The corona transition and student learning

Use of Learning Analytics indicators to assess short term effects of emergency remote teaching on student learning

Report 1C- December 2022

Dr.ir. Ad Kleingeld, Dr. Uwe Matzat, and Prof. dr. Chris Snijders

[Deliverable 1C: Short-term effect of transition, Canvas and survey data]

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY   4TU. CENTRE FOR ENGINEERING EDUCATION

Introduction

In line with other universities worldwide, on March 12, 2020, Eindhoven University of Technology decided to change learning and teaching drastically, as a response to the corona (COVID-19) pandemic. From that moment on, almost all teaching in the third and fourth quarters of the academic year was conducted online.

Since the start of this transition, we have been surveying Bachelor and Master students from the department of Industrial Engineering and Innovation Sciences (IE&IS) to obtain insights into their experiences with online learning. For each student, we focus on one specific course that they have attended.

Furthermore, and independent of any course, we examine various dimensions of students' well-being, including feelings of loneliness, worrying, depression, and concentration problems. In the previous three reports, we described students' experiences and well-being during the transition (2019-2020, Q3) and the first quartiles of online learning (2019-2020, Q4 and 2020-2021, Q1). The third report describes a follow-up analysis on students' experiences and well-being over Q2 of the academic year 2020-2021.

In this report, we combine data from student survey data with Canvas clickstream data in order to create a broader picture of the (short term) effects of emergency remote teaching on student learning. Earlier research presents inconsistent results. Survey studies often conclude that the transition period made learning more difficult or reduced the quality of student learning. These studies (e.g., Meeter et. al. 2020; Petillion & McNeil, 2020; Tulaskar & Turunen, 2022) make use of self-reported data. A very few other studies make use of Learning Analytics. They conclude that the transition period increased students' (online) learning engagement and led to higher grades (Gonzales et al, 2020; Iglesias-Pradas et al., 2021).

In our report, we examine how student learning changed in quantity and quality during the corona transition period, whether these changes are different for different types of students, and how they relate to grades. Thereby, we examine whether the earlier claims can be replicated. We are especially interested in the potential effects on online learning engagement. Furthermore, we fill two gaps of knowledge: 1. We examine whether this potential increase holds for all types of students or whether some student groups were more successful in adjusting their learning behavior, 2. We examine how changes in online learning behavior relate to changes in offline learning behavior.

Specifically, the following questions are answered in this report:

1.How did emergency remote teaching affect students' learning a) in their own (self-reported) experience and b) in their learning behavior on Canvas (online)? Can we replicate the increase in online engagement and grades found in other studies?

2.Were the changes during the transition period unique for Q3 or typical throughout the period of emergency remote teaching until summer 2020?

3.Was the increase uniform or were some student groups more successful in their adjustments? If yes-which ones?

4.How do changes in offline learning and online learning relate to each other?

The survey

Sample

For this report, we combine the survey data of a random sample of IE&IS students who answered questions about their study behavior in one course in Q3 (academic year 2019-2020) with their Learning Analytics (Canvas click stream data of the same course in Q3). Furthermore, we compare some findings about changes in the online learning behavior with potential corresponding changes in Q4. For the Q3 survey, 346 students replied (response rate of 36%) and 302 students followed at least one course and completed the full survey. For Q4, 286 students replied (response rate of 37%), and 202 followed at least one course and completed the full survey. More information about the two samples can be found in Express Report 1 of this project (Matzat et al., 2020). For the following analyses, however, we only work with smaller (randomized) sub-samples of these two larger samples since several items were presented only to randomly selected subgroups of respondents.

Out of the 209 students who provided information about Q3, 91 were female, and their average age was 20.3 years, with the youngest student of 17 and the oldest of 29. The students are distributed over 22 courses.

Indicators

We measured several relevant characteristics of the students' learning activities and motivations, such as mastery goal orientation and study engagement. These characteristics have been measured via established scales, consisting of several seven- or four-point Likert scales. All scales have satisfactory reliability. In addition, we measured students' self-reported changes in their learning experiences. With these items (examples include "Compared with the first part of the semester, after courses transitioned to remote instruction…" …I felt the quality of my work decreased"", "…I found it was more difficult to learn"), we measure some short-term effects of emergency remote teaching. The resulting scale also has a satisfactory reliability (Cronbach's alpha=.78).

