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THE IMPACT OF TEACHING FORMAT IN A HYBRID COURSE ON OFF-TASK ACTIVITY ENGAGEMENT AND LEARNING PERFORMANCE

Travail de fin d'étude en vue de l'obtention du Diplôme en Enseignement Supérieur et Technologie de l'Education

Sous la direction de Dorothée Ayer

Andreas SONDEREGGER & Carli OCHS
Département de Psychologie / Université de Fribourg
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Je déclare sur mon honneur que mon travail de fin d'étude est une œuvre personnelle, composée sans concours extérieur non autorisé.

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1. Project description (Description du projet)

1.1 Context

The idea for the following project came to us during the covid 19 pandemic. We are both researchers interested in how technology use is perceived and impacts humans. During the pandemic, technology was massively used in many contexts to continue with functional life, even if social distances had to be maintained.

In this context, our work as researchers and teachers was also affected. Teaching first only took place online and then in a hybrid format. The hybrid format meant students could choose to come to class or follow the on-site class online. This allowed to both satisfy students' social need to come to university and guarantee other students' safety by letting them follow the class online from home. In addition, in many contexts, classes could not welcome all students due to strict distance regulations. Therefore, in certain classes students were given a rotation schedule of when they were allowed to come to class or not.

Overall, in this context, we worried about the quality of our classes. We were concerned that online students were disadvantaged compared to on-site students. Teaching online students and on-site students simultaneously was more complicated than doing only one or the other. Because we could see the on-site students and not the online students, it was easy to forget about thelatter. Which might mean that if online students faced technical difficulties, we might not notice right away. In addition, in case of interaction with the on-site students, it could happen that teachers, us included, would forget to repeat the questions and answers of the on-site students so that online students could hear them.

In addition to all these concerns regarding the differed experience between online and on-site students, we

were concerned about the risks to online students' distractibility. Prior to the pandemic, we had already examined the impact of digital off-task activities during class and discovered that only external interruptions, such as notifications, had a significant impact on learning (Ochs & Sonderegger, 2021). We were concerned, however, that the differences between online and on-site students' experiences, such as reduced teacher contact and technical issues, as well as the absence of social pressure and a potentially more distracting environment for online students, could lead to more serious learning issues. Therefore, for our final didactic project, we decided to conduct a research project comparing the effects of off-task activities on learning in online and on-site teaching in the context of a hybrid class.

1.2 Prior research on the impact of off-task activities on learning

Research has shown that students' attention may fluctuate during a lesson (Risko et al., 2012; Wammes & Smilek, 2017) and that reduced attention may be associated with reduced learning performance (Altmann et al., 2014; Anshari et al., 2017; Winter et al., 2010). This link has been established for various forms of attentional disengagement, such as mind wandering and engagement in digital as well as non-digital off-task activities (Aellig et al., 2009; Junco, 2012; Wammes et al., 2016).

Mind wandering can be defined as “a situation in which executive control shifts away from a primary task to the processing of personal goals” (Smallwood & Schooler, 2006, p. 946). Mind wandering has been shown to be prevalent in teaching and learning situations (Pachai et al., 2016; Schooler et al., 2004; Szpunar et al., 2013; Unsworth et al., 2012). Various studies adopting different methodological approaches (e.g., using probes of attention in recorded video lectures or live courses, self-reports, diary studies etc.) have shown that the occurrence of mind wandering is negatively linked to academic performance (e.g., Randall et al., 2014; Risko et al., 2012; Unsworth et al., 2012; Wammes et al., 2016; Wammes & Smilek, 2017). Interestingly, however, more recent work has indicated that the negative effect of mind wandering on

learning outcomes is less important compared to other indicators of attentional disengagement, such as engagement in digital off-task activities (Wammes et al., 2019).

Research on engagement in digital off-task activities (also referred to as multimedia multitasking) has primarily focused on different forms of digital off-task activities (Junco, 2012; May & Elder, 2018; Parry & le Roux, 2019). More specifically, research has focused on computer use in the classroom, (e.g., Aaron & Lipton, 2018; Ravizza et al., 2017; Sana et al., 2013), smartphone use in the classroom (Anshari et al., 2017; Bjornsen & Archer, 2015; Chen & Yan, 2016; Dietz & Henrich, 2014; Gingerich & Lineweaver, 2014; Kuznekoff et al., 2015; Mendoza et al., 2018), or the use of specific content such as social media (Barton et al., 2021; Junco & Cotten, 2012; Karpinski et al., 2013; Rosen et al., 2013; Wood et al., 2012). Additionally, research has also specifically looked at the impact of notifications on students' off-task activities and learning (Graben et al., 2022; Ochs & Sonderegger, 2021). Overall, empirical evidence mostly suggests that students regularly engage in digital off-task activities and that this negatively affects their learning (Aaron & Lipton, 2018; Bjornsen & Archer, 2015; Kuznekoff et al., 2015; Sana et al., 2013; Wammes et al., 2019).

While digital off-task activities in the classroom have been studied quite intensely in the past, there has been a relative lack of research on the link between non-digital off-task activities and learning (Blasiman et al., 2018). One non-digital off-task activity that has received some attention is doodling. Doodling is defined as absentmindedly drawing symbols, designs, figures, and patterns that are unrelated to the primary task (e.g., listening to the lecture). Results on doodling and learning performance have been mixed. Doodling has been shown to positively influence the retention of information in an auditory task (Andrade, 2010; Nayar & Koul, 2019; Tadayon & Afhami, 2017) but to negatively influence retention and learning in visual tasks (Aellig et al., 2009; Chan, 2012).

Interestingly, there is only little empirical research addressing the consequence of other types of non-digital off-task activities. This could be related to the fact that the range of such activities is very broad and diverse. Moreover, many such non-digital off-task activities are only possible in the context of online learning, as they cannot be practiced in the traditional classroom environment (e.g., ironing clothes, cleaning, cooking, performing yoga exercises). This last type of attentional disengagement might be particularly relevant in hybrid lessons as online students have a wider variability of potential non-digital off-task activities they could engage in (e.g., cleaning or taking a walk). In this regard, one experimental lab study addressing the effect of doing laundry while following a recorded online lecture has indicated negative consequences on learning (Blasiman et al., 2018).

