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Tweet to Teach: Using a Twitter-Based Instructional Method
to Improve Student Motivation, and Academic Outcomes in Higher Education

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Abstract

Scholars are aware of the power of social media to capture the attention of students, notably during lectures. Far from banning them, some teachers have considered using them to improve the motivation of students. One of the most popular social media platforms for that purpose is Twitter. It has been widely used in educational settings as a tool for collaboration and communication, but studies using Twitter as a tool to help students remember course concepts and stimulate their motivation to learn are scarce. In the present study, we conducted a three-year study in a ‘naturalistic’ educational setting using Twitter to remind students of course concepts, and asking questions every week during one semester. Comparing the groups of user and non-user students showed that this Twitter-based method elicited higher intrinsic motivation and interest in the course throughout the semester; importantly, it also reduced amotivation. Some benefits of using Twitter were also observed on learning and academic outcomes. We discuss the benefits and the limits of repurposing social networks for pedagogical activities.

Keywords: Academic performance; course interest; motivation; social media; Twitter

Highlights

- A three-year study used a pedagogical Twitter in actual course settings
- Students could volunteer to be sent course-related information
- Intrinsic motivation and interest increased, and amotivation decreased using Twitter
- There were some positive effects on learning and academic outcomes

1. Introduction

Social media platforms such as Facebook, Instagram, Snapchat, Twitter, and YouTube have been widely adopted by students (Adams et al., 2018; Denker et al., 2018; Evans, 2014; Smith & Anderson, 2018), but their use is debated, notably in educational settings. Could the use of social media be beneficial for education? This possibility has been explored within the perspective of blended learning (i.e. using a combination of face-to-face teaching and content delivered online). Using social media for blended learning may help facilitate learning, motivation and improve student attitudes toward learning (e.g. Alexander, 2010; Barrot, 2018, 2020; Garrison & Kanuka, 2004; Manca & Ranieri, 2016a). However, there is little data available about the effectiveness of using social media to promote course content, in terms of impact on actual student learning or attitudes regarding the course. The current study examined this question by testing whether using a social media platform such as Twitter to send messages related to the content of a course could improve motivation, interest in the course, learning, and academic outcomes.

1.1 Using Twitter in Educational settings

Scholars are well aware of the power of social media to attract the attention of their students. Instead of banning social media, some teachers have tried to divert their original purpose to promote engagement in the classroom (e.g. Dragseth, 2020; Rutherford, 2010; Vahedi et al., 2019). Twitter is one of the most popular social media platforms for scholars, which may partly explain why it has been used for educational purposes (Lupton, 2014; Manca & Ranieri, 2016b; Veletsianos & Kimmons, 2016). Twitter is a microblogging platform that enables individuals to send and receive in real time information, which can be accessed using a mobile phone or a personal computer. Twitter allows users to share textual messages (with a limit of 280 characters), pictures and videos, in a format called *tweets*. Tweets can be liked, commented, and retweeted or

shared with others. Users can follow others' accounts, address other users directly by mentioning them with the symbol "@", and generate a discussion topic with the symbol "#".

This particular format may have several advantages when used in teaching. Several studies have reported the various benefits afforded by micro-blogging services in an educational context (Adams et al., 2018; Gao et al., 2012; Manca & Ranieri, 2016a): favoring concision due to the word limit; enhancing relationships and communication between students and teachers; prompting participation and engagement; promoting reflective thinking; supporting collaborative learning; expanding learning contents in both formal and informal learning settings; and enhancing the social presence of students and teachers. According to these studies, however, these possible benefits must be weighted against a few pitfalls (Adams et al., 2018; Gao et al., 2012; Manca & Ranieri, 2016a; Nagle, 2018): time-consuming involvement of the teacher in the tweeting process, an overwhelming volume of tweets that could cause "log-in overload" among students, unfamiliarity with the tools, distraction, privacy concerns, cyberviolence, and constraints due to short text writing (possibly including lower course relevance, restricted freedom of expression, or weaker grammatical qualities).

There have been multiple efforts to use Twitter in higher education. Several researchers have embedded Twitter into blended learning approaches as an educational tool, notably as a way to create communication between students and instructor, inside or outside of the classroom (Malik et al., 2019; Menkhoff et al., 2015). Tang and Hew (2017) conducted an extensive review describing the possible implementations of Twitter in learning courses and evaluating its benefits on teaching and learning. Based on 51 studies, they listed six major ways to use Twitter in education: (1) exchanging information related to the topic of the course, (2) collaborating, (3) assessing student learning, (4) communicating about class organization, (5) reflecting upon

teacher practices, and (6) providing a support for students to capture pictures (e.g. in the context of an art class).

Of these six possible uses, the first two in particular could be expected to directly facilitate learning. In the next section, we review the literature about possible benefits of Twitter relevant to these two uses, in two particular areas: learning and academic outcomes on one hand, and motivation and interest about the course on the other hand. Both have been particularly studied in the context of the second possible use of Twitter (promoting collaboration between students), whereas there has been much less investigation of the first possible use that is the focus of the present study (sending students information related to the topic of the course).

1.2. Using Twitter to Enhance Learning

Meaningful learning is "the critical analysis of new ideas, linking them to already known concepts and principles, and leads to understanding and long-term retention of concepts so that they can be used for problem solving in unfamiliar contexts" (Kester et al., 2007, p. 1048). In this sense, using Twitter to interact with the course could be expected to help shape a more complete mental representation of course content and in turn, enhance learning. This is particularly true when using Twitter to send course-related contents: this reactivation of prior knowledge should facilitate the integration of information (Mayer & Pilegard, 2014). Unfortunately, much of the existing literature regarding the educational use of Twitter has focused on its socio-affective effects without providing a clear picture of its actual impact on learning (e.g. Alias et al., 2013; Gao et al., 2012).

However, two reviews of the literature have scrutinized the impact of Twitter on learning and academic outcomes (Malik et al., 2019; Tang & Hew, 2017). Most of the included studies tested the benefit of Twitter on learning when it was used for communication and collaboration

(e.g. to promote peer collaboration, to display questions-and-answers, to support discussions, or to send course reminders). For example, Junco et al. (2011) demonstrated that students who were assigned to a Twitter group for communication and collaboration had significantly higher grade point averages (GPAs) than a control group. Similarly, Kim et al. (2015) showed that using a class response system on Twitter enhanced grades when compared to the previous academic year. Overall, the literature concluded that using Twitter could be conducive to increased learning in classroom settings (Malik et al., 2019; Tang & Hew, 2017).

