require reconsideration of several teaching practices and among them a better design on the delivery of feedback interventions, an aspect that we attempt to address during this workshop.

2.2 Workshop Outcomes

Including both concrete outputs from the workshops, as well as research outcomes, this workshop will help:

- the participants to discuss and reflect:

  - on the limitations of the current feedback practices to learners who face problems during the course run-time
  - on how to design and decide more adequate support for the learner population

- the researchers:
  - to gain insights to collect a set of support practices (per presented scenario) in MOOC contexts.

The researchers will be gain access to the insights and outcomes of the workshop for further synthesizing a set of guidelines for MOOC practitioners with the aim to facilitate instructors in the design of feedback interventions for their courses. The produced materials and knowledge will be documented and distributed in the form of a report to the participants and potentially an academic publication that will summarize the outcomes of the workshop.

3 Who Is This Workshop For?

This workshop targets interested in MOOCs (either in designing, delivering or receiving courses) and in feedback provision strategies for massive contexts. We identify as a target audience the following:

- Researchers with an interest educational data mining, LA, online and massive learning, MOOCs;
- MOOC practitioners delivering and designing courses;
- MOOC learners.

We envision that this workshop will be beneficial for all the stakeholders involved in the design and delivery of MOOCs. First, COFEEMOOC-V.2 can offer to the researchers the opportunity to study different ways of interpreting learners' trace data contextualized under the course learning design in order to design tools (technological or conceptual) for feedback interventions. At the same time, MOOC practitioners will have the opportunity to reflect on further aspects that they should consider in order to provide adequate support to their learner population and enrich their actual practices. Finally, MOOC learners can provide their insights to practitioners and researchers regarding the interventions strategies they consider as most appropriate based on their needs.

The expected number of participants is from 5–40 persons approximately. In order to attract the desirable number of participants, we plan to promote CoFeeMOOC-v.2 to communities of practice and people interested in MOOCs. Precisely, we will launch a website including all the details and updates of our workshop and we will use it to communicate and disseminate this work (the website that supported the previous instance of this workshop can be found here: https://sites.google.com/view/cofeemooc2020/). Additionally, we will use social media to announce CoFeeMOOC-v.2 and we will promote it to relevant online communities (i.e. MOOC instructors, researchers on the topic etc) and research societies (such as, the International Society of the Learning Sciences, ISLS and the Society for Learning Analytics Research, SoLAR). Finally, we will invite researchers of our networks to attend the event.

4 Previous Events

The current workshop is the second workshop edition we conduct on the topic of feedback intervention strategies with focus on MOOC contexts. The first edition was presented in the 15th European Conference on Technology Enhanced Learning (ECTEL2020). The first workshop focused on the metrics that can alert MOOC practitioners about problematic learner behaviours. The workshop outcomes regarded insights about the importance of course learning design and its contextualization with learners' trace data to inform feedback interventions.

This round of CoFeeMOOC will apply the ideas gathered previously to explore different feedback practices considered as more adequate for various learners' problems reported in MOOCs. As added value of these two rounds will be the production of a set of good practices in terms of feedback interventions addressing specific MOOC problems reported in the literature.

Additionally, we have carried out two previous workshop series regarding personalized feedback in online higher education:

- Nordic Learning Analytics Summer Institute (LASI Nordic) 2019, Workshop Title: "Using Learning Analytics to Design Appropriate, Student-Centered Feedback", (https://lasi2019.tlu.ee/program/workshops/, https://colaps.ut.ee/?page_id=130)
- Eapril 2019, Workshop Title: "Using Learning Analytics to Design Personalized and Adaptive Feedback for Higher Education", (https://eapril.org/sites/default/files/2019-11/EAPRIL2019%20Programme_v13.pdf, https://colaps.ut.ee/?page_id=131)

Furthermore, the proposed workshop builds on prior work presented in the ECTEL 2019 poster session regarding the identification of parameters that could facilitate the detection of struggling learners during the course run-time. The study received the Best Poster Award of the conference (http://ectel2019.httc.de/index.php?id=918).

5 Workshop Format

The workshop will run divided in the following parts. Explicit information about the timing of each part can be found in Figure 1. The workshop is expected to last 3 hours.

1. **Self-introduction**: Participants will introduce themselves briefly.

2. **Presentation-MOOCs & feedback provision practices**: Organizers will briefly present related work to MOOCs and feedback provision practices usually applied.

3. **Workshop purpose & layout:** Workshop purpose and Layout will be stated.

4. **Hands-on activity-design of feedback intervention:** We will follow up with a hands-on activity. During this activity, participants will be split into groups (approximately from 3 to 8 participants per group depending on the total number of the assistants). Each group will be presented a different scenario regarding learners' problems. For these scenarios, we will ask the groups to work together to design appropriate feedback interventions.

5. **Break time!**

6. **Presentation of participants' input:** Each group will present their interventions and rationale to the rest of the participants. We will carry out a focus group discussion to elaborate on the pros and cons of each intervention and its applicability in situ.

7. **Open discussion & reflections:** We will discuss the "lessons learnt".

We plan to run the workshop purely online. To facilitate the workshop, we will use an online conference system (to be decided after discussion with the conference organizers and the workshops chairs) – including additional video recordings for the participants' talks. We explore the possibility of using virtual breakout rooms for enabling the group discussions and the assignment of facilitators for each breakout room to orchestrate the activities. Additionally, we will use online tools, such as shared workspaces for the collaborative creation of concept maps and argument diagrams and online polls, to document participants' opinions, to support groups' activity.

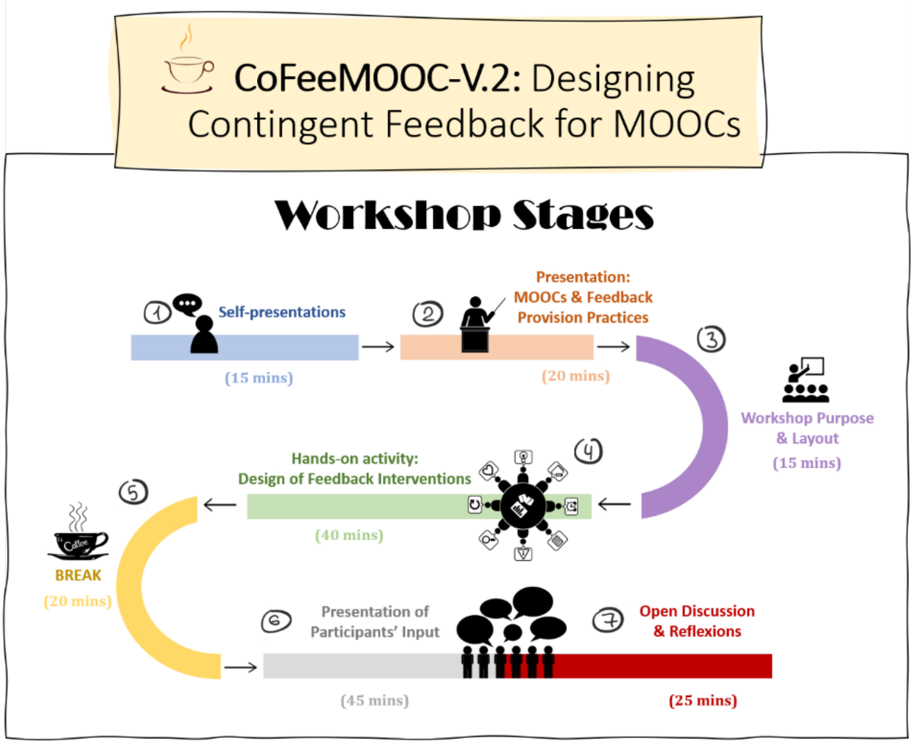

Figure 1: Workshop structure

6 Acknowledgement

This workshop is funded by the Estonian Research Council (PSG286), by the European Regional Development Fund and the National Research Agency of the Spanish Ministry of Science, Innovation, and Universities, under project grant TIN2017-85179-C3-2-R and the European Social Fund and the Regional Council of Education of Castile and Leon.

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Learning During COVID-19
Engagement and Attainment in an Introductory Biology MOOC

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During the COVID-19 pandemic, learning in higher education and beyond shifted *en masse* to online formats, with the short- and long-term consequences for Massive Open Online Course (MOOC) platforms, learners, and creators still under evaluation. In this paper, we sought to determine whether the COVID-19 pandemic and this shift to online learning led to increased learner engagement and attainment in a single introductory biology MOOC through evaluating enrollment, proportional and individual engagement, and verification and performance data. As this MOOC regularly operates each year, we compared these data collected from two course runs during the pandemic to three pre-pandemic runs. During the first pandemic run, the number and rate of learners enrolling in the course doubled when compared to prior runs, while the second pandemic run indicated a gradual return to pre-pandemic enrollment. Due to higher enrollment, more learners viewed videos, attempted problems, and posted to the discussion forums during the pandemic. Participants engaged with forums in higher proportions in both pandemic runs, but the proportion of participants who viewed videos decreased in the second pandemic run relative to the prior runs. A higher percentage of learners chose to pursue a certificate via the verified track in each pandemic run, though a smaller proportion earned certification in the second pandemic run. During the pandemic, more enrolled learners did not necessarily correlate to greater engagement by all metrics. While verified-track learner performance varied widely during each run, the effects of the pandemic were not uniform for learners, much like in other aspects of life. As such, individual engagement trends in the first pandemic run largely resemble pre-pandemic metrics but with more learners overall, while engagement trends in the second pandemic run are less like pre-pandemic metrics, hinting at learner "fatigue". This study serves to highlight the life-long learning opportunity that MOOCs offer is even more critical when traditional education modes are disrupted and more people are at home or unemployed. This work indicates that this boom in MOOC participation

may not remain at a high level for the longer term in any one course, but overall, the number of MOOCs, programs, and learners continues to grow.

1 Introduction

Universities and companies offer massive open online courses, or MOOCs, through a platform provider. MOOCs branch across many subject areas of varying expertise levels, and platforms offer thousands of MOOCs that increase access and affordability of education to learners worldwide. By lessening the barriers of entry into traditional higher education, the diversity of the virtual, international MOOC "classroom" is greater than what an in-person classroom typically achieves, and thus learner motivations, personal backgrounds, and learning environments are also greatly varied [1].

However, the COVID-19 pandemic shifted schools from pre-K to graduate level *en masse* to virtual formats, with many countries running schools primarily online by the end of March 2020 [15, 6]. While serving an important role before, MOOCs became exceptionally critical in this time of upset, in part due to their easy access for a variety of new learners or the sudden need for online teaching resources. In addition, unprecedented employment loss occurred during 2020, particularly in the Americas, for women, and for young workers [8]. Rising unemployment likely gave some learners the time and need to gain or enhance skills for future employment. Many MOOC platforms cited increased website traffic and offered discounted or free services to meet these learners' concerns [17, 5, 4]. Indeed, MOOC providers had exceptional growth during 2020, with 30 new MOOC-based degrees and over 60 million new learners [17].

Prior analyses of the pandemic's effect on learners largely focused on the great increase in enrolled learners and shifting learner interests in MOOC topics, though one study investigated how learner experiences in the pandemic impacted their MOOC engagement [17, 16]. These authors cited increases in the number of new learners and overall enrolled learners, but did not address changes in learner participation, engagement, or achievement.

We sought to determine whether the COVID-19 pandemic increased learner engagement and attainment in a single introductory biology course through the following measures:

1. Enrollment and demographics (country and ".edu" participants).
2. Proportion of learners engaged with videos, problems, and forums.
3. Number of individual engagement events with videos, problems, and forums.
4. Verification and performance.

Given the increases in MOOC provider website traffic, we hypothesized that learner enrollment and engagement in this biology MOOC increased during the COVID-19 pandemic. Despite expecting more learners, we hypothesized that these learners would not score or pass the course at higher proportions as prior to the pandemic.

This college-level introductory biology course has been available on a MOOC platform since 2013. Learners can choose to enroll in the free auditor track or pay for the verified track. The verified track gives access to additional course content, namely a comprehensive competency exam required to earn a passing score for certification. The course materials are mostly available for self-paced learning within a defined start and end date, but the competency exam is only available during the final week of the course run. To address our research questions, we evaluated data from three pre-pandemic runs of the course and two runs during the pandemic.

2 Body of Paper

2.1 Materials and Methods

The enrollment and individual course activity data came from five runs of the course in this study: three pre-pandemic runs of April 2019, July 2019, November 2019 and two pandemic runs of March 2020 and July 2020. These runs follow the naming convention of the month and year (March 2020) from the course start date (March 3, 2020). The course ran with no overlapping dates between runs and no differences in the organization of the course except for an extra week of time during the pandemic runs. Learners received course staff emails with similar frequency and content in all course runs.

We defined classification labels to categorize course registrants. Learners enrolled in the course. If enrolled in the auditor track, we referred to those learners as auditor-track; if enrolled in the paid verified track, we referred to those learners as verified-track. As previously defined, we used the term participants for learners who viewed the course at least once [7]. As such, being a learner was a prerequisite to being a participant which was a prerequisite to being engaged. Engaged participants performed one of the following engagement metrics:

1. Viewed a video: participant clicked the play button on a video.
2. Attempted a problem: participant submitted an answer to a problem.
3. Posted on the forum: participant posted/commented on the forum. Posts start a new thread, responses are answers to the original post, and comments are answers to a response.
4. Attempted the competency exam: verified-track participant who scored higher than zero.

We calculated learner enrollment, participation, engagement, and attainment using BigQuery pre-computed files from clickstream data. These files contained learner IDs, demographic and performance data, and engagement information such as video views, problem attempts, and forum posts. We excluded non-learners, staff and community teaching assistants, and considered only engagement within the start and end dates of each run. In many cases, we judged engagement as a percentage of participants to account for large differences in enrolled learners. We processed data, performed calculations, and plotted results with Python *pandas* in Jupyter Notebook and Tableau Desktop [14, 10]. We determined significance of data using a student's t-test where applicable.

2.2 Results

2.2.1 Enrollment and Demographics

Since the pandemic affected different countries in different ways, we first determined participants' location according to their profile. For all course runs, the most common participant location was the United States followed by India and the United Kingdom. Cumulatively, these three countries accounted for approximately 40% of participants with an additional 10% of participants having no location reported. Participants represented more than 160 countries. The proportions of participants from the other countries remained mostly constant between all runs, with each other country contributing less than 4% of participants.

To address our first research question more, we analyzed enrollment change over time by enrollment count, the total number of learners who enrolled and remained enrolled in the course for three pre-pandemic runs (April 2019, July 2019, and November 2019) and two pandemic runs (March 2020 and July 2020) of this course. Considering the enrollment count by date (Figure 1), the March 2020 run peaked at nearly 15,000 learners, and the July 2020 run peaked at nearly 12,000 learners, much higher values than the pre-pandemic mean peak enrollment count of 6,811.

When evaluating enrollment over time, the enrollment count for the March 2020 run increased at almost triple the rate of the three pre-pandemic runs. However, during the early days of the March 2020 enrollment metrics appeared particularly similar to the enrollment metrics in the April 2019 run, both in rate and in count, with enrollment rate increasing sharply around March 15, 2020. In contrast, the July 2020 run began with more than twice as many learners already enrolled by the first day of the course but continued with half the enrollment rate of the March 2020 course run rate.

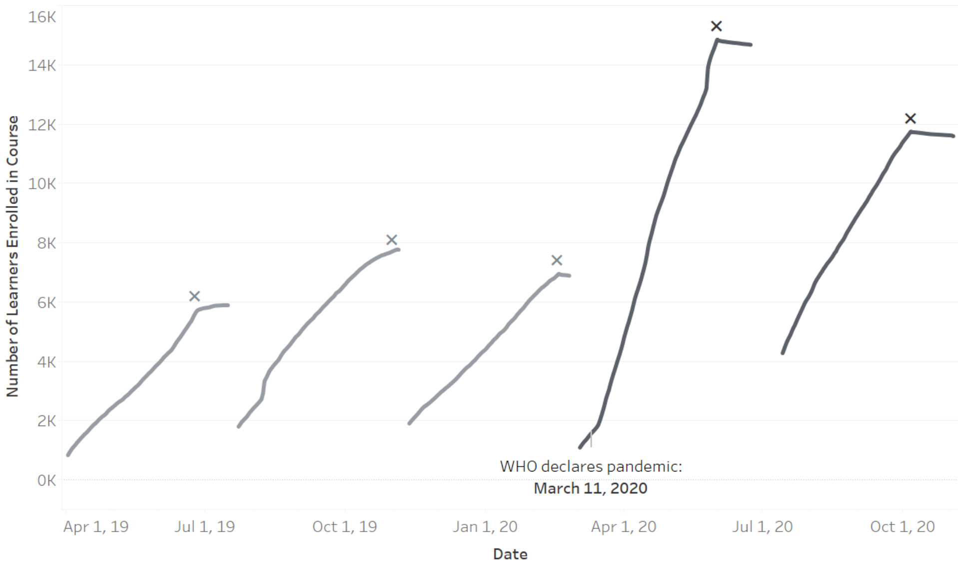

Figure 1: Enrollment trends for five course runs. Enrollment count of learners by date for the three pre-pandemic runs (gray) as well as the two pandemic runs (black). Important global and course run-specific dates are noted. Symbols (×) indicate the enrollment closing date for each run: June 26, 2019 for April 2019; November 3, 2019 for July 2019; February 18, 2020 for November 2019; June 2, 2020 for March 2020; and October 6, 2020 for July 2020.