Concerning hybrid teaching, previous research on attentional disengagement in hybrid classes and their effect on performance is scarce, and researchers have called for further research in this field (Schacter & Szpunar, 2015; Wammes & Smilek, 2017). One previous study investigating the link between attentional disengagement and learning in the hybrid context focused specifically on the impact of mind wandering on learning performance between students having followed a class live on-site as compared to watching a video recording of that class (Wammes & Smilek, 2017). While results of that study indicated a decrease of mind wandering over time in the on-site class condition, mind wandering increased over time in the video lecture condition. However, regarding the assessment of learning, however, the results are inconclusive, with non-significant higher learning scores for the video-lecture as compared to the on-site class. This, the authors reasoned, might have to do with the sterile conditions the students were in when they watched the class (e.g., in a lab with no access to their phone or computer). Therefore, in contrast to natural conditions, students in the classroom were exposed to more potential distractors, such as digital

distractions, compared to students that watched the class online. This may have confounded the results, as digital distractions also lead to attentional disengagement and have been linked to lower learning performance (Bjornsen & Archer, 2015; Mendoza et al., 2018).

In summary, mind wandering as well as engagement in digital and non-digital off-task activities serve as important indicators of students' attentional disengagement and can interfere with their learning performance. Furthermore, as described in the previous section, online students may be more prone to distractions due to various factors, such as the distractibility of their learning environment and the lack of social control. However, the empirical evidence comparing different forms of attentional disengagement (digital and non-digital off-task activities) in on-site and online classes while assessing their impact on learning performance is very scarce. Consequently, we aim to fill this research gap by investigating the relationship between hybrid teaching and learning performance mediated by students' engagement in digital and non-digital off-task activities.

2. Project implementation (Mise en œuvre du projet)

To conduct research on the impact of off-task activities across both formats of hybrid teaching, we decided to conduct a quasi-experimental field study. Specifically, we assessed the digital and non-digital activities of students as well as their learning performance in classes that were taught in hybrid form (i.e., students following the same class either on-site in a lecture theatre or online in a location of their choice).

Based on our review of the literature, we put forward the following hypotheses (a depiction of our proposed model can be found in figure 1):

H1: Teaching Mode is associated with time spent on digital off-task activities. Specifically, we expect students who participate online to spend more time on digital off-task activities than students who participate on-site.

H2: Teaching Mode is associated with time spent on non-digital off-task activities. Specifically, we expect students who participate online to spend more time on non-digital off-task activities than students who participate on-site.

H3: Time spent on digital off-task activities mediates the relationship between teaching mode and learning score, such that online students spend more time on digital off-task activities, which, in turn, leads to a decreased learning score.

H4: Time spent on non-digital off-task activities mediates the relationship between teaching mode and learning score, such that online students spend more time on non-digital off-task activities, which, in turn, leads to a decreased learning score.

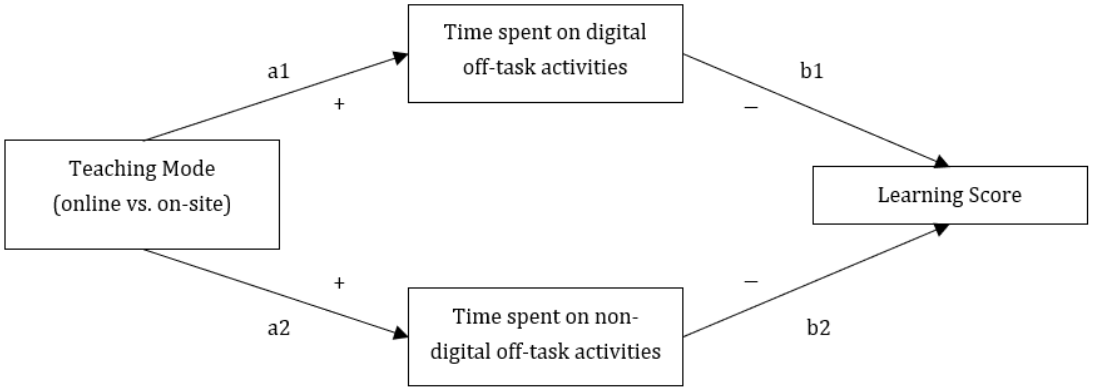

Figure 1. Proposed Conceptual Model

2.1 Participants

We collected 690 responses to our survey (556 participants identified themselves as female, 129 as male, and 5 as other). The ages of participants ranged between 18 and 64 (M=21.46; SD= 4.42). Participants were recruited at the end of six different magistral lectures of psychology courses (i.e., introduction to work and organizational psychology (N= 47), clinical psychology (N=107), introduction to developmental psychology (N=161), introduction to cognitive psychology (N=188), research methods (N=142), diagnostical tests (N=45)) held in hybrid teaching mode by six different teachers. We aimed to recruit as many participants as possible during these courses. For each course some participants (total N=436) were following a class on-site, and some participants (total N=254) were following the class online. The choice whether to participate online or on-site was at the student's discretion.

Observations of two independent raters indicated that the lectures did not differ considerably with regard to number of questions asked by the teacher (M=7.33, SD=6.57), online student interactions (M=.33, SD= .82), on-site student interactions (M=7.33, SD=5.49), technical problems (M=.25, SD=.61) and break duration (M=10.83, SD=5.15).

2.2 Self-report measures

2.2.1 Questions regarding digital off-task activities

Participants were asked a series of questions about their computer and smartphone use during the lecture. These questions can be found in Table 1. Second-order questions (e.g., 1a. How many notifications/messages did you receive on your computer during this lecture?) were only presented if participants answered yes to the first-order question (e.g., 1. Did you use your computer during this lecture?). Items 2.a, and 3.c left enough space to report up to 5 activities.