By contrast, very few studies have explored the impact of using Twitter to strengthen learning of concepts by sending course-related materials to students. A first generation of studies investigated the use of Twitter for pedagogical purposes using surveys. For example, Lowe and Laffey (2011) in a marketing course sent information about miscellaneous marketing concepts via Twitter during 8 weeks. Out of 126 students, 80 students voluntarily followed the tweets. Exploratory interviews showed that 80% of the respondents anticipated positive learning outcomes with this educational method. Similarly, Bahner et al. (2012) evaluated the effect of an educational Twitter on the theme of ultrasounds. In this program, the followers received one subject-related tweet per day. After one year, over 80% of the followers reported that they thought this practice was useful. Later on, a second generation of studies focused on documenting the process of knowledge construction in microblogging-based learning environments. For example, Luo and Clifton (2017) proposed a Twitter-based instructional methods for students in a hybrid classroom including both face-to-face and online environments. Using a coding scheme to assess the level of learning, Luo and Clifton (2017) categorized students' tweets. They pointed out that while a hashtag exploration activity elicited low-order cognitive processes (such as remembering), on the contrary, backchannelling (Using Twitter as a question forum in real time for clarification) and

topic discussion triggered higher-order cognitive processes (such as understanding, analyzing, evaluating) essential for meaningful learning.

In line with their previous work, Luo et al. (2019) investigated what types of knowledge are involved when Twitter is used to reflect on course readings, and how students perceive Twitter-supported activities. During 10 weeks of a course regarding effective technology integration, some students were required to contribute to question prompts on a blackboard. The same course was then administered to a new cohort of students but the blackboard was replaced by Twitter for exactly the same activities. The authors observed that the students viewed positively the integration of Twitter to support reflection and discussion. They also participated more actively, and Twitter-supported activities led to more reflective responses corresponding to meaningful learning. The positive effect of Twitter on perceived learning and quality of knowledge elaboration was also confirmed by student's claims in other recent surveys (Abella-García et al., 2019; Luo & Xie, 2019)

Taken together, these studies suggest that using Twitter to provide pedagogical content might also improve learning, but there is little guarantee that student's attitudes translate into actual learning benefits (Tang & Hew, 2017). Instead of self-reported estimates, these benefits should preferably be assessed with performance measures, such as assessment scores in quizzes and tests, or semester grade point averages (GPAs). To the best of our knowledge, only a single study (Blessing et al., 2012) actually tested this question using an experimental design and performance measures. In their study, students were assigned to one of two different Twitter feeds: the *humor-only group* received only humoristic tweets, and the *course concept group* received both humoristic and pedagogical tweets. Students received tweets once per day on average, during one semester. The *course concept group* outperformed the *humor-only group* on a multiple-choice test

targeted specifically on the content of pedagogical tweets, but the results failed to show a positive effect of pedagogical tweets on exam performance. Given these results, it is unclear whether Twitter actually improved learning outcomes. If the multiple-choice test assessed memory for the content of tweets, it is hardly surprising that the course concept group outperformed the *humor-only group* on this test; the practical benefits seem limited if students did not actually succeed better in the final exam.

1.3. Using Twitter to Enhance Motivation and Interest in the Course

When reflecting on the possible beneficial effects of Twitter for education, it is of interest to consider student engagement: the amount of energy that students invest in the course (Astin, 1984; Dhir et al., 2013). Many authors have suggested that student achievement may be proportional to their engagement (see Annetta et al., 2009; Denker et al., 2018; Welch & Bonnan-White, 2012 for example), and a few studies have suggested that Twitter, when used to promote communication and collaboration activities, can benefit student engagement (See Abella-García et al., 2019; Elavsky et al., 2011; Evans, 2014; Junco et al., 2013; Junco et al., 2011; Kunka, 2020; Luo & Gao, 2012 for example). In the current study, we focus on two determinants of student engagement: motivation and interest in the course.

Motivation can be viewed as the set of processes that influence the direction, vigor and persistence of behaviors. It is especially relevant to education (Moos & Marroquin, 2010; Murphy & Alexander, 2000), because motivation reflects the reasons why students engage in a course. Motivation is a highly complex construct, which is often approached based on the self-determination theory (Deci & Ryan, 2002). This theory assumes that individuals can be in a state of amotivation (complete lack of motivation and self-regulation of behavior), extrinsic motivation (the desire to engage in an activity is driven by external incentives such as money, grades and

praise), or intrinsic motivation (the desire to engage in an activity is driven by interest, enjoyment, pleasure, and/or challenge). Several authors have proposed that intrinsic motivation can lead to better learning performance (see Liu et al., 2011; Mayer, 2014 for example).

The effects of pedagogical tweeting on student motivation to learn have received little attention in the literature, but the review of Malik et al. (2019) provided a few insights on this point. For example, one survey by Fewell (2014) observed that the use of Twitter had a positive impact on students, with 57% of them agreeing that Twitter helped increase their motivation to learn English. In another study, Adams et al. (2018) found that students were more likely to experience intrinsic motivation when they used Twitter for educational purposes on a voluntary basis. On the contrary, they found that imposing mandatory use of Twitter was counterproductive, in that it encouraged extrinsic motivation instead of intrinsic motivation. However, these studies used Twitter for communication and collaboration, not to provide students with course-related materials.

In addition to motivation, heightened interest in the course can be expected to help students engage more fully in learning. For example, Lowe and Laffey (2011) observed that providing a regular support by tweeting contents related to the course helped stimulate student interest. McArthur and Bostedo-Conway (2012) have also shown that interest in a course was positively associated with the use of Twitter to communicate and post content related to the course. Bista (2015) asserted that providing access to a social media platform like Twitter could reinforce the interest of students in educational activities. In a small-scale pilot study, Adams et al. (2018) also demonstrated that students could be interested in using Twitter in a course.

1.4. Rationale and Hypotheses for the Present Study

Our review of the literature shows that the possibility of using Twitter to remind students of concepts learned during a course has scarcely been investigated, with almost all studies testing a different use of Twitter, namely promoting communication or collaboration. By contrast, using Twitter to send pedagogical content and measuring its effects on learning outcomes has been directly tested in only one study (Blessing et al., 2012) without any observed effect on final exam performance. Moreover, the effect of this use of Twitter on student motivation and interest in the course has never been tested to our knowledge.

In this context, we aimed to evaluate the possible beneficial effects of using Twitter to strengthen concepts taught in a face-to-face course. To this end, we gave students the option of receiving tweets about course-related content (such as pieces of news that reflected course content) several times per week. We started tweeting halfway through the semester (at a point where most students who were not interested in the course had already left the class). We focused on two major possible benefits of using Twitter: improving motivation and interest in the course, and improving learning and academic outcomes. The effect on motivation and interest in the course was measured with a questionnaire completed at the beginning and at the end of the semester. The effect on learning and academic outcomes was tested by measuring performance directly, both with a questionnaire completed at the end of the semester, and by retrieving grades on the final exam.

We expected that the use of Twitter to send information related to the topic of the course would reinforce motivation and interest in the course. In terms of motivation, and in line with the results of Adams et al. (2018), we expected that students using Twitter would experience an increase in intrinsic motivation (i.e. the reasons for engaging in learning should be more fully internalized and self-regulated) and possibly an increase in extrinsic motivation. Conversely, we

expected that they would experience a decrease in amotivation. We also expected that students using Twitter would experience an increase in interest in the course. Lastly, we expected that students using Twitter would experience better learning and academic outcomes.