2.2.2 Proportion of Engaged Learners

The pandemic runs of this MOOC had a significantly increased number of learners enrolled, but did more learners engage with the course? We first calculated the percent of learners who classified as participants (accessed the course at least once over the course of the run) in Table 1. We found the percent of participating learners peaked in the first pandemic run, March 2020, at 75.3% and dipped to a low of

65.4% in the second pandemic run, July 2020, with pre-pandemic percentages between the two pandemic runs. Despite an approximately 10% decline between the March 2020 and the July 2020 runs, both pandemic runs still have the highest count of participants due to much higher enrollment count.

Table 1: Percentage and count of participating learners

Run	Percent of Participating Learners of Registered	Count of Participants
April 2019	68.3%	4,222
July 2019	68.3%	5,619
November 2019	71.1%	5,184
March 2020	75.3%	11,679
July 2020	65.4%	8,097

To better understand participant engagement, we calculated the percent of participants who performed an engagement action at least once in the course run: viewed a video, attempted a problem, and posted to a forum (Figure 2). We selected these actions to represent a range of engagement efforts from more passive viewing a video to more active attempting an assessment or posting to a forum that are associated with learning [11]. We found the proportion of participants who viewed at least one video decreased in the July 2020 run to 53% from a mean of 64% in prior runs. However, the percent of participants who attempted at least one problem in the assessments remained consistent between 45% and 50% across the five runs of this course. In contrast, we found 4.4% of the March 2020 participants and 4.5% of the July 2020 participants engaged through forum posting. This was 1.4 to 3.3 times higher than pre-pandemic proportions of forum posting.

2.2.3 Individual Engagement

Based on these differences in proportions of engaged participants, we investigated our third research question: did learners show increased individual engagement with videos, problems, and the forum during the pandemic runs? We considered only engaged participants for each metric, excluding learners and participants that did not perform the specific engagement action once. For each metric, we split our engaged participants into auditor-track participants, verified-track participants who did not earn certification, and certified participants.

First, we analyzed the number of unique videos viewed by video-engaged participants (Figure 3). Trends of video viewing differed between learner subcategories,

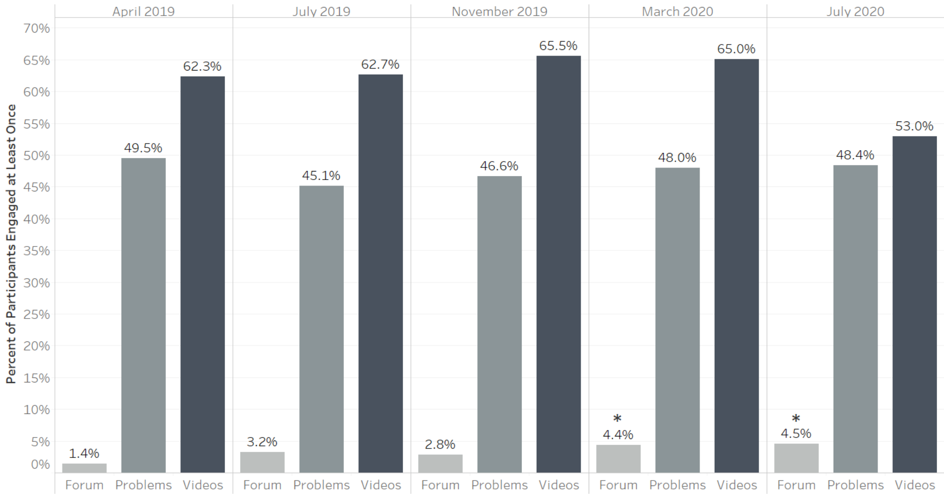

Figure 2: Percentage of engaged participants. The percentage of participants who engaged by posting to a forum (left bar in each block), attempting a problem (middle bar), or viewing a video (right bar) at least once during the course run. Asterisk (*) indicates a significant difference (p = 0.036) between pre-pandemic and pandemic forum engagement proportions.

with auditor-track participants viewing the fewest unique videos and certified learners viewing the most unique videos as we hypothesized. However, video viewing varied widely among auditor- and verified-track participants. Auditor-track participants not aiming to earn certification still viewed all available videos for the course. The median and range of unique video views remained consistent for auditor-track participants across all five runs. During the March 2020 run, certified participants viewed far more unique videos than during the pre-pandemic runs. In contrast, both verified-track and certified participants viewed far fewer unique videos during the July 2020 run than all prior runs. The July 2020 certified participants in particular had a far lower median and third quartile and greater range than the prior runs.

For each video-engaged participant, we calculated a play-per-video ratio by dividing the cumulative number of video play events by the number of unique videos viewed for every individual, a metric of interest as deeper video engagement. Pre-pandemic video-engaged participants had similar play-per-video ratios within their auditor-track, verified-track, or certified status regardless of run (Figure 4). During the March 2020 run, the median and range of play-per-video ratios

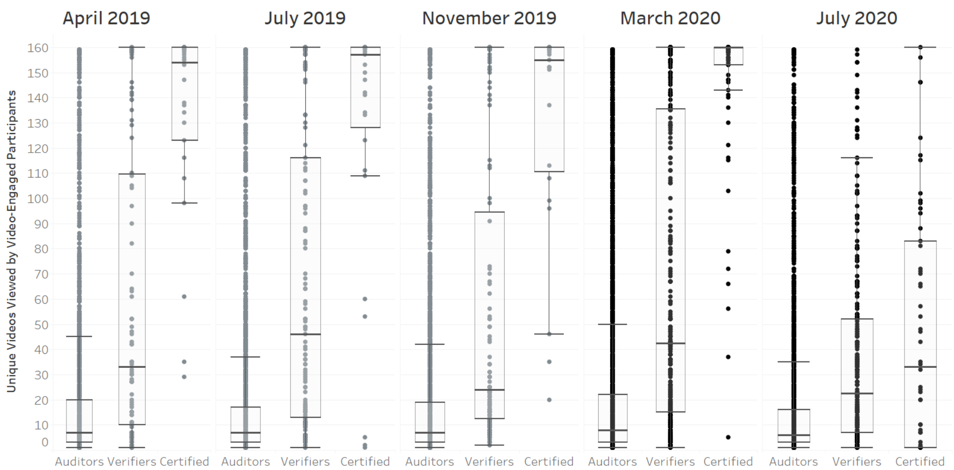

Figure 3: Engagement by number of unique videos viewed. Boxplots of number of unique videos viewed by auditor-track (left boxplot), verified-track without earning certification (middle boxplot), and certified (right boxplot) participants for three pre-pandemic (gray) and two pandemic (black) runs of the course.

increased for all subcategories of video-engaged participants. Interestingly, while video-engaged participants viewed fewer unique videos during the July 2020 run, they also had a higher median and range of play-per-video ratios than prior course runs for both auditor- and verified-track participants.

Similar to our percentage of problem-engaged participants results in Figure 2, we also found that the number of unique problems attempted by problem-engaged participants (Figure 5) remained similar between the five course runs, with auditor-track participants attempting the fewest number of unique problems and certified participants attempting the most.

To further explore the metrics of problem-engaged participants over time, we compared the normalized problem attempts per day, calculated as the total number of problem attempts per day divided by total count of problem-engaged participants in each run (Figure 6). The high peaks at the end of each run indicate studying and engagement with the competency exam for verified participants, though the April 2019 and July 2020 runs also had early peaks of activity. We found that the three pre-pandemic runs and the July 2020 run showed similar participant activity, with a median of normalized problem attempts per day of approximately 0.29. For the March 2020 run, the median was 0.40, an increase of nearly 38% and most evident in the months of April and May in 2020.

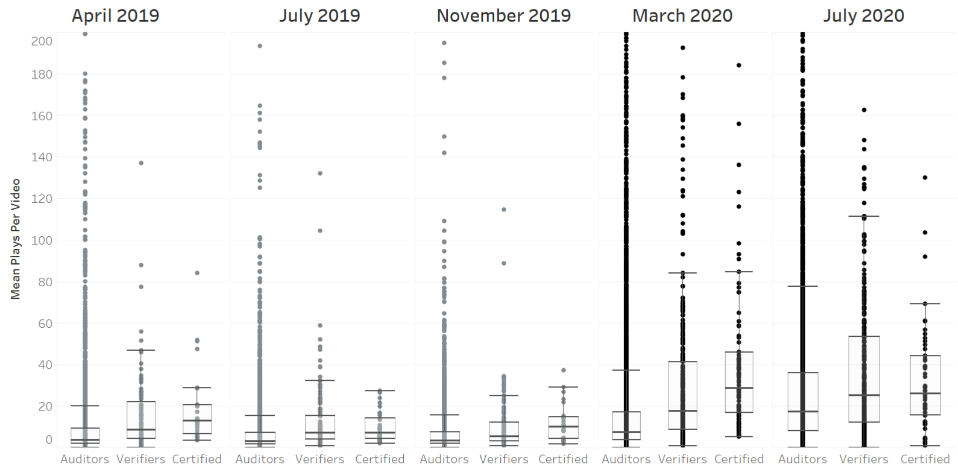

Figure 4: Engagement by video play-events. Boxplots of play events per unique videos viewed by auditor-track (left boxplot), verified-track without earning certification (middle boxplot), and certified (right boxplot) participants for three pre-pandemic (gray) and two pandemic (black) runs of the course.

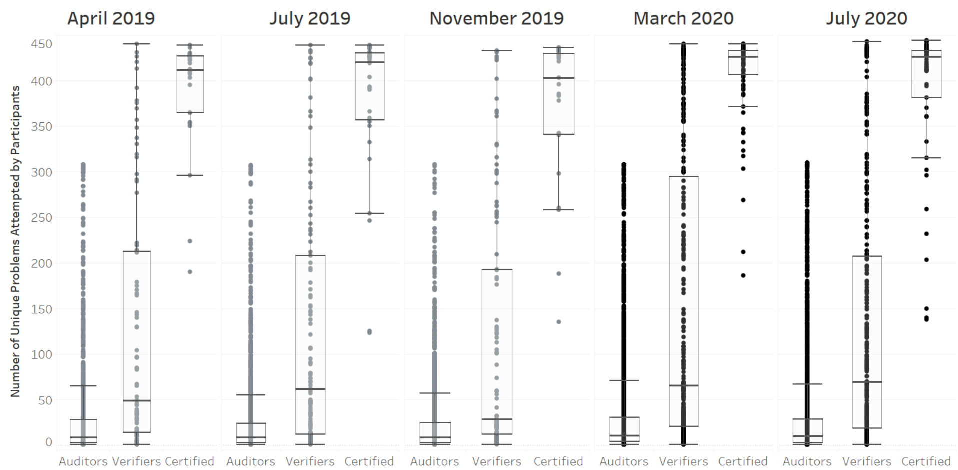

Figure 5: Engagement by number of unique problems attempted. Boxplots of number of unique problems attempted by auditor-track (left boxplot), verified-track without earning certification (middle boxplot), and certified (right boxplot) participants for three pre-pandemic (gray) and two pandemic (black) runs of the course.

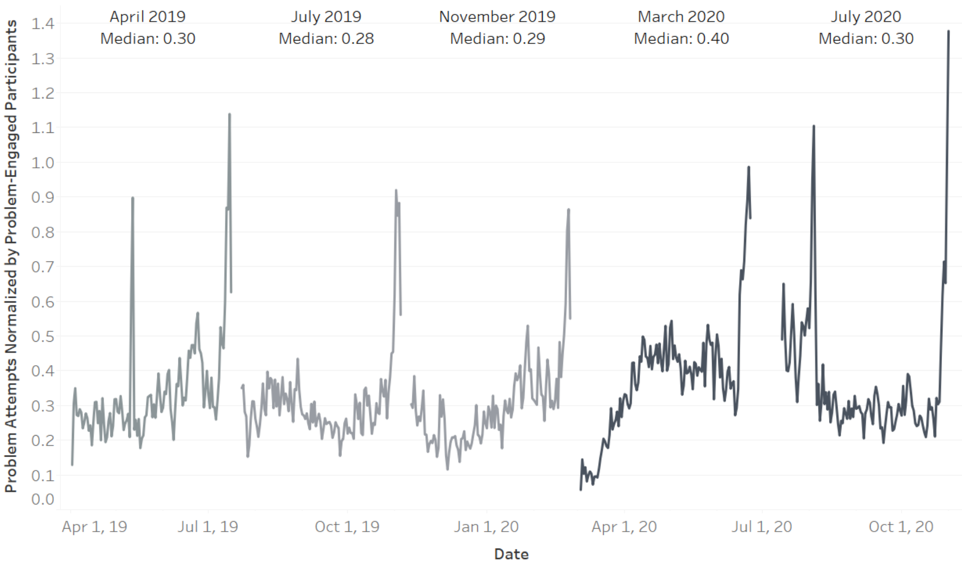

Figure 6: Problem attempts per problem-engaged participant by date. Number of problem attempts per day normalized by total number of problem-engaged participants in each course run. Normalized problem attempts plotted by date for three pre-pandemic runs (gray) and two pandemic runs (black).

In the analysis of the number of forum posts per forum-engaged participant, we found little difference between pre-pandemic and pandemic runs of the course for auditor- and verified-track participants (Figure 7) despite the earlier results (Figure 2). Unlike unique videos viewed (Figure 3) and unique problems attempted (Figure 5), certified participants sometimes, but do not always, make more forum posts than other subcategories [13]. While the majority of forum-engaged participants posted to forums between one and three times, a greater number of forum-engaged participants have posted more times to the forum during the pandemic runs; this is most evident among auditors.

2.2.4 Verification and Performance

We compared the verification and certification trends of participants across course runs. By choosing verified-track, learners indicate an intention to complete most or all of the course content (or at least maintain long-term course access) and, as prior figures have shown, tend to "follow through" on this intention by engaging more with course content. However, as intention does not always lead to successful

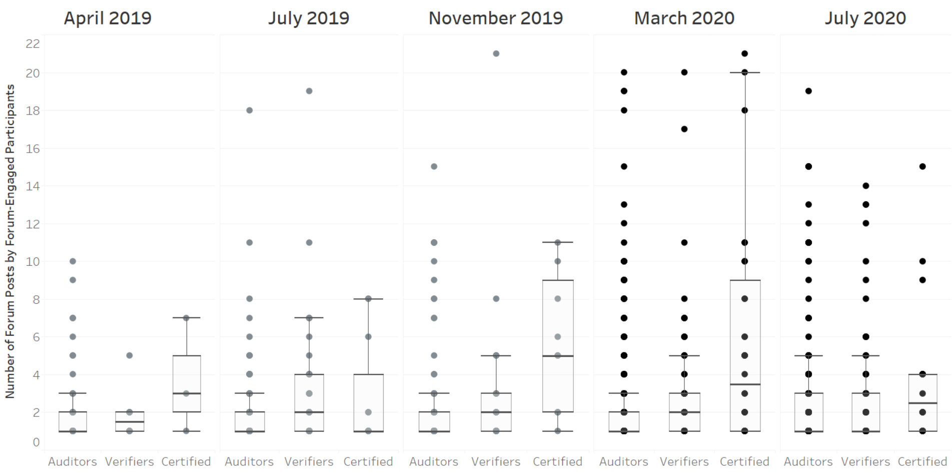

Figure 7: Engagement by number of forum posts. Boxplots of number of forum posts made by auditor-track (left boxplot), verified-track without earning certification (middle boxplot), and certified (right boxplot) participants for three pre-pandemic (gray) and two pandemic (black) runs of the course.

outcomes, we also investigated the final scores and achievement of certification for these verified-track learners.