Table 1: Questions regarding participants' digital off-task activities during the lecture

Computer use		
1.	Did you use your computer during this lecture?	Yes*/No
1.a	How many notifications/messages did you receive on your computer during this lecture?	
2.	Have you used your computer for activities other than those related to today's lecture?	Yes*/No
2.a	Which off-task activities did you do on your computer? Indicate the different activities and the estimated time you spent on doing them. Activity: _____ Estimated time: _____	
Smartphone use		
3.	Did you use your smartphone during this lecture?	Yes*/No
3.a	How many times did you pick up your smartphone or clicked the Main/Home button?	
3.b	How many notifications did you receive during this lecture?	
3.c	Which off-task activities did you do on your smartphone? Indicate the different activities and the estimated time you spent on doing them. Activity: _____ Estimated time: _____	

2.2.2 Questions regarding non-digital off-task activities.

Participants were asked if they engaged in any off-task activity that was not performed on a digital device. If they did engage in such activities, they were asked to list the activities and estimate how much time they spent on each separate activity (cf. Table 2).

Table 2: Questions regarding participants' non-digital off-task activities during the lecture

1.	Apart from the activities you have done on your digital devices, have you done any other activities that are not related to the course?	Yes*/No
1.a	Indicate the different activities and the estimated time you spent on doing them.	
	Activity: _____	Estimated time: _____

2.2.3 Context variables.

To get a better understanding for the physical and mental context of participants, participants were asked to rate their experience on a series of items on a 7-point Likert scale (1 = totally disagree, 7 = totally agree) measuring their motivation (*During the class I felt motivated*), boredom (*During the class I felt bored.*), fatigue (*During the class I felt tired*) as well as how engaged they perceived their teacher (*The teacher kept the subject interesting*.) and how distracting they rated their environment (*During this class my environment was distracting*.).

2.2.4 Learning score.

Six multiple-choice questions on the content of the specific topic of the class were asked to assess students' learning scores. For each question, four answer options were provided, of which either one or two were correct. An example of a question can be found in Table 3. The learning score was based on the number of correctly responded answer options, with 24 being the highest attainable score (6 questions x 4 answer options = 24).

Table 3: Exam example question

1) Short term memory holds information for

a)	5 to 10 seconds
b)	10 to 15 seconds
c)	15 to 20 seconds
d)	20 o 25 seconds

2.3 Observations

To collect objective data, an observation grid was created (Figure 2). It is made up of general information about the course, but also information specific to the course taking place at the time of the data collection. The grid is completed by two observers who are part of the research team and who attend the course to collect the various items of information. Beforehand, the entire research team agreed on how to fill in the grid so that the data collected would be as objective as possible. This is also why the observations are collected twice, independently, for each course.

GENERAL:	EN LIGNE:	PRESENCE:
Nom salle	*Problème Teams :*	*Entrée / sortie étudiants*
Horaire	Interruption son	< 10 min de cours
Nom prof	Interruptions écran	Reste du cours
Mode d'enseignement	*Interactions*	*Son*
Caméra du prof	Questions étudiants	Objets
	Check-in prof	
Capacité salle	Réponses étudiant	*Interactions*
Nombre étudiants salle		Questions étudiants
Nombre étudiants Teams	Cours enregistré ?	Répétitions (pour en ligne)
Nombre inscrit cours		Réponses étudiant
Pause		Guetteur ?
Temps (HH:MM - HH:MM)		
Durée		
Interactions		
Questions prof		
Activités + Type + Durée		

Figure 2: Observation Grid

2.4 Procedure

We implemented the exact same procedure for the six classes from which we recruited participants. Before each class, lecturers were contacted and asked for permission to perform recruitment in their class. Once they had agreed, we collaborated with them to create six exam questions on the course material for the upcoming class session. In each class, two researchers attended the course both online and on-site. Researchers sat at the back of the classroom and connected to the digital collaboration platform used to

stream the class online (Microsoft Teams), where they listened with one earphone to the online class. With the other ear, they listened to the on-site class. This allowed them to code for aspects such as interactions on-site (questions from students) as well as interactions online (e.g., in chat) or issues with connections or lag.

The classes ended approximately 15 minutes before the scheduled time. The two researchers came to the front of the class and asked students to participate in the study. Students were told that the survey was on the effects of teaching mode (online/ on-site) on their learning. As incentives, participants were told that there would be a quiz on course material that might help them to prepare for the end-of-term exam, and participants were also rewarded points toward course credits. Great emphasis was given (orally and in written form on the first page of the survey) to the anonymous nature of the study and it was stressed that students should answer as honestly as possible. After the participants had confirmed their informed consent, they answered the questionnaire and responded to the quiz on the course material.

2.5 Qualitative data analysis

Participants' responses regarding their digital and non-digital off-task activities were analyzed using inductive coding. Eleven categories were identified for digital off-task activities, and eleven were identified for non-digital off-task activities. Activities were then coded into their respective categories by two coders. The inter-rater reliability was estimated using Cohen's kappa and showed to be satisfactory for digital off-task activities (k=.93.5) as well as for non-digital off-task activities (k=.97). The few differences in coding were then solved through discussion.

2.6 Quantitative data analysis

We performed a single-level mediated linear regression analysis via the R package lavaan (Rosseel, 2012) to probe our hypotheses. Arguably, we could have also estimated a multilevel model with students nested in

classrooms. However, as stated by Gelman and Hill (2006), multilevel modeling adds little to no benefits when the number of higher-order units is small.

Preceding the analysis, we checked for potential violations of relevant inference assumptions. We performed visual inspections of residuals. Our inspections did not reveal any apparent violations of the linearity assumption. However, residuals were non-normally distributed, thus violating the homoscedasticity assumption. We hence based our inference on bootstrapped confidence intervals (1.000 bootstrapped samples) to ensure robust estimation.

Lastly, because different tests were employed to measure learning scores per class, we centered students' learning scores around the respective class mean. Thereby, we effectively controlled for differences between classes in students' learning scores.

