Procrastination, participation, and performance in online learning environments

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ABSTRACT

The present study focuses on a specific learner characteristic in the management of time – procrastination-, and its role in an online learning environment. More specifically, it was expected that procrastination would influence the successfulness of online learning and that this could be explained by the level of participation of learners in discussion forums. A study was conducted to test this hypothesis among a sample of learners taking a 10-week course on environmental and land use issues. As predicted, a negative relationship was found between procrastination and performance, and this relationship was mediated by the level of the learners' participation in discussion forums. In other words, it appears that if high procrastinators are less successful online learners than low procrastinators, it is partly due to their lack of participation in discussion forums during the learning process. Additionally, some behavioral differences between high and low procrastinators were found in the times they decided to (re)start working at a distance, felt motivated to work on their course, and felt like dropping out of the course. To conclude, some practical implications for tutoring online activities and for stimulating participation in online learning environments have been proposed.

1. Introduction

Today, there is an increasing need for education in a society in which citizens are required to have a good level of education and to constantly upgrade their skills through life-long learning. A recent EU commission report on European cooperation in education and training clearly indicated that further efforts are required to promote adult learning, including the development of new forms of learning and the use of new teaching and learning technologies (The European Commission, 2009).

Online learning is considered as one way of meeting this growing need because it makes education accessible to all, including people living in remote areas or who have work or family constraints. Figures show that the number of distance learners has increased rapidly in recent years (e.g., Gunawardena & McIsaac, 2004). A better understanding of the processes which can improve this type of learning is a challenge for the future. Research into online learning is an emerging field, and some studies have already investigated the factors underlying the success or failure of online learning. These include issues of time management and participation at a distance. Indeed, the main reasons given by students when asked why learners fail or drop out of an online course were lack of time and procrastination (e.g., Doherty, 2006). Many learners have to overcome a tendency to put off completing assignments. Consequently, it is important to identify which learners are most at risk of procrastination, as well as the processes whereby this tendency may affect performance. However, few studies have examined the role of the tendency to procrastinate in online learning performance (e.g., Elvers, Polzella, & Graetz, 2003; Romano, Wallace, Helmick, Carey, & Adkins, 2005; Tuckman, 2002, 2005, 2007; Wilkinson & Sherman, 1990), and even fewer have considered the underlying social factors. The present study aimed to investigate the impact of procrastination on performance, taking the level of learner participation in discussion forums as a mediating variable.

2. Time management in (online) learning environments

Time management is recognized as one of the major factors of success in traditional educational settings where university grades are strongly influenced by time management skills (e.g., Britton & Tesser, 1991; Macan, Shahani, Dipboye, & Phillips, 1990; Trueman & Hartley,

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1996). Indeed, the ability to manage time successfully is positively related to academic performance, and conversely, poor time management contributes to academic underachievement (e.g., Balduf, 2009). It has been demonstrated that these skills account for 36% of the variance of grade averages of university students. Time management skills are also vital in online learning which requires self-discipline in order to devote adequate time to course work. Although online learning provides flexibility for adult learners to engage in and complete learning programs at times which suit them, it requires a high level of motivation and good time-management skills (e.g., Kerr, Rynearson, & Kerr, 2006). However, there are individual differences in the ability to manage time which may affect online learning success.

2.1. Individual differences in time management

Individual differences in aspects of time management have been identified in learning settings, procrastination being one of the most important. Procrastination has been defined as the tendency to delay initiation or completion of important tasks (Lay, 1986), or to put off tasks to the point of discomfort (Solomon & Rothblum, 1984). The tendency to postpone tasks has been reported within everyday settings (e.g., Burka & Yuen, 1983), and as many as 20% of nonclinical adults labeled themselves as "chronic procrastinators" (Harriott & Ferrari, 1996). Procrastination is a problem confronting many adults on a daily basis, particularly for tasks which have to be completed by a specific deadline, and it is common among students, particularly at college and university levels.

A number of researchers have examined the relationship between procrastination and academic outcomes (e.g., Akinsola, Tella, & Tella, 2007; Beswick, Rothblum, & Mann, 1988; Howell, Watson, Powell, & Buro, 2006; Rothblum, Solomon, & Murakami, 1986; Tice & Baumeister, 1997; Wesley, 1994). Academic procrastination is defined as intentionally deferring or delaying work that must be completed (Schraw, Wadkins, & Olafson, 2007). In a meta-analytic study, Steel (2007) reported findings that 80%–95% of college students procrastinate (Ellis & Knaus, 1977) and that 50% procrastinate consistently (Solomon & Rothblum, 1984). Although research in this domain has yielded mixed results, most studies report negative correlations between procrastination, grades, learning, and completion of course work (e.g., Beswick et al., 1988; van Eerde, 2003; Howell et al., 2006; Moon & Illingworth, 2005; Rothblum et al., 1986; Tice & Baumeister, 1997; Wesley, 1994). Thus, procrastination is usually related to poor academic performance (e.g., Akinsola et al., 2007; Beck, Koons, & Milgrim, 2000; Wesley, 1994). For example, it has been found that a procrastination tendency relates negatively to course grades (e.g., van Eerde, 2003; Rothblum et al., 1986; Tice & Baumeister, 1997), and that students with low procrastination tendencies achieve higher grades in mathematics than students with moderate and high levels of procrastination (Akinsola et al., 2007). It has also been found that a tendency to procrastinate is associated with lower performance on a writing task when participants have no feedback (Fritzsche, Young, & Hickson, 2003) or no fixed deadlines (Ariely & Wertenbroch, 2002). Research into the relationship between procrastination and performance has been extended to explore the underlying self- and social-regulation processes.

