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Tension between Digital Distance and Physical Presence in Hybrid Teaching: Evidence from Two Natural Experiments During the COVID-19 Pandemic in a French Business School

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Abstract

The advent of digitization has promised learning paradigms based on digital communication and virtual reality at the expense of physical presence. During the COVID-19 health emergency, the tension between digital distance and physical presence evolved from competing alternatives to a more nuanced coexistence. Several organizations resorted to hybrid arrangements; hybrid teaching is a notable example. In this paper, we draw from the theory of planned behavior to theorize the effect of physical presence on learning outcomes in the context of hybrid teaching. We differentiate between individual and team learning outcomes. We predict that physical presence induces competition and has a negative effect on individual learning outcomes. For team learning outcomes, we predict that physical presence induces cooperation and has a positive impact. We exploit two natural experiments in a French business school during the fall semester of 2020. The school's administration allocated students to subgroups randomly for fairness reasons. This context offered a natural within-subjects experiment, where every student was randomly assigned to either in-person or online lectures. Students had up to 4.9% lower likelihood of correctly answering exam questions for lectures they followed in person rather than online. However, in group-work assignments, teams with one more student following in person tended to see a 3.6% increase in their team evaluation. Digital distance, therefore, constitutes a barrier to learning in a hybrid setting only when tasks are evaluated on a team basis.

Keywords: *Digital distance*; *Physical presence*; *COVID-19*; *Hybrid teaching*; *Learning outcomes*

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Digitization has long promised a rupture in how learning takes place. Digital communications and virtual reality technologies have become pervasive in all organizations, from education to the workplace and private life. One of the most promising and notable aspects of digitization has been the introduction of the distance learning model (Alavi et al., 1997; Redpath, 2012; Webster & Hackley, 1997); this form of learning implies the introduction of digital distance at the expense of physical presence to achieve learning outcomes.

The existing literature puts emphasis on the adverse effects of (physical) distance on desired learning outcomes in work and social environments (Glaeser, 1999; Griffith et al., 2003; Podolny & Page, 1998; Purvanova, 2014; Razmerita et al., 2020; Storper & Venables, 2004; Szulanski, 1996). Other studies highlight how the negative relationship between proximity, communication quality, and knowledge transfer may depend on the context and the desired outcomes of a learning process (Mesmer-Magnus et al., 2011; Trope & Liberman, 2010). All in all, the results on the tension between distance and physical presence are inconclusive concerning learning outcomes (Buhl-Wiggers et al., 2022).

This tension evolved during the COVID-19 health emergency. The sudden spread of the virus in 2020 forced virtually all organizations to limit social interactions and adopt digital communication tools (Gibson, 2020; Porcher & Renault, 2021). Most workforces began working from home, with video conferencing substituting for in-person meetings and new workplaces being arranged in domestic environments. Even after

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the pandemic has reached its peak, certain limitations have persisted, and organizations have been left to deal with the challenge of establishing procedures to manage limited access to office space. Conferences and other social events have shifted from purely in-person to exclusively online and then hybrid forms, with physical presence co-existing with digital distance. For example, the 82nd Annual Meeting of the Academy of Management featured distance and in-person attendance. Consequently, the conversation about digital distance and physical presence has evolved from seeing these as competing alternatives to seeing the possibilities of their more nuanced coexistence.

Higher education institutions are the organizations for whom the issue of how to manage such interactions is most salient (Jemine et al., 2022). At the beginning of the COVID-19 pandemic (between March and June 2020 in many European countries), higher education institutions swiftly moved from teaching in the physical presence of students to purely online teaching supported by digital platforms (Carugati et al., 2020). Starting from the fall semester of 2020, these institutions faced the dual challenge of guaranteeing both a safe environment and a complete learning experience for their students. In many countries, schools and institutions of higher education resorted to hybrid teaching. In hybrid teaching, learners receive the same content synchronously, but those who are in the classroom experience physical presence, and those who are online are exposed to digital distance. In this paper, we ask the following research question: what is the effect of physical presence on learning outcomes in hybrid contexts?

To answer our research question, we borrow from the learning literature and consider our question through the lens of the theory of planned behavior (Ahmadi & Vogel, 2022; Baden, 2014). We propose that different learning outcomes change the effect of physical presence on normative and control beliefs and, therefore, on the level of learner engagement. Individual learning outcomes are abstract and independent from interactions. For learners, physical presence may imply a normative pressure of competition and a lack of autonomy, thus reducing their level of engagement (Chatzisarantis et al., 2008; Denham, 2014; Purvanova, 2014). Team-based learning outcomes are, by contrast, applied and based on interactions. As such, physical presence may facilitate cooperation and the perception of autonomy, thus increasing the level of learner engagement (Gunawardena, 1995; Purvanova, 2014). We develop a nuanced theory in terms of which the direction of the relationship between physical presence and learning in hybrid contexts depends on the type of learning outcome: physical presence has a negative effect on individual learning outcomes and a positive effect on team-based learning outcomes.

To test our theory, we exploit two natural experiments in a French business school during the fall semester of 2020. We evaluate the causal effect of physical presence on learning outcomes for up to one third of students of the undergraduate program enrolled in three management courses. The first semester of the 2020–2021 academic year began with students in a section divided into two subgroups. Both groups alternated between days of in-person and online classes to comply with reduced classroom capacity limits. The school's administration allocated students to subgroups randomly for reasons of fairness. This context offered a natural within-subjects experiment since every student had to alternate their mode of lecture attendance based on the letter of their surname.

In the first natural experiment, we compare individual learning outcomes. At the end of the semester, we measured learning outcomes using answers to a multiple-choice question (MCQ) final exam that all students took online using a digital platform. Each student answered questions for the entire course, which included the lectures where they were in class and those where they attended online. This setting allows us to test whether students performed better answering questions for lectures attended in person than they did if they were online. By looking at within-student differences, we can thus rigorously test the difference between digital distance and physical presence in a hybrid context for predicting individual learning outcomes.

In the second natural experiment, we compare team learning outcomes. In one of the three courses, students were required to work in teams, and team membership was orthogonal to subgroup membership. As a result, each team of five students comprised a random mix of in-person and online students, ranging from a minimum of one in-person student (and four online) to a maximum of four in-person students (and one online). This setting allows us to test whether teams performed better when more students were physically present or when more were online. Looking at within-team differences allows us to rigorously test whether digital distance or physical presence is superior for team learning outcomes in a hybrid context.

Our results offer support to our hypotheses and show that in hybrid contexts, there is a complex relationship between physical presence and digital distance. Students who followed lectures in person rather than online were 4.9% less likely to correctly answer the exam questions. On the contrary, the results suggest that digital distance harms teamwork. The second natural experiment shows that for every extra student following in person, there is a 3.6% increase in the team's assignment grade. Rather than acting as a barrier, digital distance seems to be an enabler of individual learning outcomes in a hybrid setting when no interaction is required by the assignment. By contrast, digital distance seems to constitute a barrier to learning outcomes in a hybrid setting when the work requires interaction and learning outcomes are evaluated on a team basis.

