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THE EFFECT OF THE COVID-19 PANDEMIC ON A MOOC IN AEROSPACE STRUCTURES AND MATERIALS

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ABSTRACT

In March 2020 COVID-19 brought the world and with that aviation to a standstill. Also in March 2020, the third run of the DelftX MOOC Introduction to Aerospace Structures and Materials started on edX. This MOOC generally attracts a mixture of young aviation enthusiasts (often students) and aviation professionals. Given the large interest MOOCs have received as the pandemic hit, we investigate how the new global context affected the motivation and the way learners interact with our course material. For this project, we will use learning analytics approaches to analyse the log data available from the edX platform and the data from pre- and post-course evaluations of two runs of the same MOOC (2019 and 2020).

With the insights gathered through this analysis, we wish to better understand our learners and adjust the learning design of the course to better suit their needs. Our paper will present the first insights of this analysis.

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1 INTRODUCTION

After the first reported case of COVID-19 in December of 2019 in China, the virus quickly spread throughout the world causing travel to come to an almost complete standstill. By mid-April 2020, more than two-thirds of the 22,000 passenger airliners, had been grounded and associated staff either furloughed or made redundant, by April 2021 aviation data analysts still report 8,684 aircraft in storage [1]. Already in mid-March 2020 most higher education institutes in the world had closed their campuses [2] and switched where possible to online teaching, either creating their own or using existing online resources, a situation persisting on and off until today.

1.1 MOOC Aerospace Structures and Materials

The MOOC Introduction to Aerospace Structures and Materials (ASM MOOC) has been running on edX since August 2018 [3], and is currently in its fourth run. This MOOC is an introductory course, requiring only basic knowledge of physics, and is aimed at anyone interested in aerospace structures and materials. On 10 March 2020, the third run of the MOOC Aerospace Structures and Materials opened on edX for a 12-months run, one month after the previous run of the course, running for 10 months, had finished. The first run in 2018 was excluded from our analysis as it was not self-paced and only ran for 12 weeks. Within the MOOC, learners have a choice to try the course for free with limited access (9 weeks) or to upgrade to edX's 'Verified Track' for \$49 giving unrestricted access and the opportunity to earn a certificate by taking online exams and doing online assignments during the course.

1.2 MOOC learners and COVID-19

With so many people associated with the aviation industry unable to work, as well as many students and educators switching to online learning, the question arose how the new global context affected the motivation and the way learners interact with our course material compared to learners in the earlier run of the MOOC. In this paper, we used data collected in the pre- and post-course surveys carried out by our institution and learner data extracted from edX trace logs in order to understand how learners interact with the platform. Ethical permission was sought and granted by the TU Delft's Ethics Board for this research and learners were asked for informed consent on the gathering of their data both by TU Delft and by edX.

2 METHODOLOGY

With the rise of online education, the field of learning analytics was born. Learning Analytics is "*the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs*" [4]. Learning analytics can help educators to understand and optimise learning and form an important tool in the field of online education research. Especially MOOCs, with their relatively large number of enrolments provide great data sources to better understand the behaviours of learners in online courses and are as yet often underused [5].

2.1 Research questions

Our main research question for this paper is: How does the COVID-19 pandemic affect the motivation and the way learners interact with the course material in the MOOC introduction to Aerospace Structures and Materials on edX? To answer this question, we compared the data from the 2019 (collected 9 April 2019 - 20 June 2020) and the 2020 run (collected 10 March 2020 to 21 March 2021) of the ASM MOOC in terms of (i) the number of enrolments, and the professional and educational background of enrolled learners, (ii) the completion rates of verified certificate holders, (iii) the motivation in taking the course and (iv) the level of interaction with the course material.

2.2 Data sets and data analysis

For the analysis, we used the anonymised edX learner data sets to determine the overall number of enrolments in the run and the self-reported age, gender and education level of the population and course completion. On the edX platform, formal course completion is defined as obtaining a Verified Certificate but that only applies to those learners who chose to pay to upgrade. Therefore, we defined course completion for the audit track as students who attempted all quizzes in all 7 modules. The second data set used in this paper is the answers offered by learners to the pre- and post-course survey which included detailed questions about their motivation for enrolling in the course, their background, expectations and evaluations of the course.

Table 1. Cohort and sample size.

*percentage calculated with respect to total enrolment

**percentage calculated with respect to number of Verified Enrolments

	Run 2019		Run 2020	
Total enrolment	11987		26329	
Verified Enrolment	663	5.5%*	2533	9.6%*
Verified Certificate	301	45.4%**	1027	40.5%**
Countries represented	151		168	
Pre-course survey				
Agreed consent	2318		5807	
Full Surveys	1944		4978	
Net Response Rate*	16%		19%	
Post-course survey				
Agreed consent	269		957	
Full Surveys	226		802	
Net Response Rate*	2%		3%	
Response Rate Verified Track**	27%		53%	

All data was analysed using JAMOVI (jamovi.org). In table 1 the description of the population of both runs is given as well as the response to the pre- and post-questionnaire. For all analyses, only complete surveys were used.