2. Method

2.1. Participants

Undergraduate students were recruited in a first-year course of cognitive psychology in a medium-sized university in France. The course took place during the first semester of the academic year. The experiment was conducted over three consecutive academic years between 2017 and 2019; a total of 1731 students were enrolled in the course over these three academic years (2017-2018 = 651 students; 2018-2019 = 530 students; 2019-2020 = 550 students). Out of this total sample, 488 students volunteered to participate in the study and filled out the required surveys at the beginning and end of the class. This sample size is given after excluding three categories of students: (1) students who were repeating this grade level (because they had prior knowledge in cognitive psychology), (2) students who were exempted from regular attendance (because they could miss the incentives provided during the class to consult the pedagogical Twitter, and the feedback about Twitter content given in class), and (3) students who failed to complete one of the measures. The final sample size included in the study was $n = 167$ for the 2017-2018 cohort, $n = 135$ for the 2018-2019 cohort and $n = 186$ for the 2019-2020 cohort (430 females, 58 males; mean age = 19.07 years, $SD = 1.15$).

2.2. Materials

2.2.1. *The Course and the Twitter-based Instructional Method*

Our Twitter-based instructional method was integrated in a first-year undergraduate student course in cognitive psychology. This 12-weeks course is taught on campus during the first semester of the academic year (from September to December), and deals with basic concepts of cognitive psychology: history of cognitive psychology, perception, and conditioning. The course comprises a lecture, taught for 2 hours once a week (for a total of 24 hours); students are divided randomly in three groups of about 170 students, and the lecture is given separately to the three groups by three associate professors. The same slides and course materials are used to ensure that course content is exactly the same for the three groups.

A Twitter account was specifically created for this course and clearly stated its educational purpose: supplementing the instructional content of the course. The students could freely subscribe to this educational Twitter. Due to the ethical concern of not forcing students to subscribe to a social media platform in order to access course-related content (and not preventing non-subscribers to access the same content), we also created a widget that embedded our pedagogical Twitter account, made available on the Learning Management System (Moodle) of the university (a widget is a small module that displays information to a user; in this case, the module was displayed as a window embedded to the left of the course space). The students in this group were not considered in the statistical analyses¹ because it was unclear to what extent they would behave differently from a Twitter group although they had access to the same content, (1) access to the pedagogical content via the widget was less straightforward than using Twitter (it required several more steps, including authentication on the university website and selection of the correct course), (2) the display quality of the contents was substantially degraded on the widget (the contents were

¹ Regarding the widget group, the results showed that students in this group had no significant increase of motivation and interest throughout the semester, contrary to the Twitter group. Their results in terms of learning performance and academic performance were comparable to the Twitter group.

presented in a small window on the side of the course page, with small text size, and much scrolling required to view each piece of content), and (3) accessing the widget required a voluntary effort to log in to the course page (usually from a computer), making students likely to miss part of the contents and quizzes, contrary to the pedagogical Twitter which is easily accessible from a smartphone and can also send notifications to students who subscribe, additionally allowing to extend the learning context into daily life.

The purpose of the Twitter account was to strengthen concepts taught during the course with scientific press articles selected by the teachers. We posted three or four tweets a week, all referring to a press article with the corresponding topic clearly marked (e.g. #phobia). The contents of the tweets were selected jointly by all teachers. All press articles were selected to have approximately a 10 minutes reading time. They were systematically in relation with the topic covered in the course during the previous week. Examples of tweets are displayed in Figure 1.

2.2.2. Measurements

2.2.2.1. Preliminary questionnaire. Before we started the protocol and began tweeting, students first completed a brief survey collecting demographic information. They were asked their age, gender, type of university enrollment (exempted from regular attendance or not), whether they were repeating the grade or not, and whether they used Twitter or not and if so, how often.

2.2.2.2. Use of Twitter during the Semester. At the end of the semester, students were asked to report on their use of our pedagogical Twitter. They were asked whether they had subscribed and read tweets during the semester or not; if they had, they were asked to rate how frequently they had checked the contents of the pedagogical Twitter (on an ordinal scale from 1, *never*, to 8, *several times a day*) and to estimate the total number of tweets they had read (on a scale from 1, *none*, to 7, *over 30*).

2.2.2.3. Learning and Academic Outcomes. Learning was first examined using an assessment test performed at the end of the semester, at the end of the last class. This multiple-choice test comprised 20 items, including 10 items related to the first half of the course (before the protocol started) and 10 items related to the second half of the course (after we started tweeting). Responses to each question were scored 0 point or 1 point, for a total score from 0 to 10 points on each part of the course. As this assessment test did not count toward the students' grade, it was kept unchanged for the three cohorts.

Academic outcomes were also examined by retrieving scores on the 1-hour final exam performed at the end of the semester. This final exam comprised 30 items (with a mix of 10 multiple-choice items, 10 true/false items, 5 write-the-legend-for-a-picture items, and 5 fill-in-the-blank items). Total scores were computed as the sum of correct responses, transformed in order to obtain a total grade from 0 to 20 in accordance with the French rating system. This format was identical for the three cohorts, but given that this exam counted toward the students' grade, the questions were different between the cohorts (to avoid students cheating at the final exam due to knowing the questions in advance). To check whether the difference between students using Twitter and those not using Twitter was specific to the course, we also retrieved the average of grades on the final exams of two other courses delivered during the first semester and where no Twitter contents were sent to students (social psychology and neuroscience).

2.2.2.4. Motivation. We assessed motivation using a modified version of the *Echelle de Motivation Globale* [Global Motivation Scale] (EMG-28; Guay et al., 2003). The EMG-28 is based on self-determination theory and measures intrinsic motivation (three aspects: intrinsic motivation for knowledge, achievement, and stimulation), extrinsic motivation (three aspects: identified, introjected, and external regulation), and amotivation. Each item is scored on a scale from 1 (*not*

at all like me) to 7 (exactly like me). We rephrased items so that they were directly related to the course (e.g. *I would feel guilty not engaging in this cognitive psychology course* instead of *I do things because I would feel guilty not to*), and kept only half the items in the intrinsic and extrinsic motivation subscales. Our version had six items for intrinsic motivation (e.g. *I feel pleasure in understanding complex concepts in this cognitive psychology course*), six items for extrinsic motivation (e.g. *I don't want to disappoint teachers by not engaging in this cognitive psychology course*), and four items for amotivation (e.g. *I don't think it is worth devoting time to this cognitive psychology course*). Reliability was good for intrinsic motivation ($\alpha = .85$) and amotivation ($\alpha = .79$), but unsatisfying for extrinsic motivation ($\alpha = .57$): the results for extrinsic motivation are presented along with other analyses but they should be interpreted with this caveat in mind. An exploratory factor analysis showed the predicted factor structure for this questionnaire (three factors corresponding to the three dimensions).

2.2.2.5. Interest in the course. We assessed interest using four items: two items for situational interest (adapted from Rotgans and Schmidt (2014): “*This course makes me want to know more about cognitive psychology*” and “*This course encourages me to discover more about cognitive psychology*”) and two items for personal interest (“*I am interested in cognitive psychology*” and “*I appreciate works that use the principles of cognitive psychology*”). These items were embedded within the motivation questionnaire and used the same rating scale. Responses on the four items were summed to obtain a total interest rating ($\alpha = .83$),

2.3. Procedure

This study was conducted over three years with three different cohorts of students. The three cohorts followed the same procedure, organized in three main phases.