First, we calculated the percent of verified-track participants out of all participants in each course run (Figure 8 A). The verification percentage during March 2020 was 3.8%, 0.8% higher than the pre-pandemic mean, a 30% change. Since the pandemic runs had so many additional learners, this increase in percentage translated to the March 2020 run having the same count of verified-track participants as the three pre-pandemic runs combined. Additionally, the July 2020 run enrolled nearly as many verified-track participants as the March 2020 run. Due to a lower peak enrollment count during the July 2020 run – though still higher than pre-pandemic runs – the percentage of verified-track participants during the July 2020 run reached 5.2%. This is 2.3% higher than the pre-pandemic mean percentage, a nearly 80% change in verification percentage.

We next investigated the certification percentages among verified-track participants. In this course, participants who have paid for the verified track and have earned a score of 80% or higher on the cumulative competency exam, administered in the final week of the run, earned a certificate (Figure 8 B). We found the certification percentage to decrease in consecutive runs pre-pandemic. The March 2020 run "reversed course" and returned to the pre-pandemic mean of 18.4%, though it did not surpass the peak certification percentage of 21.5% during April 2019. In contrast, despite the much higher proportion of verified-track participants, the July 2020 run showed the lowest certification percentage of 12.5%. As before, the count of certified individuals during the pandemic runs were much higher than pre-pandemic runs due to far higher enrollment counts.

By including all verified-track participants in the calculation of percent certified, we captured verified-track participants who did not engage with the competency exam (Figure 8 (B)). As such, the percent of verified participants passing is low, as a high proportion of verified participants (approximately 50%) did not attempt the competency exam. However, when we excluded participants with a score of zero and included only at those who engaged with the competency exam, we found certification percentages to be much higher, approximately 40% (Figure 8 (C)). During the July 2020 run, only one-third of exam-engaged verified-track participants earned certification, the lowest passing proportion of the five runs.

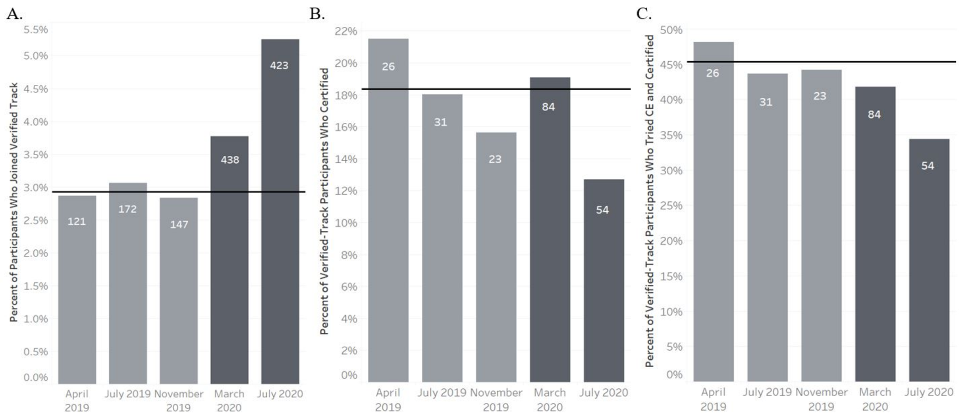

Figure 8: Percentages and counts of participant verification and certification. Percentage (y-axis) and count (number at the top of each bar) of (A) participants registered for the verified track, (B) verified-track participants who earned a certificate, and (C) verified-track participants who attempted the content exam, scored higher than zero, and certified. Pre-pandemic runs shown in light gray, pandemic runs in dark gray, and count of participants making up the calculated percentage labeled in white on each respective bar. Pre-pandemic mean percentage denoted by the horizontal black line.

The massive shift in traditional education to online format could have contributed to the increase in the number of verified learners. To explore this hypothesis, in both pandemic runs, the percentage of learners with an email domain associated with a higher education institution increased for verified-track and certified participants (Figure 9). In particular, the percentage of certified participants with a university-affiliated email address was two to three times that of pre-pandemic runs. The proportions of learners and participants with a university-affiliated email address remained similar, both to each other and between all five runs of the course.

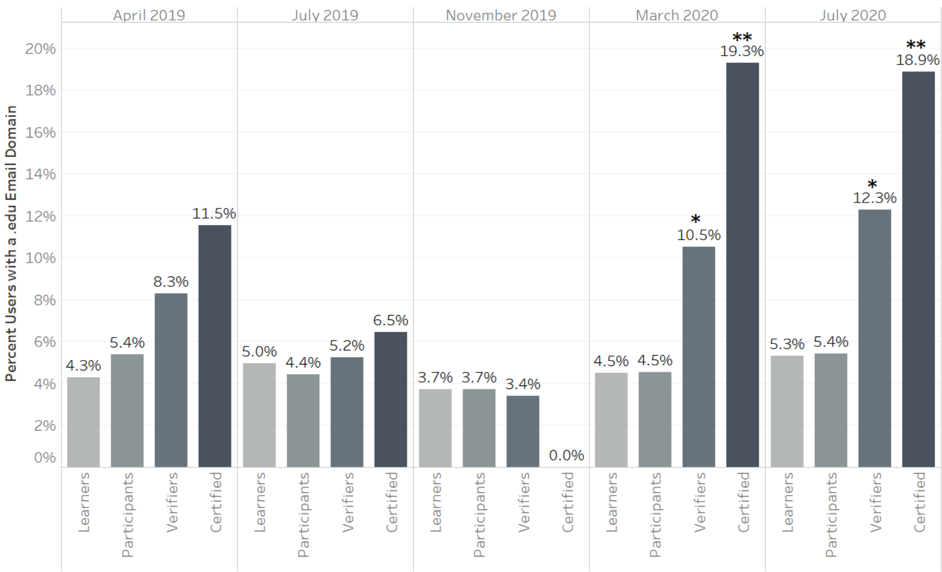

Figure 9: Percentage of learners registered with a higher education-associated email address. We calculated the percentage of learners registered for the course run with a ".edu" email address among all learners, participants, verified-track (verifiers) participants, and certified participants. Asterisks indicates a significant difference between pre-pandemic and pandemic percentages of verified-track participants (*, $p = 0.030$) and certified participants (**, $p = 0.030$).

The lower percentage of learners earning certification during the July 2020 run prompted us to investigate learner scores. As only verified-track participants could earn a passing score in the course if they took the competency exam, scores give

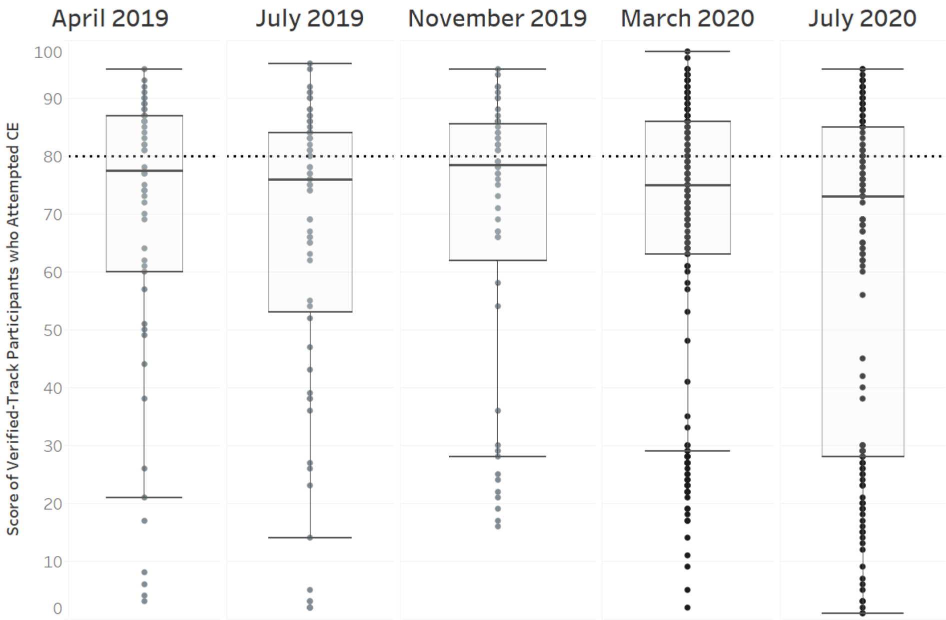

Figure 10: Verified-track participant scores. Boxplots showing scores of verified-track participants who attempted the competency exam and earned a score higher than zero. Horizontal dotted line denotes the passing score (score required to earn a certificate).

more insight into the range of performance of verified participants attempting the competency exam. We analyzed the scores of verified-track participants who attempted the competency exam (Figure 10). We found that verified-track participants earned similar scores during the March 2020 run as those in prior runs of the course. However, in the July 2020 run, more verified-track participants earned lower scores than in prior runs, which resulted in the lower certification percentage (Figure 8).

3 Conclusion

We hypothesized that the COVID-19 pandemic increased learner engagement in an introductory biology MOOC. As noted broadly [17, 16], we found an increased number of registered learners during the two pandemic runs relative to the three pre-pandemic runs for this MOOC. A sharp increase in the rate of enrollment per day occurred shortly after the WHO declared the COVID-19 pandemic in March 2020 [18], but that rate and total enrollment level did not continue during the July 2020 run. This indicates that the unprecedented enrollment during the early months of the pandemic are not continuing throughout the pandemic or likely post-pandemic. MOOCs offered multiple times tend to experience a drop of about 25% in total enrollment per each repeat [3], but this course did not show this trend, even prior to the pandemic.

We next focused on the proportions of learner participation and engagement. We normalized proportions to the participant numbers, meaning that similar percentages corresponded to vastly different numbers of participants. For example, the 2,100 problem-engaged participants in the April 2019 run and the 5,600 problem-engaged participants in the March 2020 run are both around 50% of participants in that respective run. We chose to evaluate in terms of proportions to understand if engagement increased independent of enrollment numbers that fluctuate.

Since overall engagement metrics did not indicate the individual depth of engagement, we further investigated the individual measurements of participant engagement. Among video-engaged participants, the March 2020 certified participants viewed far more unique videos than the same subcategory of learners in pre-pandemic runs, while the July 2020 participants viewed far fewer. This latter result is especially surprising, as we expected verified-track and certified participants to view most of the videos given that previous studies showed these learners are more motivated to engage with course materials [13, 12]. Participants certified in the July 2020 run are perhaps repeat learners who have already explored the content in a prior run and are returning to the course after already taking it. Perhaps these certified participants are taking this MOOC concurrently with an outside biology course, thus necessitating less video viewing to earn a passing score as we did find more ".edu" learners certified than prior to the pandemic. However, we found increased play-per-video ratios in both pandemic runs indicating increased engagement for the participants watching videos. A higher play-per-video ratio could represent participants taking more detailed notes, processing information within the videos, or re-watching video content [9].

The 2020 course runs showed little change in patterns of unique problems attempted among problem-engaged participants, but normalized problem attempts per day revealed an overall higher engagement in the first pandemic run. Since the proportion of problem-engaged participants was similar to the other four runs, this result is likely due to increased engagement with problems at the individual level. Additionally, the high peaks of normalized problem attempts at the end of each run are likely due to verified-track participants "cramming" for the competency exam and taking the exam itself [2].

Unexpectedly, forum use had the greatest increase during the pandemic. We expected lower-effort activities, such as video watching, to have larger increases. This boost to forum participation could be in part to the sudden lack of in-person interactions due to COVID-19 stay-at-home procedures, but a further analysis of the forum would be necessary to determine the cause. In spite of the higher proportion of participants engaging with the forum, the individual number of forum posts did not differ widely between course runs. However, we found differences in the posting trends of learner subcategories, wherein certified participants tended to make more posts, except in the July 2020 run. Though outliers, more participants also posted more times in 2020 runs. It is important to note that the subset of learners who engaged with forums was the smallest of the types of engagement we analyzed in this paper. Forum posting requires engagement of higher effort than viewing a video or attempting a problem, and thus fewer participants posted to a forum. In the future, we can explore other aspects of forum engagement, such as low-effort reading/viewing the forum, responses, or even evaluate post content or length.

The increased percentage of verified participants during the pandemic runs could be attributed to the shift to online schooling, more partnerships with universities, or increased motivation to validate new skills gained for later employment. Specifically, in each pandemic run a higher percentage of verified-track and certified participants had university-affiliated email addresses, perhaps due to a teacher encouraging course registration. This is likely an underestimate of the proportion of learners who are associated with higher education, as university-enrolled MOOC learners may use a non-educational email address. Additionally, many services offered discounts on the paid verified track [5, 4]. The particularly high verification numbers in the July 2020 run could also be due to more returning learners from the March 2020 run, who might have used the prior run as a preview before committing to a paid certificate-earning track. We noted that, for this particular course, the certification percentage of all verified-track participants did not accurately reflect attainment, since many verified-track participants never attempted the competency exam. The much lower certification percentage in the July 2020 run resulted from more participants earning a lower score on the competency exam. This could be related to viewing fewer unique videos, struggling to understand video content, and even interacting less with the forum. This decrease in certification rate could also be due to learner "fatigue" or changing lifestyle as learners return to in-person activities.

We investigated a single introductory biology MOOC and found enrollment trends to be applicable to other MOOCs. However, engagement trends may not be generalizable for other courses, such as those outside biology, non-introductory courses, or for courses with more restricted learner demographics. Comparison of engagement metrics across courses could reveal the nature of course-specific learner engagement and the impacts of subject matter on course engagement metrics. This deeper look into learner activity during the pandemic exemplifies the role of MOOCs in life-long learning, particularly in times of uncertainty, and reinforced their importance as an accessible learning option. While MOOCs had a massive surge in learners during the early months of the COVID-19 pandemic, prompting "The Second Year of the MOOC", [17] those numbers do not appear sustainable as enrollment numbers are trending back toward pre-pandemic values. Furthermore, learner fatigue, changing lifestyle, or loss of motivation has proved detrimental to performance, an unfortunate consequence of the pandemic for MOOCs.

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Investigating Mechanical Engineering Learners' Satisfaction with a Revised *Monozukuri* MOOC

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Aside from providing instructional materials to the public, developing massive open online courses (MOOCs) can benefit institutions in different ways. Some examples include providing training opportunities for their students aspiring to work in the online learning space, strengthening its brand recognition through courses appealing to enthusiasts, and enabling online linkages with other universities. One such example is the *monozukuri* MOOC offered by the Tokyo Institute of Technology on edX, which initially presented the Japanese philosophy of making things in the context of a mechanical engineering course. In this paper, we describe the importance of involving a course development team with a diverse background. The *monozukuri* MOOC and its revision enabled us to showcase an otherwise distinctively Japanese topic (philosophy) as an intersection of various topics of interest to learners with an equally diverse background. The revision resulted in discussing *monozukuri* in a mechanical engineering lesson and how *monozukuri* is actively being practiced in the Japanese workplace and academic setting while juxtaposing it to the relatively Western concept of experiential learning. Aside from presenting the course with a broader perspective, the revision had been an

exercise for its team members on working in a multicultural environment within a Japanese institution, thus developing their project management and communication skills.

1 Introduction

Tokyo Institute of Technology (Tokyo Tech) is a top research-based national university in Japan dedicated to science and engineering higher education. Tokyo Tech has more than 140 years of history with approximately 10,500 students across its three campuses in Tokyo and Yokohama. To establish its place as one of the world's top institution in science and technology, Tokyo Tech started offering MOOCs on edX as TokyoTechX in 2015 [5]. Aside from serving as an outreach educational activity by providing course materials to the public on science and engineering, TokyoTechX's MOOCs serves as an ambassador by providing courses highlighting Japanese culture and values (e.g. modern Japanese Architecture, Science and Engineering Ethics, and Japanese Civil Law). TokyoTechX also aims to enhance the institute's brand image by introducing the concepts behind its cutting-edge research (e.g. deep earth science and Nobel prize winning research on autophagy) in a more accessible manner. On several occasions, MOOCs had enabled Tokyo Tech to strengthen its linkages with other universities both inside and outside Japan through organizing workshops and symposia on MOOCs [3] and the creation of joint flipped classroom via the Association of East Asian Research Universities – Summer Institute for Extended Flipped Education program [1]).

In 2016, Tokyo Tech started an education reform to strengthen its research capabilities [8] as shown in Figure 1. The reform promoted the "wedge-shaped education" where students can choose to be exposed to specialized courses or research activities if they wish to do so. Another important aspect of the education reform is the emphasis on liberal arts education to deepen the students' understanding of the social significance of science and engineering research, build their character with broader values, and foster creativity in the face of internationalization. The *monozukuri* MOOC is one such example of Tokyo Tech's aspiration of blending scientific theory with practice with a humanistic perspective.