3 RESULTS

3.1 Learners

As can be seen from table 1, there was a sharp increase in learners in COVID times. The number of learners in the course more than doubled compared to 2019. Figure 1 shows the normalised enrolment of both courses plotted over time, revealing a much steeper increase in growth of learners of the 2020 run in the first 6 weeks after the world-wide shutdown began (vertical grey line). This trend is confirmed in reports by other MOOC makers [6]. Also, more learners opted to purchase access to the Verified Track and the number of countries learners originated from also increased.

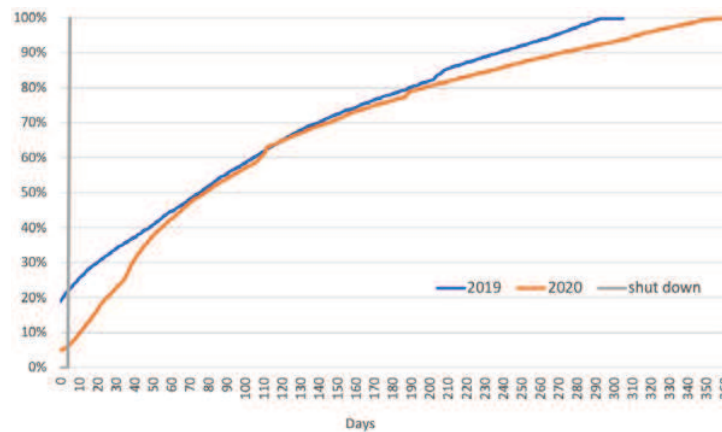


Fig. 1. Normalised Enrolment over Course Length

Using the edX learner data sets, the self-reported age of both runs was compared using an Mann-Whitney U test, $U = 4.08 \cdot 10^7$ and $p < .001$ with a small effect size $z = 0.134$ showed that in the 2020 run the learners were significantly younger (Median = 23 and $N = 12908$) than in the 2019 run (Median = 25, $N = 7301$). In terms of self-reported gender, a X^2 - analysis showed that there is a significant difference in gender distribution, with $X^2(2) = 32.6, p < .001$ with a 3.4% increase in the participation of women in the 2020 run. In 2019, 17.5% of enrolled learners were female compared to 20.9% in the following year. The overall share of women taking part in both runs is higher than the yearly influx in the BSc aerospace engineering of TU Delft. The number of enrolled learners that reported their gender as "other" did not vary across cohorts: 0.5% in 2019 and 0.4% in 2020. A X^2 - analysis of the self-reported level of education of the learners in the MOOC, see table 2, also showed significant differences with $X^2(5) = 44.0, p < .001$ with increases of learners with just high school education or lower and decreases in learners holding a masters or PhD, again indicating that the major increase is among undergraduates.

Table 2. Level of education

	Run 2019 (N=6470)	Run 2020 (N=10387)	Total (N=16857)

PhD	2.2%	1.7%	1.9%
Master	17.9%	14.7%	15.9%
Bachelor	36.8%	36.7%	36.7%
High School or lower	35.7%	39.2%	37.9%
Other	7.7%	7.7%	7.6%

We also looked at the differences between the self-reported employee situation of both runs in the pre-course survey. Again, significant differences were found between the 2019 and the 2020 run, $X^2(6) = 107, p < .001$. There is a sharp decrease of almost 10% in the number of people classing themselves as working, recent graduates or looking for a job and a sharp increase in students (Table 3). An investigation into the average age of these students did not indicate that the average age of this group was rising so the increase in students is not due to a return to education of people who were working. Surprisingly in COVID times, the share of parents and care-givers remains the same.

Table 3. Current job situation

	Run 2019 (N=1934)	Run 2020 (N=4962)	Total (N=6896)
Working	37.0%	27.3%	30.0%
Looking for a job	7.1%	6.3%	6.6%
Retired	0.7%	0.7%	0.7%
Student	42.7%	56.2%	52.4%
Recently Graduated	9.8%	7.3%	8.0%
Parent/care-giver	0.5%	0.4%	0.4%
other	2.3%	1.8%	1.9%

For those working, we analysed what industry sector and industry branch they worked in. Significant differences were reported, $X^2(16) = 35 > 4, p = .004$, between both runs, with a 45% increase in 2020 in learners reporting to work in Transportation, indicative of the reported shutdown of aviation (full contingency table omitted due to lack of space). The top 5 represented industry branches in table 4, show that particularly in aerospace-related industry, there is an increase in the absolute number of learners in COVID times with particularly airlines/aviation standing out. This may be indicative of a culture of Lifelong Learning in the aerospace sector.

