

Pattern of accesses over time in an online asynchronous forum and academic achievements

Luisa Canal, Patrizia Ghislandi and Rocco Micciolo

Luisa Canal is a professor in the Department of Psychology and Cognitive Sciences at University of Trento, Italy. She is particularly interested in employing statistical methods in interdisciplinary studies where differences of perspectives are important. Patrizia Ghislandi is a professor in the Department of Psychology and Cognitive Sciences at University of Trento, Italy. She carried out research in the field of training technologies and methodologies and coordinated the Online Teaching project while being pro-rector for distance teaching/learning at the University of Trento. Rocco Micciolo is a professor in the Department of Psychology and Cognitive Sciences at University of Trento, Italy. His main research interests are in the field of biostatistics, in particular longitudinal data analysis and repeated measures. Address for correspondence: Professor Luisa Canal, Department of Psychology and Cognitive Sciences, University of Trento, Corso Bettini, 31, Rovereto 38068, Italy. Email: luisa.canal@unitn.it

Abstract

In this study, the participation of 119 students in an online asynchronous forum as part of an academic course on statistical methods was evaluated. The pattern of accesses during the course was analyzed by means of the cumulative mean function. Taking into account the times (hours) at which accesses occurred, it is possible to achieve more accurate and more sensitive assessment of the role of concomitant variables (gender, final mark of the high school attended, examination outcome). As far as academic achievement was concerned, it emerged that graduating probability within 3.5 years from the end of the course was related only to a regular posting activity and not to the overall number of accesses.

Introduction

The momentum in higher education to replace or supplement traditional pedagogical methods with online learning has seen considerable acceleration in the last few years, especially in relation to distance learning (Emerson & MacKay, 2011). The use of online discussion forums is now a widespread medium for learning dialogue. Research in computer-supported collaborative learning has shown forum pros and cons to promote learning among students (Dillenbourg, Järvelä & Fischer, 2009; Naranjo, Onrubia & Segués, 2012; Rourke & Kanuka, 2009). Among the determining factors currently being proposed, there is a growing interest in the evaluation of the students' degree of participation in virtual discussions.

In a recent paper, Naranjo *et al* (2012) have addressed the issue of advancing “towards more carefully elaborated participation measures, combining several indicators, referring to the quantity of participation (such as the number of accesses or the number of postings on the discussion) and to the dynamics and participation characteristics (who interacts with whom and the degree of intensity of the interaction).” Also, Arbaugh *et al* (2008) had advanced the request for a more quantitative orientation of the researches into online communities and for more efficient measures of the framework. On this line, Barbera, Gros and Kirschner (2012) have addressed a fundamental question regarding temporal issues in e-learning research recalling that “time is a critical factor in learning, but time is also a very complicated factor that has many facets.”

Practitioner Notes

What is already known about this topic

- Many universities are currently encouraging the use of web support for traditional classroom teaching.
- According to some authors, there is a positive relationship between students' participation in online activities and their learning and performance.
- According to other authors, greater online interaction does not lead to higher performance for students in achieving passing grades.

What this paper adds

- Taking into account the times at which accesses occur, it is possible to achieve more accurate and more sensitive assessment of the role of predictive variables.
- Students with the highest passing grades have higher forum accesses through all the period of classroom teaching.
- Belated activity on the forum is not sufficient for passing the examination.
- Graduating probability is related only to regular posting activity and not to the overall number of forum accesses.

Implications for practice and/or policy

- It is important to promote and ensure a regular participation of students in forum activities, in particular in forum discussions.
- It is important to establish/negotiate with the students the objectives, the lectures, the assignments, the time scale and course pace, the evaluation strategies, and the individual and collaborative tasks.
- It is important to take into account the online activity in a longitudinal way; cross-sectional measures could give misleading results.

The aim of this paper is to explicitly take time into account (1) to evaluate the role of participating in a web forum by analyzing the students' access frequency and (2) to relate accesses with the student's career (both as final mark of a specific examination and as an academic outcome after 3.5 years of follow-up). In doing so, both well-established "survival" techniques and a simple and robust graphical method for the analysis of recurrent events (Lawless & Nadeau, 1995) will be employed.