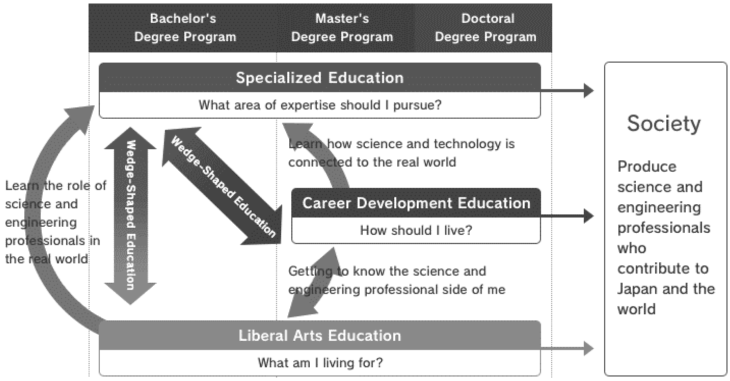

Figure 1: Tokyo Tech's Curriculum Design with Focus on Liberal Arts and Career Development Education [8]

2 Context

2.1 Original Monozukuri Course

Monozukuri (物作り or ものづくり), which is typically translated as "making things", is the Japanese philosophy generally applied to craftsmanship where a product is produced with the highest possible quality for the customer [9]. It is closely related to the concept *hitozukuri*, or character building, where an individual develops fortitude and craftmanship skills by, to some extent, surrendering themselves to the process of trial and error in order to improve quality (seeking excellence). An important aspect of *monozukuri* is dual-aspect monism, usually depicted as the necessary presence of both Yin and Yang. In *monozukuri*, Yang stands for theoretical knowledge while Yin for practical exercise.

TokyoTechX released its first *monozukuri* MOOC in September 2018 where the learners' goal is to create their own steam engine toy boat or pop-pop boat. Figure 2 shows the course map for the 2018 release. It is a four-week course covering the themes Principle, Design, Make, and Improve. In each week, the mechanical engineering theories behind a steam engine is discussed by Professor Hiroto Tanaka. This is followed by a workshop session where a teaching assistant, "Seiya" guides the learners in creating and finetuning their pop-pop boats. The learners can then invoke their experience in understanding the *monozukuri* lectures by Professor Masahiro Mori. Each week culminates with an interview with persons who have hands-on *monozukuri* experience.

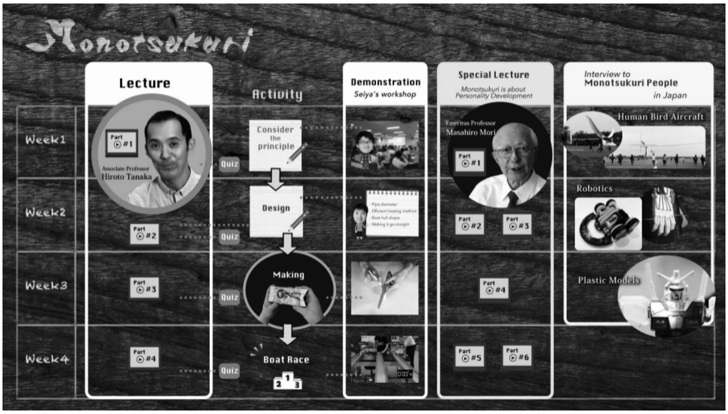

Figure 2: Course Map of the original *monozukuri* course called *Monotsukuri* (alternative Romanized spelling)

The rationale for touching on each of the four points mentioned above every week is to develop a broader view on the scientific theory while engaging the learners with a fun activity. However, each of these points appeared too distinct that several learners tended to focus more on a single point rather than taking the individual points as part of the bigger picture. As a consequence, the boat-making project took too long for those who focused on the thermodynamics part, the *monozukuri* message had not been as strong with some learners complaining that it sounded "cheesy", and there had been possibly not enough opportunities to showcase Tokyo Tech's *monozukuri* efforts as nobody mentioned about it.

2.2 Monozukuri Course Revision

TokyoTechX released an updated revision of the *monozukuri* MOOC in March 2020. Unfortunately, the original course development members, who are mostly Japanese, were no longer available for the revision efforts. The new course team was instead a mixture of students and faculty of various nationalities as shown in Table 1.

What was not heavily emphasized in the original *monozukuri* MOOC is at its core, *monozukuri* provides the philosophical substrate to Japan's manufacturing prowess mostly known as lean production and *Kaizen* or continuous improvement [10]. These concepts are not entirely new for a lot of people and is in fact one of Japan's manufacturing appealing factors. The international *monozukuri* revision team was made acutely aware of this not just through their experiences in their research laboratories but through their various levels of exposure to corporate

Japan. In the revised *monozukuri* course, not only is the importance of *monozukuri* in industries given emphasis, but also the notion that developing expertise as seen in Japan is a long learning process that can take a lifetime.

Table 1: Nationalities of the team members and their main roles in the course revision

Country of Nationality	Role
Tunisia	Course designer
Mexico	Content creator (pop-pop boat tutorial)
Mexico	Lead beta tester
Philippines	Content creator (experiential learning)
Philippines	Content creator (*monozukuri* in industries)
Greece	Graphics designer
Vietnam	Video editor
USA	Project manager

Another unique perspective that the international team was able to offer in the revised *monozukuri* MOOC is the relationship of *monozukuri* to the Western concept of experiential learning. The experiential learning theory defines learning as a process of transforming experiences into knowledge [7]. Without linking back to experiential learning, *monozukuri* may be misconstrued as the non-cognitive grit where an individual persists to achieve their goal. In reality, *monozukuri* is also a cognitive development process where the individual reflects on their experience to improve the quality of their work related to preparing a tangible object.

With the inputs from the international team, *monozukuri* is presented as a less esoteric concept in the revised MOOC. Table 2 shows the revised course outline. The *monozukuri* philosophy is first discussed in detail in Week 1. *Monozukuri* as seen in industries as well as in the academic setting is shown in Week 2. The learners are given the chance to experience *monozukuri* for themselves in Week 3. New tutorials were also added in Week 3 for creating pop-pop boats with alternative materials. Finally, Week 4 discusses how *monozukuri* affects all levels of a company and how it contributes to the continuous learning process. Each week is capped by a short showcase of *monozukuri* activities in Tokyo Tech. With the new course outline, the learners are given time to internalize each aspect of the course instead of jumping from one concept to another.

The entire course revision experience had been a first on several fronts. For instance, nobody in the team had created pop-pop boats in the past. The pop-pop boat introduced in the original course as seen in Figure 3 (a) requires materials (e.g. balsa wood, thick copper wire, etc.) not easily available and can be difficult to

Table 2: Revised *monozukuri* course outline

Week	Topic	Details
1	*Monozukuri* Philosophy	Introduction to *monozukuri* concept; *monozukuri* as dual-aspect monism; the process of learning and learning curves.
2	*Monozukuri* in Practice	*Monozukuri* in large, medium, and small corporations; *monozukuri* in education setting; learning styles, experiential learning, and reflection
3	Design Challenge	Physics and dynamics of the pop-pop boat; designing and prototyping the pop-pop boat; pop-pop boat tutorial
4	*Monozukuri* and Technology Transfer	Skill transfer through *monozukuri*; experiential learning in the workplace (individual and organizational learning); management learning

handle for younger learners. The team devised an alternative way to construct the pop-pop boat with more readily available and malleable materials (e.g. milk carton, aluminum can, sealing material, etc.). The team likewise applied the *monozukuri* concept in creating the boat shown in Figure 3 (b) to provide the learners with accurate instructions for creating their own pop-pop boats. These boats are showcased in Figure 3 (c) which served as the course banner page.

Figure 3: The pop-pop boat with balsa wood for the hull from the original course (a) and the pop-pop boat using milk carton (b) introduced in the revised course. These pop-pop boats inspired the course banner design (c).

A few members of the course team were working on course creation for the first time. Not everyone has knowledge on *monozukuri* at the start. Considering the extent of changes made, the consequent tasks had been too numerous for the team that it required everyone to develop project management skills. Some members have never worked in a Japanese setting yet outside their research laboratories; working on the *monozukuri* MOOC helped them calibrate their expectations for their future work. In a way, the team was teaching experiential learning while experiencing experiential learning for themselves.

3 Results and Discussions

3.1 Learner Data

Table 3 shows the learner data for the entire duration (from July 11, 2018 to March 3, 2020) of the original course and from March 4, 2020 to January 22, 2021 for the revised course. edX has made changes to its platform in December 2018 making the graded assessments inaccessible to those who are auditing the course for free [6]. All the assessments in both the original and revised courses are graded. In lieu of looking at completion rates, we looked at total enrollments, verified certificate enrollments, passing learners for those in the verified certificate track, and the responses in the post-course survey. Even for a shorter period of time (10 months against 20 months), the revised course has already attracted more learners both in the audit (free access) and verified certificate tracks, with higher percentage of verified learners having passed the course even before the course has ended. It should be noted the original course required the learners to prepare a pop-pop boat from wood and copper coil while preparing a pop-pop boat in the revised course became optional.

Table 3: TokyoTechX *monozukuri* MOOC learner data.

Description	Original Course	Revised Course
Total enrolled	4742	4005
Enrolled for verified certificate	39	91
Passing learners	16	45
Post-course survey responses	71	126

3.2 Learner Reception

We do not intend to change the learner workload required despite the drastic changes introduced to the course in the revision. Since the course requires considerable time outside the learner platform for the learners to create their pop-pop boats, we used the self-reported hours per week spent in the post-course survey. Figure 4 shows the density plot of the weekly hours for both the original and revised courses. The curves are approximately similar, and mean values for both values are about the same: 3.705 (standard deviation: 2.799) for the original course and 3.743 (standard deviation: 3.618) for the revised course. The values were also found to be not statistically different since the calculated p is larger than .05, which is traditionally taken to be the statistical significance cut-off (U : 3299, z-score: –0.08122, p = .936). Because the number of responses received is less than 200, the normal approximation for the two-tailed Mann-Whitney U test was used for evaluation.

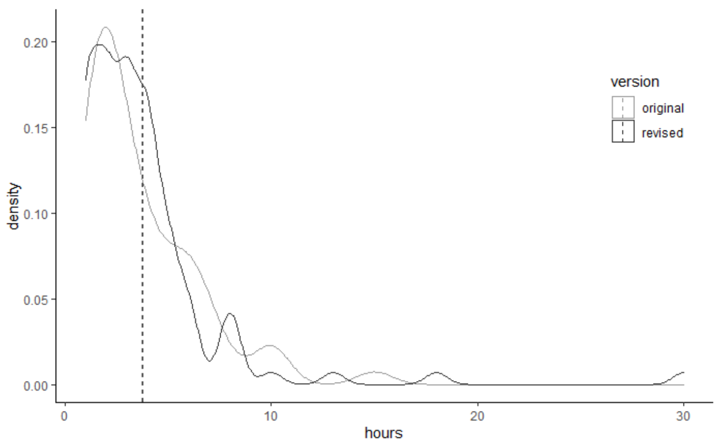

Figure 4: Density plots of the reported weekly hours spent for the original and revised courses with mean scores plotted as dashed lines.

The effort dedicated to creating a new tutorial for creating a pop-pop boat using alternative materials has proven to be fruitful. Several learners commented in the course's discussion forum that creating the pop-pop boat during some of the lockdown periods helped them in coping with the pandemic situation. Of the 97 learners who responded to our question about their favorite experience in the course in our post-course survey, 29 mentioned that making the pop-pop boat is one of their favorites.

A technique that we had been using to determine learner satisfaction while a course is running is to conduct sentiment analysis on discussion board posts [4]. Figure 5 shows the density plot for the sentiment polarity values of the discussion board posts using Python's TextBlob library. We can see from here that the learners in the revised course had more positive sentiments (mean: 0.249, standard deviation: 0.292) than in the original course (mean: 0.202, standard deviation: 0.278). The statistical difference was similarly calculated, this time using the Welch's t test since there are considerably many samples (more than 200) for both original and revised courses. This resulted to a statistical difference with p = .013 (t = 2.485, df = 368, standard error of difference: 0.019). The Cohen's d was computed to be 0.559, which conventionally is medium effect size.

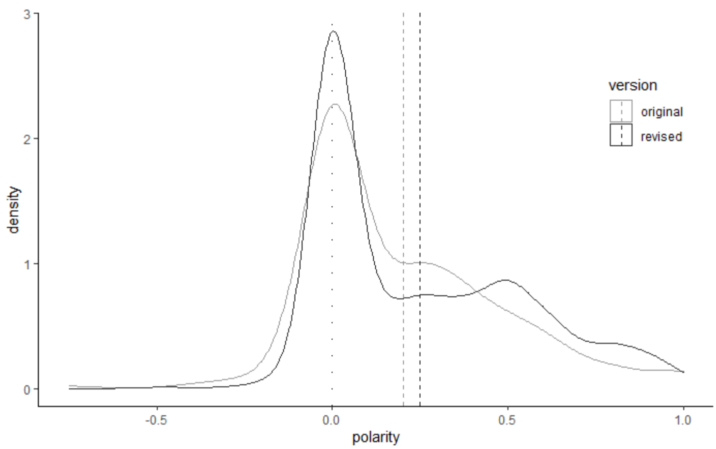

Figure 5: Density plots of the sentiment polarity scores for the original and revised courses with mean scores plotted as dashed lines and the neutral score with dotted line.

What the course team most appreciate are the learner testimonies in the revision's post-course survey. Several learners indicated that the revised course had a positive effect on them. Here are some of these positive testimonies:

- *All the people that were featured in the videos, their experience and advice is very valuable and very helpful.*

- *I agree a lot with the professor about learning from experience is one of the best approaches to master any processes. More important in actual industries when it is not allowed to commit mistakes in the final product.*
- *I truly enjoyed the videos, all of them. Amazing valuable interviews. Very happy with the broad information material provided on philosophy, learning styles, information on Tokyotech [sic] students club and the pop-pop boat. Every bit is so valuable. It did make me think a lot, very excited with the course and shared what I learned with my family. Re-reading and watching all. Monozukuri will be part of my whole life from now on.*
- *Learning from Emeritus Professor Masahiro Mori, the reading text about Emeritus Professor Shigeo Hirose, learning the engineering principles of pop-pop boat, learning the experience and wisdom of Professor Tanaka. I love learning from all those people I wish I could meet them.*

Nevertheless, there is still room for course improvement based on the learner's feedback. Some learners commented that the course is very text-heavy and will benefit more from more videos and exercises. Given the results of an existing study that most courses have more than 50% of its content based on word counts are presented in video format [2], this feedback from the learners is warranted. For the revised *monozukuri* course, less than 39% of the words were from video transcripts. Other related topics that the learners wanted to explore include Japan manufacturing philosophies such as *Kaizen* (continuous improvement) and *5S* (sort, set in order, shine, standardize, sustain). There are also several requests to have English audio for the Japanese lecture videos instead of closed-caption transcripts in English.

4 Conclusion

Tokyo Tech has utilized MOOCs to promote its educational reforms that aim to develop researchers with both technical and humanistic perspective. The *monozukuri* MOOC is an example of Tokyo Tech's brand of education focusing on knowledge with experience. Involving an international team in revising this distinctively Japanese course highlighted Japanese concepts such as lean production which is popular among learners outside Japan and linked foreign concepts such as experiential learning making *monozukuri* more accessible. Being involved in the *monozukuri* revision enabled to team to exploit aspects of *monozukuri* for themselves and has indeed been a learning-by-teaching encounter.

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Using the Addie Model to Produce MOOCs
Experiences from the Oberred Project

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MOOCs have been produced using a variety of instructional design approaches and frameworks. This paper presents experiences from the instructional approach based on the ADDIE model applied to designing and producing MOOCs in the Erasmus+ strategic partnership on Open Badge Ecosystem for Research Data Management (OBERRED). Specifically, this paper describes the case study of the production of the MOOC "Open Badges for Open Science", delivered on the European MOOC platform EMMA. The key goal of this MOOC is to help learners develop a capacity to use Open Badges in the field of Research Data Management (RDM). To produce the MOOC, the ADDIE model was applied as a generic instructional design model and a systematic approach to the design and development following the five design phases: Analysis, Design, Development, Implementation, Evaluation. This paper outlines the MOOC production including methods, templates and tools used in this process including the interactive micro-content created with H5P in form of Open Educational Resources and digital credentials created with Open Badges and issued to MOOC participants upon successful completion of MOOC levels. The paper also outlines the results from qualitative evaluation, which applied the cognitive walkthrough methodology to elicit user requirements. The paper ends with conclusions about pros and cons of using the ADDIE model in MOOC production and formulates recommendations for further work in this area.