2.2. Self-regulation processes

The tendency to procrastinate is often related to a deficiency in self-regulation processes. A large number of studies have examined "self" variables such as self-handicapping (e.g., Beck et al., 2000), self-esteem (e.g. Ferrari, 1994; Solomon & Rothblum, 1984), self-efficacy (e.g., Bandura, 1997; Effert & Ferrari, 1989), self-regulation (e.g., van Eerde, 2000; Senécal, Koestner, & Vallerand, 1995; Steel, 2007), metacognitive self-regulation through achievement goal orientations (e.g., Howell & Watson, 2007; Pintrich, 2000), and self-efficacy for self-regulation (e.g., Klassen, Krawchuk, & Rajani, 2008). While a large number of "self" variables are related to procrastination, there is a strong body of evidence that higher levels of procrastination are related to lower levels of self-regulation (e.g., Ferrari, 2001; Klassen et al., 2008; Senécal et al., 1995; Steel, 2007; Wolters, 2003). For example, Ferrari (2001) found that "chronic procrastinators" fail to regulate their functioning, particularly in situations of stress and high cognitive load. This failure to regulate cognitive functioning may explain the lower performance of people who tend to procrastinate. Similarly, other researchers have shown that metacognitive self-regulation and self-efficacy for self-regulation, i.e. confidence in selecting and implementing self-regulation strategies, appear to be strongly related to procrastination (e.g., Howell & Watson, 2007; Klassen et al., 2008; Wolters, 2003). For example, Howell and Watson (2007) found that procrastination was generally associated with lower use of cognitive and metacognitive learning strategies and with disorganization, i.e. underutilization of a methodical approach to learning. Overall, these results demonstrate that (metacognitive) self-regulation is one of the key variables underlying procrastination and its influence on performance. Although research has demonstrated that self-regulation processes may explain the relationship between procrastination and learning outcomes, there is little evidence regarding the mediating role of social regulation processes at work during social interactions. Nevertheless, it is reasonable to consider that the social regulation processes occurring between tutors/instructors and learners and between learners themselves may explain the relationship between procrastination and learning outcomes.

2.3. Social regulation processes and participation

The construct of social or co-regulation is generally used to explain the dynamics and relational nature of participation in learning activities (e.g., Efklides, 2008; Salonen, Vauras, & Efklides, 2005; Volet, Summers, & Thurman, 2009). In line with several social theories of learning (e.g., Doise, 1990; Doise & Mugny, 1984; Johnson & Johnson, 1989; Vygotsky, 1978; Wenger, 1998), interacting with others appears to be one of the main indicators of active participation, enabling social regulation processes such as negotiating, confronting, externalizing ideas, explaining, questioning, and so forth. The importance of active participation has long been emphasized in education (e.g., Alavi, 1994; Astin, 1996; Pratton & Hales, 1986), particularly when this is inspired by constructivist, collaborative, and social learning theories. The social regulation processes involved in participation have been widely investigated during collaborative learning tasks (e.g., Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003; Michinov & Michinov, 2007, 2008, 2009; Strijbos, Martens, & Jochems, 2004; Volet et al., 2009), less so during individual online learning courses where learners have the possibility of using asynchronous communication tools such as discussion forums. Nevertheless, a major challenge of online learning is to encourage learners to participate actively even though they are geographically dispersed (e.g., Moore & Kearsley, 1996). Indeed, learner–learner interaction, whereby students serve as resources for each other and also provide mutual psychological support (e.g., Underwood & Underwood, 1999), has been recognized to play an important role,

both in reducing the physical and psychological isolation of learners (e.g., Hrastinski, 2006, 2008, 2009; Lake, 1999) and in influencing a wide range of learning outcomes (e.g., Astin, 1996; Bento & Schuster, 2003; Davies & Graff, 2005; Fredericksen, Picket, Shea, Pelz, & Swan, 2000; Nistor & Neubauer, 2010; Webster & Hackley, 1997). In a study including a great diversity of outcome measures, Astin (1996), concluded that "the greater the interaction with peers, the more favorable the outcome" (p. 126).