In the first phase, students were informed of the existence of our educational Twitter project and were invited to complete a first survey. This survey included the preliminary questionnaire (2.2.2.1), and assessed motivation and interest in the course (2.2.2.4 and 2.2.2.5); completion time was about 5-10 minutes. The first two cohorts completed this survey online, via a link they received in an institutional e-mail; they had 15 days to complete the survey. For the third cohort, we handed out the questionnaires on paper at the end of a course (in an effort to increase participation of the least motivated students, and thus increase the breadth of our sample). Students were informed that these data were collected as part of a study on pedagogical practices, and that participation was not mandatory.

In the second phase (halfway through the semester), all students received a second e-mail announcing the launch of the educational Twitter and further explaining how it worked (what type of content would be posted, how often, etc.). We began posting tweets at this point.

The third phase of the study took place at the end of the semester in December. All students received a third e-mail asking them to complete a second survey to assess the way they interacted with the course and the associated Twitter. This second survey included the questionnaire about use of the instructional Twitter (2.2.2.2), the multiple-choice test measuring learning performance (2.2.2.3), and the same questions related to motivation and interest in the course as the first survey (2.2.2.4 and 2.2.2.5). Completion time was about 10-15 minutes. These data were collected with the same methods as the first survey. Lastly, student grades were retrieved after the final exam, and all data were anonymized.

Given that this study was conducted in a ‘naturalistic’ setting (i.e., as part of an actual course between 2017 and 2019), there were procedural changes across the three cohorts as refinements of the protocol were introduced. There were two meaningful changes. Firstly, the

question emerged of whether a difference in academic outcomes between students using or not using our Twitter would actually be driven by use of the instructional Twitter, or by pre-existing differences. To control this possibility, students in the third cohort completed a test evaluating their memory for concepts taught in the first part of the course (before we started tweeting). This test was performed at the end of the first part of the course, effectively measuring baseline differences in course learning and understanding between students before the instructional Twitter started. This 10-items multiple choice test yielded a total score between 0 and 10. The corresponding analyses are described separately in the Results section.

Secondly, for the second and third cohorts, we went further in strengthening concepts taught during the course by introducing course-related quizzes in our pedagogical Twitter. This change was taken as a supplementary way to use Twitter to send course-related contents. The purpose of this change for years 2 and 3 was to help students pinpoint the important course-related concepts for the final exam, and also to maximize motivation and interest in the pedagogical Twitter. A new quiz was proposed every Thursday on the pedagogical Twitter account, after the end of all classes of the week in the course. We expected that after this activity, students would be more likely to identify important course concepts and seek out more information in our pedagogical Twitter content. Three multiple-choices questions (with four response options, and only one correct) were posted on the course Twitter each week. The feature was announced in class and students were prompted every week to visit the account and answer them. Immediately after answering a question, Twitter displayed the percentage of students who gave the same answer, but not the normatively correct answer; all questions were corrected at the beginning of the next on-campus class, and we also posted correct answers on Twitter. Examples of quizzes and feedback are displayed in Figure 2.

In short, our instructional use of Twitter during the study could be summarized as follows: every week, teachers: 1) shared content relevant to the course, 2) reminded students about course content, and 3) quizzed students on course content using the Twitter-integrated survey feature (during years 2 and 3).

2.4. Data Analysis

There were generally no missing data, except for grades on the final exam for the third cohort where an issue with anonymization prevented retrieval of 53 grades (28% of the third cohort). We analyzed the data by classifying students in two groups: those who reported reading the instructional Twitter ($n = 254$), and those who did not ($n = 134$). Students who only interacted with the widget that mirrored the Twitter contents on the Moodle Learning Management System ($n = 100$) were excluded from all analyses, as described above.

For motivation and interest in the course, we tested the effect of following our instructional Twitter using mixed-design analyses of variance (ANOVAs), with use of Twitter (user vs. non-user) as a between-subjects variable and measurement point (first survey vs. second survey) as a within-subjects variable. Significant interactions were decomposed using contrasts analyses. For learning and academic outcomes, we used between-subjects ANOVAs, with use of Twitter (user vs. non-user) as an independent variable. For students in the third cohort, who had completed a preliminary test to assess their learning in the first half of the course (before the instructional Twitter started), we also tested the effect of Twitter on learning and academic outcomes when controlling for performance on the preliminary test.

The student's cohort (2017-2018, 2018-2019 or 2019-2020) was included as a controlled variable in all analyses; the results showed that cohort never interacted with use of Twitter (user vs. non-user) or measurement point (first survey vs. second survey), so these results are not detailed

further. Controlling for the degree of Twitter use prior to the course, or for identity of the teacher, did not substantially change the results presented here.

3. Results

Descriptive statistics for all measures of interest are displayed in Table 1. All measures had a distribution very close to normal. An outlier analysis using Cook's distance did not reveal major outliers; no data were excluded from the final sample. A total of 254 students reported following the instructional Twitter, and 134 students reported that they did not. For students who followed the instructional Twitter, the median number of messages they read was 5-10 in total, and the median frequency of visiting the Twitter was once a week. Students who had a Twitter account prior to the study were much more likely to follow the instructional Twitter, $\chi^2(1) = 45.80$, $p < .001$, and students who reported using their personal Twitter account to a greater extent also visited the instructional Twitter more frequently, $r(252) = .23$, $p < .001$.

Bivariate correlations between all measures are displayed in Table 2. The results showed the expected correlations between measures: intrinsic motivation had positive correlations with interest, and with learning outcomes; the opposite pattern was found for amotivation, which correlated negatively with intrinsic motivation. Measures of interest and motivation were all highly correlated. Overall, construct validity appeared to be good, except for extrinsic motivation which seemed to function poorly, possibly due to its low reliability (see Methods section).

Table 1

Descriptive statistics for measures of interest

Measures	<i>M</i>	<i>SD</i>	skewness	kurtosis	range
Intrinsic motivation (T1)	4.94	0.85	-0.37	0.14	2 to 7
Intrinsic motivation (T2)	5.08	0.91	-0.39	0.37	1.33 to 7
Extrinsic motivation (T1)	4.44	1.07	-0.22	0.09	1 to 7

Extrinsic motivation (T2)	4.45	1.11	-0.11	-0.42	1.50 to 7
Amotivation (T1)	2.35	1.01	0.93	0.74	1 to 6.75
Amotivation (T2)	2.46	1.14	0.98	0.84	1 to 7
Interest in the course (T1)	4.79	0.95	-0.28	-0.07	1.50 to 7
Interest in the course (T2)	4.82	1.02	-0.45	0.20	1 to 7
Exam grade (this course)	11.66	3.97	-0.16	-0.41	0 to 20
Exam grade (other courses)	12.38	3.21	-0.48	0.24	0 to 19.04
Learning test (first half of the course)	4.61	2.36	0.24	-0.69	0 to 10
Learning test (second half of the course)	5.69	1.88	-0.17	-0.38	0 to 10
Preliminary test (third cohort only)	6.13	1.90	-0.14	-0.57	1 to 10

Note. M = average, SD = standard deviation, T1 = before starting Twitter, T2 = end of the semester. Motivation and interest measures were scored on a scale from 1 to 7; possible exam grades ranged from 0 to 20; possible values for performance on the learning tests ranged from 0 to 10. Note that questions of the learning tests were not necessarily the same difficulty for the first and second part of the course: the two scores are not comparable.