1 Introduction

MOOCs have been produced using a variety of instructional design approaches and frameworks. Oftentimes approaches and frameworks have been selected to support specific design objectives such as scalability, openness, adaptability and engagement. MOOC designs focusing on enhancing the openness including cultural and linguistic diversity and inclusion of the participants have applied a range of strategies and approaches such as Supported Open Learning (SOL) and Universal Design for Learning (UDL) [11, 1, 9]. The production of adaptive MOOCs has been informed by design frameworks rooted in Design Based Research (DBR) [14] and the four-dimensional learning (4DL) model [20]. MOOC productions focusing on enhancing engagement have applied such as approaches as the flipped MOOC and different gamification approaches [12, 16, 6]. Some designers have applied format-oriented approaches such as micro-learning with micro-content and micro-credentials [8], while some have applied process-oriented approaches based on development cycles, such as production phases including course design, pre-production, production, post-production, validation [17], and multi-step models [24].

However, the ADDIE model by Branson, Rayner, Cox, Furman, King, and Hannum [5] stands out as one of the most popular instructional design models. A quick search on Google Scholar using the keywords MOOC and ADDIE generates about 1,270 results, compared to 605 for UDL and 363 for DBR. The ADDIE model is a generic instructional model and a systematic approach to the design and development of training [2]. The ADDIE model divides the process of instructional design into five stages, i.e. analysis, design, development, implementation and evaluation, and can be applied in an interactive manner. ADDIE has been applied worldwide in a number of MOOC productions including vocational training in Malaysia [15] and English for academic purposes MOOCs for undergraduate students in the United Arab Emirates [3]. The ADDIE model has been also combined with other methods such as System Thinking [10] and Universal Design for Learning [22]. It has also informed approaches to MOOC design focused on quality assurance, such as the Quality Reference Framework (QRF) divided into Analysis, Design, Implementation, Realization and Evaluation [21]. The reminder of this paper is structured as follows: section 2 provides an overview of the case study of MOOC design in the OBERRED project based on the ADDIE model. This section is structured into five subsections corresponding to the five phases of the ADDIE model, providing information about the application of the model at each stage.

2 Case Study

This section describes practical experiences in applying the ADDIE model as a generic instructional design approach to produce MOOCs in the OBERRED[1] project. The OBERRED project is founded under the Erasmus+ program on co-operation for innovation and the exchange of good practices in higher education, and is dedicated to designing an Open Badge ecosystem for the recognition of skills in the field of research data management. The key part of this endeavour is to design and deliver a series of online training programs in the form of Massive Open Online Courses (MOOCs). The first MOOC "Open Badges for Open Science" in this series focuses on understanding Open Badges in the context of Open Science. The objective of this introductory MOOC is to prepare the participants for the use of Open Badges in their work with relevant stakeholders in RDM, for example to design Open Badges in order to recognize skills related to RDM. Following this first MOOC, the two further MOOCs developed in the OBERRED project are "Managing & Sharing Research Data" and "Facilitating the Open Badge Ecosystem". All MOOCs are delivered on the European MOOCs platform EMMA: https://platform.europeanmoocs.eu. All three MOOCs produced in the OBERRED project are designed following the iterative approach of the ADDIE model. The design of the MOOC "Open Badges for Open Research" has been created in a number of iterative stages following the overall framework of the ADDIE model. The process has been documented in a living document in Google Docs, which has been collaboratively edited by the MOOC production team and updated during iterations. This multi-stage process is described below.

2.1 Analysis

The first stage of the ADDIE process focuses on a comprehensive analysis and aims to clarify instructional problems and objectives as well as to establish some groundwork related to the learning outcomes and the learning environment. At this firs stage, the project team conducted an extensive analysis of relevant issues such as (1) the context of the MOOC (including the conceptual links between all three MOOCs and partners involved in the design and production), (2) requirements for the MOOC design and delivery (including content-related and technical requirements), (3) target groups and their characteristics (including a list of relevant target groups and their characteristics in relation to different roles and responsibilities in RDMt), (4) learning outcomes (including their allocation to the levels of the MOOC), (5) required resources (including learning resources, human resources and technical resources), (6) course delivery (including the delivery model, language policy, copyrights policy, assessment policy, micro-credentialing policy), (7) timeline for project completion (including the set-up of the Trello board, the Gantt chart and a table with the description of each milestone).

In this way, the analysis part laid the foundation for the production of the MOOC. The key part of the analysis was the definition of the learning outcomes. The learning outcomes were described following the Competency-Based Design Approach (CBDA) applied to the MOOC design [23]. The MOOC was structured into three levels: (A) Foundations Level, (B) Technology Level, and (C) Application Level. Each level has a specific set of learning outcomes and includes different forms of an e-assessment of learning outcomes. Additionally, the analysis part outlines the micro-credentialing policy, which specifies that participants have to pass e-assessments at each level in order to obtain a micro-credential (Open Badge) for this level. One of the requirements is that the learning environment/system should allow to automatically issue and notify the participant about the issuing of the micro-credential.

2.2 Design

The design stage in the ADDIE model outlines the instructional design in more detail. The ADDIE model recommends to define the design elements in a systematic and specific way, by applying logical methods for identifying and developing strategies, which can help attain the project's goals [2]. The design stage in the production of the first MOOC in the OBERRED project dealt in more detail with learning outcomes, e-assessment and micro-credentialing and defines the learning activities, content and media in a systematic and specific way. The instructional design principles of micro-learning and micro-content specified at this stage, draw on the guidelines on designing micro-learning as a strategy for ongoing professional development by Buchem and Hamelmann [7] and the MOOC design principles recommended by Guàrdia, Maina, and Sangrà [13], as well as principles laid out by the MOOCs platform EMMA.

The key design principles for the MOOC design described in the design stage were: (a) a competence-based design approach, with focus on the learning outcomes, (b) learner empowerment, with focus on learners as active participants, and (c) collaborative learning with focus on adding value through social networking and peer-feedback. The design stage included the learning plan and a schedule with assignments, milestones and deadlines for clear orientation in each part of the course and also outlined the MOOC structure, which results from the break-down into the three levels and micro-learning units. In order to specify content for each micro-learning unit, the storyboarding technique was applied, and a storyboard created for each learning outcome. Each storyboard specifies learning content, format, media, materials and specific instructional methods such as expository learning and discovery learning. Furthermore, the SOLO Taxonomy by Biggs and Collis [4] was used to map verbs in learning outcomes statements to the levels of learning and to assessment criteria. The design stage includes the specification of the digital micro-credentials and the specification of open licenses for the MOOC content.

2.3 Development

The development stage in the ADDIE model is dedicated to the creation of the content assets specified in the design phase. This stage described the process for creating the MOOC in the EMMA platform and the steps and methods for the production of course materials. The production of course materials included the reuse of selected Open Educational Resources (OERs) and the use of the H5P tool for the production of new MOOC content. The H5P tool was used to create the interactive micro-content for the MOOC in the form of OERs, with each OER published under a Creative Commons Licence. H5P is a free and open-source authoring tool based on JavaScript, which enables to produce interactive content in form of reusable HTML5 packages. The development stage also specifies how reviews are carried out following the iterative approach to the MOOC design. After production of each version of the MOOC, peer-reviews and user-tests are conducted and results are used as feedback and input in the next design iterations. The iterative approach with frequent reviews and tests helps to remove weak spots in the design (e.g. when a design element was omitted) and resolve inconsistencies (e.g. logical links between levels) early in the production process.

2.4 Implementation

The implementation stage describes the procedure for delivering the MOOC in the Europan MOOC platform EMMA with focus on the facilitation of learners and the preparation of the facilitators. The key tasks of the facilitators are listed in the implementation part of the MOOC concept and are based on the model with five stages of online moderation by Gill Salmon: access and motivation, online socialisation, information exchange, knowledge construction and development [19]. To ensure access and motivation, each level of the MOOC (called "lesson" in the EMMA platform) is introduced with a kick-off zoom session with all participants. The kick-off session are meant to provide essential information to the participants, e.g. about the content of each unit, duration, assignments and micro-credentials, and at the same time to initialise the online socialisation which is carried out throughout the MOOC and is supported by the technical tools in the EMMA platform such as discussion forums and personal blogs of the participants. The information exchange, knowledge construction and development are supported by a range of diverse learning activities.

2.5 Evaluation

Finally, the evaluation stage in the ADDIE model defines the methods of formative and summative evaluation. The evaluation stages defines the objectives of the evaluation, items, scales and tools. The formative evaluation in our case study was present at each stage of the MOOC production process and included peer reviews, user tests and cognitive walkthroughs [18]. We conducted altogether three cognitive walkthroughs with three different prototypical learners, who were specifically selected for the study. The aim of the cognitive walkthroughs was to assess the level of comprehension, the ease of use and the usability of the MOOC prototypes developed at different stages in the design and development stages of the ADDIE model, i.e. before the implementation in the first pilot. We asked the three prototypical learners to complete a sequence of learning activities and verbally describe their experience, focusing on how easy or difficult it was to understand and use different learning elements including course and lesson information, interactive H5P content, assignments and tasks. The results were protocolled and change requests documented in a change-log table, which then served as a backlog for the next design and/or development iterations. The summative evaluation encompassed the post-MOOC survey and the use of learning analytics using log data recorded by the EMMA platform. For the purpose of formative-summative evaluation, detailed user surveys were conducted after the completion of each MOOC level (lesson), which helped us to collect the data about participants' perception of the MOOC usability and the overall user experience. The user surveys for each MOOC level also include items related to specific MOOC components, such as OERs, assignments and Open Badges, which are evaluated by the participants after the completion of each level. This feedback is used for improvement of the MOOC design.

3 Discussion and Conclusions

Our experiences from the case study about the application of the ADDIE model to the production of the MOOCs as outlined in this paper show that the ADDIE model offers a comprehensive yet flexible approach, which can be combined with many other instructional approaches and models. For example, in our case study we could easily combine the ADDIE model with further instructional design approaches such as Competency-Based Design Approach (CBDA), expository learning and discovery learning. In this way we could apply different models to design different levels of the MOOC. While the ADDIE model was applied at the macro-level of design of the entire MOOC, further instructional design methods such as competency-based learning were applied to the meso-design of the MOOC levels, with each level design being guided by the set of pre-defined learning outcomes. Furthermore, more specialised approaches such as expository and discovery learning were applied the micro-level of design of single learning units.

We can summarise our experiences and lessons learned from applying the ADDIE model to the MOOC production as pros and cons. The pros include: (1) ADDIE is a comprehensive and flexible approach and can be combined with diverse didactic approaches and instructional design models; (2) ADDIE is universal and covers all essential phases of the MOOC production process; (3) ADDIE can be subdivided and extended into further sub-steps according the project goals and requirements; (4) ADDIE offers a structured and manageable approach which can be used in larger and smaller MOOC design projects; (5) while ADDIE resembles a linear, waterfall model at the first sight, it can be also applied as an iterative, cyclic model with iteration cycles repeating ADDIE phases to attain expected results as shown in our case study using cognitive walkthroughs and the change-log table to document change requests; (6) the comprehensive analysis at the beginning of the design process allows MOOC developers to validate their assumptions as early as possible in the design process, which helps to ensure quality and make efficient use of available resources; (7) the inclusion of formative evaluation serves as a reminder to the design team to gather feedback from users at different stages of design, development and implementation. The cons include: (1) ADDIE is too general and does not provide detailed guidelines and steps for instructional designers to follow as each stage, so it becomes necessary to supplement this model with further, more specific design approaches; (2) the separation of the design and the development phases in the ADDIE model is not clearly described and in practice both phases are closely interwoven; (3) ADDIE model does not provide any reference to pedagogical approaches.

Based on our experiences in the application of the ADDIE model to the production of the MOOC "Open Badges for Open Science" in the OBERRED project, we can state that the ADDIE model proves to be a flexible, generic framework which covers all main stages of the MOOC production process. It can be easily applied as a meta-design framework to the design of any MOOC as well as extended and subdivided into further substages depending on the project objectives and requirements. Because of the generic nature of this model, in which no specific didactic and/or quality-related principles are recommended to instructional designers, it is necessary, from our point of view, to augment and enrich the ADDIE model with more specific didactic and instructional design approaches to arrive at a sound design of a MOOC.

In order to quantify the impact of our experiences, we have conducted the first evaluation study after the first pilot run of the MOOC and will present the results in subsequent publications. At this point it must suffice to say that our experiences and observations are in line with similar work reported by [2, 15, 3, 10, 22], mentioned at the beginning of this paper.

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Who Are the Students of MOOCs?
Experience from Learning Analytics Clustering Techniques

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Clustering in education is important in identifying groups of objects in order to find linked patterns of correlations in educational datasets. As such, MOOCs provide a rich source of educational datasets which enable a wide selection of options to carry out clustering and an opportunity for cohort analyses. In this experience paper, five research studies on clustering in MOOCs are reviewed, drawing out several reasonings, methods, and students' clusters that reflect certain kinds of learning behaviours. The collection of the varied clusters shows that each study identifies and defines clusters according to distinctive engagement patterns. Implications and a summary are provided at the end of the paper.

1 Introduction

Massive open online courses (MOOCs) attract hundreds and thousands of students who barely reach the end of the courses. Only a small fraction of students successfully finishes MOOCs [6]. At the current state of MOOCs in 2021, understanding the low percentage of students who succeed in MOOCs has been thoroughly researched in the literature. Among the reasons, we may link that to student motives to get a specific portion of knowledge from courses, the lack of interest in courses because of the general infrastructure of the MOOC platforms or the courses, MOOC design issues, or other reasons from student social lives that prevent them from continuing. Many researchers and practitioners focused on student engagement to keep the students' retention high to the extent that it may keep them motivated.

Because tracking student interactions in MOOCs in real-time is challenging [13], at least to a large extent of the MOOC platforms including off-the-shelf and custom learning analytics tools, engagement cannot be easily incited. However, engagement can be understood by interpreting their behaviours in MOOCs and by then define their type of involvement [12]. Still, MOOCs provide excellent scope for analysing large-scale online interaction and behavioural data to explore, understand and improve student engagement, and the overall experience. We have also seen how the educational research of MOOCs, including but not limited to Learning Analytics and Educational Data Mining, has led to a surge in explanation, predicting, and optimizing students' behaviour not only for MOOCs but also for other online learning environments (e.g. learning management systems, virtual labs).

Data-driven methods in education (i.e. Learning Analytics methods) such as clustering are popular techniques to categorize student engagement in MOOCs. The goal of clustering is to discover a new set of categories. In the case of MOOCs, clustering brings potential in understanding students' behaviour and their degree of engagement. Howbeit, the knowledge that exists on profiling students in MOOCs is limited and is just restricted to the ratio of presence and general profile description [3]. In fact, this has opened the line for this work to highlight a selected number of papers from the literature that bring in a good overview on MOOC student profiles based on their level of engagement and using clustering techniques.

The main body of the paper is organised as follows: 1) a list of the five selected papers, 2) the reasoning behind using clustering from the papers, 3) methods used in clustering, 4) variables used from the MOOCs to carry out the clustering, 5) the identified clusters by the researchers from the five papers, and 6) finally a summary of grouping the clusters from the selected works.

1.1 Clustering of MOOC Datasets

Recently, researchers have been exploring clustering methods of educational datasets and comparing them aiming for creating cohorts of mutual objects. Despite that clustering techniques are broadly used in other fields, they are not thoroughly explored as much as those in computing in educationa [1]. Applying clustering in MOOCs is powerful. Barthakur, Kovanovic, Joksimovic, Siemens, Richey, and Dawson [1] were able to track the assessment of student learning strategies over four MOOCs. The implication of their work has been reflected in identifying those with poor self-regulation skills and suggest interventions. Another study by Li, You, and Sun [11] shows that their clustering has helped them to divide groups of students which in return make them to understand students in real-time. Li, You, and Sun [11] see that their contribution will yield into enhancing MOOCs teaching.

2 Five Studies, Diverse Student Categories

This work is based on our experience with the "Better Learning Experience (BLE)" project, of which we worked on designing a customized clustering of students used in OXALIC, an Open Edx Advanced Learning Analytics tool [8]. Our selection of the five papers in this study has: 1) focused on engagement as a reason for clustering, 2) classify cohorts based on degrees of engagement (e.g. low engaged, high engaged), and 3) used Learning Analytics as a keyword to do the study and reveal a variety of student clusters. We scanned the first appearing 50 papers in Google Scholar, provided "MOOCs", "Learning Analytics", "Clustering" as search terms and applied the inclusion criteria. The selected five papers are: "Deconstructing Disengagement: Analysing Learner Subpopulations in Massive Open Online Courses" [10]; "Moving through MOOCS: Pedagogy, learning design and patterns of engagement" by Ferguson, Clow, Beale, Cooper, Morris, Bayne, and Woodgate [4]; "Clustering patterns of engagement in Massive Open Online Courses (MOOCs): the use of learning analytics to reveal student categories" by Khalil and Ebner [9]; "Who will pass? Analysing learner behaviours in MOOCs" by Tseng, Tsao, Yu, Chan, and Lai [14]; and "Research on Clustering Mining and Feature Analysis of Online Learning Behavioural Data Based on SPOC" by Zhang, Zhang, and Ran [15].