Similarly, studies have investigated the impact of participation in online learning environments on learning effectiveness, measured both as perceived learning by means of questionnaires and as final grade, i.e. effective performance. Research has shown that learning in an online environment is most successful when students feel that they participate (e.g., Bento & Schuster, 2003; Webster & Hackley, 1997) and when they participate effectively (e.g., Davies & Graff, 2005; Fredericksen et al., 2000). For example, some research suggests that students who fail tend to interact less frequently with their peers than those who succeed (e.g., Davies & Graff, 2005). Others have found that learning effectiveness, measured as perceived learning by students, is boosted when there is interaction with the instructors and peers (e.g., Fredericksen et al., 2000). Similarly, Alstete and Beutell (2004) found that the strongest indicator of student performance in online courses was related to the use of discussion forums. This finding was supported by the fact that the number of student sessions was positively and significantly related to overall course performance. Because writing is necessary to interact with others by posting a message in a discussion forum, and because several cognitive advantages of writing have been recognized by researchers (e.g., Bereiter & Scardamalia, 1987; Olson, 1994), the number of messages in the discussion forums may be considered as a relevant (although simple) indicator of active participation in online learning environments (see Hrastinski, 2008, for a review). Indeed, writing a message is a particularly useful way of externalizing ideas as well as for other social regulation processes such as negotiating, confronting, reasoning, explaining, questioning, and so forth.

2.4. Hypothesis

As demonstrated in previous studies, the higher the procrastination tendencies are, the lower the performance (e.g., Akinsola et al., 2007; Beck et al., 2000; Beswick et al., 1988; van Eerde, 2003; Howell et al., 2006; Moon & Illingworth, 2005; Rothblum et al., 1986; Tice & Baumeister, 1997; Wesley, 1994). Similarly, higher participation leads to better performance (e.g., Bento & Schuster, 2003; Davies & Graff, 2005; Fredericksen et al., 2000; Webster & Hackley, 1997). In the present study, it was expected that the relationship between procrastination and performance would be mediated by the level of learner participation. In other words, learners with higher procrastination tendencies would participate less in the discussion forums and their performance would be lower.

3. Method

3.1. Participants

Eighty-three adults, aged between 28 and 52 years, enrolled on an online learning program, were asked to fill out a web questionnaire. The questionnaire was presented as part of a study for improving the design and tutoring of online learning courses. Completion of the questionnaire was voluntary. Forty participants (21 females and 19 males) completed the self-report measures in full and were selected to participate in the present study ($M_{age} = 42.3$; $SD_{age} = 7.2$). All the participants completed the module up to the final assessment allowing their performance to be evaluated.

3.2. Procedure

The present study was carried out entirely online using Moodle as an e-learning platform. Moodle (Modular Object-Oriented Dynamic Learning Environment) is an Open Source Learning Management System (LMS) allowing effective online learning courses to be created and offering a wide range of learning resources and activities such as web questionnaires, blogs, wikis, lessons, and so on.

At the beginning of the online learning course, all the participants completed a web questionnaire which included a procrastination scale and socio-demographic measures. The learners had enrolled to take one of ten modules containing a similar number of online sessions. The modules covered topics such as climate change, hydrology, biodiversity, wetlands, solar energy, and aquatic ecology. Teaching staff evaluated them to be very similar in terms of difficulty and structure. Each module was scheduled over a 10-week period and monitored by a tutor/instructor. During this period, learners had to work on a case study presenting an authentic environmental and land use issue and to write a report analyzing the case and describing the most appropriate actions. During the module, the tutor/instructor adopted the three classical roles in online learning environments: expert, facilitator, and assessor. More specifically, they supplemented self-study materials, clarified misunderstandings, indicated sources of information, helped the learners achieve their learning goals and carried out assessment to check that they achieved these goals.

A general discussion forum was created for each module, together with a specific discussion forum for each case study. For example, in the "Watershed hydrology" module, there were discussion forums about case studies covering topics such as "run-off in the Roujan catchment (Languedoc-Roussillon, France)", "analysis of the hydrological reaction to rainfall in the Kervidy to Naizin catchment (Brittany, France)", and "analysis of the water table in the Kervidy catchment (Brittany, France)". Each case study forum contained several topics (3–8 threads) with messages organized in a semi-threaded display format to facilitate multiple replies. The discussion forums were moderated by the tutor/instructor of a specific module.

Although learners were not obliged to use the discussion forums, they were invited at the beginning of the learning module to use them to analyze their case study and to learn by exchanging knowledge with others. They were informed that the best solutions for all the case studies could be found through discussions between learners, for two main reasons: (1) no single student had all the knowledge needed to resolve complex and authentic environmental problems, and therefore they needed to find information from others in order to analyze the problem presented in the case studies; (2) all of them were involved in a continuing education program, and as professionals they had considerable experiential knowledge and information that could be shared with other adult learners to resolve the problems presented. For these reasons, learners were strongly encouraged to use the discussion forums and take advantage of interactions with other distance learners.

At the end of the 10-week period, learners had to post their written report on the online learning platform. Before the final assessment, they were asked to complete a further web questionnaire designed to investigate the dynamics of behavior of learners with a greater or

lesser tendency to procrastinate. This questionnaire included additional self-reported information regarding the times (weeks) when they wanted to start (or restart) working, felt like dropping out, and felt motivated to do their course work.