2.7 Results

2.7.1 Off-task activities

Table 4 reveals that a higher proportion of online students engaged in non-digital and digital activities compared to students that joined the class on-site. On average, online students also spent more time engaging in these activities.

Table 4. Summary of students' overall off-task activity engagement

	Online (N=254)		On-site (N=436)		Total (N=690)	
	% of students that engaged in	Avg. time in min. (SD) on	% of students that engaged in	Avg time in min. (SD) on	% of students that engaged in	Avg time in min. (SD) on

Non-digital activities	46.06%	9.17 (12.4)	27.29%	6.62 (13.5)	34.20%	7.88 (12.98)
Digital activities	77.56%	16.21 (17.72)	64.91%	13.52 (19.98)	69.57%	14.61 (19.02)

Percentages were calculated based on the total number of participants in the respective groups. Avg. time was calculated based on the time spent by students who engaged in the respective off-task activity. Thus, students who spent zero minutes on the respective off-task activity were dropped from this part of the analysis.

Table 5. Detailed summary of students' non-digital and digital off-task activities.

	Total (N=690)		Online (N=254)		On-site (N=436)	
	% of mentions	Avg time of use in min. (SD)	% of mentions	Avg time of use in min. (SD)	% of mentions	Avg time of use in min. (SD)
Non-digital activities						
Eating and drinking	35.56%	3.41 (3.48)	30.31%	4.64 (4.06)	17.89%	2.2 (2.25)
Other	4.49%	12.69 (19.23)	8.66%	8.7 (10.01)	2.06%	22.43 (31.19)
Social interactions	4.2%	5.97 (5.53)	5.12%	6.08 (4.52)	3.66%	5.88 (6.38)
Drawing	2.75%	11.18 (13.95)	3.54%	13.94 (19.52)	2.29%	8.7 (5.98)
Daydreaming	2.17%	8.13 (5.33)	2.76%	8.71 (4.46)	1.83%	7.62 (6.25)
Selfcare	2.03%	3.44 (1.68)	3.54%	4.83 (4.81)	1.15%	.82 (.74)
Organizing/ planning	1.74%	4.92 (5.5)	2.36%	8.25 (6.27)	1.38%	1.58 (.66)
Cleaning	1.3%	5.39 (6.01)	3.15%	6 (6.12)	0.23%	0.5
Cat care	1.16%	3.44 (1.68)	3.15%	3.44 (1.68)	-	-
Writing and reading	0.72%	39 (33.43)	1.18%	18.33 (23.09)	0.46%	70 (14.14)
Bathroom	0.72%	2.8 (1.3)	1.97%	2.8 (1.3)	-	-
Digital activities						
Instant messaging	57.1%	6.79 (7.66)	64.17%	6.75 (6.11)	52.98%	6.82 (8.6)
Social media	19.42%	6.96 (6.82)	29.52%	7.57 (7.04)	13.53%	6.19 (6.5)
E-mail	13.48%	3.66 (3.73)	14.96%	4.21 (4.87)	12.61%	3.28 (2.65)
Other	10.29%	7.69 (12.17)	10.63%	5.96 (7.76)	10.09%	8.75 (14.2)
Activities other class	4.78%	26.29 (21.68)	3.94%	30 (19.72)	5.27%	24.67 (22.7)
Internet searches	4.9%	6.71 (8.96)	5.52%	7.04 (11.33)	4.36%	6.47 (7.17)
Organization	4.49%	6.59 (12.01)	4.72%	4.33 (4.72)	4.36%	8.01 (14.88)

Games	3%	15.98 (14.82)	6.3%	16.66 (15.15)	3.21%	15.21 (14.96)
Online shopping	2.75%	9.05 (6.54)	3.54%	6.89 (6.25)	2.29%	11 (6.48)
News	2.46%	7.69 (12.17)	1.57%	7 (3.56)	2.98%	5.56 (5.26)
Video	1.59%	10.59 (8.84)	4.33%	10.59 (8.84)	-	-

Percentage where calculated based on the total number of participants in the concerned groups.

2.7.2 Hypotheses testing

Table 6 shows the means, standard deviations, intra-class coefficients and intercorrelations of the study variables. All hypotheses were tested by means of a single level mediated linear regression model. Table 8 displays the results of this analysis.

Table 6. Means, Standard Deviations, Intra-class coefficients and Correlations Among Study Variables

	Variable	M	SD	ICC	1	2	3	4
1	Teaching Mode[a]				-			
2	Time[b] on digital off-task activities	10.16	17.23	.19	.11*	-		
3	Time[b] on non-digital off-task activities	2.70	8.45	.00	.14**	.04	-	
4	Learning Scores	18.21	2.42	.11	-.06	-.14**	-.02	-

Note. N = 690,[a] Coding of Teaching Mode: 0 = on-site; 1 = online, [b] time is indicated in minutes, * p < .05. ** p < 0.01.

2.7.3 Test of direct effects.

We proposed a direct association between teaching mode and time spent on digital (H1) and non-digital (H2) off-task activities by students in hybrid classrooms. In line with H1, data analysis (see Table 7) revealed that teaching mode was associated with time spent on digital off-task activities, with students who participated online spending more time on digital off-task activities than students who participated on-site (*a1* = 3.77, *95%* CI [1.22; 6.61]). Hypothesis 1 was thus supported. In line with H2, teaching mode was associated with time spent on non-digital off-task activities, with students who participated online spending more time on non-digital off-task activities than students who participated on-site (*a2* = 2.42, *95%* CI [1.05; 2.83]). Hypothesis 2 was thus supported.

2.7.4 Test of indirect effects.

We further assumed time spent on digital (H3) and non-digital (H4) off-task activities to mediate the relationship between teaching mode and learning scores. Our results revealed an indirect effect of teaching mode via time spent on digital off-task activities on learning scores (*a1b1* = -.05, *95%* CI [-0.10; -0.01]). Hypothesis 3 was thus supported. However, our results did not reveal an indirect effect of teaching mode via

time spent on non-digital off-task activities on learning scores (*a2b2* = -.02, *95%* CI [-0.08; 0.02]). Hypothesis 4 was thus not supported.