2.1 Reasoning for Using Clustering

We first start by listing the reasons behind carrying out the clustering in the selected papers. While the focus of the studies relied on classifying the students based on their engagement, we wanted to explore the motivation behind using clustering in the five papers (see Table 1). The reviewed works show that exploring learning behaviour and defining common learning characteristics have been the authors' greatest motive to do the clustering in the MOOCs.

2.2 Method(s) Used for Clustering

Table 2 shows the used clustering techniques in the five selected papers. It is clear that the authors preferred to use k-means clustering in the first place. While it is essential to validate clustering [5], only two studies validated the outcome. Validation of clustering and engagement can show that the number of clusters of students provides an authentic generalization of the data.

2.3 MOOC Variables Used for Clustering

Clustering depends on sourcing out data variables. In MOOCs, variables vary depending on the platform, Learning Analytics data collection systems, and the objectives of the clustering. In the case of the five studied papers, MOOC variables used to cluster the students (see Table 3) were a series of at least two events, such as the study by Kizilcec, Piech, and Schneider [10], and five variables like Zhang, Zhang, and Ran's [15] study.

Table 1: Reasons for using clustering in MOOCs

Study	Reasons
Kizilcec, Piech, & Schneider (2013)	Characterise learning engagement, define learning trajectories of patterns of engagement, analyse learning behaviour
Ferguson et al. (2015)	Investigate engagement; create engagement profiles; engagement with content, with assessment and with discussion
Khalil & Ebner (2016)	Discover characteristics of student profiles, portray engagement and behaviour of learners, assign common learning styles to groups
Tseng et al. (2016)	Understand students' engagement in MOOCs and offer insight to what keeps the student engaged in MOOCs
Zhang et al. (2018)	Explore learning behaviour characteristics, combine learner behavioural data with clustering algorithms to group learners into relatively homogenous groups

Table 2: Clustering methods

Study	Clustering method	Clustering validation
Kizilcec, Piech, and Schneider [10]	custom longitudinal distribution and k-means clustering	Yes, silhouette cluster validation
Ferguson, Clow, Beale, Cooper, Morris, Bayne, and Woodgate [4]	k-means clustering	No
Khalil and Ebner [9]	k-means clustering	Yes, elbow method
Tseng, Tsao, Yu, Chan, and Lai [14]	Ward's hierarchical and k-means non-hierarchical clustering	No
Zhang, Zhang, and Ran [15]	k-means clustering + hierarchical clustering	No

Table 3: MOOC variables used for clustering

Study	MOOC variables
Kizilcec, Piech, and Schneider [10]	course–video lectures and assessments
Ferguson, Clow, Beale, Cooper, Morris, Bayne, and Woodgate [4]	course visits, forum posts, assessment submission
Khalil and Ebner [9]	discussion forum reading frequency, discussion forum writing frequency, videos watched, self-assessment attempts
Tseng, Tsao, Yu, Chan, and Lai [14]	logging in system, watching lecture videos, submitting assignments, posts in the discussion forums
Zhang, Zhang, and Ran [15]	discussion forum posts, discussion forum replies, final scores, total duration of watched videos, number of videos viewed

2.4 Clusters Identified

Kizilcec, Piech, and Schneider [10] found four categories in three MOOCs on the Coursera platform based on their engagement behaviour as the following:

- On track: if students submitted assessment in the week it was set
- Behind: if students completed an assessment after the week in which it was set
- Auditing: if students engaged with content but not with the assessment
- Out: if students did not participate in a course week

Furthermore, Kizilcec, Piech, and Schnieder further employed cluster analysis and categorized the students into the four following categories:

- Completing: students who complete most of the assessments
- Auditing: students who watch videos but complete assessments infrequently
- Disengaging: students who complete some assessments but then withdraw from the MOOC
- Sampling: those who explore the MOOCs through simple engagement with videos

Ferguson, Clow, Beale, Cooper, Morris, Bayne, and Woodgate's [4] study applied k-mean clustering on five MOOCs, two long and three short. The number of clusters identified in the longer MOOCs which are two months long, were as the following:

- Samplers: visited a course briefly
- Strong Starters: left after the first week's assessment
- Returners: completed assessments in the first two weeks, then left
- Mid-way Dropouts: completed 3–4 assessments before leaving
- The Nearly There: cluster completed most assessments but left early
- Late Completers: completed most assessments but were either late in submitting these or missed some
- Keen Completers: engaged actively throughout the course

Ferguson, Clow, Beale, Cooper, Morris, Bayne, and Woodgate [4] applied the k-mean where k = 7 to shorter MOOCs, however the results were not meaningful due to either smaller groups identified and extremely biased toward one of the variables (see Table 3). The authors then applied different value for the k-means for the other three MOOCs and found the following clusters:

- Very Weak Starters: who show low level of engagement in the first weeks
- Improvers: students whose their activity rise along the MOOC
- Surgers: who visit more than two-third of a short MOOC but stop before the MOOC finishes
- Saggers: engaged actively throughout the course but not as high as the keen completers

Khalil and Ebner [9] study applied k-means study on two MOOCs. The first one is a compulsory MOOC provided to undergraduates, and the second MOOC was a free open one. The number of clusters founded by Khalil and Ebner are four and three clusters respectively as the following:

- Dropout: low engaged students with high attrition
- Perfect students: very active students who are engaged in forums, video watchers, and pass all the self-assessment tests
- Gaming the system: students who pass the exams but have several attempts with barely watched videos

- Social: students who are engaged only in forums.

The authors when replicating the study on the open and free MOOC found three out of four groups: "Dropout", "Perfect students", and "Gaming the system". "Social" students were not detected by the k-means value applied before.

Zhang, Zhang, and Ran's [15] work explored a small private online course (SPOC) using k-means and hierarchical analysis and found the following four groups of learners:

- Weak-cognitive learners: those with high video viewing rates, long duration but low final scores.
- Self-conscious learners: the excellent learners who have completed the indicators that do not count toward achievement.
- Short-cut learners: those with a higher final score, but who have a low completion rate of indicators that do not count towards achievement
- Lazy learners: the learners who do not have high-scored indicators.

Tseng, Tsao, Yu, Chan, and Lai [14] classified learning behavior in three MOOCs provided by the Yuan Ze University in Taiwan and came up with three types of students based on their interaction in the MOOCs as follows:

- Active learner: who submitted assignments on time and frequently watched lecture videos with high completion and engagement ratio.
- Passive learner: who frequently watch MOOC videos, show limited participation in course forums, and attempted few assignments and quizzes
- Bystander: learners who register and their activity is way below a low threshold.

3 Clusters – Combined

The total number of clusters identified by the researchers from the five papers is (N = 30) clusters. Each of which describes distinctive learning behaviour according to each paper. Nevertheless, combining all the clusters together draws a line of common learning attitude that is shared in the alluvial illustration in Figure 1 below. Unfortunately, grouping clusters alike is subjective to what the authors of the papers describe. For instance, Zhang, Zhang, and Ran's [15] four clusters were identified based on students' cognitive ability and engagement. In my attempt to group the 30 clusters into general themes, three are identified: Motivation (N = 7), Chronology (N = 6), and Commitment (N = 17). The motivation includes students by whom their engagement present motives in studying in MOOCs according to their engagement. Chronology includes students by whom their engagement is defined within a time frame. Commitment incorporates hierarchies that belong to the engagement of dropping out or completing.

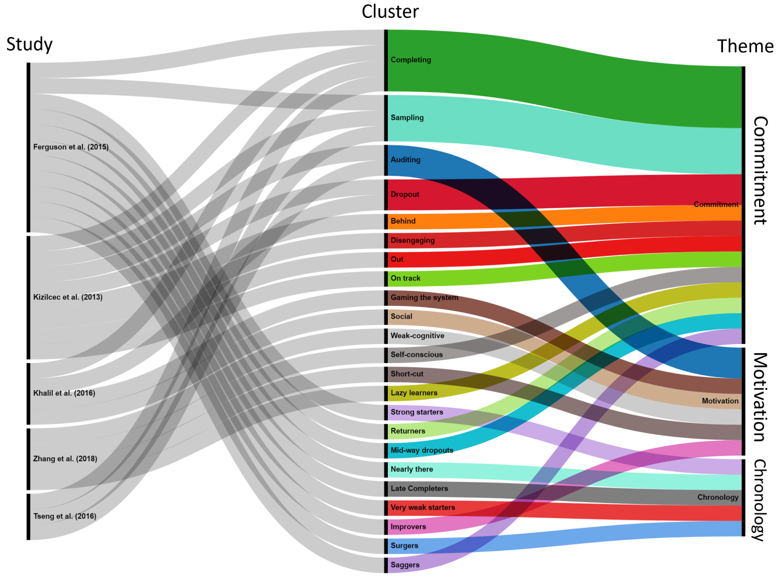

Figure 1: Grouping the student clusters from the five selected papers (N = 30 clusters)

4 Implications and Conclusions

This work is a contribution to provide a brief and quick overview on how clustering is used in MOOCs. Sharing experiences in the field of MOOCs is a key functioning wheel for research. Through reviewing five papers from the literature on clustering in MOOCs, the following remarks are highlighted:

- *Clustering in MOOCs is connected to Learning Analytics with focus on engagement*: research that uses datasets from MOOCs is strongly linked to Learning Analytics. The goal of which is to optimise the learning experiences of the learners.

The reviewed papers looked deeper into engagement, trying to understand the learning behaviour through clustering. However, clustering MOOCs is not limited to engagement, but other forms of grouping and classification such as text and discourse clustering.

- *K-means is the popular technique for clustering in MOOCs*: Table 2 shows that k-means is the primary method used to cluster engagement. Bharara, Sabitha, and Bansal [2] had also concluded the same results including platforms other than MOOCs. Through a bigger review of 15 papers, the authors found that k-means was used the most among the papers. Barthakur, Kovanovic, Joksimovic, Siemens, Richey, and Dawson [1] agreed that k-means is the most used algorithm for clustering in MOOCs.
- *There is a positive correlation between engagement and completion ratio*: the reviewed papers show that active engagement through fulfilling MOOCs' assignments and tasks are associated to an increased completion rate.
- *Cohorts in clustering are named subjectively to the authors and study objectives*: Even though researchers came to similarities of learners' behaviour in MOOCs, their naming of the identified cohorts was different. For example, "Perfect student" in one study was named "Completing" in another.
- *Clustering has not yet been used to optimize student learning*: The papers reviewed are clickstream (i.e. clicks of activity) dependent. That is, clustering is focused on exploring and explaining learning behaviour based on data-driven approaches. There is a gap in linking traces of students' learning behaviour in MOOCs and the actual learning processes. Perhaps including self-reporting information from the students helps improve student learning.
- *Absent learning theories*: It becomes quite common in data-driven approaches that learning theories are overlooked [7]. This has been evident in the reviewed studies. Data might not only suggest that theory is unnecessary but that it could make sense of that data.

5 Limitations

The study has some limitations. The search to retrieve and select the papers were conducted only using Google Scholar, the number of selected papers was restricted to five, the aggregation of all the clusters from the five studies is subjective, and even though the time of the work publication of this work is 2021, the most recent paper of the five reviewed is 2018.

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The Role of MOOCs in the New Educational Scenario
An Integrated Strategy for Faculty Development

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The COVID-19 pandemic emergency has forced a profound reshape of our lives. Our way of working and studying has been disrupted with the result of an acceleration of the shift to the digital world. To properly adapt to this change, we need to outline and implement new urgent strategies and approaches which put learning at the center, supporting workers and students to further develop "future proof" skills. In the last period, universities and educational institutions have demonstrated that they can play an important role in this context, also leveraging on the potential of Massive Open Online Courses (MOOCs) which proved to be an important vehicle of flexibility and adaptation in a general context characterised by several constraints. From March 2020 till now, we have witnessed an exponential growth of MOOCs enrollments numbers, with "traditional" students interested in different topics not necessarily integrated to their curricular studies. To support students and faculty development during the spreading of the pandemic, Politecnico di Milano focused on one main dimension: faculty development for a better integration of digital tools and contents in the e-learning experience. The current discussion focuses on how to improve the integration of MOOCs in the in-presence activities to create meaningful learning and teaching experiences, thereby leveraging blended learning approaches to engage both students and external stakeholders to equip them with future job relevance skills.

UNESCO[1] estimated that 1.5 billion learners were affected by school closures, more than 200 million in higher education. Several educational institutions moved to remote teaching in a few days and with emergency plans.

The unexpected scenario highlighted the resiliency of several educational institutions and unraveled how digital and interactive solutions can complement the rich and unique in-person experience. Particularly, Massive Open Online Courses

[1] COVID-19 Educational Disruption and Response. UNESCO. May 2020. Available at: https://en.unesco.org/news/covid-19-educational-disruption-and-response (Accessed: 7 February 2021)

(MOOCs) proved to be an important vehicle of flexibility and adaptation in a general context characterized by several constraints. According to Class central[2] analysis, the top three MOOC providers (Coursera, edX, and Future Learn) registered as many new users in April 2020 as in the whole of 2019. As we all know, there was a lot of hype surrounding MOOCs in 2012, "The year of MOOCs" with an explosion of providers, new courses and users enrollment, but after a while the registration trend normalised and, since then, the numbers have grown constantly but relatively slowly.

The pandemic broke this trend. According to Class central around 25–30% of the total registered users on these platforms came after the pandemic. Coursera[3] added 15 million new learners in the period from March to June 2020, receiving 35 million enrollments between mid-March and the end of July[4]. Coursera declares that governments and universities using Coursera's Campus Response Initiative[5] have equipped more than one million people with free access to job-relevant online learning.

In order to support teachers in integrating MOOCs in the learning experience, Politecnico di Milano has launched a series of online training paths for faculty development, offering a series of stimuli and tools useful to redesign learning and teaching experiences by enhancing the coherence between learning objectives, assessment methods and active learning experiences.

In March 2020, the training path for faculty development moved online due to the pandemic: a complete redesign of the usual workshop structure was made. The synchronous activities have been characterized by workshops based on workgroups held in "Interactive classrooms" provided by Webex, with the visual support of Miro[6], a collaborative digital advanced whiteboard: participants were requested to reflect in groups on the key issues related to learning design. Then, they were asked to deepen the details following the "MOOCs for teachers" track and, specifically "Designing Learning Innovation" MOOC.

"Designing Learning Innovation" aims to put the design culture at the service of learning innovation. It addresses the topic of learning design with a systemic approach, thus fostering the implementation of coherent learning and teaching experiences which can leverage on different possibilities to engage students and teachers in meaningful educational experiences. This MOOC constitutes the main pillar of the "MOOCs for Teachers" track. The first edition was in Italian, but it has been developed also in English during the pandemic to reach a wider audience and

[2]By the Numbers: MOOCs During the Pandemic, https://www.classcentral.com/report/mooc-stats-pandemic/
[3]www.coursera.org
[4]Coursera Global Skills Index 2020, https://about.coursera.org/press/insights/report-global-skills-index-2020
[5]Coursera Coronavirus Response Initiative. Coursera. March 2020.
[6]https://miro.com/

to support the redesign task of several teachers that needed to adapt their courses to the urgent needs emerged. Both editions were developed as MOOC-BOOK with a deep mutual integration with the handbooks published by Pearson.

Other relevant MOOCs of the track address specific topics, such as active and blended learning, assessment strategies, Open Educational Resources. They have strongly supported the Politecnico di Milano faculty during the disruptive educational period we experienced, boosting the creation of a new online and blended learning culture. Following some of them.

"To Flip or Not To Flip" MOOC presents the flipped classroom approach, thus supporting the reflection about the design of valuable activities to be carried out remotely or on-campus and the effective integration of them.

"Engaging Students in Active Learning" focuses on techniques that allow teachers to actively engage students during lessons, improving collaboration and interaction within the students, but also supporting them in taking responsibility for their own learning journey. Although online, many teachers grasped the deeper meaning implementing active teaching methodologies that avoided the risk of high student dropout rates during a semester characterized by all-day online classes.