Our study offers two main contributions. First, we contribute to the learning literature by showing that there is no one-size-fits-all arrangement for hybrid teaching. The appropriate model depends on the nature of the learning outcome and the type of content being dealt with face-to-face (Buhl-Wiggers et al., 2022). Second, we contribute to the management literature in general. We show the value of identifying natural experiments in the organizational environment and leveraging existing data to rigorously test and validate managerial intuition. Deliberate experiments may be costly and unaffordable for organizations under conditions of uncertainty and time pressure (Agrawal et al., 2019). Natural experiments generated by exogenous decisions under uncertainty may be identified and exploited by organizations to evaluate the effectiveness of their intuitions.

Theoretical background

Hybrid teaching: Bodily presence and digital distance

In our paper, we define hybrid teaching as a style of teaching and learning that delivers the same content to learners in class and online synchronously using hybrid classroom tools such as learning management systems and video conferencing, and where physical presence and digital distance exist synchronously for the same content.[1] Hybrid classrooms incorporate live-streamed video of in-person class activities that allow a two-way conversation, integrating remote and in-person students in a singular environment.

Whereas the existing literature has yet to devote attention to hybrid teaching and learning outcomes, numerous studies have separately analyzed the pros and cons of physical presence and digital distance. The established literature states a negative relationship in work and social environments between (physical) distance and desired outcomes, such as social bonding, knowledge sharing, and learning (Griffith et al., 2003; Podolny & Page, 1998; Purvanova, 2014; Storper & Venables, 2004; Szulanski, 1996). The main explanation proposed for this negative relationship is the association between proximity and communication quality. Compared to virtual relations, face-to-face encounters contribute to the creation of shared contexts and trust among participants and, therefore, facilitate in-depth and immediate feedback, thereby increasing the level of engagement (Kraut et al., 2002; Trefalt, 2013).

However, studies have also found that (digital) distance can be beneficial when learners have to engage with abstract knowledge because it allows them 'to see the forest rather than individual trees' (Trope & Liberman, 2010, p. 8). Abstract knowledge requires participants' attention and cognitive engagement. Distance enables these conditions to be met by reducing the influence of group members and the associated evaluation apprehension (Siegel et al., 1986). Research also shows that virtual tools may allow better communication than physical presence by providing less redundant and more focused information (Mesmer-Magnus et al., 2011). With digital distance, the learner enjoys more autonomy and freedom in deciding the level of cognitive attention and engagement to dedicate to the activity.

In the context of hybrid teaching, physical presence and digital distance co-exist, and learners typically experience both. On the one hand, learners may benefit from a better communication context resulting from the increased trust and intimacy they experience when physically present; on the other hand, learners may benefit from autonomy when they experience digital distance.

Digital distance in hybrid teaching: Individual learning outcomes

Learning outcomes depend on learners' cognitive engagement, a personal investment that is directed to learning (Fredricks et al., 2019). Scholars in psychology have shown that engaged learners remember better, recall for longer, and can achieve stronger conceptual change (Johnson & Sinatra, 2013; Loaiza & Lavilla, 2021). To assess the influence of digital distance and physical presence on learning outcomes, we apply the lens of the theory of planned behavior (Ajzen, 1985). This theory posits that specific action depends on the individual's intention. In our context, this intention takes the form of cognitive engagement. According to the theory of planned behavior, intentions rely on behavioral, normative, and control beliefs. We evaluate how each of these beliefs affects the relationship between digital distance and physical presence and learning outcomes.

First, behavioral beliefs refer to an individual's perception of the usefulness of the learning content and stem from the individual's traits and characteristics. Impacting the engagement decision via behavioral beliefs is therefore contingent on an individual's intrinsic interest. These beliefs are independent of the learning environment, and they should play only a marginal role in our explanation.

Second, normative beliefs refer to an individual's subjective feeling about the expectations of others regarding behaviors and conformity to social standards. Such feelings may generate a perception of social pressure that inhibits engagement (Ajzen, 1991; Hrubes et al., 2001). We argue that the learning environment, particularly the physical presence of others, may affect learners' normative beliefs (Siegel et al., 1986).

[1] Hybrid teaching differs from the notion of blended learning (Bonk & Graham, 2005). In blended learning, instructors use different media to deliver different content. In hybrid teaching, instructors use different media to deliver the same content.

Third, control beliefs refer to the feeling that a successful outcome is attributable to the learner's sense of autonomy (Ajzen, 2002; Bandura, 1982). Control beliefs – more than the actual exercise of control – are associated with a natural drive to control and to perceived autonomy (Leotti et al., 2010). We argue that the learning environment may also influence the intention to engage in learning activities via control beliefs.

When the context exposes learners to normative pressure from peers and affects their perception of autonomy, they are expected to decrease their cognitive engagement and produce inferior learning outcomes. In considering the influence of context on learning outcomes, we distinguish between individual and team-level outcomes.

Tasks with individual learning outcomes are performed independently of other students and are based on abstract knowledge. Abstract knowledge stated in explicit form tends to be more schematic and prototypical but also more precise and coherent than applied and context-specific knowledge (Cohen et al., 2010). We define individual learning as an approach requiring the student to pay attention to the lecture, take notes, make sense of new information, and recollect concepts to answer exam questions correctly at a later stage.

When outcomes are individual and no interaction is required, as in the case of individual learning, physical presence may generate an unfavorable learning environment. For instance, colleagues working in the same space on similar but independent tasks may find physical presence facilitates comparison between peers and stimulates competition. Learners are all learning the same abstract content, and they are 'competing' for who learns it better. Physical presence also restricts the alternative actions in which the learner may engage to facilitate their learning; this may affect the learner's control beliefs as they perceive that outcomes are less dependent on their choice than when they are not physically present. In this context, physical presence may reduce the intention to engage in learning activities and generates the pressure of normative beliefs – what to do – and control beliefs – how to do it (Wilson & Stacey, 2004).

Under digital distance, the social pressure of normative beliefs eases, and there is an increase in the perception of autonomy as a result of control beliefs. In particular, distance and perceived distance tend to increase the learner's disposition to learn abstract and declarative knowledge (Isaacson & Fujita, 2006; Liberman & Trope, 1998; Trope & Liberman, 2010). Learners under digital distance face fewer competitive pressures as the teacher and their peers are less likely to notice them. They perceive they have more control over their learning pace as they have more autonomy in what they do when engaging with the content. Based on this understanding, we predict that physical presence could bring a drawback in a hybrid context where digital distance and bodily presence co-exist. Hence, we hypothesize the following:

Hypothesis 1: *In a hybrid setting, digital distance will have a positive impact on students' outcomes when no interaction is required and learning outcomes are evaluated on an individual basis.*

Digital distance in hybrid teaching: Team outcomes

According to Hypothesis 1, we propose that when the learning outcome is individual – builds on abstract knowledge, and requires little or no interaction – digital distance is more useful than physical presence in hybrid settings because it alleviates normative beliefs about competition and strengthens control beliefs concerning perceived autonomy. In this section, we identify the conditions of team-based learning outcomes, which build on applying knowledge and require interaction among members.