Table 4. Reported Industry

Industry (sector)	2019 #	2020 #	Increase %
1. Aviation & Aerospace (manufacturing)	144	229	59%

2. Airlines/Aviation (transportation)	90	255	183%
3. Mechanical or Industrial Engineering (manufacturing)	46	64	39%
4. Military (government)	33	65	97%
5. Defence & Space (High Tech)	33	53	61%

3.2 Motivation

Learners were asked for their motivation to enrol in the course. An overview of both runs is given in table 5. For both runs, the most named motivation is (prospective) career, followed by (prospective) studies and personal interest. A X^2 - analysis revealed significant differences in motivation to enrol between the two runs with $X^2(4) = 14.2, p = .007$, which seems to stem from less people reporting taking the MOOC for their (prospective) career, but more people reporting taking the MOOC in view of their (prospective) studies. The explanation for this, combined with the results reported in tables 3 and 4, may be that as universities and schools were mostly shut down students were looking for alternative courses to take, were encouraged by their own schools to do so or taking these courses in lieu of being able to visit open days to help them decide on their future. Sadly, no COVID specific questions were asked in the 2020 course questionnaires.

Table 5. Motivation to enrol

	Run 2019 (N=1923)	Run 2020 (N=4929)	Total (N=6852)
(Prospective) career	41.2%	37.1%	38.2%
(Prospective) studies	30.2%	34.0%	32.9%
Personal interest	25.5%	26.4%	26.1%
(Prospective) teaching	2.0%	1.6%	1.7%
Other	1.0%	1.0%	1.0%

3.3 Challenges

Learners were asked in the pre-course survey what they felt was their biggest expected challenge and in the post-course survey what they felt was the biggest challenge they faced during the course. The pre-course survey showed significant differences between the expected challenges between the two runs $X^2(5) = 51.9, p < 0.001$ and the post course survey confirms these findings with significant differences in the challenges faced: $X^2(5) = 13.4, p = 0.020$. If we take a closer look at the results as listed in table 6, it can be seen that, compared to 2019, in 2020 learners indicated that they expected time to be less of a challenge and this was confirmed in the post-course survey. This may be indicative of more people being able to make time during the pandemic as they followed the advice to stay at home as much as possible.

Table 6. Expected challenges in taking this online course

Challenges	pre course			post course		
	2019 (n=1946)	2020 (n=4992)	total (n=6938)	2019 (n=199)	2020 (n=692)	total (n= 891)
Finding sufficient time	57.2%	47.8%	50.5%	50.3%	39.9%	42.2%
Grasping the content	13.8%	18.0%	16.8%	13.6%	19.7%	18.3%
I expect no challenges	8.5%	10.8%	10.2%	18.1%	25.6%	23.9%
Meeting the deadline	12.2%	13.7%	13.3%	9.0%	6.4%	7.0%
Using the platform	6.1%	7.0%	6.8%	1.5%	2.5%	2.2%
Other	2.1%	2.6%	2.8%	7.5%	6.1%	6.4%

3.4 Interaction and engagement with course material

As can be seen from table 1, there is an almost 80% increase in the number of learners opting to buy access to the Verified Track in the course, which can be an indication of learners during COVID times wishing to engage longer with the course material. This is in part supported by the lower certificate completion rate of the 2020 learners compared to 2019. This can be an indication that they are more interested in engaging with the material for longer than in obtaining a qualification. When comparing the reported participation level in the post-course survey no significant differences between the two runs were found $X^2(4) = 3.89, p = .426$.

However, participation can also be measured in interaction and engagement using the learning activities: Video Lectures, Reading, Discussion Forum and Exercises. To do so, we first look at the reported pre-course levels of importance learners placed on these activities as well as the post-course reported levels of satisfaction and value of these activities. Using a Mann-Whitney U test to check if there were significant differences between the two runs on the importance learners placed on these learning activities, only significant differences between the 2019 run (N = 1934, Mean = 3.15) and the 2020 run (N = 4963, Mean = 3.23)) were found for the Discussion Forum (U= 4.62.106, p = 0.013 and a small effect size z = 0.038), indicating that interaction with other learners is more important to learners in the 2020 run. When looking at post-course satisfaction of learning activities, we again see significant differences between the 2019 (N = 59, Mean = 3.73) and 2020 (N = 237, Mean = 4.19) run for the Discussion Forum satisfaction: U = 5267, p = .002 and a medium effect size z = 0.25 and similarly for the value of the Discussion Forum between 2019 (N = 60, Mean = 4.27) and 2020 (N = 237, Mean = 4.38): U = 5460, p = .004 and a medium effect size z = 0.23. Learners also reported a significantly higher satisfaction of the exercises between 2019 (N = 199, Mean = 4.27) and 2020 (N = 675, Mean = 4.37) with U = 61354, p = .039 and a small effect size of z = 0.09. In terms of hours worked per week, in the post-course survey learners reported an average of 7.14 hours/week in the 2019 run (N = 207) against 7.91 hours/week in the

2020 run. A Mann-Whitney U analysis showed a borderline significant difference: $U = 69338$, $p = 0.05$ and a small effect size, $z = 0.089$.