"Using Open Educational Resources in Teaching" illustrates how to exploit the potential of educational resources released in the public domain or under a Creative Commons license, to design, innovate or update a course. This course has been useful when the quick shift to an online scenario has requested to redesign several learning and teaching activities overnight, for example requiring translating Labs in-presence experiences into online virtual experiments and tours.

"New Assessment Strategies – The magic of feedback" explains how formative assessment can foster learning, as constant feedback allows students to improve and to reach the desired results. This MOOC has been appreciated by teachers who needed to rethink their assessment strategies, so to move from an approach based on few final assessments (managed with online proctoring services and processes and creating several difficulties) toward an approach based on continuous assessment.

The last MOOC of this series is "Active Learning for Softs skills Development", accessible from the 22 of February (2021), which provides insights on how to foster the development of soft and digital skills while teaching disciplinary subjects. This course is one of the outputs of the Erasmus+ eLene4life project[7] and it collects meaningful experiences of international teachers around Europe who have implemented an active learning method also during the pandemic (in the academic year 2019/2020).

The "MOOCs for Teachers" track is constantly updated and integrated with new MOOCs addressing key issues: more than 13,000 users have enrolled in at least

[7] https://www.pok.polimi.it/courses/course-v1:Polimi+SSD101+2021_M1/www.elene4life.eu

one MOOC, and nearly 3,600 of them have earned a certificate of accomplishment, with a completion rate of 27%, quite unusual in the MOOC panorama.

The COVID-19 pandemic acted as a truly disruptive moment: every sector was forced to rethink processes and strategies that could rely on digitalization to be more effective. In the education sector, MOOCs have shown to be a great resource, at a time of several constraints: they have supported the training of both university staff and students, offering the possibility to scale-up numbers without any constraints, for example the presence of several people at the same place. By being open and accessible to anyone, they have also supported the upskilling of different stakeholders, for example in innovative small medium enterprises, so that they could cope with the difficult situation.

The COVID-19 pandemic has thus fostered the widespread of the "MOOCs culture": within several organizations the discussion about new educational scenarios is now open and livening up. The educational institutions are searching for best practices to integrate them in their learning and teaching processes and MOOCs surely provide some of them. One of the main risks is to merely conceive MOOCs as a series of videos or digital contents disconnected from the teaching activities, both online and in-presence, and from the flexible spaces, enhanced with technologies, that are slowly spreading in the university context.

The connection between pedagogy, technology and learning spaces in educational innovation processes is the focus on which several studies and models are based. Radcliffe [2] outlined the "Pedagogy-Space-Technology" (PST) framework, which has to be considered as a reference for setting up an integrated instructional innovation strategy, where new pedagogical approaches, flexible spaces and technologies are the main ingredients of the ecosystem where innovation in education can find opportunities to evolve. The challenge to tackle will be to apply this model to a "blended educational system" that integrates MOOCs while maximising the possibilities of flexible spaces and innovative technologies to create valuable learning.

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DigiCulture MOOC Courses Piloting with Students

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The creation of Massive Open Online Courses and platforms has become popular in recent decade, with several private and international initiatives. Such courses have made education available for all, and basic knowledge from a variety of domains available online in simple to use information. 13 different MOOCs courses developed as part of DigiCulture Erasmus+ project – Improving the Digital Competences and Social Inclusion of Adults in Creative Industries- are made available in the UniCampus platform. Based on open source, Moodle platform, with several years of iteration and improvements, integrating open badges and certificates, and dedicated to university students, UniCampus needed to be adapted for low-digital-skilled adults. The evaluation of a first pilot of the DigiCulture courses is presented in this paper.

1 Introduction

The creation of Massive Open Online Courses [4] and platforms has become popular in recent decade, with several private and international initiatives. Such courses have made education available for all, and basic knowledge from a variety of domains available online in simple to use information. Since 2018, we create a sustainable and efficient open education program – DigiCulture – dedicated to adult learners with low digital skills and low-qualified adults involved in the creative industries sector [2]. This education program is part of the Erasmus+ Digital Culture project, a diverse partnership formed by educational institutions and creative industries stakeholders: Politehnica University of Timisoara, Romania (coordinator), Roma Tre University, Italy, Aalborg University, Denmark, Graz University, Austria, Dublin City University, Ireland, Timisoara European Capital of Culture Association, and InterArt Triade Foundation from Romania, JME Associates Ltd, UK, National Association of Distance Education, Lithuania and associated partners EDEN and Culture Action Europe (www.digiculture.eu).

The multilingual online courses are hosted on the UniCampus platform, developed on Moodle open source platform [3], which is the first MOOC platform in Romania open to all universities [1]. This paper analyses a pilot of these courses performed with university students.

2 The Experience

This research presents the experience we had with 2nd year Master students from a hybrid programme in Communication and Digital Media. For this iteration we had a number of 19 students, 1 male and 18 female with ages between 23 and 50 years old. The pre-course evaluation shows that our students have basic digital skills and experience, with a good diversity between very able students and less experienced students, which is relevant for our study. All students had to register on the UniCampus platform[1] for free online MOOC courses. Each student chose two short courses[2] from: The Internet, World Wide Web and introduction to the digital world; Digital Content & Publishing; Data Protection and Open Licenses; Digital Curation – Digital Libraries and Museums; Digital Safety, Security and Ethics; Digital Storytelling; Digital Audiences, Digital Analytics; Social Media for Culture; Augmented and Virtual Reality; Digital Management in Culture; Online and Mobile Digital Media Tools.

2.1 Analysis of the Reports

We divided the analysis into several parts, first analyzed being the MOOC platform the students piloted. The UniCampus platform is similar to the Moodle based one our university uses, the Virtual Campus.

The platform interface was described as easy to use (55%), familiar (35%), intuitive (29%), well organized/structured (29%) and user-friendly (29%) which makes it accessible (20%) to all people interested in MOOC courses, regardless of the level of familiarity with the online environment.

The registration process went quickly and easily, without asking for too much pointless personal data (15%).

Highly appreciated was the fact that students were able to access the platform from several devices, such as PC, tablet or mobile phone, through its mobile application (35%).

An interesting point of viewed showed that learning on this platform is a gradual one, from simple to complex, being also a more pleasant and interactive way to have certain information. Similar, one student said it was a useful way for learning, by mixing and developing learning and teaching activities to be more dynamic and interactive with the help of technology. Interactivity was underlined by 50% of our students.

[1] https://unicampus.ro/cursuri/login/index.php?lang=en
[2] https://digiculture.eu/en/project-summary/

The time indicators from each "subchapter" and the progress bar that show you how much percent of the course you have taken are very useful to determine how much time is left until its completion (40%). Also appreciated was the fact that they can choose to print the content, if they want, and this is arranged automatically.

Other points signaled by our students were the fact that you can learn for free (15%), at your own pace, from wherever you are (20%) and you have the best examples from experienced people.

After each loaded topic or activity that had to be done, a confirmation email was received by e-mail, which is a positive aspect.

In terms of technical issues, the most common error encountered was that progress is not automatically monitored as you progress through the courses and one can manually check the activity as completed (50%). Here is an interesting opinion regarding this: "the fact that I can check by myself that I read everything was a little discouraging, thinking that anyone can go through the course without reading a line, but only after I noticed that it can be checked, indeed, when the person taking the course considers that he finished reading, plus that the assignments I had could not be checked manually, but only automatically after uploading the assignment". Another problem was the fact that the student's did not receive a badge (20%) followed by some errors in the quizzes (15%). Another suggestion was that one should access the next topic in the current chapter only after one has gone through the previous topic, without being able to see all course material and activities from the start. Some people might choose the bad order in which to follow the course, not in the one intended for the information to be best understood. Accessing the courses from the platform seemed difficult to some. By clicking on "My Courses" they expected to find first the courses they enrolled in and then other sections. Students would have liked the information to be available in Romanian as well, but they don't mind that it's in English, especially since the language used is an easy to understand one (15%).

2.2 Findings from the Questionnaire

All students were required to complete a questionnaire related to their MOOC experience, after finishing all MOOC activities. The questionnaire has 27 questions and the estimated completion time is 10–15 minutes.

In the end, we also wanted to see how our students evaluate each of the DigiCulture courses. The ratings received were the following (1 low, 5 high): Social Media for Culture (4.2), Augmented and Virtual Reality (3.9), Digital Storytelling (3.9), Digital Safety, Security and Ethics (3.8), Online and Mobile Digital Media Tools (3.7), Data Protection and Open Licenses (3.6), Digital Curation – Digital Libraries and Museums (3.6), Digital Content & Publishing (3.5), Digital Audiences, Digital

Analytics (3.5), Digital Management in Culture (3.5), The Internet, World Wide Web and introduction to the digital world (3.4). The full results can be seen in Figure 1.

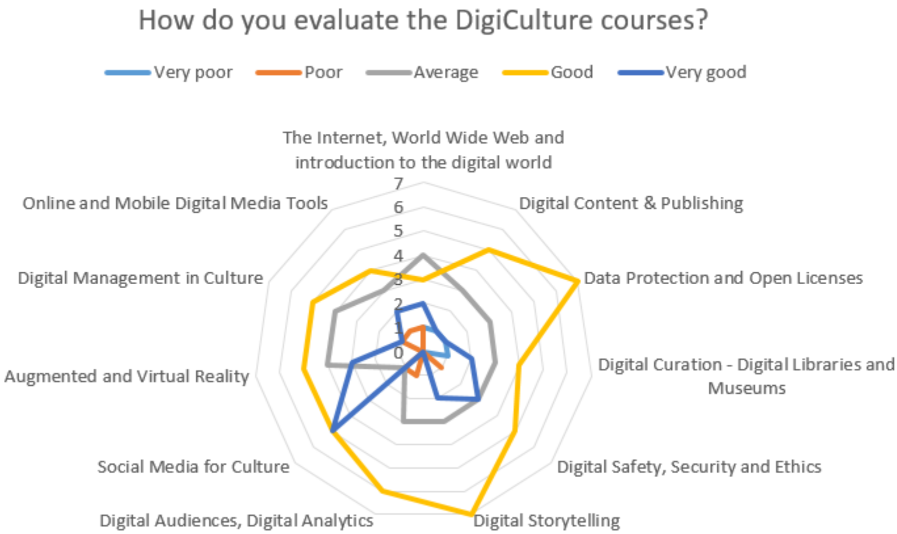

Figure 1: How do students evaluate the DigiCulture courses

3 Conclusion

Students' conclusions from the piloting indicates that the UniCampus platform is a useful platform for accessing basic knowledge for students with mixed digital skills. To summarize the whole experience of MOOC courses, one said that it had a big impact on her from different points of view. It was something different, something she was glad she was able to experience again, because this is a different way of accumulating information. The general experience was a pleasant one, and students declared that they accumulated knowledge about the topics covered.

4 Acknowledgement

This paper is based on the joint work and research conducted by partner organisations in the Erasmus+ Project Improving the Digital Competences and Social Inclusion of Adults in Creative Industries – DigiCulture, Cooperation for Innovation and the Exchange of Good Practices, Strategic Partnerships for higher education, (partially) founded by the European Union, Project Number 2018-1-RO01-KA204-049368.

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Behavioral Patterns in Enterprise MOOCs at openSAP

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While Enterprise MOOCs have been established alongside academic MOOCs in recent years, there is still only limited evidence on learner behavior in MOOCs with a clear focus on job-related training and professional development. This short paper addresses this gap by analyzing learner behavior in openSAP Enterprise MOOCs. By means of lag sequential analysis, data from 13 MOOCs from the topic areas business, design, and technology with a total number of N = 72,668 learners have been analyzed. Consistent high-level behavioral patterns over all three topic areas could be identified. Implications for future research and development are being discussed.

1 Introduction

Massive Open Online Courses (MOOCs) have been a growing element in higher education for more than ten years. Especially the advantage of reaching large numbers of learners worldwide seems to be attractive for universities and educational organizations [5, 10]. Over the recent years, MOOCs have also become a viable alternative for corporate training and professional development [6]). One of the most advanced implementations is openSAP, an open learning platform related to the Tech/IT-sector. While many companies do not seize the full potential of MOOCs for training and development [4] or even lack adequate support [8], openSAP implements so-called Enterprise MOOCs [18] to successfully convey knowledge about new technologies and business topics within the organization as well as to external stakeholders throughout the enterprise ecosystem [15]. Against the background of the common criticism of MOOCs in terms of instructional quality [7] or completion rates [13], openSAP seeks to constantly optimize its offering and thus to improve the learning experience. Therefore, the existing R&D partnership with the Hasso Plattner Institute (technical expertise) has been extended with the University of Mannheim, Chair of Learning, Design and Technology (instructional design and learning analytics expertise). As part of the partnership, several research activities seek implications for learning design of MOOCs to further advance the openSAP offering, and its learning experience [9]. This paper reports an initial case study of this R&D partnership focusing on the behavior of learners in openSAP Enterprise MOOCs. More specifically, the research project seeks to (1) identify typical behavioral patterns in openSAP Enterprise MOOCs and (2) find out if such patterns differ between courses from different topic areas. The remainder of this paper introduces the openSAP University and describes how the R&D partnership addressed the research questions using a Lag Sequential Analysis (LSA) approach. Then, the context and findings are presented. The paper closes with a discussion of implications and an outlook for future research.

2 The openSAP University

As part of SAP's digital education strategy, the openSAP learning platform (available at open.sap.com) was established in 2013 to meet the increasing demands of partners, customers and suppliers for knowledge on corporate strategy, business innovations and product releases in a timely manner [16]. openSAP delivers knowledge via scalable online courses, thus suitable for larger audiences. The courses are open to everyone and free of charge, providing videos, quizzes, and interaction in a digital classroom over a fixed period of time. The main topic areas are technology and software, business, or design; while some additional courses provide insights on corporate social responsibility-related topics. The technical infrastructure is based on the HPI MOOC platform developed at the Hasso Plattner Institute in Potsdam, Germany. In early 2021, the platform counts more than 1.1 million unique registrants from over 200 countries with more than five million enrollments in around 250 different courses.

With respect to instructional design (ID), openSAP courses follow an elaborate xMOOC model, providing a structured and well-organized offering [2]. Course completion can be achieved upon two kinds of certificates. Learners receive a so-called Confirmation of Participation (CoP) by accessing at least 50% of the overall course content. In addition, the participants will obtain a Record of Achievement (RoA) when achieving at least 50% of the points available in the weekly assignments and the final exam.

3 Sequential Analysis of Online Learning Behavior

Sequential analysis is a well-established method of inferential statistics [19], which can be employed for investigating behavior of learners in online learning systems [17]. It is regarded as a suitable approach when investigating behavior within an ongoing interaction [1] and thus has been applied to various MOOC settings (e.g. [3]. Sequential relationships of observations and events with each other are also considered in sequential analysis [1]. Log-linear models, lag sequential methods, z-scores and sequential pattern mining can be used to carry out sequential analysis and determine sequential patterns. In order to identify typical learning behaviors of learners, transition probabilities are used to identify significant patterns [1]. The stochastic models provide the mathematical basis for precisely computing learning-dependent changes in learning environments such as MOOCs [12]. The analytics process of LSA for this project consists of six distinctive steps: (1) develop event sequence, (2) map out transitional frequency matrix, (3) derive transitional probability matrix, (4) calculate z-scores and carry out test of significance, (5) draw state transition diagram.

4 Learner Behavior in Enterprise Moocs

4.1 Sample, Data Collection, and Procedure

User events from 13 openSAP courses from the topic areas Business, Design and Technology have been analyzed with regard to patterns in learner behavior. The courses in the sample show variations in terms of length, effort, and design parameters like assessment configuration or additional ID elements (e.g. reflection prompts or coding exercises). Table 1 provides on overview of the courses in the sample.

The data used to conduct LSA consists of learners' interactions with the digital learning environment on the basis of traceable system states and events. In a preliminary step of data preparation, the event data generated by interactions with the platform was coded into delineable sessions. A session is based on a sequence of events whose interval does not exceed 60 minutes, i.e. sessions expire after an hour of inactivity.

Learners' interactions with digital learning environments can be classified into three categories: learner-content, learner-discussion (learner-learner), and learner-instructor [14]. Following the HPI MOOC platform's overall structure, the learner events in a course can be assigned into four main categories: L – Learning (e.g. video playbacks, self-test submissions, visits to learning items), D – Discussion (e.g.