We further suggest that the influence of physical presence is not necessarily detrimental to team-based outcomes. Past studies have highlighted how the influence of distance on learning is dependent on the frequency of interactions (Cramton et al., 2007; Hinds & Mortensen, 2005) and that physical presence is beneficial when the learning outcomes require more frequent interactions (Cramton et al., 2007; Hinds & Mortensen, 2005). Physical presence allows personalized communication, collective observation, and practice that stimulates participative engagement (Szulanski et al., 2016).

We argue that physical presence reinforces control beliefs when the learning outcome is team-based. When learning depends on the co-creation of meaning among team members in an uncertain context, physical presence triggers positive emotional energy that enhances enthusiasm and focused effort, facilitating problem-solving (Christensen & Foss, 2021; Owens et al., 2020). Educational scholars confirm the importance of collaborative and social learning in collective meaning-making environments (Greeno, 1998; Rogoff et al., 1995; Wenger & Snyder, 2000): physical presence fosters the learner's perception of autonomy and control beliefs that support team-based learning outcomes (Assinder, 1991; Holliday & Li, 2004; Loh & Ang, 2020).

For team-based learning outcomes, physical presence also reduces the feeling of social pressure because it elicits normative beliefs supporting cooperation rather than competition. During group work, a teacher listens, guides, and encourages learners. Learners actively discuss the content, analyze each other's contributions, and propose collective solutions. More than social pressure due to expectations about competition, physical presence entails collective engagement between learners and their teachers. Such collective engagement fosters a sense of belonging, mitigates feelings of social pressure, and increases trust. Physical presence thus facilitates the experience of collective engagement, which elicits normative beliefs about cooperation and increases learning intentions.

Because the physical presence of team members facilitates cooperation, digital distance may be detrimental. Interactions over digital distance tend to be less synchronous, and teams tend to share information less openly (Mesmer-Magnus et al., 2011). Consequently, it takes more time to develop trust in teams with digital distance than in those that enjoy physical presence (Kanawattanachai & Yoo, 2007). Hence, we hypothesize the following:

Hypothesis 2: *In a hybrid setting, digital distance has a negative impact on group outcomes when interaction is required and learning outcomes are evaluated on a team basis.*

Research design

Empirical setting and data

The setting is the management concentration of an undergraduate program at a top-10 business school in France. The concentration included 159 students registered in one or more of three courses: Fundamentals of Management, Essentials of Project Management, and Organizational Behavior (Table A1 in the appendix reports a summary of the three courses). The Fundamentals of Management course had two sections of 42 and 41 students. The Essentials of Project Management course had two sections of 33 and 32 students. Organizational Behavior had one section of 21 students.[2] The courses lasted from mid-September 2020 until early December 2020 and consisted of 12 lectures each. Among these courses, a total of six Fundamentals of Management, five Essentials of Project Management, and seven Organizational Behavior courses were run using a hybrid teaching format.[3] All courses were taught in English.

The lectures lasted 180 min and usually involved two modules of 90 min, one involved teaching abstract knowledge about the topic, the other involved students applying such knowledge to a business case. For instance, Fundamentals of Management was structured as follows. In the first module, the teacher explained the lecture topic to students. In the second module, students worked in teams to apply their knowledge of the lecture topic to a business case. The first part allowed the evaluation of individual learning outcomes, while the second part allowed the evaluation of team learning outcomes.

The school's administration designed and implemented a hybrid format with two groups for each section – group A and group B. For each lecture of the course, the plan was to expose students to the same experience – the same content, same delivery, and same assignments – at the same time. However, only one group was in the classroom for the lecture; members of the other followed the lecture online through the Microsoft Teams platform. A camera and a microphone captured the video and audio that transmitted the content synchronously. Each classroom was provided with the same materials, and faculty were instructed not to alter these. Online students could ask questions either via the app's chat function or by intervening directly. At the end of each lecture, both online and in-person students had access to the recording on their e-learning portal.

During the first lecture, group A was physically present in class, and group B attended online. The two groups then alternated after each subsequent lecture; for instance, for the second lecture, group A was online, and group B was physically present in class; during the third lecture, group A was again physically present, and group B online. The student office randomly assigned students according to their surnames at the start of each course. For instance, students in one section of Fundamentals of Management with surnames *A* to *K* were assigned to group A, and students with surnames from *L* to *Z* were assigned to group B.[4] A total of 11 students took all the courses online for geographical or personal reasons. For Fundamentals of Management, Essentials of Project Management, and Organizational Behavior, the number of students following the course entirely online was six, four, and two, respectively. Table 1 reports the structure of the hybrid teaching template adopted by the school.

Selected classes were scheduled to be fully online and took place entirely online before the second lockdown was imposed. For Fundamentals of Management, one lecture was fully online for one section only (lecture 1), and one lecture was fully online for both sections (lecture 5). For Essentials of Project Management, no lecture was fully online for any section. For Organizational Behavior, one lecture was fully online for the only section (lecture 2).

All students completed a closed-book final exam in the second half of December 2020. The final exam included 40 MCQs for Fundamentals of Management, 23 for Essentials of

2. Among them, two students took Fundamentals of Management and Organizational Behavior, four students took Organizational Behavior and Essentials of Project Management, three students took Fundamentals of Management and Essentials of Project Management.

3. By the end of October 2020, the French Government had imposed a second lockdown, moving all remaining lectures online for everyone.

4. We performed a randomization check to determine whether there were systematic differences between groups along the dimensions of exam performance (*correct*), time to answer a question (*duration*), gender, age, GPA, whether they were a French national (*French*), and if they were from the department where the school is located (*local*). Importantly, there were no systematic differences in exam performance (and duration) between groups A and B. We identified a small systematic difference in GPA for Essentials of Project Management (2.45 vs. 2.77), as well as the share of locals among the class members (0.10 vs. 0.64). We address this imbalance as a potential driver of our results in two ways. First, in additional specifications, we add controls for the imbalanced variables. Second, we add a control for the course that captures potential imbalances in the group allocations. Our results are robust to the inclusion of these additional controls.