3.3. Measures

3.3.1. Procrastination

The 16-item Tuckman Procrastination Scale (Tuckman, 1991) was administered. This self-report scale provides a measure of "the tendency to waste time, delay, and intentionally put off something that should be done" (Tuckman, 1991, p. 479). Items include: "I always finish important jobs with time to spare"; "I postpone starting in on things I don't like to do"; "When I have a deadline, I wait till the last minute." Learners respond on a four-point scale ranging from 1 = *That's not me for sure* to 4 = *That's me for sure* (no neutral point). A Cronbach alpha reliability coefficient of .90 had previously been reported (Tuckman, 1991). In this study, the reliability coefficient of the scale was calculated as .92. A principal component analysis conducted on the items of the procrastination scale revealed a first component explaining 49.64% of the total variance. We used the scores of this component as indicators of the participants' level of procrastination.

3.3.2. Participation

As in many studies, we used the number of posted messages on discussion forums to measure participation, because it is the simplest and most common method. Although limited in scope, this measure has generally been preferred to comparing groups of learners by different characteristics (e.g., gender, learning styles, individual differences). The number of messages posted by learners was counted by a research assistant blind to the hypothesis. All the postings were counted, including the initial and feedback/subsequent ones, to measure the level of participation of each learner.

3.3.3. Performance

The written reports were marked by instructors who were unaware of the hypotheses of this study. Marks ranged from 0 (*very poor*) to 20 (*excellent*) and counted towards each student's final assessment. The learners did not have the same case study because they were taking different modules, but similar assessment principles were applied for each; the report had to contain the following five parts, each given a mark from zero to four:

(1) a summary of the facts about the case, (2) identification of the key issues, (3) a list of possible courses of action, (4) generation and evaluation of a range of alternative solutions, and (5) recommendation of the best solution and suggestions for implementing it.

Before the final grading decision, a pedagogical team composed of tutors/instructors met to harmonize the marks. During this meeting, the results were compared and the reasons for any significant differences in marks discussed with the subsequent revision of some marks. The harmonization procedure involved examining the best and worst reports in order to determine the scope of the assessments, i.e. the highest and the lowest mark. After that, a number of reports that appeared relatively ambiguous were read aloud by the instructors who had made the assessments and examined point by point in order to adjust the marks. The procedure ended when all the reports had been examined and all ambiguities removed.

3.4. Additional behavioral measures over time

A web questionnaire about the behavior of learners during the online learning module was used to monitor the dynamics of the behavior of high and low procrastinators (e.g., Michinov & Michinov, 2007, 2008). This questionnaire was administered at the end of the course before the learners were given their marks. Three self-reported behaviors were specifically investigated: when each learner had started (or restarted) to work at a distance, felt like dropping out, and felt motivated to work during the 10-week course. To this end, learners were asked the following three questions, and to tick the corresponding week(s) (from 0 to 10): (1) At what point(s) did you want to start (or restart) working remotely? (2) At what point(s) did you feel like dropping out? (3) At what point(s) did you feel most motivated to do your online course work?

4. Results

4.1. Mediation analysis

The purpose of the present study was to go beyond a simple correlation analysis and ascertain whether participation mediates procrastination and performance (Baron & Kenny, 1986). To test this model, a path analysis was performed using Mplus5 software (Muthén & Muthén, 1998–2009). As the number of participants was relatively small, a bias corrected bootstrap method (5000 bootstrap samples) was used to calculate the confidence intervals of the model estimates. As predicted, procrastination had both direct and indirect effects on performance. As can be seen in Fig. 1, high procrastination directly predicted poor performance. Moreover, an indirect effect also demonstrated that low participation was in turn a predictor of poor performance. This indirect effect was found to be significant using a further bootstrapping procedure (bias corrected, 5000 samples) which has higher statistical power than the classic Sobel test (Sobel, 1982,
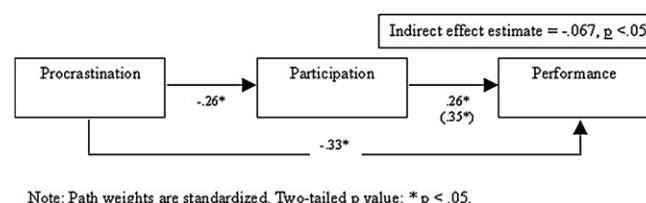

Fig. 1. Results of path analysis testing participation as a mediator of the effect of procrastination on performance.

see Hayes, 2009 for more arguments in favor of indirect effects with bootstrapping). Based on the present results, it can be suggested that if high procrastinators have less success in online learning than low procrastinators it is partly because they participate less in discussion forums during the learning process.