Table 1: Descriptive information on the courses in the sample

Topic area	Course	Course length (weeks)	Max effort (hours)	Assess-ment config.[a]	Add. ID elements	Enroll-ments[b]	Number of active learners[b]	Number of inter-actions
Business	xm1	1	3	w	0	4609	2597	125147
	leo2	2	8	w+f	1	10542	5626	534548
	pa1-tl	3	12	w+f	1	6904	4070	415258
	s4h15	4	16	w+f	0	18265	12277	2023627
	sbw1	6	24	w	1	11664	6270	731436
Design	build1	4	16	w+f	2	7749	4350	355387
	cwr1-1	3	12	w+p	2	1810	1005	82072
	dafie1	5	20	w+p	2	5283	2678	204060
	sps3	5	20	w+p	1	6629	3143	380989
Technology	ieux1	1	4	w	0	13431	6784	205950
	java1	5	30	w+e+f	3	21693	11757	3866382
	mobile3	5	25	w+f	1	10374	5928	807607
	sps2	3	12	w+f	1	10940	5783	721967

Note. [a] w: weekly assignment; f: final exam; e: graded exercise; p: peer assessment; [b] at course end.

post comments), P – Progress (e.g. visits of the progress page) and A – Announcement (e.g. visits of the announcement page).

In the first step of LSA, event sequences were created session by session for each learner based on the interactions with the learning platform. An example of a simple event sequence would be: LLLLDDLLLPDAALLLL. In the second step, transitional frequency matrices were created. Then, the transitional probability matrix was mapped out. Transitional probability is a conditional probability; events occur in different times and "lag" is used to express these time differences [1]. In order to test the statistical significance of the transitions, z-scores were calculated, together with a Bonferroni adjustment to determine the z-score threshold. In the last step, a state transition diagram was generated for displaying the results.

4.2 Results

4.2.1 Behavioral Patterns in openSAP Courses

Over all 13 courses in the sample, significant transitions between the four main categories could be traced. Table 2 shows the respective z-scores.

Table 2: z-scores based on the interaction categories

z-score	Announcements	Discussion	Learning	Progress
Announcement	**587.92***	**41.20***	−203.42	**135.13***
Discussion	**30.26***	**2274.35***	−1814.73	**75.90***
Learning	−237.32	−1799.57	**1572.44***	−223.21
Progress	**208.72***	**17.38***	−191.24	**227.52***

Note. z-score threshold: 2.96; * statistically significant transitions

The respective state transition diagram for the high-level interactions is shown in Figure 1.

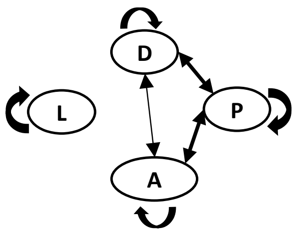

Figure 1: State transition diagram for the overall sample

The state transition diagram shows significant transitions between all the main categories except for the learning category. Looking at high-level interactions, the biggest category in terms of events captured is rather isolated.

4.2.2 Differences in Behavioral Patterns According to Topic Area

In order to tackle the second research question, LSA was carried for each "course bucket" (set of courses from one topic area) separately. The underlying assumption is that learners from the topic areas Business, Design und Technology are using different learning elements in a different frequency through different learning paths, to different dates in time, with a difference in effort and thus show differences in content consumption. Results, again, are illustrated in state transition diagrams (Figure 2 a–c):

As the learning category, again, remains isolated from the others, the data show a consistent pattern on this high level of analysis. Apart from that, behavioral patterns are similar but there are some minor differences. For example, learners interact within the discussion category and then interact with the progress.

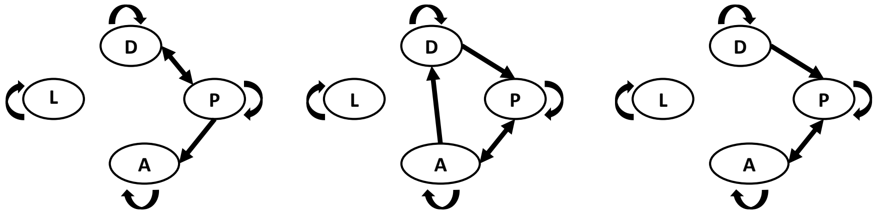

Figure 2: (a) Business courses (b) Design courses (c) Technology courses

5 Discussion and Outlook

This study sought to investigate typical behavioral patterns in openSAP Enterprise MOOCs and if such patterns differ between courses from different topic areas. Findings indicate that (1) there are consistent patterns and that (2) many characteristics of those patterns also apply when a differential perspective is adopted with respect to topic areas. The learning category, for example, which contains the majority of system interactions, remains isolated from the other categories, at least from the high-level perspective employed in this research. This might be due to a clear learner focus on working through the contents and towards the assignments, while the announcement, progress and discussion categories are more likely to be addressed at the beginning or the ending of a learning session. Moreover, announcements are also communicated via additional channels (e.g. e-mail), and the learner progress is evident in the learning area, too. So if there really is a need to better connect learning activities to collaborative (discussion) or meta-cognitive (announcements, progress) activities, cannot yet be decided at this stage.

Thus, there is a need for further analyses, on a more granular level, related to system interactions, as this is also the level on which possible interventions have to be designed to. Likewise, progress and performance data must be combined with the more granular interaction data, in order to discern successful and possibly misleading patterns with regard to learning success. Learner context data collected in accordance with applicable data protection guidelines will add an additional layer of detail here. Eventually, the goal is to develop an analytics-driven behavioral process model that might serve as a baseline for learning design [11]. The high-level behavioral patterns identified mark the necessary initial step to contextualize and interpret user-generated data to identify, understand, and cater different user groups and their learning behavior in an instructional setting, and to ultimately improve the overall learning experience and success.

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Podcasts, Microcontent & MOOCs
The Integration of Digital Learning Formats into HEI Lectures

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Covid-19 poses major challenges to the higher education landscape. Junior professors from the Computational Neuroscience department at Charité – University medicine Berlin and a small team of developers from the AI Campus learning platform saw this as an opportunity to develop digital learning formats in modular, interactive and participatory form that can be integrated into university teaching. While elements from the AI Campus learning opportunity "Dr. med AI" were integrated into the formal seminar setting, an accompanying podcast was to support the learning process in an entertaining way and embed the learning content in a coherent narrative by using exciting and engaging application scenarios of AI used in the different fields of medicine nowadays.

The workshop aims to explore the needs to be considered when designing, developing and implementing a multimedia learning format, how to implement processes of quality assurance in the development process, and how to include students in this process to ensure that a user-centered design is created. The workshop will take place in an online course on the AI Campus platform. By this means participants will have the opportunity to review provided content in the course regarding instructional design aspects and quality of the content. Based on the review results, participants then create interactive formats hands-on by using an interoperable open-source authoring tool. Finally, the core learnings of the workshop will be reflected, discussed and formulated.

1 Setting the frame: A Holisitc Learning Approach

1.1 Smart and Digitally Enhanced Learning

Digital learning has recently been facing a boost due to the Covid-19 pandemic. No matter what part of the educational system – primary school, secondary school or higher education – every institution has been affected by the immense changes and had to adapt quickly to the new situation. Although higher education institutions in Germany, namely Universities and Universities of Applied Sciences, were comparably well equipped concerning technical devices and broadband internet access, students and academic lecturers had to solve the problem of a 100 percent distance learning setting for all students and departments from one moment to the next [4].

In the light of the above, a small team consisting of lecturers from the Charité – University medicine Berlin and developers from the AI Campus – the digital learning platform for Artificial Intelligence was faced with the question of how to get medical students excited about the topic of AI in this exceptional situation of a pandemic lockdown using digital learning formats. A seminar-accompanying online course (Micro-MOOC) was to offer the opportunity to learn the content and develop competences in a self-paced way, including interactive tests and quizzes. Individual formats and components (learning nuggets) from the online course should be embeddable into the live setting of the seminar (blended learning). Finally, a non-formal learning format should be developed that matches learners' usage habits and which is interconnected with the course/seminar narrative.

Following the holistic approach of creating a smart learning environment [6], the overarching instructional design framework consists of the modularity of the digital learning elements, different ways of accessing the learning content (course setting, online course, podcast provider platforms), the combination of formal and non-formal learning ((virtual)seminar, online course, podcast), and various opportunities forms of participation (seminar setting, discussion forums, virtual collaborative learning spaces).

1.2 Learning Content Packaged in Two Formats

With this framework in place, the conception and development of "Dr. med. AI" began – a learning offering composed of an interactive online course and a podcast. While the online course depicts the formal setting in which learners expand knowledge and competencies based on clear learning outcomes, the podcast offers the opportunity to learn the content casually in everyday life. Expert talks on exciting practical examples and application scenarios of AI in different fields of medicine forms the basic storyline which can be imagined as a medical journey with focus on AI innovation. This problem-based approach establishes a direct connection to the study contexts and everyday realities of the learners and thus acts as a door opener to the deeper technical content of the seminar in a low-threshold form. Both the use cases of the podcast and, for example, the learning videos of the online course can in turn be embedded in the seminar context, as they are aligned (Constructive Alignment) with its content and learning outcomes, thus enabling a qualitative embedding in the blended learning scenario [3, 2, 5]. In addition to the seminar setting, learners were given the opportunity to exchange ideas in expert discussion forums with eTutors from the AI Campus and with other learners in chat forums. The mutual exchange creates the opportunity for reflection and a deeper understanding of the content, as it has a motivating effect that additionally evokes a sense of belonging among the learners which is seen as a crucial aspect for the learning success [1].

The holistic approach of "Dr. med. AI" goes beyond classical learning settings in digital contexts by complementing formal learning content with non-formal learning, while formats for personal exchange offer the opportunity to develop competencies together on a communicative level. Thanks to the modularity of the different formats other Higher Education Institutions are able to embed learning nuggets, for example, while creating overarching teaching and learning scenarios. How to best meet upcoming challenges within the development process of such a learning opportunity will be the central topic of the workshop.

2 The Workshop Setting

The workshop will take place in a virtual setting by using a conference tool and a workshop course prepared on the Learning Management System (LMS) of the AI Campus learning platform. Breakout rooms will be provided during different stages of the workshop to give participants the opportunity to work in small agile groups. The workshop follows three basic goals: (1) Participants should be able to distinguish between non-formal and formal digital learning formats and understand their core features out of a learner-centered perspective. This includes the ability to distinguish between the special case of a learning podcast in contrast to an entertainment format. In this context, advantages and disadvantages of different podcast settings are highlighted (interview style, expert talk etc.). (2) The participants understand how learning nuggets can be integrated into virtual and offline teaching scenarios based on the use-case of Dr. Med AI. Furthermore, they (3) gain development and implementation experience by developing different types of learning nuggets within four different workshop teams.

Following an exploratory approach, the workshop provides the opportunity to explore the offered content (podcast snippets, learning videos, interactive quiz formats, etc.) and identify the key features of the different formats through experience. Prepared question sets are used to pre-structure the discussions in the plenary phases, allowing key learnings to be defined afterwards.

One key aspect of the workshop design is to keep the periods where participants act as recipients as short as possible. For this reason, the planned activities will be offered in an online course on the Learning Management (LMS) of the AI Campus. The learning nuggets to be explored and assessed, the questions to be answered and the space for developing content will be provided in this way.

To achieve the goals of the workshop, participants work in different social forms. While the provided learning nuggets are explored, classified and assessed individually, content is developed in small agile teams. For presentation and discussion phases, the exchange takes place in the plenary round.

2.1 Intro: Activation & Assessment (30 min)

In the activation phase, participants have the opportunity to get to know the individual formats and content types of Dr. med. AI in the prepared online course on the LMS of the AI campus. They can listen to excerpts from podcast episodes, work through learning videos with integrated quizzes, or go through knowledge quizzes to make this setting hands-on, engaging and interactive. During this initial phase the participants have the opportunity to familiarize themselves with the content and formats at their own pace. A short query on the learning nuggets is then made in order to structure the exchange in the subsequent plenary phase and to steer the learning in the right direction. One main goal of this approach is to identify specifics of formal and non-formal learning. Furthermore, participants take on the role of learners who engage with new content and formats. This change of perspective will be crucial during the subsequent content development phase.

2.2 Input: Use Case & Learner-Centered Content Development (20 min)

During this part, Kerstin Ritter – the junior professor from the Charité – describes in the virtual setting i.e. via Big Blue Button concrete scenarios for embedding the learning nuggets, which are intended to make the seminar setting more varied and entertaining and to facilitate competence development. In this way, a picture of a more comprehensive learning design is to be created, which can be conceptually mapped, for example, in the form of storyboards. The AI Campus team concludes by outlining how learner-centered instructional design can be established as part of the iterative content development.

2.3 Production: Agile Content Development (1.15 hour)

In this stage, the previously acquired knowledge is applied collaboratively in break-out rooms provided for different content teams. The development processes in each team are moderated and guided by the developers of the AI Campus team. Like in a real world settings each agile team can consist of 5 to 8 people.

Content Team 1: Micro Podcast Production

Based on a given topic and content, the podcast team develops a 3–5-minute podcast episode. A product owner appointed by the team decides which setting (interview, expert talk etc.) is chosen and moderates processes like the definition of learning outcomes. The team records and implements the podcast after a brief onboarding by an AI Campus learning designer. The recording is done using the Zencastr recording tool for podcasting (https://zencastr.com/), while the implementation will be in the workshop course on AI Campus.

Content Team 2: Learning Video Production
Based on a given topic and content, the learning video team develops a 3–5-minute learning video. A product owner appointed by the team decides which setting (presentation, talk, discussion etc.) is chosen and which learning outcomes need to be defined. The team implements the learning video after a brief onboarding by an AI Campus learning designer. The recording is done using the Zencastr recording tool for video podcasting (https://zencastr.com/), while the implementation will be in the workshop course on AI Campus.

Content Team 3: In-Video Quiz Implementation
The video quiz team develops and implements 2–3 different quiz types into an embedded course video. A product owner appointed by the team decides which learning outcomes need to be defined and moderates the quiz development process. The team develops the quizzes after a brief onboarding by an AI campus learning designer. The H5P authoring tool (https://h5p.org/) is used for quiz implementation.

Content Team 4: Implementation of Gamification Elements
The gamification team develops varied exercise formats based on a given topic and content. The formats should support learning in an entertaining way instead of merely testing and assessing knowledge. A product owner appointed by the

team decides which learning outcomes need to be defined and moderates the quiz development process. The team develops the quizzes after a brief onboarding by an AI campus learning designer. The H5P authoring tool (https://h5p.org/) is used for quiz implementation.

2.4 Presentation: Product Pitch and Quality Assurance (35 min)

After the implementation phase, the respective product owners present the learning nuggets. They describe briefly the development process and name learnings and possible challenges. Afterwards, the workshop participants have the opportunity to explore and review the content created by the content teams similar to the initial phase of the workshop, which provides a basic quality assurance process.

2.5 Discussion: Formulating the Key Learnings (20 min)

Finally, the results from the review process are discussed in plenary and the key learnings are extracted from them. The key points are recorded in the workshop course. The course remains open to participants in order to guarantee access to the materials and results of the workshop. Furthermore, it offers the possibility afterwards to share one's future experiences with the workshop participants in the forum.

Due to the complexity of the workshop design, 3 hours are scheduled for the workshop. We consider the target group to be educators, instructional and learning designers, and all education enthusiasts interested in innovative and open education.

3 Why Is This Workshop Relevant For the EMOOCS 2021?

While digital education technologies continue to evolve, comparatively little is happening in the field of instructional and learning design [7]. MOOCs are still largely monolithic events which have little curricular modularity, a limited interaction design in terms of exercise and assessment variety, a video design largely in presentation style and basic exchange formats, partly because they are tied to the functionalities of an LMS. By adding and integrating additional tools and features (authoring tool, programming environment, chat tool, podcast provider, etc.) to the LMS, we pursue a more open approach. A more complex Smart Learning Environment provides the opportunity to extend the instructional and learning design, allowing learners to achieve learning outcomes based on individual student journeys by using a variety of applications for different scenarios. The workshop will provide perspectives and potentials on how a new form of digital content can be developed using the expanded feature set. Here the focus is on a high variety of exercises and assessment, engaging audio and video formats, different forms of social learning and last but not least an open access to all of the content.

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From June 22 to June 24, 2021, Hasso Plattner Institute, Potsdam, hosted the seventh European MOOC Stakeholder Summit (EMOOCs 2021) together with the eighth ACM Learning@Scale Conference.
Due to the COVID-19 situation, the conference was held fully online.
The boost in digital education worldwide as a result of the pandemic was also one of the main topics of this year's EMOOCs. All institutions of learning have been forced to transform and redesign their educational methods, moving from traditional models to hybrid or completely online models at scale. The learnings, derived from practical experience and research, have been explored in EMOOCs 2021 in six tracks and additional workshops, covering various aspects of this field. In this publication, we present papers from the conference's Experience Track, the Policy Track, the Business Track, the International Track, and the Workshops.

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