Table 7. Summary of direct and indirect effects

Effect	beta estimate	95% CI for beta estimate	Beta estimate
Direct effects			
Teaching Mode[a] → Time[b] on digital off-task activities (a1)	3.77	[1.22; 6.61]	0.11
Teaching Mode[a] → Time[b] on non-digital off-task activities (a2)	2.42	[1.05; 3.83]	0.14
Time[b] on digital off-task activities → learning success (b1)	-0.01	[-0.02; -0.01]	-0.10
Time[b] on non-digital off-task activities → learning success (b2)	-0.01	[-0.03; 0.01]	-0.03
Indirect effects			
Teaching Mode[a] → Time[b] on digital off-task activities → Learning Scores (a1b1)	-0.05	[-0.10; -0.01]	-0.01
Teaching Mode[a] → Time[b] on non-digital off-task activities → Learning Scores (a1b1)	-0.02	[-0.08; 0.02]	0.00

Note. N = 690 students. Learning scores were centered around the respective class mean. R^2 = .02 for student learning success.

[a] 0 = on-site; 1 = online. [b] time is indicated in minutes.

2.7.5 Analysis of context variables

The analysis of the context variables revealed very small, non-significant differences between online and on-site ratings of student motivation, experienced boredom and fatigue as well as the evaluation of the teacher's engagement (see Table 8). The environment however was rated as more distracting by students taking the class online compared to students participating on-site (see Table 8).

Table 8. Comparison of control variables as a function of teaching mode

	Online (N=254)		On-site (N=436)					
	M	SD	M	SD	t_{Welch}	df	*p*	*d*

Motivation	4.7	1.4	4.9	1.4	-1.54	537	.123	-0.12
Boredom	3.1	1.5	2.9	1.5	1.74	527	.082	0.14
Fatigue	4.1	1.8	4.1	1.9	0.05	533	.961	0.00
Teacher engagement	6.4	0.9	6.4	1.0	0.83	563	.404	0.07
Distracting environment	3.6	1.9	2.9	1.6	4.66	453	< .001	0.38

2.7.6 Analysis regarding number of interactions

In terms of interaction between teachers and students during the various courses, we can see first of all that there is more or less interaction depending on the course (and hence depending on the lecturer). In addition, there was more interaction with students in the classroom than with those taking the course online. Furthermore, we see that there is very little repetition of the questions and answers given in the classroom so that the students taking the online course can hear them (Table 9).

Table 9 : Number of interactions with students online and on site.

	Questions from lecturer	Online questions from students	In presence questions from students	Online answers from students	In presence answer from students	Repetition for online students
Course 1	4	0	4	0	1	1
Course 2	19	1	1	1	12	4
Course 3	10	0	3	0	6	0
Course 4	9	0	9	0	7	0
Course 5	3	0	0	0	0	0
Course 6	0	0	2	0	0	0

2.8 Results Discussion

As predicted, we found that students following a class online spend more time on digital and non-digital off-task activities than on-site students. Engagement in digital off-task activities mediated a detrimental effect of online teaching mode on learning. Notably, we did not find evidence for engagement in non-digital off-task activities as a mediator between teaching mode and learning.

The arguments made in the introduction are supported by the findings about the effects of teaching mode on off-task activity engagement. The descriptive data revealed that online students did not only engage in more off-task activities overall, but they also engaged in these activities for a longer duration compared to on-site students. Interestingly, some of the off-task activities were exclusively carried out by online students. This

might be because some activities can only be carried out at home (e.g., cat care) while others might be considered inappropriate to be carried out in class (e.g., watching a video). These examples indicate that online students might be confronted with more potential distractors (e.g., a cat) and might feel less restricted to engage in certain behaviours (e.g., watching a video) due to a lack of social control. This pattern of results indicates that despite the important advantages of hybrid teaching (e.g., increased accessibility of teaching), online students are a particularly vulnerable population within this setting: They report a higher degree of distractibility that is linked with an increased engagement in off-task activities, which showed a negative links with learning in the case of digital off-task activities.

Regarding the effect of off-task activities on learning, data analysis revealed a negative direct link between digital off-task activities and learning but not for non-digital off-task activities. The question arises why students' engagement in non-digital off-task activities did not show the same negative effects as the engagement in digital off-task activities. This might be related to the nature of the activities students engaged in. Most of the reported non-digital activities are manual tasks (e.g., eating and drinking, drawing), while digital activities mainly require verbal and visual resources (e.g., writing text messages and reading). Listening to a class and learning are tasks that require verbal resources (Blasiman et al., 2018). According to Wickens' multiple resource theory (Wickens, 2008), individuals can engage concurrently in tasks that require different cognitive resources, such as verbal and manual resources, without negative consequences on task performance. In contrast, concurrent engagement in tasks that require similar resources has been linked to reduced task performance. In the context of learning, such effects have been shown already in research on doodling, where positive effects of absentminded drawing (a task requiring some visual resources) on learning were reported for auditory tasks (Andrade, 2010; Nayar & Koul, 2019; Tadayon & Afhami, 2017), while negative effects were observed for visual tasks (Aellig et al., 2009; Chan, 2012). Although some of the reported non-digital off-task activities in this study required verbal resources (e.g., social interactions or writing and reading), these were less often mentioned than non-digital off-task activities requiring manual resources. In comparison, reported digital activities drew heavily on students' verbal and visual resources, interfering with the resources needed to follow the class.