Table 1. Template structure of hybrid teaching as adopted in the study

Lecture		1	2	3	4	5	6
Section 1	Group A	In person	Online	In person	Online	In person	Online
	Group B	Online	In person	Online	In person	Online	In person
	Online only	Online	Online	Online	Online	Online	Online

Project Management, and 20 for Organizational Behavior. The exam was administered through the TestWe platform, which allowed instructors to remotely monitor students with the assistance of a camera and automatic detection of anomalous behaviors.

This setting allowed for two natural experiments, which we used to test the relative effect of bodily presence and digital distance on two different learning outcomes: individual learning outcomes for hypothesis 1; team learning outcomes for hypothesis 2.

Variables description

Dependent variable

The *individual learning outcome* dummy is equal to one if the student responded correctly to an MCQ during the final exam. This variable is an established measure of individual learning outcomes (Garaus et al., 2016; Lee & Klein, 2002), and it is desirable in our setting for the following reasons. First, the exam evaluated student learning outcomes on an individual and independent basis. The answer was either right or wrong, without the confounding effects of relative performance evaluation. Second, compared to a quiz at the end of each lecture, the final exam offered a conservative measure of students' learning outcomes rather than a measure of short-term memory and attention. The exam measured outcomes at the end of the course in December, and students prepared on the basis that all topics were included. The exam was highly relevant for students because it accounted for up to 40% of the final grade. Finally, the focus on MCQs reduces the confounding factors of instructors' grading style and leniency, enabling a smoother comparison across the courses.

Team learning outcome measures the grade obtained by the group for the case discussion, consistent with the literature on team learning outcomes (Baldwin et al., 1997; Jiang et al., 2022; Schippers, 2014). In Fundamentals of Management, students were expected to work on a business case in teams for 90 min. The teams had to answer three case-related questions that required the application of the knowledge they were exposed to in the first half of the class. Their performance was evaluated with a grade from 0 to 100.

Independent variable

To analyze individual learning outcomes, we use an *in-person student* dummy that is equal to one if the focal student was physically present for the focal lecture and zero if the student attended online. For the team learning outcomes analysis, we use the *number of in-person students*, which is a count variable for the number of students physically present in the team for the focal lecture. The variable ranges from zero (the team is all online) to five (the team is entirely physically present).

Controls

Several individual and group factors – beyond the two independent variables – are likely to influence the individual and team outcomes. For the analysis of individual learning outcomes, we control for the following characteristics. *Online-only student* is a dummy variable equal to one for students that took the entire course online all the time for geographic or personal reasons (of which there were 11). Students' learning outcomes might be impacted by following the course entirely online. For Fundamentals of Management, Essentials of Project Management, and Organizational Behavior, the number of students following the course entirely online was six, four, and two, respectively.

Local student is a dummy that captures if the student is from the department where the school is located. France has a total of 101 departments; the business school that is the focus of this study is located in Alpes-Maritimes (6th department). We expect, for instance, that students who were far away from their families were more likely to feel isolated (particularly during a pandemic such as COVID-19), with potentially negative consequences for their learning outcomes. Overall, 36% of the students were from the department where the school is located.

Duration measures the time in seconds a student took to answer each question as recorded by the TestWe software. *Women* measures the gender of the student. *Age* measures the student's age. *GPA* captures the average grade for all the exams the student passed in the undergraduate program in which they were enrolled at the time of the exam. *French* is a dummy equal to one if the student is a French national. We further saturate our model with course, section, lecture, and question

fixed effects to rule out systematic differences based on courses, section composition, lecture content, and questions.

The second set of controls accounts for various group characteristics. *Share of women* measures the percentage of women in a team. *Share of locals* measures the percentage of students in the group from the department where the school is located. *Share of French nationals* measures the percentage of French students in the team. *Team average GPA* measures the average Grade Point Average (GPA) (on a total of 4.0, consistent with the US system) of the students comprising the team. *Team size* measures the number of students in the team. We further saturate our model with lecture fixed effects to control for the intrinsic difficulty of each case and the teacher's grading style for the focal lecture.

Methods

We test hypothesis 1 via a within-subjects natural experiment, thanks to the allocation of subjects to either group A or group B (by the first letter of their surnames) orthogonal to the explanatory variable (physical presence). For the lectures that followed a hybrid-teaching format before the lockdown, we can use the final exam to evaluate the within-student variation in learning outcomes based on the associated lecture having been attended in person or online. We estimate the probability of correctly answering MCQs using a linear probability model. We perform a robustness analysis using conditional logit to ensure that the results are not sensitive to the model specification. We estimate in-person interaction via a random-effects specification. We perform a Hausman test to evaluate the choice of the random-effects over the fixed-effects model; the results ($chi2(1) = 0.07$, $p = 0.790$) support the adoption of the random-effects specification. Our main model thus takes the following form:

$$q_{ijlk} = \alpha + \emptyset_{ilk} f\,2f_{ilk} + BX_i + \eta_i + \varepsilon_{jlk}$$

where q is an indicator variable that takes the value of 1 if student i provides a correct answer to MCQ j from lecture l in course k, and 0 otherwise. The constant α measures the baseline probability of each student answering the question correctly. Parameter $\emptyset$ measures the performance differential if student i followed lecture l in person rather than online. The vector of parameters B captures correlations that are student (gender, age, local, French, online only, GPA, and time spent on the question) and lecture (course, section, and group membership, lecture, and question) specific. Parameter η_i captures unobserved individual characteristics, and ε_{jlk} captures unobserved characteristics related to the lecture and the question. Standard errors are clustered at the student level.

To test hypothesis 2, we take advantage of another within-subjects natural experiment. During the Fundamentals of Management course, students were expected to work in teams on a business case for the second half of each class. Before the lockdown, students worked on cases in lectures 2, 3, 4, 6, and 7. Students worked on all cases in teams that were randomly assigned before the start of the course, and they had to discuss the case to produce a PowerPoint to be submitted up to 11 h after the class.

The team assignment was without stratification by subgroup because it occurred before the subgroup assignment. Teams comprised either four or five students. The team composition resulted in from one to four students being present in person. This setting allows us to estimate a model similar to study 1 but at the group level. We use a linear model and a random-effects specification, as suggested by a Hausman test ($chi2(1) = 0.00$, $p = 0.962$). Such a test validates the intuitive understanding of the natural experiment that there is no correlation between the unobservable and explanatory variables, a fundamental assumption of the random-effects model. For robustness and to ensure that the results were not sensitive to model selection, we tested for consistent results using the conditional Poisson model. The equation we estimate is as follows:

$$grade_{kl} = \alpha + \beta * f2f_{kl} + \lambda_l + \eta_k + \varepsilon_l$$

where $grade_{kl}$ is the grade of team k for the discussion of the case in lecture l. Parameter α is a constant, parameter β identifies the marginal effect of an additional student present in team k of lecture l, λ_l is a set of lecture fixed effects, η captures team-specific unobserved variation, and ε captures other lecture-specific unobservables. Standard errors are clustered at the team level.