Table 2

Bivariate correlations between all measures

Measures	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Intrinsic motivation (T1)	-												
2. Intrinsic motivation (T2)	.64	-											
3. Extrinsic motivation (T1)	.07	.09	-										
4. Extrinsic motivation (T2)	.06	.14	.51	-									
5. Amotivation (T1)	-.62	-.51	.10	-.03	-								
6. Amotivation (T2)	-.44	-.54	.04	.06	.62	-							
7. Interest in the course (T1)	.77	.53	.00	.01	-.56	-.40	-						
8. Interest in the course (T2)	.61	.79	.02	.09	-.51	-.51	.66	-					
9. Exam grade (this course)	.13	.19	.10	.06	-.12	-.16	.06	.12	-				
10. Exam grade (other courses)	.18	.22	.06	.05	-.18	-.19	.11	.16	.72	-			
11. Learning test (first half of the course)	.19	.11	.13	.05	-.16	-.06	.22	.16	.27	.27	-		
12. Learning test (second half of the course)	.16	.17	.09	.08	-.12	-.09	.11	.13	.39	.45	.46	-	
13. Preliminary test (third cohort only)	.07	.17	.09	-.02	-.13	-.13	.06	.17	.25	.29	.39	.33	-

Note. Significant correlations are in bold.

3.1. Effects of the Instructional Twitter on Motivation and Interest in the Course

The first series of analyses examined the effect of Twitter on motivation and interest. For intrinsic motivation, there was a significant main effect of using Twitter, $F(1, 382) = 18.00$, $p < .001$, $\eta^2_p = .05$, and using Twitter moderated the change of motivation between the middle and the end of the semester, $F(1, 382) = 6.50$, $p = .011$, $\eta^2_p = .02$. This interaction is displayed in Figure 3A. Students who followed the instructional Twitter had higher intrinsic motivation, and their intrinsic motivation significantly increased between the middle and the end of the semester, $F(1, 382) = 22.12$, $p < .001$, $\eta^2_p = .05$. For students who did not follow the Twitter, intrinsic motivation did not change significantly between the middle and the end of the semester, $F(1, 382) = 0.04$, $p = .836$, $\eta^2_p = .00$.

For extrinsic motivation, contrary to our hypotheses, there was no main effect of following the instructional Twitter, $F(1, 382) = 1.49$, $p = .224$, $\eta^2_p = .00$, and following the Twitter did not moderate the change of extrinsic motivation, $F(1, 382) = 0.32$, $p = .571$, $\eta^2_p = .00$. In fact, average extrinsic motivation did not significantly change throughout the semester, $F(1, 382) = 0.06$, $p = .802$, $\eta^2_p = .00$ (see Figure 3B), in line with the generally poor results for this measure.

For amotivation, there was a significant main effect of using Twitter, $F(1, 382) = 14.48$, $p < .001$, $\eta^2_p = .04$, and using Twitter also moderated the change of amotivation between the middle and the end of the semester, $F(1, 382) = 14.14$, $p < .001$, $\eta^2_p = .04$. This interaction is displayed in Figure 3C. In line with our hypotheses, the pattern was reversed when compared to intrinsic motivation: for students who followed the instructional Twitter, amotivation was lower and did not increase throughout the semester, $F(1, 382) = 0.45$, $p = .503$, $\eta^2_p = .00$; whereas for students who did not follow the Twitter, amotivation significantly increased throughout the semester, $F(1, 382) = 17.09$, $p < .001$, $\eta^2_p = .04$.

For interest in the course, also in line with our hypotheses, there was a main effect of following the instructional Twitter, $F(1, 382) = 15.63, p < .001, \eta^2_p = .04$, and following the Twitter moderated the change of interest throughout the semester, $F(1, 382) = 4.18, p = .042, \eta^2_p = .01$. This interaction is represented in Figure 3D. Students who followed the instructional Twitter were more interested in the course on average, and their interest significantly increased throughout the semester, $F(1, 382) = 5.55, p = .019, \eta^2_p = .01$; for students who did not follow the instructional Twitter, there was descriptively a slight decrease in interest throughout the semester, but this decrease was not significant, $F(1, 382) = 0.69, p = .403, \eta^2_p = .00$.

The results displayed in Figure 3 suggested that students who followed the instructional Twitter were already more motivated and more interested in the course at baseline, before the Twitter started. A complementary series of ANOVAs confirmed that this was indeed the case, with significant differences for intrinsic motivation, $p = .006$, for interest, $p = .007$, and a difference at the trend level for amotivation, $p = .060$; there was no difference at baseline for extrinsic motivation, $p = .439$. In sum, there were pre-existing differences between students who chose to follow the instructional Twitter and those who did not, but motivation and interest increased to a greater extent in students who followed the instructional Twitter – above and beyond those differences at baseline (see Figure 3).

3.2. Effects of the Instructional Twitter on Learning and Academic Outcomes

The second series of analyses tested whether the benefits of Twitter on motivation and interest in the course were accompanied by actual benefits for learning and academic outcomes. We first examined the effect of using Twitter on grades on the final exam. On average, students who followed the instructional Twitter had significantly higher grades on the final exam ($M = 11.86, SD = 3.87$) than students who did not ($M = 10.80, SD = 4.16$), $F(1, 346) = 6.79,$

$p = .010$, $\eta^2_p = .02$. To test whether this was specific to the course or whether this could reflect a selection bias (with better students more likely to follow the Twitter), we also tested the difference for other courses. Students who followed the instructional Twitter also had marginally higher grades on exams for other courses ($M = 12.34$, $SD = 3.18$) than students who did not ($M = 11.77$, $SD = 3.37$), but the effect did not reach significance, $F(1, 346) = 2.92$, $p = .088$, $\eta^2_p = .01$.

For scores on the learning tests, there was a significant main effect of using Twitter: for content taught in the second half of the course (covered by the instructional Twitter), students who followed the instructional Twitter had significantly higher scores ($M = 5.68$, $SD = 1.81$) than students who did not ($M = 5.16$, $SD = 1.94$), $F(1, 382) = 7.02$, $p = .008$, $\eta^2_p = .02$. By contrast, for content taught in the first half of the course (not covered by the instructional Twitter), there was no significant difference between students who followed the instructional Twitter ($M = 4.56$, $SD = 2.36$) and those who did not ($M = 4.16$, $SD = 2.21$), $F(1, 382) = 2.66$, $p = .104$, $\eta^2_p = .01$. However, there was no interaction between the section of the pre-exam test (first half vs. second half of the course) and the use of Twitter, $F(1, 382) = 0.31$, $p = .578$, $\eta^2_p = .00$. In other words, the advantage of students who followed the instructional Twitter was not significantly greater for content covered via Twitter than for content not covered via Twitter.