As self-reported levels can have issues [7], we also analysed the edX learner data to look at how many learners interacted with each type of activity. In table 7, the number of learners is listed that engaged at least once with videos, assignments or the forum. Significant differences were found with learners engaging in larger numbers than in the 2019 run. In table 8 we compare the extent of the engagement between the two runs and again we notice a significantly higher engagement with the course material with regard to videos watched, problems attempted and activity on the forum in 2020.

Table 7. Learners that engaged at least once with videos, assignments or the forum

Activity (N = 38316)	2019	2020	Total	$\chi^2 (1)$	p
Watched at least one video	40.2%	44.1%	42.9%	52.0	<.001
Submitted at least one problem	36.2%	38.1%	37.5%	13.2	<.001
Posted in the forum at least once	10.0%	12.7%	11.9%	61.3	<.001

Table 8. Comparing the extent of engagement with videos, assignments and the forum for learners that engaged at least once with these activities

Activity	Year	N	Mean	Med	SD	Mann Whitney		
						U	p	z
# of videos watched	2019	4813	10.5	4	15	$2.69 \cdot 10^7$	<.001	0.04
	2020	11607	12.2	5	16.8			
# of problems attempted - audit	2019	3707	15.4	4	27	$1.41 \cdot 10^7$.004	0.03
	2020	7856	18.3	4	32.3			
# of problems attempted - verified	2019	627	81.7	106	54.9	$6.67 \cdot 10^5$.407	0.02
	2020	2173	80.9	98	55.2			
# of posts in the forum	2019	1193	1.31	1	1.5	$1.98 \cdot 10^6$.450	0.01
	2020	3355	1.34	1	1.63			

If we look in more detail at videos, we see that in 2020, significantly more learners watched at least one video ($\chi^2 (1) = 52.0$, $p < .001$) and they watched significantly more videos than in 2019: $U = 2.69 \cdot 10^7$, $p = <.001$ (see Table 8). A similar pattern is also seen when looking at the interaction with problems of learners that are auditing the course. In 2020, more learners attempt at least one problem and these learners attempt to solve more problems on average. This trend is not visible among learners on the 'verified' track, i.e., learners who purchased access to the course. Our data does not show significant differences between 2020 and 2019 with regards to the number of problems attempted by the learners that paid for the course ($U = 6.67 \cdot 10^5$,

$p=.407$). Finally, our data shows that although a significantly higher number of learners posted on the MOOC forums in 2020 ($X^2(1) = 61.3, p = .450$), most learners did not post more than 1 message on the discussion board.

3.5 Course satisfaction levels

Looking at overall indicators of course satisfaction in the post-course evaluation in terms of overall course rating, the likelihood of recommending the course and the ratings learners gave the course for uniqueness, usefulness, being interesting and difficulty, no significant differences between the two runs were found. This may be in part that some of these ratings were already very high in the first run.

4 CONCLUSION

Our data showed significant differences between the 2020 “COVID” run of the MOOC and the 2019 run. It appears the 2020 run not only attracted a larger overall audience but it also attracted a younger audience, consisting of significantly more students and significantly more females than the year before and a decrease in the percentage of people who are working. In absolute numbers however, the aerospace sector bucks that trend, which is not surprising given the standstill in aviation due to COVID and the topic of the MOOC.

When looking at the motivation to enrol, we see here that focus in the 2020 run shifts more towards (prospective) studies than towards (prospective) careers even though this still makes up for 37% of the motivation to enrol. This is not surprising given the increase in the number of undergraduate and graduate students enrolling in this course. We also observed lower course completion rates, even though learners reported significantly less problems with allocating sufficient time. This may be indicative of less interest in obtaining a qualification and more interest in interacting with the course material.

We also see a greater need, value and satisfaction for more interactive course activities such as Discussion Forums in the MOOC, which is not strange given that most learners will have been stuck at home with less opportunities for social interaction elsewhere. Looking in more detail into the learning data of edX confirmed that during COVID times learners engaged far more with the material than learners in non-COVID times and seemed to be genuinely interested in gaining more knowledge about the topic than gaining a qualification.

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