Results

Individual learning outcomes

Table 2 reports the descriptive statistics for the students in the sample by course. We first analyze the answers to the exam. On average, students answered correctly 62% (Fundamentals of Management), 65% (Organizational Behavior), and 76% (Essentials of Project Management) of the time. Each question took, on average, 1 min and a half to answer, ranging from 93 s for Essentials of Project Management to 106 s for Organizational Behavior. In all samples, half of the students are women (51–55%), and the age of students is higher in Essentials of Project Management and Organizational Behavior because they are more specialized than Fundamentals of Management. French students comprise 62–71% of the student population, and one out of three students reside in the department where the business school is located.

In Tables 3 and 4, we report the results in respect of hypothesis 1. Table 3 reports raw mean differences for the

Table 2. Student demographics. Descriptive statistics

Variable	*N*	Mean	SD	Min	Max
Panel A: total sample					
Correct	159	70%	10%	56%	96%
Duration	159	98.54	45.49	21.26	259.78
Women	159	52%	50%	0%	100%
Age	156	21.25	1.25	19	27
GPA	159	2.60	0.45	1.87	3.61
French	159	67%	45%	0%	100%
Local	159	32%	47%	0%	100%
Online only	159	7%	25%	0%	100%
Panel B: Essentials of Project Management					
Correct	65	76%	10%	56%	96%
Duration	65	92.86	49.09	21.26	259.78
Women	65	55%	50%	0%	100%
Age	63	21.78	1.28	19	27
GPA	65	2.60	0.40	1.87	3.61
French	65	71%	46%	0%	100%
Local	65	36%	48%	0%	100%
Online only	65	6%	24%	0%	100%
Panel C: Fundamentals of Management					
Correct	83	62%	13%	30%	85%
Duration	83	101.16	38.36	21.93	197.13
Women	83	51%	50%	0%	100%
Age	83	20.72	0.93	19	24
GPA	83	2.59	0.51	1.39	3.94
French	83	63%	49%	0%	100%
Local	83	28%	45%	0%	100%
Online only	83	7%	26%	0%	100%
Panel D: Organizational Behavior					
Correct	21	65%	10%	35%	75%
Duration	21	105.80	58.7	23.2	234.9
Women	21	52%	51%	0%	100%
Age	19	21.84	1.21	20	25
GPA	21	2.65	0.40	1.87	3.46
French	21	62%	50%	0%	100%
Local	21	38%	50%	0%	100%
Online only	21	9%	29%	0%	100%

SD, Standard deviation; GPA, Grade point average.

Table 3. Mean differences

Hybrid teaching mode	Total	Management	Project management	Organizational behavior
In-person	0.689	0.636	0.754	0.582
	(0.450)	(0.467)	(0.431)	(0.497)
Online	0.719	0.680	0.766	0.650
	(0.463)	(0.481)	(0.424)	(0.480)
Difference	−0.030	−0.044	−0.011	−0.068
t-statistic	1.857	1.807	0.511	0.841

Table 4. Effect of bodily presence in hybrid teaching – Individual learning outcome

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	RE	RE	RE	RE	FE	RE	RE
	Baseline	Controls	Lecture FE	Question FE	Question FE	No online only	Syllabus topics
In-person student	−0.030*	−0.030+	−0.028+	−0.035*	−0.034*	−0.035*	−0.030*
	(0.015)	(0.017)	(0.017)	(0.015)	(0.023)	(0.015)	(0.015)
Online-only student		−0.024	−0.022	−0.024	Omitted	-	−0.026
		(0.037)	(0.039)	(0.038)		-	(0.040)
Local student		0.010	0.012	0.013	Omitted	0.014	0.012
		(0.022)	(0.023)	(0.023)		(0.023)	(0.023)
French national		−0.037+	−0.038	−0.039+	Omitted	−0.039+	−0.038
		(0.022)	(0.023)	(0.023)		(0.023)	(0.023)
Women		0.011	0.010	0.009	Omitted	0.012	0.013
		(0.019)	(0.018)	(0.018)		(0.018)	(0.019)
Age		−0.003	−0.003	−0.003	Omitted	−0.002	−0.002
		(0.004)	(0.003)	(0.003)		(0.003)	(0.003)
GPA		0.122***	0.125***	0.126***	Omitted	0.123***	0.120***
		(0.021)	(0.021)	(0.020)		(0.020)	(0.020)
Time to response		−0.063***	−0.041***	−0.021*	−0.041***	−0.022*	−0.062***
		(0.009)	(0.009)	(0.009)	(0.011)	(0.009)	(0.009)
Topic 1: organizations							−0.141***
							(0.040)
Topic 2: individuals							−0.110***
							(0.034)
Constant	0.716***	0.677***	0.593***	0.623***	0.963***	0.656***	0.785***
	(0.012)	(0.017)	(0.034)	(0.028)	(0.067)	(0.103)	(0.084)
Course FE	No	Yes	Yes	Yes	Yes	Yes	No
Lecture FE	No	No	Yes	No	No	No	No
Question FE	No	No	No	Yes	Yes	Yes	No
R^2	0.001	0.045	0.103	0.246	0.124	0.248	0.044

RE, Random effects; FE, Fixed effects; GPA, Grade point average.

Note: Student-clustered standard errors in parentheses. The dependent variable is the correct MCQ answer (the individual learning outcome). Course FE includes a full set of dummies for any combination of course (Fundamentals of Management, Essentials of Project Management, and Organizational Behavior), section, and subgroup (group A or B). Not all students responded to all MCQs because they took only a subset of the three exams in the fall 2020 semester. The sample in each column comprises 3,179 observations for 159 students and 43 questions. For column 5, the number of students is 148. *** $p<0.001$, ** $p<0.01$, * $p<0.05$, + $p<0.1$.

entire sample, as well as mean differences. Table 4 reports the results of this random-effects estimation. Model 1 of Table 4 first estimates parameter Ø with a random-effects model without controls as if it were an experiment. Students who were physically in class during lectures before the second lockdown were less likely to answer the question correctly, and the difference was statistically significant; the probability decreases by 3% from 71.6 to 68.6%, which corresponds to a penalty of 4.2% from the baseline. Model 2 in Table 4 estimates Ø including controls, and models 3 and 4 include lecture- and question-fixed effects, respectively. The penalty ranges from 2.8% (3.5% compared to the baseline) in model 3 in Table 4 and 3.5% (4.9% compared to the baseline) for model 4.