Lastly, we performed a subsample analysis on the preliminary learning test completed by the third cohort, to control the effect of previous knowledge acquired during the course. Analyses of covariance (ANCOVAs) controlling for scores on the preliminary learning test found that the effect of using Twitter was no longer significant for exam grades on the course, $F(1, 115) = 1.06$, $p = .305$, $\eta^2_p = .00$, $\eta^2_p = .00$. However, there was still a significant effect of using Twitter on scores on the learning test for content taught in the second half of the course, with higher scores for students who followed the instructional Twitter ($M = 5.57$, $SD = 1.74$) than for students who did

not ($M = 4.77$, $SD = 2.13$), $F(1, 149) = 4.35$, $p = .039$, $\eta^2_p = .03$. There was no difference for content taught in the first half of the course, $F(1, 149) = 0.00$, $p = .987$, $\eta^2_p = .00$, and in this analysis, the interaction between use of Twitter and section of the pre-exam test (first half vs. second half of the course) was marginally significant, $F(1, 149) = 3.42$, $p = .067$, $\eta^2_p = .02$, reflecting a marginally higher advantage of students following the instructional Twitter for content covered in the Twitter than for content covered in the first half of the course when controlling for preliminary learning.

4. Discussion

4.1. Summary of the Results

The purpose of the present study was to examine how using Twitter as an educational tool can affect motivation and interest as well as learning and academic outcomes. To complement the existing literature, which especially suffers from a lack of direct measures of actual performance, we conducted a three years experiment in a ‘naturalistic’ setting in a French university. Our results revealed that following a pedagogical Twitter significantly increased motivation (with both an increase of intrinsic motivation and a decrease of amotivation) and interest in the course over the semester, above and beyond preexisting differences between students. The effects on learning and academic outcomes were less clear: there were significant differences between groups of users and non-users, but these differences were more difficult to assign unambiguously to the benefits of using Twitter. We discuss these two series of results in turn.

One of the most interesting findings of the current study is related to intrinsic motivation and amotivation, as well as interest in the course. A few studies had been conducted on the impact of a Twitter-based instructional method on motivation, but the researchers based their conclusions

on a single survey, often including a single item to examine the impact of Twitter on motivation. As expected based on existing literature, our results using a dedicated motivation questionnaire administered before and after the intervention demonstrated that using a pedagogical Twitter was associated with an increase in intrinsic motivation and a decrease in amotivation (Adams et al., 2018; Fewell, 2014; Malik et al., 2019). In our opinion, this result is quite promising. It was also not to be taken for granted before the study started, given that it goes against the results found by Coutts et al. (2011) showing that interventions conducted over time, including evaluations of knowledge throughout the semester, can actually decrease intrinsic motivation in students.

Likewise, the effect of a pedagogical Twitter on interest in the course had scarcely been investigated in past literature (Adams et al., 2018; Bista, 2015; McArthur & Bostedo-Conway, 2012). Our results regarding interest confirmed that students engaging in the pedagogical Twitter experienced a significant increase in their interest in the course content. Taken together, these are promising findings for teachers who want to implement this instructional design to stimulate student interest in the course content. In a nutshell, our social media intervention could positively affect motivation and interest or could support specific students' profile in helping them to develop and maintain intrinsic motivation and interest throughout the semester.

A major contribution of our study, when compared to prior research, was methodological. The use of reliable measures helps complement existing findings based on single items. Another originality of our work was the use of repeated measures, which made it possible to partly account for the selection bias inherent in a 'naturalistic' setting (where participation in the instructional Twitter was partly confounded with preexisting differences in motivation and interest). Using repeated measures confirmed the conclusions obtained previously in surveys (Adams et al., 2018),

and showed that students who participated in the pedagogical Twitter experiment experienced a higher *increase* in motivation and interest throughout the year, above and beyond preexisting differences.

Concerning scores on learning tests and academic outcomes, our results were generally in line with the literature (Blessing et al., 2012; Luo & Clifton, 2017; Luo et al., 2019) in showing a significant improvement of students' knowledge with the pedagogical Twitter. Students enrolled in the Twitter-based instructional method had both higher performance on the learning tests for course content, and better grades on the final exam for the course. However, when taking a closer look at the data, the benefits did not appear as clear-cut as could have been hoped. For grades on the final exams, students using the pedagogical Twitter had better grades not only on our course, but also on other unrelated courses. Likewise, for the learning tests, students using the pedagogical Twitter had significantly higher scores only on content covered via Twitter, but they were also descriptively better on content not covered via Twitter, and their advantage was not significantly greater on content covered via Twitter – except for the third cohort controlling for learning with a preliminary test, who performed marginally better on content covered by the instructional Twitter.

4.2. Methodological Limitations

The results for learning and academic outcomes, with a general advantage for students following the instructional Twitter, point to a difficulty in disentangling the actual benefits of the instructional Twitter from a selection bias. Since the current study was performed in a ‘naturalistic’ setting, we could not use an experimental design randomly assigning the students to the instructional Twitter or to a control group. Such a strategy would have created a major breach in equity between students, raising insurmountable ethical issues, in addition to altering the ‘naturalistic’ conditions of the course. The downside is that this design allowed the more motivated

students to engage in following the instructional Twitter more than the non-motivated students, creating a baseline difference between the groups of users and non-users – unrelated to an effect of the intervention itself. This does not invalidate our results regarding motivation and interest in the course, given our use of a design with multiple measures which allowed for a test of motivation and interest *increases* during the semester. However, it is not possible to entirely deconfound the results regarding learning and academic outcomes from this selection bias. In light of the results (with a non-significant advantage for the content not covered via Twitter and with a marginally significant interaction in the third cohort when controlling for preliminary learning), a tentative conclusion is that most of the learning advantage of the user group was driven by a selection bias, but there was some benefit of Twitter (i.e. intrinsic motivation and interest increased, amotivation decreased and positive effects on learning and academic outcomes) above and beyond this bias.

Another limit of the current study was the results regarding extrinsic motivation: we failed to find an effect of the instructional Twitter, in contradiction with our hypothesis and with the literature. There are two possible interpretations. This absence of an effect could be explained by the fact that using the pedagogical Twitter was not mandatory: all the students who participated were volunteers. As argued by Adams et al (2018), this design could have encouraged only intrinsic motivation instead of extrinsic motivation. Another possibility is that the lack of results was due to the low reliability of this measure, as also reflected in the low correlations with other variables. Fortunately, the other measures of interest and motivation retained very good reliability, allowing for clear-cut conclusions.

A more general concern with our design in ‘naturalistic’ conditions was the impossibility to track the actual number of consultations of the instructional Twitter contents by the students. Twitter as a platform does not enable reliable tracking of which users read which content. As a

result, we could only collect retrospective measures regarding the frequency with which students engaged with the content and the quizzes. The only way to ensure that the students effectively read the content and responded to the quizzes would have been to record their activities online, with trackers implemented on their personal devices. Every week during the course, we reminded the cohort that some new material was provided, but there was no way for us to ensure that they deeply processed the information.

4.3. Directions for Future Studies

In the course of this experimentation, the teachers involved in the study identified a few obstacles and possibilities for improvement that should be considered by colleagues interested in adopting a pedagogical Twitter.