4.2. Additional behavioral measures

In order to gain a better understanding of the dynamics of behaviors over time among high and low procrastinators, additional analyses were performed on the data gathered from the web questionnaire administered at the end of the online learning module. Because perceived behaviors were measured at ten time points (t1–t10), new variables were created to measure their evolution over time (linear, quadratic, or cubic) using a trend analysis procedure. Trend analysis is a specialized form of single-df comparisons when a quantitative predictor is taken into account. One way of assessing a linear trend is to use a set of coefficients representing an idealized version of a straight-line relationship. A quadratic trend represents a U-shaped relationship with a single upward or downward change of direction, while a cubic trend is a more complex pattern with two major changes of direction (e.g., Kirk, 1995; Winer, Brown, & Michels, 1991). Consequently, a set of contrast weights corresponding to the predicted linear (-5 -4 -3 -2 -1 $+1$ $+2$ $+3$ $+4$ $+5$), quadratic (-2 -1 0 $+1$ $+2$ $+2$ $+1$ 0 -1 -2), and cubic (-2 -1 $+1$ $+2$ $+1$ -1 -2 -1 $+1$ $+2$) effects of each measure was carried out. These contrast weights were applied to the individual scores observed on the web questionnaire (e.g., Furr & Rosenthal, 2003; Rosenthal & Rosnow, 1991) and a set of formulae were applied to calculate the linear, quadratic and cubic trends for each behavior (for example, linear trend $= -5 \times$ t1 $+ -4 \times$ t2 $+ -3 \times$ t3 $+ -2 \times$ t4, $+ -1 \times$ t5 $+ 1 \times$ t6 $+ 2 \times$ t7 $+ 3 \times$ t8 $+ 4 \times 9 + 5 \times$ t10). Each trend was regressed on the level of procrastination (high *versus* low) to be compared (see Table 1 for gathered data). All t-test analyses performed were reduced to 1 df to avoid the family-wise Type I error (see Michinov & Michinov, 2009; Michinov & Monteil, 2002, for similar analyses).

4.2.1. Desire to (re)start working remotely
The results of trend analyses indicated only a cubic effect of procrastination on the times when learners wanted to (re)start working remotely, $\beta = .34$, $t(1, 39) = 2.23$, $p < .03$, $R^2_{adj} = .09$ (see Fig. 2). This effect suggests that, unlike low procrastinators who said that they wanted to (re)start working during the first weeks of the online learning module, high procrastinators put off study till the middle or end of the module, exhibiting a cubic trend over time. Alternative trend analyses (linear and quadratic) showed no differences between high and low procrastinators in the times they wanted to (re)start their online work.

4.2.2. Desire to drop out
Similarly, trend analyses indicated only a quadratic effect of procrastination on the times when learners felt like dropping out, $\beta = .44$, $t(1, 39) = 3.01$, $p < .005$, $R^2_{adj} = .17$. As shown in Fig. 3, this effect suggests that, unlike low procrastinators, there was a quadratic trend for high procrastinators to feel like dropping out over time. This pattern shows that the high procrastinators' desire to drop out increased at the midpoint of the course, suggesting that this behavior was privileged when they had the greatest difficulty in managing their time. Alternative trend analyses (linear and cubic) revealed no statistically significant differences between high and low procrastinators on this measure.

4.2.3. Motivation to work remotely
Trend analyses also indicated a quadratic effect of procrastination on the times when learners felt motivated by their work, $\beta = -.41$, $t(1, 39) = -2.76$, $p < .009$, $R^2_{adj} = .14$. As shown in Fig. 4, this effect suggests that, in contrast to low procrastinators, there was a quadratic trend in the motivation of high procrastinators to do their course work. Indeed, while the motivation of the low procrastinators remained high and stable over time, the motivation of high procrastinators decreased dramatically at the midpoint of the course and then increased at the end. Alternative trend analyses (linear and cubic) showed no differences between high and low procrastinators on this measure.

Statistical differences between high and low procrastinators were also examined on each of these measures. No significant difference was revealed in the number of times that low and high procrastinators indicated that they started (or restarted) working over the 10 weeks, $t(38) = -1.30$, $p = .20$ ($Ms = 1.40$ and 2.15, respectively). By contrast, the two groups differed in their desire to drop out of the course and in their motivation to work online. While high procrastinators were more inclined to drop out than low procrastinators, $t(38) = -2.05$, $p < .05$ ($Ms = 1.60$ and $.35$, respectively), the reverse pattern was observed for motivation which was higher among low procrastinators than high procrastinators, $t(38) = 2.46$, $p < .02$ ($Ms = 3.85$ and 1.70, respectively).

4.3. Intercorrelations

Finally, relationships between the variables were analyzed by examining their correlations. Table 2 presents the Pearson correlation coefficients between the different variables in the study, as well as some descriptive data (means and standard deviations).

Table 1
Trend analyses of the three measures for low and high procrastinators.