Overall, our study has several important implications for research and practice. First, we showed that engagement in off-task activities is a pervasive phenomenon in hybrid classes, particularly among online students. This result underscores the importance of creating interactive and engaging lessons so that students remain focused on the class content and do not feel inclined to engage in off-task activities. Since online students are more vulnerable to distraction, this population needs to be made aware that they should choose a distraction-free environment for following online courses. In this context, social control from fellow students might play an additional role. Following classes remotely in smaller groups could be an interesting solution to create desirable conditions for online learning. Second, this study also revealed a negative effect of digital off-task activities on learning performance. Therefore, it is important to consider potential measures such as making students aware of the negative consequences of partaking in off-task activities as well as suggesting rules of conduct regarding digital devices during class. Third, concerning non-digital off-task activities, a negative effect on learning was not found as, most likely, most activities did not interfere with the resources required for learning. However, for future research it might be interesting to conduct a more fine-grained analysis of the specific off-task activities. Lastly, while literature on how to conduct good hybrid teaching was available, it was not used in the examined classes. This suggests a gap between practice and research and should stimulate reflection on how to effectively communicate this knowledge to practitioners.

3. Personal reflexion (Réflexion personelle)

While teaching, we regularly asked ourselves what our students were doing with their computers and mobile phones during the course. When we launched this research project, we aimed to gather detailed information on this, and we wanted to investigate how these activities would affect students' learning.

We were expecting students to participate in various off-task activities, but we were genuinely taken aback by the quantity, diversity, and nature of the activities. Astonishingly more than two thirds of students participated in off-task activities during class. Our results clearly demonstrate that off-task activities were exceedingly prevalent to the extent that it appears unavoidable for students to engage in them. In this regard, these off-task activities may closely resemble instances of mind-wandering, as they are bound to occur at some point during the class due to limited attention spans. While this is true, the fact that online students engaged in more off-task activities does speak for the fact that there are elements that could disfavor or favor the engagement

in off-task activity. This led us to wonder how we could adapt our teaching to address this issue (see section 3.1. below).

With regard to the nature of off-task activities, we were quite astonished at the wide range of different activities that students reported doing during the lessons. For example, it came as a surprise that many students were working on assignments for other courses while attending our class. This seemed counterintuitive, as we had assumed that their off-task activities would be unrelated to coursework. Another unexpected example was students practicing yoga during the class. While we did anticipate online participants to be more mobile during off-task moments than their in-person counterparts, engaging in sports activities was more extreme than we had expected. More in line with our expectations was the high rate of social interactions (e.g., chat or e-mail messages) that students engaged in during class. This seems to correspond to a general trend in society: to always have technological devices (e.g., mobile phones) at hand and to be online continuously. This can lead to phenomena such as pubbing (phone-snubbing), a topic that has been explored by our research team addressing negative consequences of technology use in social life (Ochs et al., 2023; Ochs & Sauer, 2022). Interestingly, the data in this TFE has shown that not every off-task activity has a negative impact on learning. Here, the negative impact of digital activities is particularly important to highlight, while apparently non-digital activities are less detrimental to learning. These insights should thus be taken into account and be taught to students (see section 3.2. Learnings for students below).

However, the data from this TFE have also revealed general issues with hybrid teaching. Observational data from the six different courses have shown that most teachers rarely meet the specific challenges and requirements of hybrid teaching and show a teaching style that is rather unfavourable for students participating the class online. This casts doubt on the usefulness of this form of teaching and shows the need to train lecturers to successfully facilitate student learning in such demanding learning environments (see chapter 3.3).

3.1 Lessons for our own teaching

3.1.1 Lessons s for on-site teaching

This study heavily reminded us of the fact that students cannot follow a lecture with concentration for more than 90 minutes – this is why it is normal for them to engage in off-task activities. A student's attention span is between 10 and 15 minutes (Bradbury, 2016; Wammes et al., 2019; Wilson & Korn, 2007) – we should be aware of this as lecturers. This means for our teaching that we have to make it as *interactive and varied* as possible so that students stay activated and actively follow the lesson (see also Bradbury, 2016). Our didactic training has shown various tools and exercises that can be used in this sense. For example, we can use MOODLE to create surveys, questionnaires, wikies or hot questions but also other platforms such as Menti or Cahoot. Another example of an activity that we have newly introduced in our teaching to activate students during class is a 3-minute summary after each topic block. Students are asked to summarise online on Padlet the most important aspects of the topic just discussed in the form of text or memes. This not only serves to activate the students but also helps them to reflect on and recapitulate the content discussed, which is extremely helpful for successful learning (see Figure 3 from a course example). Overall, we want to integrate more of these activating and interactive methods into our teaching in the future, so that students feel as little urge as possible to carry out off-task activities due to their reduced attention span.