One way to enhance the implementation of a Twitter-based method would be to elicit more interactions with the system. Students did not generally interact with the content on Twitter (e.g. by commenting or sharing the tweets with others): they tended to remain attached to face-to-face interactions (Manca & Ranieri, 2016b). In line with Manca and Ranieri (2016a), we observed that the management of relationships with students must be considered in order to ensure the effectiveness of a Twitter-based instructional method. Future work could consist in exploring the benefits of supporting communication in Twitter, in order to promote its positive effects on learning, academic outcomes and motivation.

Boosting social interactions in a pedagogical Twitter also means having a better understanding of the drawbacks of being visible on social media. Some studies demonstrated that students may feel subordinate to expert users of Twitter, or vulnerable to criticism of their own Twitter audience; they may also sometimes encounter cyberbullying (Lackovic et al., 2017; Nagle, 2018; Waycott et al., 2017). As suggested by Nagle (2018), efforts should be made to propose

ethical recommendations to teachers who wish to invest in this kind of learning methods on social networks open to the public.

Another important factor to consider when integrating a Twitter based instructional method is interaction with the platform. Informal discussions in the first year of the study suggested that students failed to engage significantly with the content provided on the social media platform. In order to stimulate the interest of our students with our Twitter-based method, we gradually added practice questions on Twitter about previously studied material during the course. Based on the testing effect (Fiorella & Mayer, 2015; Roediger & Karpicke, 2006), we supposed that self-testing should enhance long-term learning and consequently, performance on the final exam. Including practice recall tests could thus be a way to elicit deeper processing of the content, which could potentially transfer to the final exam and enhance effectiveness of the method. We did not directly test the effectiveness of these quizzes in the current study (which was not designed to contrast the three cohorts of students), but this could be a possible extension of our results.

As a future direction, we recommend to focus especially on the pedagogical affordances in social media that can help support pedagogical activities and overcome the limits of the traditional Learning Management Systems with this platform. Indeed, the present study was focused on Twitter but our results have broader implications for pedagogical use of social media in education. Twitter shares with other social networks the following specificities (Barrot, 2020): a high number of users, a wide usage across geographical boundaries and multiple interactive affordances exceeding those provided by traditional Learning Management Systems. According to Manca (2020), this set of affordances can be defined as : 1) Mixing information and learning resources coming from different channels, especially visual resources, 2) Hybridizing the expertise including the participation of students, past students, experts and external professionals, 3) widening the

context of learning. These affordances are exploited at different degrees in other social media platforms. For example, mixing visual resources is rather common on Instagram. Other platforms sharing affordances similar to Twitter may offer the same benefits found in the current study, especially in terms of student motivation and interest.

As a consequence, to get the best value from social media, it would be necessary to identify which features are most relevant for increasing learning and motivation. It would also be valuable to have a typology of these affordances in order to know which platforms are best suited to which pedagogical uses. Manca (2020) provided a basis for this work by showing that the specificities of each platform can be adapted to certain educational activities. Indeed, WhatsApp is adapted to facilitate interaction and exchange of information in several media formats, Pinterest serves the need to create a “catalogue of ideas” and aggregate contents retrieved from the Web. Specifying the affordances of each platform will make it easier to support teachers who want to propose contents with a real educational value. Helping teachers to make the best choice of social media platform in a given pedagogical context, while ensuring that their choice is compatible with regard to the pedagogical objectives, is essential to ensure the success of this innovative pedagogical practice.

4.1. Conclusion

Using an instructional Twitter as a teaching tool seems to be an effective way to increase motivation and interest for a course during a semester. Some potential benefits were also observed in terms of learning and academic outcomes, but these benefits were less clear-cut and more difficult to disentangle from a selection bias. Further studies would be helpful to test more integrated versions of the instructional Twitter method, including both course-related content and

activities designed to enhance interaction with the content and the rest of the class, such as online quizzes, as a way to boost effectiveness of the method.

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Figure 1. Multiple examples of tweets with course-related contents (partly blinded).

The figure consists of two side-by-side panels. The left panel shows a tweet with a quiz question. The text is partially obscured by black redaction boxes. The question asks about the visual pathway that continues to function in a certain condition. Four options are listed: A (cortical), B (dorsal), C (retino collicular), and D (ventral). Below the options are four rounded rectangular buttons labeled A, B, C, and D. At the bottom, it says '2 votes · Il reste 23 heures 57 minutes' and has icons for replies, retweets, likes, and share. The right panel shows the results of the quiz. The question text is also partially redacted. The results are shown as a list of options with their corresponding percentages: 'Une fois sur deux' (11%), 'Une fois sur trois' (12%), 'A la fin' (11%), and 'A partir du 11e jour' (66%). The last option is highlighted in blue. Below the results, it says '66 votes · Résultats définitifs' and has icons for replies (1), retweets (2), likes, share, and a bar chart icon.

3 Dans le [redacted] la voie visuelle qui continue de fonctionner est :

A La voie corticale
B La voie dorsale
C La voie rétino colliculaire
D La voie ventrale

2 votes · Il reste 23 heures 57 minutes

3- Dans l'expérience de [redacted] (1930) sur l'apprentissage latent, le premier groupe n'est jamais renforcé, le second toujours renforcé, le troisième est renforcé :

Une fois sur deux	11 %
Une fois sur trois	12 %
A la fin	11 %
A partir du 11e jour	66 %

66 votes · Résultats définitifs

Figure 2. Left panel: example of a tweet with a course-related quiz (partly blinded). Right panel: example of feedback after a quiz has been answered (partly blinded).