Furthermore, we unobtrusively measure students' online learning behavior by making use of their course-specific Canvas clickstream data in Q3 (N = 2010). For each student we measured four course-specific indicators, on a weekly basis:

- the total session time (minutes per week)
- the number of study sessions per week
- the (mean) interval time between sessions (minutes per week)
- the number of files accessed per week (downloads).

To examine potential changes in their online learning engagement, we distinguished two periods within Q3, namely the **course weeks 1-4 before the transition versus the course weeks 6-8 after the transition**. (In week 5, the transition took place, and no courses were offered.) For each week, we calculate the four indicators per student and take the arithmetic mean of the first versus the second period. These scores are (square-root and logarithmic) transformed to reduce deviations from a normal distribution.

For other analyses, the difference score of the two (untransformed) mean values [value2-value1] is a first approximation of the size of change in students' online learning engagement. Also, these difference scores are then (square-root) transformed to reduce deviations from a normal distribution. Finally, since many clickstream indicators are strongly affected by the course design (e.g., the more course materials on Canvas the higher the number of downloads), we standardize the resulting values course-specifically.

Self-reported effects of emergency remote teaching

In the following table, we show the students' answers to items that describe potential changes in how they experienced their learning during quartile 3.

Table 1: Change in learning experience after the transition

Compared with the first part of the semester, after courses transitioned to remote instruction...	disagree	indifferent	agree
I found the coursework more challenging	34%	18%	48%
I felt the quality of my work decreased	36%	17%	47%
I found it was more difficult to learn	22%	18%	50%
I felt I was successful as a student in this course	20%	15%	65%

Answers on a seven-point scale were combined as follows: 1-3: disagree, 4: indifferent, 5-7: agree

Table 1 shows that, depending on the specific item, about half of the students (47-50%) agreed to the proposition that their learning experience after the transition decreased in quality: course work became more challenging, their quality of work decreased, and it was more difficult to learn. The other students either were indifferent (17-18%) or disagreed (22-36%). Interestingly, most students (65%) considered themselves (somewhat) successful as a student after the transition.

Effects of emergency remote teaching on online learning

In the following, we compare the students' online learning engagement before and after the transition in Q3, making use of the four Canvas clickstream indicators. Note that the numbers presented in Table 2 are the transformed mean values and SDs, as indicated at the bottom of the table.

Table 2: Effects of transition in Q3 deviate from usual patterns)

	Before M (SD)	After M (SD)	Diff.	t	p	ES
Total session time (min per week)	8.32 (3.75)	9.48 (5.31)	+1.16	10.46	<.001	+0.23
Number of sessions per week	0.78 (0.22)	0.84 (0.26)	+0.05	10.77	< .001	+0.24
Interval time between sessions (min)	43.9 (15.5)	42.8 (16.5)	-1.1	-3.22	.001	-0.07
Number of files accessed per week	1.74 (0.46)	1.48 (0.75)	-0.26	-15.24	<.001	-0.34

N = 2010, Number of sessions per week was log-transformed and the other variables were square-root transformed to achieve normality; ES = effect size (small = 0.20, medium = 0.50, large = 0.80)

After the transition, students had a significantly higher total session time and number of sessions per week. Both effect sizes are small. The time between two sessions also decreased, although the change

represents a very small effect size. These indicators are in line with the hypothesis that the transition and the resulting emergency remote teaching led to a somewhat higher student engagement in online learning. Only the number of files accessed (downloads) per week was after the transition significantly lower than before (small to medium effect size).

We know from other research in the pre-Covid period that students' online learning engagement tends to decrease throughout the course weeks (Conijn & van Zaanen, 2017). In the next step, we compare this pattern of change in Q3 with the pattern of change during courses in Q4 (N = 2485) to find out whether the increase in Q3 can be found in the later period as well. If not, this would confirm that the changes in Q3 indeed positively deviate from this traditional pattern.