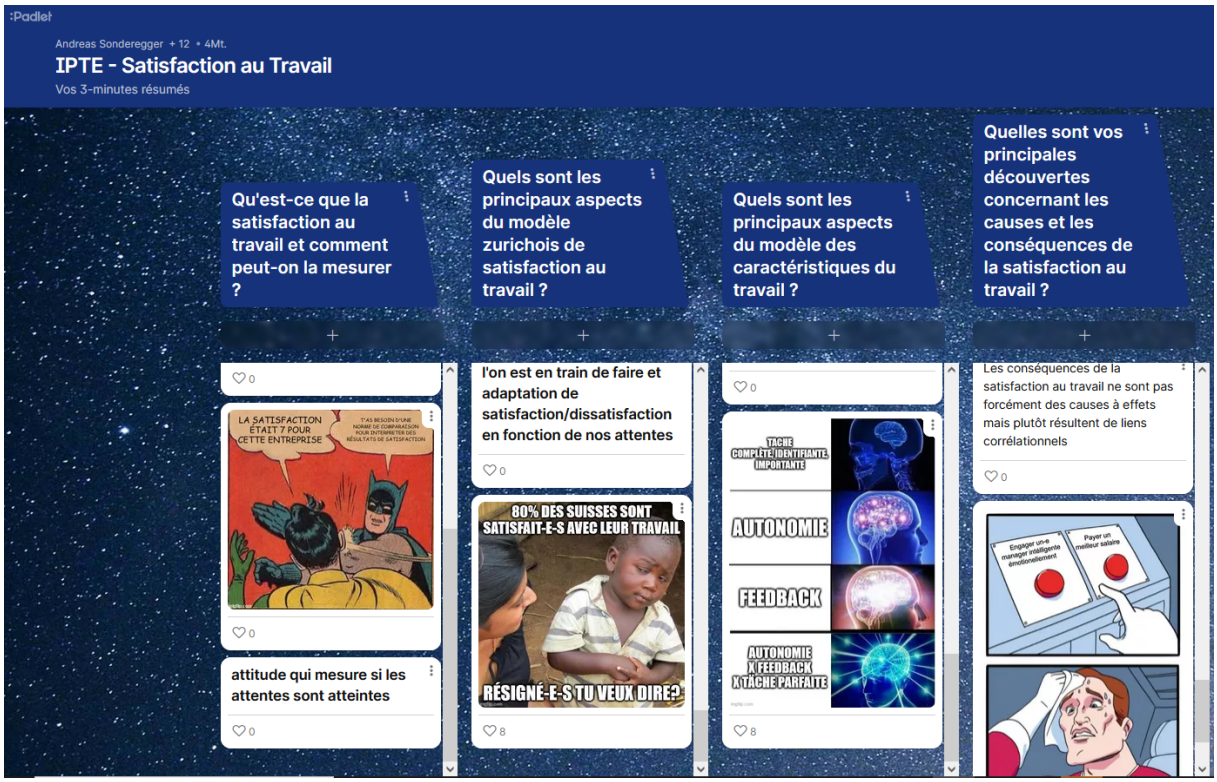

Figure 3: Screenshot of a three-minutes summary of a class on job satisfaction.

The results of this study have shown that digital off-task activities have a negative impact on learning. In addition, our previous study revealed that off-task activities initiated by notifications in particular have a negative impact on learning. These findings are important and should be *communicated to students*. Therefore, in our teaching, we have started to briefly refer to these studies at the beginning of each semester in the first class and to discuss with the students what could be derived from their findings. Student actions suggested such discussions included:

- Taking handwritten notes and not working directly on the computer screen
- Turning off notifications on laptop (email, Facebook, Instagram, etc.) as well as on phone
- Leaving phone and laptop stored away
- Doodling (or other physical activity) when attention is fading instead of checking messages or chatting with fellow students

In the future, we want to continue this exchange with the students, collect the measures mentioned by the students and present them at the end of each class discussion. Over time, this will provide a comprehensive

collection of measures that can be taken in order to avoid engaging in off-task activities that are detrimental to learning. Finally, it is also possible to ask students to leave their laptops and mobile devices in their bag, which might have a positive impact on their learning according to our findings (see also Mueller & Oppenheimer, 2014 who report similar findings) .

3.1.2 Lessons for online and hybrid teaching

The COVID pandemic disrupted our lives and work pretty badly for a rather extended period of time. We wore masks, were only allowed restrictedly to buy our groceries, restaurants, cinemas and bars were closed, we were no longer allowed to go to work or school. In the context of university teaching, this led to courses at first only being offered online via video conference systems or as downloadable podcasts. Later, when contact in reduced form became possible again, courses were held in hybrid form. These changes for our teaching arrived at very short notice and unexpectedly. As lecturers, our preparation for this new situation was very limited - for example, neither of us, authors of this TFE, attended (or was able to attend) any specific courses in our pre-COVID pandemic didactic training in which we would have been prepared for the specific challenges of hybrid teaching. And the observational data from this study show that most of the lecturers who participated in this study were not prepared for this form of teaching either. The online students were systematically neglected by most of the six lecturers: the online students did not ask questions, did not give answers, and the questions asked in class were rarely repeated for the online students. This suggests that not only we personally were not prepared for hybrid teaching, but that this seems to be the case for a considerably large part of the teaching staff (it is worth mentioning in this context that a large proportion of the participating lecturers were senior full professors with a very extensive teaching experience). It is therefore extremely important that these findings (as well as findings from other studies) find their way into the training of teaching staff so that online and hybrid teaching is better designed in the future. This can be done through fact sheets and course material for experienced lecturers (in the sense of a training opportunity which should be mandatory for senior staff) - but should also be integrated into basic training - and hence be part of the did@ctic training at the University of Fribourg

Hybrid teaching can be improved by implementing a few key measures (Bower et al., 2015; Ørngreen et al., 2015; Raes et al., 2020). First and foremost, regularly integrating online students into class discussions is

crucial. We can foster a more inclusive and engaging learning environment by actively encouraging their participation and ensuring their voices are heard. In this regard, adequate technological equipment of lecture rooms (i.e. Meeting Owl from Owl Labs), which allows online students to see and hear their fellow students in the classroom, can facilitate the integration of online students in hybrid classes. Additionally, leveraging the chat function to interact with online students in real-time can facilitate seamless communication, enabling them to ask questions, share insights, and feel connected with their peers and the instructor. Furthermore, repeating questions from in-person students in the lecture hall is a minimum requirement to ensure that online students can follow and comprehend the class discussions and participate in them. This practice helps bridging the gap between physical and virtual learners, ensuring that no one is left behind in the learning process. Additionally, incorporating online quizzes and interactive tools can generate a dynamic and engaging learning experience for all students. These tools can foster active participation, instant feedback, and deeper understanding of the course material, regardless of the learning mode.

As it can be quite challenging for a single lecturer to implement all these aspects, it could be useful to engage a teaching assistant monitoring the chat and making sure that principles such as not forgetting to repeat questions are not forgotten. Personally, at the beginning of each course, we ask a student to observe the online chat function and interrupt us if something important happens online we are missing out. This person is also responsible to remind us in case we do not communicate well enough with our online audience (e.g., we forget to repeat a question asked by a student on-site). In our experience, this has proven to be extremely useful and is very cost-effective and efficient. In this regard, however, it is important to explore in the future to what extent this role as online responsible has a negative impact on the person's learning. If this role is associated with negative consequences, it is recommended that the same person is not assigned this task in every lesson.