| Measures	Procrastination	Time										Total number	Mean	SD	Trend analyses
		Week #1	Week #2	Week #3	Week #4	Week #5	Week #6	Week #7	Week #8	Week #9	Week #10				
Desire to (re)start working remotely	High ($n = 20$)	3	2	4	6	4	3	4	5	6	6	43	2.15	1.4	Cubic trend
	Low ($n = 20$)	7	3	3	2	2	2	2	3	2	2	28	1.40	1.4	
Desire to dropout	High ($n = 20$)	1	1	5	5	3	4	3	5	2	3	32	1.60	2.6	Quadratic trend
	Low ($n = 20$)	1	1	1	0	0	0	0	1	1	2	7	.35	.8	
Motivation to work remotely	High ($n = 20$)	7	3	1	2	0	1	5	2	5	8	34	1.70	1.1	Quadratic trend
	Low ($n = 20$)	8	9	7	7	8	7	9	8	7	7	77	3.85	3.7	
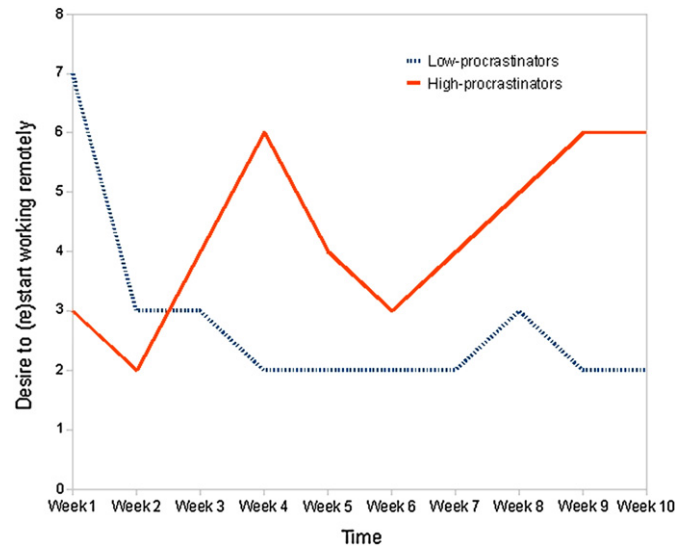
Fig. 2. Weeks selected by low and high procrastinators in response to the question about the desire to (re)start working remotely.

As shown in Table 2, the main variables (procrastination, participation, and performance) were intercorrelated. More specifically, these results show that procrastination was negatively related to participation and performance, suggesting that the higher the tendency to procrastination, the lower the participation in discussion forums and performance. Participation was also positively related to performance, suggesting that the more learners participate in discussion forums, the better their performance.

5. Discussion and implications

The purpose of the present study was to examine the impact on online learning success of a specific feature of time management – procrastination. The level of participation in discussion forums was expected to mediate the relationship between procrastination and performance. As expected, the results demonstrated a negative relationship between procrastination and performance, mediated by the level of learner participation in discussion forums. In other words, it appears that if high procrastinators are less successful than low procrastinators, it is partly because they participate less (and later) in discussion forums during the learning process. Following numerous studies on academic procrastination (e.g., Akinsola et al., 2007; Beck et al., 2000; van Eerde, 2003; Rothblum et al., 1986; Tice & Baumeister, 1997; Wesley, 1994), the present research extends these earlier findings to online learning environments, demonstrating that learners who are most likely to procrastinate are those with the poorest performance.

More importantly, this study found that the level of participation in discussion forums mediates the relationship between procrastination and performance. High procrastinators tend to write few messages in discussion forums, and thus have less communication with their peers (and their tutor/instructor) which has a deleterious impact on performance. On the other hand, low procrastinators tend to write a great number of messages in discussion forums, and this strategy, involving a high level of participation and interaction with others, has a positive impact on performance. These results suggest that merely offering asynchronous discussion forums in online courses does not
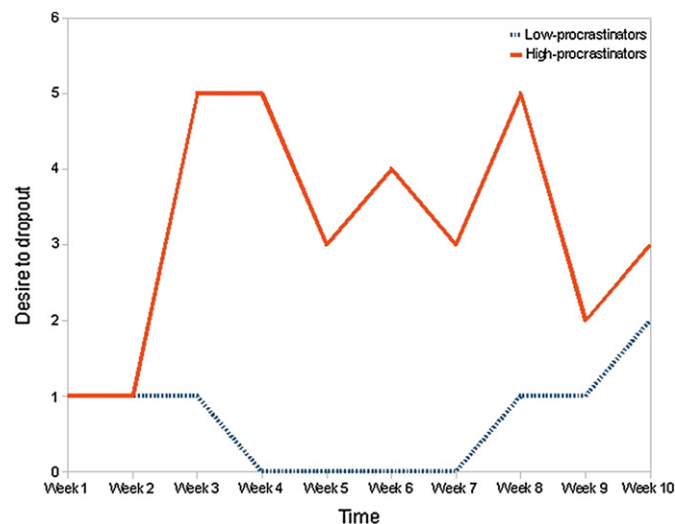

Fig. 3. Weeks identified by low and high procrastinators in response to the question about when they felt like dropping out.
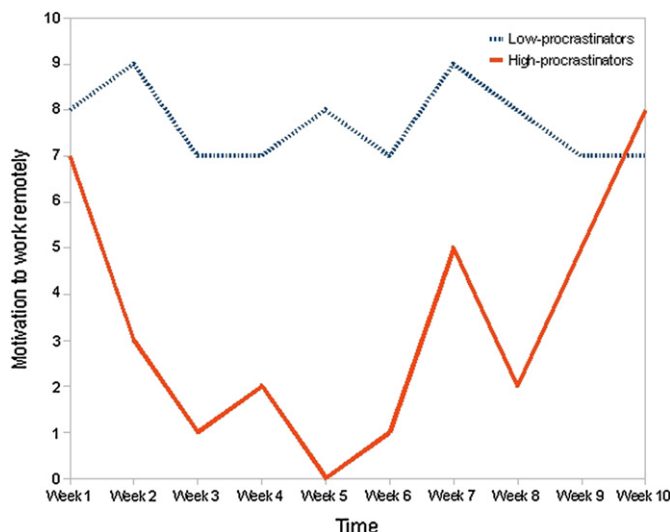
Fig. 4. Weeks identified by low and high procrastinators in response to the question about when they felt motivated to work.