We perform three types of robustness checks to increase confidence in our results. First, we also report the results of a

fixed effects specification in model 5 of Table 4 to make sure that our results are not sensitive to the model choice. Second, we exclude students who were online for the entire course to prevent our results to be driven by students whose only lecture style was online in model 6 of Table 4. Third, we address a possible concern that course fixed effects do not capture the nuanced interdependences between courses. For this reason, we performed the Latent Dirichlet Allocation using the *ldagibbs* package in Stata software (Schwarz, 2018). We identified three topics: (1) content related to organizations, (2) content related to individuals, and (3) content related to projects. The output of topic modeling is the probability that the course belongs to each of the topics. We reported the topic probabilities by course as well as their interpretation in Table A2 of the appendix. We included the values of topics 1 and 2 in model 7.

All results from robustness checks do not change the sign and the size of the coefficient for in-person students, thus suggesting that results are not sensitive to the concerns illustrated above. Furthermore, we find consistent results when we replicate the main findings using conditional logit instead of linear regression, as set out in Table A3 of the appendix. In sum, we find consistent support for hypothesis 1.

We interpret the economic significance of our results. *Ceteris paribus*, if a student followed all the courses online, the expected number of correct answers would be 72 answers (out of 100);[5] if a student attended all courses in person the expected number of correct answers would be 68 (out of 100). For the hundred MCQ exam, a student following the course entirely in person would have missed four answers due to the mode of delivery. In the course Fundamentals of Management, such a difference could have an impact of up to 1.6 points in the final grade (MCQs account for up to 40% of the student's final grade).

Team learning outcomes

In Table 5, we report descriptive statistics for the team variables. The average grade – the team-based learning outcome – is 88 and ranges from 70 to 100. On average, 48% of team members are women, with groups ranging from all-male teams to teams with four women and one man. On average, French students account for 62% of team members, and 26% are from the department where the school is located. The average GPA is 2.59 out of 4.0. The average team size is about five students, with teams ranging from three to six members. The number of students physically present in class per team is 2.31.

Table 5. Team demographics. Descriptive statistics

Variable	*N*	Mean	SD	Min	Max
Grade	18	87.92	7.12	70	100
Share of women	18	48%	20%	0%	80%
Share of French nationals	18	62%	24%	20%	100%
Share of locals	18	26%	21%	0%	75%
Team average GPA	18	2.59	2.40	2.12	2.98
Team size	18	4.78	0.63	3	6
No. of in-person students	18	2.31	0.99	1	4

SD, standard deviation.

In Table 6, we test hypothesis 2 on the impact of physical presence on team learning outcomes in hybrid teaching. In model 1 of Table 6, we evaluate the effect of the physical presence of an additional student without controls as if it were an experiment. The baseline grade is approximately 80 out of 100. In this model, an additional in-person student in the team corresponds to a 2.87 point increase in the baseline grade, which is a 3.6% increase vis-à-vis the baseline. Model 2 in Table 6 is a random-effects model that controls team characteristics, such as gender, French nationals, locals, and GPA composition. Model 4 in Table 6 includes lecture fixed effects and also controls for team size. The effect remains stable between 2.9% (model 4) and 3.2% (model 3) in the random-effects regression with and without controls. In Table A4, we replicate the results using the conditional Poisson model and find results consistent with the main analysis. Overall, we find support for hypothesis 2.

We interpret the economic significance of the results. *Ceteris paribus*, if a team had all members online, the expected grade would be 81 out of 100;[6] if a team had all members in person, the expected grade would be 93 out of 100. A team composed of all online students would have missed 12 points per case due to the mode of delivery. Such a difference could result in an impact of up to 1.2 points (out of 100) of the final grade (case discussions accounted for up to 10% of the student's final grade).

Table 7 reports our predictions, explanations for our hypotheses, and notes the support for our hypotheses in the data. We found support for both hypotheses: physical presence has a negative effect on individual learning outcomes, and it has a positive effect on team learning outcomes.

[5] This is indeed the rate of correct answers for online-only students and it offers a reassuring validation. Someone skeptical of our results may argue that there are other unobserved explanations for the differences in learning outcomes when the lecture was attended in person and when it was online. If this were the case, we should observe a systematic difference between the expected probability of answering correctly for those students who alternated between online and in-person attendance and the expected probability of answering correctly for those students who only followed online. Our results suggest that there is no systematic difference between these two groups and do not support this alternative explanation.

[6] This is indeed the rate of correct answers for online-only students.

Discussion and conclusion

This study evaluates the impact on learning outcomes of physical presence as compared to digital distance in hybrid settings. The existing literature has been characterized by a marked divide between the proponents and opponents of digital distance learning. A hybrid model, which features two groups (one present and one distant) experiencing the same content, has emerged after the onset of the COVID-19 pandemic. Although this model has diffused rapidly, relatively little is known about it.

We evaluate this tension in the hybrid model in our consideration of the effectiveness of learning outcomes through the theory of planned behavior (Dodd et al., 2022) and formulate two hypotheses. First, we argue that physical presence affects learning outcomes negatively when the learning outcome is individual, independent, and based on abstract knowledge. This influence takes place through normative beliefs (more social pressure due to competition) and control beliefs (lack of autonomy). Second, we argue that physical presence affects learning outcomes positively when the learning outcome is team-based, interdependent, and based on applied knowledge, through normative beliefs (more trust due to cooperation) and control beliefs (self-efficacy). We test and find support for our hypotheses using two natural experiments that occurred in the undergraduate program of a business school in France. Table 7 summarizes our results.

The first of the study's two contributions is a more nuanced understanding of the relationship between physical presence and learning outcomes in hybrid teaching. Our findings suggest that the theories of physical presence and digital distance are not mutually exclusive in the hybrid teaching context. Rather, they are complementary, depending on the type of learning outcome in a hybrid setting.

For individual activities that do not require interaction and are based on abstract knowledge assessed by MCQs in a final exam, our results suggest that there is a negative relationship between physical presence and learning outcomes. For team-based activities that require frequent interaction and the application of knowledge, such as discussing a business case in a class, our results point to a positive relationship between physical presence and learning outcomes. Our paper is among the first to evaluate the tension between digital distance and physical presence in hybrid teaching (Buhl-Wiggers et al., 2022; Redpath, 2012) and takes account of the 'generative dance' between individual, abstract, and independent learning

Table 6. Effect of bodily presence in hybrid teaching – Team learning outcome

	(1)	(2)	(3)	(4)
	RE	RE	RE	RE
	Baseline	Student controls	Lecture FE	Size control
Share of women		4.518	6.638^{+}	0.402
		(3.742)	(3.976)	(5.494)
Share of locals		10.045***	14.304**	11.431*
		(3.006)	(4.518)	(4.794)
Share of French nationals		−4.100	−5.569	−5.307
		(4.956)	(4.250)	(3.284)
Team average GPA		−0.218	3.271	1.125
		(4.434)	(4.288)	(4.071)
Team size				2.747
				(1.696)
No. of in-person students	2.870^{+}	2.470^{+}	2.562*	2.334^{+}
	(1.520)	(1.413)	(1.250)	(1.219)
Constant	80.311***	79.600***	70.163***	66.561***
	(4.241)	(15.892)	(14.791)	(13.418)
Lecture FE	No	No	Yes	Yes
N	90	90	90	90
N Teams	18	18	18	18
N Cases	5	5	5	5
R^2	0.047	0.086	0.294	0.301

FE, Fixed effects; GPA, Grade point average.