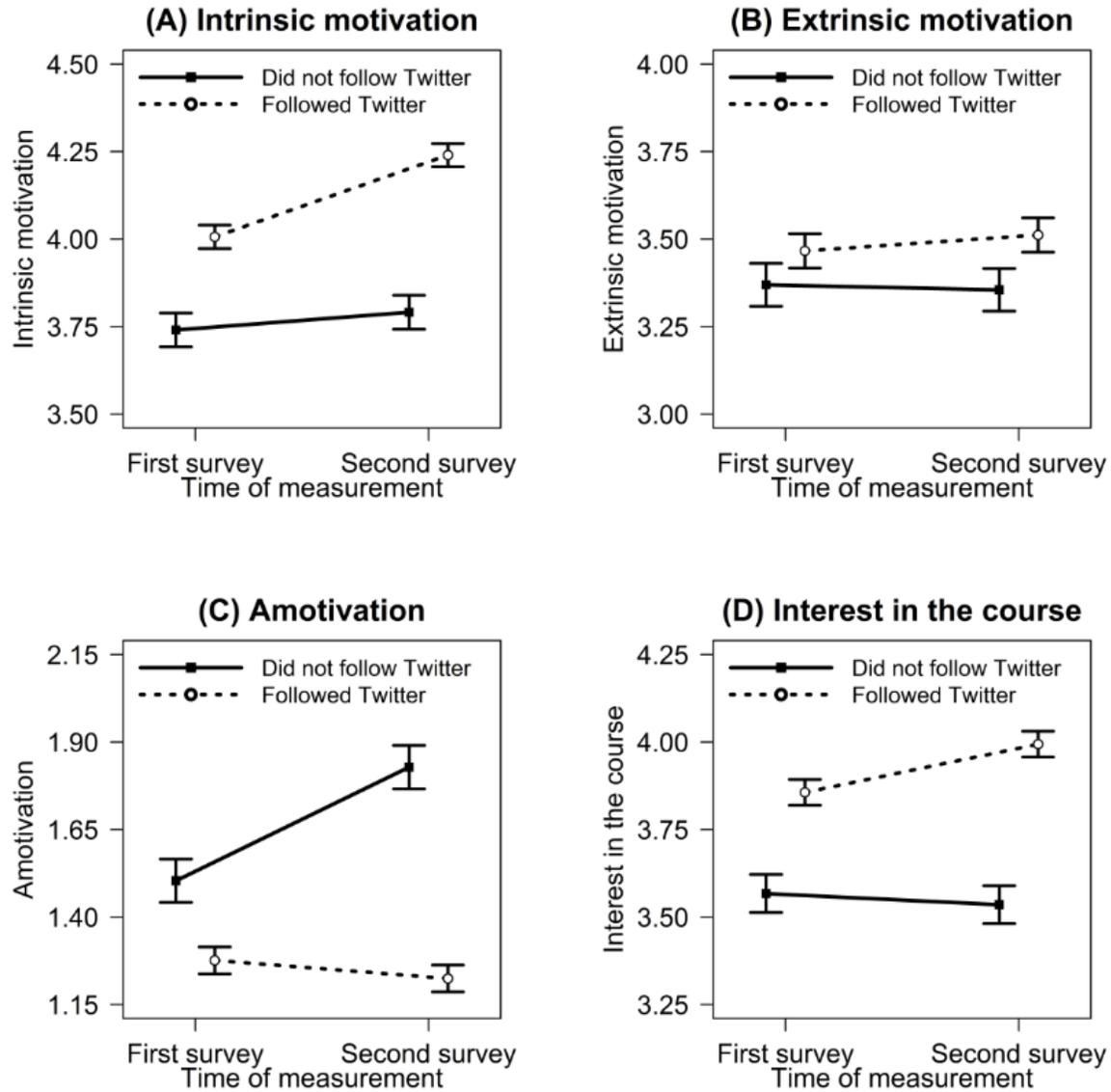


Figure 3. Effects of following the instructional Twitter on ratings throughout the semester for (A) Intrinsic motivation, (B) Extrinsic motivation, (C) Amotivation, (D) Interest in the course. Error bars represent within-subjects standard errors of the mean (Morey, 2008).

Appendix 1 : Motivation and Interest Questionnaire

Instructions (English translation): *Indicate, with a check mark, the extent to which each of the following statements corresponds to one of the reasons you spend time learning cognitive psychology. There is no "right" or "wrong" answer, so don't try to give an answer you think is desirable, but choose the one that best describes how you truly feel. Please answer all the questions.*

Instructions (French version used in the study): *Indiquez, à l'aide d'une coche, dans quelle mesure chacun des énoncés suivants correspond à l'une des raisons pour lesquelles vous consacrez du temps aux enseignements en psychologie cognitive. Il n'y a pas de « bonne » ou de « mauvaise » réponse, ne cherchez pas à donner une réponse que vous pensez souhaitable, mais choisissez celle qui décrit le mieux ce que vous ressentez véritablement. Merci de répondre à toutes les questions.*

Item n°	Construct	French version	English translation
1	Interest (situational)	J'apprécie tellement les cours que j'aimerais en savoir plus sur la psychologie cognitive.	I enjoy the classes so much that I would like to learn more about cognitive psychology.
8	Interest (situational)	Ces cours m'incitent à découvrir plus de choses sur la psychologie cognitive.	These classes inspire me to discover more about cognitive psychology.
4	Interest (personal)	La psychologie cognitive m'intéresse.	I am interested in cognitive psychology.
11	Interest (personal)	Je suis sensible aux travaux utilisant les approches de la psychologie cognitive.	I am receptive to research works that have used the approaches of cognitive psychology.
2	Intrinsic motivation (accomplishment)	Je ressens du plaisir à comprendre des choses parfois assez difficiles grâce aux cours de psychologie cognitive.	I feel pleasure in understanding things that are sometimes quite difficult thanks to cognitive psychology classes.
17	Intrinsic motivation (accomplishment)	J'ai l'agréable sensation d'être devenu(e) un peu plus compétent(e) dans le domaine grâce aux cours de psychologie cognitive.	I have the pleasant feeling that I have become a little more competent in the field thanks to cognitive psychology classes.
5	Intrinsic motivation (stimulation)	Je m'amuse à apprendre de nouvelles choses à l'aide des cours de psychologie cognitive.	I am having fun learning new things with the help of cognitive psychology classes.
13	Intrinsic motivation (stimulation)	Je peux apprendre de nouvelles choses stimulantes intellectuellement grâce aux cours de psychologie cognitive.	I can learn new and intellectually stimulating things from the cognitive psychology classes.
7	Intrinsic motivation (knowledge)	J'aime approfondir mes connaissances sur les thèmes présentés dans les cours de psychologie cognitive.	I enjoy learning more about the topics presented in cognitive psychology classes.
15	Intrinsic motivation (knowledge)	Les cours de psychologie cognitive m'offrent la possibilité d'apprendre des choses intéressantes.	Cognitive psychology classes offer me the opportunity to learn interesting things.

3	Extrinsic motivation (regulated)	Je me suis dit que suivre sérieusement les cours de psychologie cognitive pourrait peut-être m'aider à améliorer mes résultats universitaires.	I thought that maybe taking the cognitive psychology classes seriously could help me improve my academic performance.
9	Extrinsic motivation (regulated)	Je ne voulais pas décevoir les enseignants qui me demandent de suivre avec application les cours de psychologie cognitive.	I didn't want to disappoint the teachers who asked me to take the cognitive psychology classes with application.
12	Extrinsic motivation (introjected)	Je me serais senti(e) coupable de ne pas suivre consciencieusement les cours de psychologie cognitive.	I would have felt guilty for not conscientiously following the cognitive psychology classes.
14	Extrinsic motivation (introjected)	Je me suis senti(e) obligé(e) de suivre consciencieusement les cours de psychologie cognitive.	I felt compelled to conscientiously attend the cognitive psychology classes.
6	Amotivation	Pour être sincère, je n'ai fait que le strict minimum dans les cours de psychologie cognitive.	To be honest, I only did the bare minimum in cognitive psychology classes.
10	Amotivation	Honnêtement, j'ai eu l'impression de perdre mon temps avec les cours de psychologie cognitive.	Honestly, I felt like I was wasting my time with the cognitive psychology classes.
16	Amotivation	Pour être franc(che), je m'ennuie dans les cours de psychologie cognitive.	To be honest, I get bored in cognitive psychology classes.
18	Amotivation	J'avoue que je ne suis pas intéressé(e) par les contenus des cours de psychologie cognitive.	I confess that I am not interested in the content of the cognitive psychology classes.

Note. The interest items were adapted from Rotgans and Schmidt (2014), the motivation items were adapted from the EMG of Guay and colleagues (2003).