necessarily generate more student interactions, the latter depending partly on the learners' procrastination tendencies. While low procrastinators appear to use the discussion forums spontaneously to interact with other learners and tutors/instructors, high procrastinators seem to avoid this means of communication. Due to their tendency to procrastinate, high procrastinators look at the discussion forums later, deliberately keeping themselves apart. By connecting up later, they lose the thread of discussions and then fear to appear as "newcomers". Consequently, they remain isolated until the end of the course. By contrast, low procrastinators engage socially with other learners, thereby becoming more involved in the online learning environment and improving their understanding of the course with the help of other learners and tutor/instructor. All these elements contribute to better performance.

These findings have practical implications for tutoring online students. As indicated by Tuckman (2005), the lack of supervision and reliance on learner initiative often lead to excessive procrastination and reduced performance, especially among students who have a tendency to procrastinate. A number of methods have been used to overcome procrastination in various contexts, such as applying specific learning and motivational strategies (e.g., Tuckman, 2003), scaffolding (e.g., Elvers et al., 2003; Tuckman, 2005, 2007), establishing regular deadlines (e.g., Ariely & Wertenbroch, 2002), giving regular feedback (e.g., Doherty, 2006; Tuckman, 2002), and so forth.

The results of the present study suggest that stimulating the participation of learners with a tendency to procrastinate may be another fruitful strategy to discourage students enrolled on online courses from procrastinating. Consequently, tutors/instructors need to identify people who procrastinate and to stimulate their participation in the early stages of online courses in order to prevent potential failure. Several strategies can be used to encourage the learners to participate in discussion forums at the beginning of an online course.

One strategy is to provide learners with feedback to enable them to compare their level of participation with that of others and particularly with higher achieving learners. This is known to improve performance in online asynchronous environments such as forums (e.g., Michinov & Primois, 2005). Another strategy would be for the tutor to encourage the learners to respond to each others' postings (e.g. An, Shin, & Lim, 2009). This strategy is known to stimulate the learners' participation, but the tutor/instructor needs to avoid becoming too involved in the discussions, studies having shown that this can inhibit the participation of the learners (e.g., Mazzolini & Maddison, 2003, 2007). Investigating the level of tutor/instructor participation in discussion forums and its impact on learners' tendencies to procrastinate could therefore offer new perspectives for research and help improve tutoring in online learning environments. Another strategy for stimulating participation in the early stages of online courses is to establish collaboration among learners with a tendency to procrastinate (possibly including some who do not have this tendency). A useful way to do this is to set up an electronic brainstorming session in which learners generate ideas or solutions asynchronously (e.g., Michinov & Primois, 2005). Collaborating with other students, which inevitably requires participation, has indeed been shown to be a good strategy for overcoming procrastination (e.g., Schraw et al., 2007). However, a recent study (Gafni & Geri, 2010) found that when assignments involved both individual and collaborative work, learners put off the collaborative part until the end of the semester when the assignment was compulsory and did not complete it at all when it was voluntary. By contrast, they tended to perform the individual task on time, even when the assignment was voluntary. Future studies should investigate

Table 2
Intercorrelations between variables among learners.

	Mean	SD	1	2	3	4	5	6
1. Procrastination (component scores)	40.57	12.60	–					
2. Participation	4.80	7.40	−.33*	–				
3. Performance	10.21	5.86	−.39**	.35*	–			
4. Desire to (re)start working (cubic trend)	0.07	1.86	.37*	−.25	−.09	–		
5. Desire to drop out (quadratic trend)	0.07	1.09	.41**	.005	−.02	.08	–	
6. Motivation to work (quadratic trend)	−0.7	1.8	−.34*	−.05	.18	.07	−.48**	–

$N = 40$; *$p < .05$; **$p < .01$

more systematically the impact of tutors/instructors on learner behavior in online learning environments and the interaction between learner characteristics and the style of tutoring.

In addition to the main aim of the present study, the dynamics of the online behavior of high and low procrastinators over time were compared using a web questionnaire administered at the end of the course. More specifically, three self-reported behaviors were measured: the times (i.e. weeks) when learners wanted to start (or restart) working at a distance, felt motivated to do their course work and felt like dropping out. Although exploratory, these measures are important to identify (even indirectly) crucial behaviors in online learning environments among high and low procrastinators.