Table 3: Comparable effects in Q4 do not deviate from usual patterns)

	Before M (SD)	After M (SD)	Diff.	t	p	ES
Total session time (min per week)	12.11 (5.54)	9.65 (5.47)	-2.46	-25.25	<.001	-0.44
Number of sessions per week	0.85 (0.21)	0.76 (0.26)	-0.08	-23.12	< .001	-0.43
Interval time between sessions (min)	39.0 (12.2)	44.4 (16.8)	5.4	22.64	<.001	+.40
Number of files accessed per week	1.74 (0.52)	1.19 (0.75)	-0.55	-44.42	<.001	-.88

N = 2485, Number of sessions per week was log-transformed and the other variables were square-root transformed to achieve normality; ES = effect size (small = 0.20, medium = 0.50, large = 0.80)

Table 3 presents the changes in students' online learning engagement in weeks 1-4 versus weeks 6-8 in courses of Q4. Note that the numbers presented in Table 4 are the transformed mean values and SDs, as indicated at the bottom of the table. The pattern of changes in Q4 is very different from the pattern of changes in Q3. In the second period of Q4, students had a significantly lower number of study sessions per week (medium effect size), the total session time per week decreased significantly (medium effect size), the average time between two study sessions per week increased significantly (medium effect size), and the number of files accessed (downloaded) decreased significantly (large effect size). This pattern of change is very much in line with changes in students' online learning engagement as known from the pre-Covid period.

It should be noted that the total session time in Q4 was higher than in Q3 (approx. 154 minutes versus 98 minutes per week, on average). This is most likely because Q4 courses were designed for online learning, with corresponding Canvas functions, whereas Q3 courses to a large extent represented classroom learning until the transition moment in week 5 and perhaps were not full-fledged online immediately after the transition.

How do changes in online and offline learning relate to each other?

Table 4 shows correlations between various survey measures and the change total time spent weekly on Canvas after versus before the transition, as an indicator of online learning engagement (sample sizes of 71 to 218). Most importantly, the results show that there is no significant relationship between

changes in students' online learning engagement and their self-reported changes in quality of learning ($r = -.11$, *ns*). Whether students felt that their learning was more difficult after the transition or to what extent they felt that their quality of learning decreased did not affect to what extent they increased their time spent weekly on Canvas. Note that, independently of their self-reported experiences, students increased their time spent weekly on Canvas, as shown in Table 2.

The was also no relation between students' reported general study engagement after the transition and the total time spent on Canvas ($r = .04$, *ns*). There was a significant positive correlation between experienced loneliness after the transition and total time spent on Canvas ($r = .17$, $p < .05$); this relation is moderately weak. In addition, students' general achievement orientation towards mastery (motivated by the desire to learn) or prove (motivated by showing that one is doing better than others) were unrelated to the change in online learning engagement ($r = .02$ and $r = -.10$, respectively, *ns*).

Table 4: correlations between survey measures and total time spent on Canvas

		N	Scale	M	SD	1	2	3	4	5	6	7
1	mastery GO (general)	77	1-7	4.83	1.04	(.88)						
2	performance prove GO (general)	77	1-7	3.38	1.35	.17	(.91)					
3	Amotivation (after)	71	1-7	2.68	1.49	-.12	.15	(.89)				
4	Study engagement (after)	71	1-7	3.77	1.01	.22	.21	-.36**	(.90)			
5	Loneliness (after)	145	1-4	2.9	0.57	.10	-.09	-.21	.35**	(.78)		
6	Learning quality (change)	218	1-7	4.02	1.22	.06	.05	.08	-.38**	-.33**	(.78)	
7	Total session time (change)	2010		1.16	4.99	.02	-.10	-.10	.04	.17*	-.11	-

*p<.05,**p<.01; Cronbach alpha on diagonal; change in total session time standardized per course

Looking at the mean scores, it appears that, on average, learning quality did not decrease, unexpectedly, with a mean score (4.02) near the scale mean (4.0). When considering the findings in Table 1 for the separate items in this scale, it becomes clear that this mean score results from a combination of experiencing increased challenges, lower quality of the work, and more difficulties in learning (all lower than 4), but also the perception that one was successful in the course (on average higher than 4). Loneliness represents another notable mean score: on average, students felt quite lonely in the weeks after the transition (2.9 on a four-point scale).

Are there differences between students in their adjustments of offline learning?

We conducted two regression analyses to investigate whether survey measures predict changes in total session time, i.e., whether there are student characteristics that affect the change in their online learning engagement.
In the first analysis, we regressed the changes in time spent weekly on Canvas on mastery goal orientation, performance prove goal orientation (both are student traits), and amotivation and study engagement after the transition. See Table 5.