This TFE also provides indications as to why online students are more likely to indulge in off-task activities. This could be related to the reduced social control and disruptive influences in the environment. In this respect, it is extremely important for future hybrid teaching that *students are informed and trained* (see section 3.2.) about the consequences of the different forms of learning *at the beginning of each hybrid or online course*, so that they can create ideal environmental conditions for themselves, which - also in the online environment - have a positive effect on their learning.

3.2 Lessons for students

The results of this TFE are extremely relevant for academic teaching and have led to fundamental adjustments in our own teaching behaviour. However, the results are also interesting for the students themselves, as not all aspects of student learning can be influenced by well-designed teaching (e.g., the environmental conditions at home during online teaching).

The results of this study confirm existing knowledge in research that the learning environment can have an important role in attention and learning (Johnson & Liber, 2008; Lizzio et al., 2002). Therefore, it is important to convey the findings to students and make them aware of the relevance of the topic. Based on the findings of our study, a short guidebook or guidelines for first semester students could be written, in which advice is given on the ideal design of the individual learning environment, with reference to the scientific results of this study, among others.

Such a guide should address the issue of reduced attention span and explain to students that it is normal not to be able to listen actively after a certain time, but that it is crucial what the student does in such a case. Based on our research results, it would be advisable in such a case to carry out manual activities as much as possible (e.g. doodling), but certainly not to indulge in (online) communication, or even watching videos or engaging in other online activities.

Another interesting finding is the negative consequences of notifications on learning (shown by Ochs & Sonderegger, 2021). Here, it is important to make students aware of the importance of preventing notifications during lessons and to ensure that they can follow the lessons as undisturbed as possible. In order to prevent the potential urge of electronic distraction as completely as possible, it would also be worth considering taking part in the course without a computer, tablet or smartphone and taking notes on paper. If these were to be transferred to the computer afterwards, this would have the additional positive effect of repeating the content, which should generally be conducive to learning.

Similar to notifications, the physical learning environment can also have a negative impact on attention and learning. In this regard, the study in this TFE has shown that online students engage in more off-task activities than on-site students. This can be explained by two aspects: On the one hand, the positive social control in the on-site context and the potentially distracting environmental conditions of online students. This results in the following recommendations that could be given to students: 1.) create an ideal learning environment when following courses online. This means avoiding distracting stimuli as much as possible (quiet, secluded room, suppressing notifications - see above, etc.), and 2.) due to the relevance of social control, following online courses together with fellow students would also be worth considering. Following the agreement not to have private, interrupting conversations and to concentrate fully on the course could have a similar function (social control) on the students as attending the course on-site. An example of positive effects of such a study group can be found in our research group. Although not for learning but for writing, we meet as a team once a week in a room reserved for this purpose and each person individually works on their writing projects. As a rule, we have agreed that we will not write any e-mails or pursue other activities during this time but will work exclusively on our academic writing projects. We discuss and offer each other social support during the breaks. This has proven to be an extremely successful model for our team. We could well imagine that a similar organisation for students of online courses could have a positive impact on their attention and learning as well. Learning in a digital (remote) environment is a real challenge for students and they need to be prepared for this. This issue has been spotted by different universities in Switzerland already, which led to guides and tutorials which are supposed to help students to better cope with these difficulties and challenges (e.g., Salamin, n.d.)

Based on the results of this study, we were able to derive various adjustments to our teaching as well as possibilities for guidelines for students in order to counteract the negative consequences of following hybrid classes online. However, this study also revealed basic problems of hybrid teaching, which we would like to address in the following chapter.

3.3 About hybrid teaching

When reflecting upon our research, it is important to remember the context it was conducted in. We investigated hybrid teaching that was used as an emergency measure during the COVID-19 pandemic. As a

consequence, neither students nor us as lecturers were adequately prepared for this teaching format. For students this might mean that they did not have the infrastructure necessary (e.g., quiet space, good internet connection) and did not know how to organise their learning environment in such a teaching format (e.g., switching off notifications on mobile phone and computer). For most lecturers this meant that we were not trained in hybrid teaching. Most of us just shared our screen and turned on our camera for the online students without implementing any other changes. While these findings our highly contextual we think they are also very important. Prior to the pandemic, online and hybrid teaching were niche forms of teaching. Now, most teachers and students have experience with such teaching format. However, their experience relies on this rather ill prepared version of hybrid teaching that was so widespread during the pandemic. We believe that there is a risk that due to this widespread use and its simplicity (just switching on zoom), universities and teachers will continue to use such formats without investing some time in optimize their courses in a manner that reduces any potential disadvantaged for online students.

second, as we argued in the introduction, now that teachers and institutions have discovered how simple it is to live stream a class, they might do this more frequently without investing any further into the potential pitfalls of this format.

3.4 Limitations and future research

Despite the numerous insights this study provided, it comes with certain limitations. Many of them (most of methodological nature) have been presented in section 2.8 and are not repeated here. From a didactic point of view, obvious shortcomings are that only six lecturers have been evaluated and that the lectures all were psychology bachelor courses with often more than 150 participating students. It is obvious that interactive teaching is challenging in such large classes. Hence, it would be highly interesting to know whether for other teachers of other subjects (e.g., didactics, engineering, medicine etc.) in other course formats (e.g., seminar, workshop) the observations regarding lecturer-student interactions or students' off-task activities would be similar to the findings we presented in this TFE.

These are important aspects which make a generalisation of our results impossible. Nevertheless, our own experiences in other subject areas have shown that the form of university teaching does not differ too much between subjects. Therefore, we assume that similar results would also be found in other subject areas with

similar class sizes. However, this is probably less the case with regard to the differences in the course format. We assume that in seminars and workshops, the interaction with the students is generally more pronounced and intensive - and therefore the results regarding off-task activities would also be different. Additional research efforts are needed here to gain a better insight into student behaviour in such course formats. Fortunately, we have returned to teaching on-site - and we hope that we will not get the opportunity to pursue this research question in the context of hybrid teaching again very soon!

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