Note: Team-clustered standard errors in parentheses. The unit of analysis is a team-oriented lecture. The dependent variable is team case grade (the team learning outcome). The sample comprises 90 observations concerning 18 teams and 5 case studies. *** $p<0.001$, ** $p<0.01$, * $p<0.05$, + $p<0.1$.

Table 7. Study summary

Hypotheses	Physical presence	Explanation	Supported
Hypothesis 1: individual learning outcome	−	Physical presence affects normative beliefs by increasing the feeling of competition and thus reducing the intention to learn. Physical presence affects control beliefs by decreasing the feeling of autonomy and thus decreasing the intention to learn.	Yes
Hypothesis 2: team learning outcome	+	Physical presence affects normative beliefs by increasing the feeling of cooperation and thus increasing the intention to learn. Physical presence affects control beliefs by increasing the sense of autonomy and thus increasing the intention to learn.	Yes

outcomes and team-based, applied, and interdependent learning outcomes[7] (Cook & Brown, 1999).

The second contribution of this study is to the general management literature. Our identification strategy shows the value of identifying natural experiments in the organizational environment and leveraging existing data to rigorously test and validate managerial intuitions. A growing stream of research suggests that while firms can improve their decision-making by relying on rigorous experiments – including A/B testing, clear counterfactuals, valid and reliable metrics, and evidence-based decisions (Baba & HakemZadeh, 2012; Sull & Eisenhardt, 2015) – these are often costly and beyond the reach of many organizations (Agrawal et al., 2019). In this paper, we complement the existing literature by noting that, in addition to designing and implementing rigorous controlled business experiments, organizations may identify and exploit natural experiments when time pressure and uncertainty favor these.

This study has three main implications for organizations. The first is that in hybrid settings, digital distance is not inferior to physical presence. This evidence is consistent with the previous findings that physical presence implies unintended negative consequences for employees (Rockmann & Pratt, 2015). We speculate that organizations could devote effort and attention to designing online technology that delivers content efficiently to online participants and alleviates the competitive pressure among those physically present. For instance, an organizational and technological design that increases interactions between online and in-person participants may alleviate these pressures and foster individual learning.

The second implication is that hybrid contexts do not escape the 'hybrid trap', where intermediate solutions during a discontinuity tend to be inferior to pure solutions (Suarez et al., 2018). In our setting – hybrid teaching of management courses – our study suggests that lectures ought to be online, and all classroom time should be devoted to case discussions. These findings about the 'hybrid trap' may extend beyond teaching. Organizations could strive to plan business meetings accordingly. Meetings could be planned to take place entirely online (e.g., via webinar tools) that are intended to be informative or explanatory and on matters where limited interaction is required; for matters related to meaning-making or collective decision-making and where more interaction is required, meetings should take place in person.

The third implication of our work goes beyond the specific findings and relates more to its method – two natural experiments that occurred during the COVID-19 pandemic. Organizations under conditions of uncertainty and experiencing time pressure could adopt organizational design decisions that resemble experiments. Due to a lack of previous data or for reasons of fairness, they may resort to lotteries or allocation by family name, which allows for the evaluation of the causal effects of such decisions. Managers should be vigilant and capable of detecting and exploiting such opportunities that arise within an organization to develop a causal understanding of what works and what does not.

Our study has three main boundary conditions. First, we have evaluated the tension between bodily presence and digital distance on learning outcomes in an education context. In such a context, learning outcomes bear relatively few economic consequences for students in the short term. When economic consequences are higher, such as in a postgraduate or executive training, competition may still be present for interactive tasks, thus reducing the benefit of co-presence. Further research could evaluate whether the presence of economic stakes could moderate the relationship between digital distance and learning outcomes.

Second, the context of our study may define our results. One notable issue is that learners in a French context are used to accessing education opportunities via competitions and may be more sensitive to normative beliefs regarding competition implied by physical presence. In other contexts, such as the Scandinavian one, education is treated in a much less selective way, and there are efforts to alleviate competitive pressures in the learning environment (e.g., the introduction of non-graded courses). In such cases, physical presence may not elicit as much competition and be more beneficial.

Another important issue is that the subject matter may, by its nature, imply more competition. Different classes may entail different learning processes that could affect learning outcomes. Business classes expose learners to complex knowledge. The source of confusion for students may be unclear, and this can deter them from interacting to ask for clarification and thus dampen control beliefs. More technical classes expose learners to complicated knowledge. The source of confusion may be less ambiguous, inducing more interaction and a heightening of control beliefs. Another important moderator might be the frequency of interactions, which we were not able to measure within our evaluation of teamwork. Technical classes may require different frequencies of interaction in teamwork than business classes, with much less discussion and more specialization, thereby exerting a moderating effect. Further research could examine whether the nature of the content affects the relationship between physical presence and learning outcomes in hybrid settings.

Third, our study was conducted in a period of relatively high psychological distress during the COVID-19 pandemic. Despite the fact that we did not see trends as the second lockdown approached, environmental uncertainty may have heightened

[7] Individual and team-based learning outcomes parallel the dualism between "knowledge" – what we know about things and how to do things – and "knowing" – a dynamic coordinated process that results from practice in a group context. Knowledge and knowing are seen as mutually enabling rather than competing and develop in activities dedicated to solving problems (Cook & Brown, 1999, p. 387).

normative beliefs of competition and even reduced those of cooperation and control. Therefore, the negative effect of physical proximity on individual learning could have been magnified by contingent conditions.

In conclusion, our results inform the ongoing conversation about the future of learning and organizing during and after the COVID-19 pandemic. Whereas hybrid contexts were a necessity during the pandemic, this hybridity could be an opportunity or a risk in its aftermath: its impact will depend on how and when it is implemented. Thanks to the leveraging of natural experiments resulting from initiatives adopted under time pressure and conditions of uncertainty, our study shows that the changes introduced during COVID-19 – such as hybrid teaching – could have unintended consequences. Future research will need to investigate the mechanisms further and extend findings to the widespread but overlooked phenomenon of hybrid arrangements in education and organizations.