Table 5. Regression analysis between motivational and study engagement survey variables and the change in time spent on Canvas before and after the transition

	B	SE	Beta	t	p
Mastery GO (general)	-.029	.115	-.032	-.255	.799
Performance prove GO (general)	-.107	.089	-.154	-1.200	.234
Amotivation (after)	-.036	.085	-.057	-0.427	.671
Study engagement (after)	.054	.129	.058	.422	.674

Note: N = 71, $F_{(4,66)} = .554$, p = .697, $R^2 = .033$

The numbers show that the four variables only explain 3.5% of the variance in the change in time spent on Canvas. None of the four variables is a significant predictor.

In the second analysis, we regressed the changes in time spent weekly on Canvas on loneliness after the transition and the change in perceived learning quality of the students. See Table 6.

Table 6. Regression analysis between changes in loneliness and learning quality and the change in time spent on Canvas before and after the transition

	B	SE	Beta	t	p
Loneliness (after)	.255	.155	.143	1.642	.103
Learning quality (change)	-.071	.066	-.094	-1.071	.286

Note: N = 144, $F_{(2,141)}$ = 2.791, p = .065, R^2 = .033

The two variables only explain 3.8% of the variance in the change in time spent on Canvas. Neither variable is a significant predictor. Note that for loneliness both the bivariate correlation (Table 4, r = .17, p < .05) and the beta value in the regression analysis (β = .143, p = .103) suggest that students who are lonelier tend to have more strongly increased their time spent in Canvas compared to those who reported being less lonely.

What are the effects of changes in online learning engagement on grades?

Table 6 presents the effects of multiple linear regression analyses of students' grades on the standardized scores of changes in online learning engagement. In analysis 1, the outcome is the final exam grade, available for only 3 of the 27 courses (N = 472 students). Although the final written exam is an appropriate outcome, the analysis suffers from the fact that only three courses could be included in the analysis. Therefore, in analysis 2, the outcome is the final course grade, available for all 27 courses (N = 1925 students). In analysis 3, the survey variable loneliness was added in the prediction of the final course grade, leaving 138 respondents. Additional analyses reveal that there is not much variation of the grade data between courses so that no multilevel regressions are needed.

Table 6: regression analyses predicting final exam grades and final course grades.

	Analysis 1	Analysis 2	Analysis 3
	Final exam grade	Final course grade	Final course grade, including loneliness (survey)
Predictor	Beta	Beta	Beta
Change in total session time	.11*	.05*	-.07
Change in number of sessions	.27**	.14**	.14
Change in mean time between sessions	.12	.00	-,02
Change number of files accessed (downloads)	-.04	.08**	.20*
Loneliness (after transition)			.06
N students	472	1925	138
N courses	3	27	20
F	8.44**	21.68**	2.42*
R^2-overall	.067	.043	.039

*p<.05, **p<.01. Note: predictors and outcomes standardized per course.

The three analyses have in common that the amount of variance explained in the outcome (exam grade or course grade) is not large, between 3.9% (analysis 3) and 6.7% (analysis 1). Looking at the four predictors measuring aspects of online learning engagement, across the three analyses, the change in the number of sessions has the highest positive beta value, indicating that a (higher) increase in the number of sessions is related to higher grades. Generally, all single beta values are quite small, indicating that the relations are not strong (some of these are statistically significant due to the large sample size, especially for analyses 2 and 1). The best performing model of analysis 1 has a small to medium effect size (f^2=.072).

Answers to the research questions

This report has provided insights on how the corona transition and the resulting emergency remote teaching changed students' learning according to their own experience and how it changed their online learning behavior, to what extent these changes are unique to the transition period in Q3, whether different groups of students differ concerning these changes, and how the changes relate to students' exam grades. The data indicates that many students experience that the transition reduced some aspects of their quality of learning. For instance, they report that they found the coursework after the transition more challenging, and that learning was more difficult. Nevertheless, the majority reported that they were successful in the course for which they completed the survey.