The study showed that low procrastinators wanted to (re)start working remotely in the first weeks of the online learning course, whereas high procrastinators put off starting their work until the middle or end of the module, exhibiting a cubic trend over time. This result is consistent with the literature, demonstrating that when high procrastinators are not given any information or feedback about their performance, they start work later than low procrastinators (e.g., Fritzsche et al., 2003). Similarly, it was found that, in contrast to low procrastinators, high procrastinators' desire to drop out showed an inverted-U curve, increasing at the midpoint of the module. This appears reasonable given the finding that lower self-regulation predicts lower task persistence (e.g., Vallerand & Bissonnette, 1992; Vallerand & Sénécal, 1992). In contrast, a U-curve was observed for motivation to work remotely among high procrastinators. While motivation remained high and stable over time among low procrastinators, it decreased dramatically at the midpoint of the module among high procrastinators (week 5) and then increased steadily up to the deadline (week 10). This "midpoint effect" is consistent with the pattern of behaviors observed in online collaborative learning (Michinov & Michinov, 2007, 2008), although in the present case the pattern only concerns learners who tend to procrastinate. Thus, in online learning environments, it appears that high procrastinators experience greater negative effect at the midpoint of an online course when faced with a deadline. Studies on group development suggest that patterns of behaviors differ over time when there is a deadline (e.g., Gersick, 1988, 1989), so it is important to identify differences in the way learners allocate time in relation to a deadline according to their tendency to procrastinate (e.g., Gevers, Rutte, & van Eerde, 2006). For example, some individuals use a last minute cramming strategy (i.e., procrastinators), whereas others work regularly over time or show a non-linear pattern of behavior.

Other individual differences likely to be related to procrastination should be examined in order to understand better the social regulation processes at work in online learning environments and their impact on performance. For example, it may be particularly fruitful to examine individual pacing styles, i.e. allocation of time relative to a deadline (e.g., Gevers et al., 2006), temporal focus (e.g., Shipp, Edward, & Lambert, 2009), and achievement goal orientations reflecting the representation of competence-based outcomes that individuals strive to attain or avoid (e.g., Howell & Buro, 2009; Howell & Watson, 2007).

6. Conclusion, limitations and perspectives

To our knowledge, this is the first study to provide empirical evidence for the relationship between procrastination, participation in asynchronous discussion forums and performance in an online learning environment.

It appears that online learning success may be related to individual differences in time management and can be explained, at least in part, by the level of learner participation in discussion forums. These findings suggest that researchers and practitioners should take into account the individual characteristics of learners as well as the communication strategies involved in designing and optimizing online learning environments. Researchers thus need to investigate more thoroughly the relationship between procrastination, participation and performance, while these research findings will enable tutors to give greater assistance to online students. We hope that the results of the present study will provide fruitful material for future theoretical and applied research.

Like many studies, the present research has some theoretical and methodological limitations which may reduce its scope. At least three limitations may be touched on at a methodological and theoretical level. First, the study involved only 40 adult learners which may limit generalizations to similar populations. Nevertheless, although the number of online learners was small, an initial test of our theoretical hypotheses was made using a bootstrapping method particularly suitable for small samples. Second, the choice of Tuckman's (1991) procrastination scale could be criticized in that it essentially measures task avoidance rather than postponement. Consequently, future studies should extend and support the present findings using alternative scales, such as Lay's (1986) scale, or behavioral measures of procrastination which uses log analysis to measure postponement.

Finally, at a theoretical level, it is questionable whether active participation is necessary to increase performance in online learning settings. A high level of interaction and participation is clearly desirable in online learning courses as highly participatory students have been shown to achieve better results, although it has also been found that minimal online participation does not necessarily compromise results (e.g., Beaudoin, 2003). It appears that non-participative variables are also good predictors of performance, for example the number of discussion posts and content pages viewed, and time spent viewing discussions (e.g., Morris, Finnegan, & Sz-Shyan, 2005). As pointed out by Vonderwell and Zachariah (2005), participation is more than the total number of postings in a discussion forum (see also Hrastinski, 2008). It is reasonable to assume that the learners in the present study who participated most were also those who looked at the discussion posts and were therefore the most active in the online course.

Overall, these results suggest that research should not rely solely on the number of messages posted to measure learner participation, but should also consider the possibility that students also learn through passive participation in forums by reading the contributions of other learners. It is possible that individuals with high procrastination tendencies may learn through observation, whereas those with low procrastination tendencies prefer to learn by participating with others on discussion forums. However, this does not explain our finding that high procrastination tendencies are related to low performance. Future studies should examine more thoroughly the distinction between "active" and "passive" participation in discussion forums in order to identify the preferred strategies of high and low procrastinators and their impact on performance. Similarly, future research should distinguish between "passive" procrastinators who are paralyzed by their indecision to act and fail to complete tasks on time, and "active" procrastinators who prefer to work under pressure and take deliberate decisions to procrastinate (Chu & Choi, 2005). It is possible that the present study only considered "passive" procrastinators, which could explain the deleterious effects on performance mediated by a low level of participation in discussion forums.

Although limited in scope, the present research paves a way forward by examining the relationship between procrastination tendencies, participation, and performance in online learning environments. As such, it provides some interesting possibilities for improving online tutoring together with fruitful material for future research.

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