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APPENDIX

Table A1. Syllabi overview

	Fundamentals of Management	Essentials of Project Management	Organizational Behavior
Course description	This course helps students acquire management knowledge and develop management skills. It enables the students to understand management as it relates to both the employer and employee and to become acquainted with the various schools of management.	Overview of the basics of project management. It provides the theory and core methodology needed to manage projects or participate in project teams.	This course is designed to familiarize students with main theories and concepts for analyzing, understanding, and managing human behavior in the workplace. The use of case studies will provide students the opportunity to apply theories to real-life organizational issues and analyze the contributions and limitations of relevant theories. The course is ideally suited to those who wish to develop a critical understanding of human behavior in organizations.
Learning objectives: knowledge and understanding	This course provides students with a systematic approach to acquiring a solid foundation in the principles of management. The course is organized around the four functions of management: – planning (defining organizational goals and choosing the tasks to attain the goals); – organizing (assigning the tasks to various individuals or groups); – influencing (guiding the activities of organizational members); – controlling (gathering information and finding new ways of improving the firm through organizational modification).	The student is expected to master the basics of project management.	The student is expected to understand key theories of organizational behavior, including classical and contemporary theories; recognize the interdisciplinary foundation of Organizational Behavior as it brings insights from economics, psychology, sociology, and other social sciences.
Learning objectives: cognitive and intellectual skills	The student is expected to have an overview of different management principles: – corporate social responsibility; – human resource management, planning; – organizational communication and behavior; – motivation, leadership, and control.	The student is expected to: – define the project and assign key roles; – recognize project milestones – segment the project; – organize the project and negotiate for resources – launch the project in optimal conditions; – monitor the project; – close the project.	The student is expected to: – develop the ability to analyze and critically evaluate prior work in Organizational Behavior; – develop the ability to critically analyze the most recent debates in Organizational Behavior.

Table A1. Syllabi overview

	Fundamentals of Management	Essentials of Project Management	Organizational Behavior
Learning objectives: key transferable skills	The student is expected to: – understand and use group and team dynamics; – use effective communication, including feedback.	Master project management methodology and lifecycle and some methods for objectives and planning.	The student is expected to: – deliver and present group projects; – contribute actively to class discussion; – work efficiently in groups.
Learning objectives: practical skills	The student is expected to: – understand how to work with objectives and control expected results; – analyze a situation and define a strategy; – plan and organize issues in organizations; – learn to work with people; – learn to motivate people; – learn how to create good relationships with peers in order to work harmoniously with them.	The student is expected to be able to launch a project in optimal conditions, manage that project and work in a team.	The student is expected to: – understand how organizational behavior affects organizational outcomes; – provide students with a 'toolbox' to efficiently work with peers and manage employees in their future organizations.
Textbook	Certo, S. & Certo, T. (2018). *Modern management: concepts and skills* (Global Edition, 14th ed.). Pearson.	Project Management Institute. (2013). *A guide to the project management body of knowledge* (International Edition, 5th ed.). Clements, J. P. & Gido, J. *Effective project management.* Pearson.	Robbins, S. P. & Judge, T. A. (2018). *Organizational behavior.* Pearson. Bauer, T. & Erdogan, B. (2012). *Organizational behavior.* Flat World Knowledge.
Assessment	Final exam 40% (MCQ and OEQ), midterm 30% (OEQ), project 20%, case discussion 10%	Midterm 20% (MCQ), project 35%, class participation 20%, oral presentation 25%	Final exam 40% (MCQ and OEQ), midterm 30%, project 20%, individual project presentation 10%
Number of sections	2	2	1
Number of teachers	2	1	1
Hybrid lectures	6	5	6
Students per course	83	65	21

Table A2. Results of syllabus topic modeling and distribution to courses

Probability of belonging to each topic of the following courses:	Topic 1: organizations	Topic 2: individuals	Topic 3: project
Essentials of Project Management	0.004	0.009	0.987
Fundamentals of Management	0.191	0.665	0.144
Organizational Behavior	0.723	0.195	0.081

Note: The topic modeling exercise suggests that Fundamentals of Management and Organizational Behavior are most similar, as they blend topics about organizations and individuals, compared to Essentials of Project Management, which focuses mostly on project topics.

Table A3. Effect of bodily presence in hybrid teaching – individual learning outcome

	(1)	(2)	(3)	(4)
	RE	RE	RE	RE
	Baseline	Controls	Lecture FE	Question FE
Online-only student		−0.136	−0.140	−0.191
		(0.216)	(0.216)	(0.249)
Local student		0.042	0.052	0.069
		(0.122)	(0.125)	(0.147)
French national		−0.173	−0.184	−0.227
		(0.122)	(0.124)	(0.146)
Women		0.048	0.045	0.057
		(0.096)	(0.098)	(0.116)
Age		−0.010	−0.012	−0.016
		(0.014)	(0.015)	(0.017)
GPA		0.631***	0.672***	0.820***
		(0.120)	(0.118)	(0.136)
Time to response (ln)		−0.350***	−0.244***	−0.167**
		(0.054)	(0.056)	(0.061)
In-person student	−0.152*	−0.155+	−0.151+	−0.243*
	(0.075)	(0.080)	(0.089)	(0.100)
Constant	0.966***	1.438**	0.434	0.722
	(0.063)	(0.500)	(0.559)	(0.658)
Course FE	No	Yes	Yes	Yes
Lecture FE	No	No	Yes	No
Question FE	No	No	No	Yes
Log-pseudolikelihood	−1909.30	−1849.36	−1727.39	−1493.83

Note: Student-clustered standard errors in parentheses. The dependent variable is the correct answer to MCQ. Course FE includes a full set of dummies for any combination of course (Fundamentals of Management, Essentials of Project Management and Organizational Behavior), section and subgroup (group A or B). Not all students responded to all MCQs because they took only a subset of the three exams in the fall 2020 semester. The sample in each column comprises 3,179 observations in respect of 159 students and 43 questions. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$.

Table A4. Effect of bodily presence in hybrid teaching – team learning outcome

	(1)	(2)	(3)	(4)
	RE	RE	RE	RE
	Baseline	Student controls	Lecture FE	Size control
Share of women		0.027	0.023	−0.012
		(0.040)	(0.039)	(0.042)
Share of locals		0.036	0.094*	0.077+
		(0.036)	(0.040)	(0.046)
Share of French nationals		0.022	−0.003	−0.015
		(0.044)	(0.040)	(0.035)
Team average GPA		(omitted)	−0.095*	−0.093*
			(0.043)	(0.042)
Team size				0.016
				(0.014)
No. in-person students	0.018**	0.016**	0.017***	0.015**
	(0.005)	(0.006)	(0.005)	(0.005)
Constant	4.435***	4.358***	4.448***	4.426***
	(0.014)	(0.132)	(0.131)	(0.128)
Lecture FE	No	No	Yes	Yes
N	90	90	90	90
N Teams	18	18	18	18
N Cases	5	5	5	5
Log-pseudolikelihood	−306.08	−305.83	−299.65	−299.48

Note: Team-clustered standard errors in parentheses. The unit of analysis is a team-oriented lecture. The dependent variable is team case grade. The sample comprises 90 observations for 18 teams and 5 case studies. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$.