At the same time, the Canvas clickstream data reveals that students became much more engaged on Canvas after the transition. After the transition, they spent more time on their study sessions on Canvas and increased their number of sessions per week, which resulted in shorter intervals between study sessions. Moreover, these changes clearly deviate from the pattern of students' learning behavior in earlier years before the pandemic and from the pattern in the next quartile after the transition. From our analyses, we could not find strong evidence for large differences in this increase in engagement between different groups of students. What we found was that students who felt lonelier than other students after the transition increased their session time a bit more. All students seem to have increased their online engagement at least to some extent. Lastly, we found that the amount of change in online engagement predicted final exam grades and course grades, with change in the number of sessions as the strongest single predictor (albeit quite weak also).

Conclusion and future work

We conclude that the corona transition in Q3 had remarkable effects on student learning in our department. These effects are very diverse, and this diversity can only be detected through the combination of survey data *and* Learning Analytics. On the one hand, from the students' point of view, for many students, it decreased aspects of the quality of their learning experience. This is in line with what other studies have found. On the other hand, the transition has stimulated students' online learning engagement on Canvas. Whereas usually students' online learning engagement deteriorates over the course of a course, in Q3 students increased their online engagement very much. This is in line with the very few studies that made use of Learning Analytics to assess the educational consequences of the pandemic. Remarkably, there is evidence indicating that there are beneficial effects of these changes in online learning engagement on students' learning outcomes (exam and course grades), although these are not large.

We understand the lack of differences between different types of students in their learning adjustment in the following way. It seems that the transition forced students into a kind of 'straitjacket' for three weeks preceding the exam period. They had to continue online to be able to pass the upcoming exam. Any effects of differences in students' learning motivation or educational goals may take a longer period to take effect. The somewhat small effect sizes of the changes in online engagement on grades may be a result of the grading through teachers who may have been more lenient in the difficult transition period. However, since there is other evidence indicating that an increase in students' online engagement also had effects on grades that were generated automatically (Gonzales et al, 2020), we feel that our results may underestimate the beneficial educational outcomes of the change in online engagement for our students.

For TU/e, an important learning point is that the exclusive reliance on self-reported student data may allow us to detect only "half of the story." Survey data and Learning Analytics combined reveal more and correct an otherwise one-sided view of the educational consequences of the corona transition.

This is the first report of this project that made use of the Canvas Learning Analytics data in order to shed more light on the effects of the corona transition and emergency remote teaching on student learning. We will publish two more reports that demonstrate the usefulness of Learning Analytics to gain insights about students' learning in the mid-term of the corona transition (Q1 of the academic year 2020/2021) and the long term (Q2 of the academic year 2020/2021).

References

Conijn, R., & Van Zaanen, M. (2017, June). Trends in student behavior in online courses. In *3rd International Conference on Higher Education Advances* (pp. 649-657).

Gonzalez, T., de la Rubia, M. A., Hincz, K. P., Comas-Lopez, M., Subirats, L., Fort, S., & Sacha, G. M. (2020). Influence of COVID-19 confinement on students' performance in higher education. *PLOS ONE*, *15*(10), e0239490. https://doi.org/10.1371/journal.pone.0239490

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Computers in Human Behavior*, *119*, 106713. https://doi.org/https://doi.org/10.1016/j.chb.2021.106713

Matzat, U., Kleingeld, P. A. M., Snijders, C. C., & Conijn, R. (2020). The Corona transition and student learning: What works, what doesn't work, and what needs improvement?. Report: 4 TU Center for Engineering Education. Online available: https://www.4tu.nl/.uc/f8199ae5c01030f2b00000f643302668f727851d3134e00/expressreport-1.pdf?whs-download=EXpressReport_1.pdf

Meeter, M., Bele, T., Hartogh, C. D., Bakker, T., de Vries, R. E., & Plak, S. (2020). *College students' motivation and study results after COVID-19 stay-at-home orders*. Vrije Universiteit Amsterdam.

Petillion, R. J., & McNeil, W. S. (2020). Student experiences of emergency remote teaching: Impacts of instructor practice on student learning, engagement, and well-being. *Journal of Chemical Education*, *97*(9), 2486–2493. https://doi.org/10.1021/ACS.JCHEMED.0C00733

Tulaskar, R., & Turunen, M. (2022). What students want? Experiences, challenges, and engagement during Emergency Remote Learning amidst COVID-19 crisis. *Education and Information Technologies*, *27*(1), 551–587. https://doi.org/10.1007/S10639-021-10747-1/FIGURES/5