Literature review

Our literature analysis, based on Fink (2010) methodology, was done firstly with an identification of the papers of potential interest, from January 2007 to September 2013, browsing the following journals: *British Journal of Educational Technology*, *Computers & Education*, *Educational Technology Research & Development*, *American Journal of Distance Education*, *eLearning Papers*, and *IRRODL-International Review of Research in Open and Distance Learning*. Basing our analysis on the paper's title, we found 40 studies. After a more detailed analysis based on the papers' abstract, we selected 22 studies and some other relevant references.

In our literature review, we started from a study (Hrastinski, 2008) developing a sound theoretical understanding of what online participation actually is and how it may be studied empirically. We found several studies analyzing the students' degree of active participation (number of postings) and passive participation (reading without posting) in an online discussion board. Some of them show a positive relationship with the students' learning and performance (student

final unit mark/grade, etc.) (Cho, Gay, Davidson & Ingraffea, 2007; Naranjo *et al.*, 2012; Webb, Jones, Barker & van Schaik, 2004; Yang & Chang, 2012). After two experiments that involved a large number of students, Cheng, Paré, Collimore and Joordens (2011) found that the number of posts is positively related to the scores of all the assessment components in the course and forum participation, particularly post reading, which promotes and leads to better outcomes in exam performance.

Palmer, Holt and Bray (2008), in a very complete and extensive analysis of a discussion in a wholly online engineering unit, found that the number of a student's postings on the online discussion is significantly related to the student's final unit mark, whereas the number of postings simply read is not, suggesting that passive participation does not significantly contribute to students learning outcomes.

Other studies found that greater online interaction does not lead to significantly higher passing grades (Reisetter & Boris, 2004; Sadik & Reisman, 2004; Song & McNary, 2011), even if students who fail in their courses tend to interact less frequently (Davies & Graff, 2005). Ramos and Yudko (2008) write that between the three variables—page hits, discussion reads or discussion posts—only page hits account for students' success, as measured by "total quiz score." As we can see, the different indicators do not always show the same relation with the quality of learning achieved by the students.

Furthermore, in our literature review, we found few studies that made explicit reference to the time management factor in the discussion board participation, although time management is recognized as one of the major factor of success in traditional educational settings where it has been well studied. Michinov, Brunot, Le Bohec, Juhel and Delaval (2011) studied the relationship between procrastination, participation in asynchronous discussion forums and performance in an online learning environment and reported that time management skills are vital for online learning which requires self-discipline in order to devote adequate time to course work. Reimann (2009), interestingly, argues about the fact that there is a difference between variable and event-based approaches for the analysis of temporal data and reports that "if individual and group processes are analyzed . . . without taking into account history, sequence, dynamics, in short: time, then many of the resulting findings are of limited value." He writes also that "time is indeed precious. Too precious to be ignored or not treated adequately when formulating and testing theories of working and learning collaboratively" (Reimann, 2009).

Barbera *et al.* (2012), after having screened 966 papers published from 2000 to 2010 in the *British Journal of Educational Technology*, found few papers explicitly related to time. They concluded that the time factor in e-learning research has been neglected and that there are weaknesses concerning this aspect of the methodology and "lack of in-depth longitudinal research to answer questions about the evolution of educational events across time." In the last sentence of their paper, they write that "more attention needs to be given to time as a variable in educational development and evaluation" (Barbera *et al.*, 2012).

These are the reasons why, in our study, we wanted to analyze the forum activity by evaluating the pattern over time of forum posting employing methods of multivariate survival analysis to see if it could give a new perspective on the correlation between discussion board participation and final academic achievement.

Study design and methodology

The main research question addressed in this paper was to evaluate if to participate in a web forum is related with the academic achievement of a cohort of students. To answer to this question, a longitudinal, observational study was performed analyzing the daily students' access frequency, employing the statistical methodology of survival analysis. The study started on

February 15, 2008 and investigated the participation of a cohort of students in a web forum, following their academic career up to December 31, 2011.

Pattern of forum accesses

The cohort of students which followed in 2008 the course in Psychometrics, a first-year unit for the 3-year course in Cognitive Psychology at the University of Trento (Italy), was considered. The course was held in a blended form as in addition to classroom teaching, web support by means of a Moodle platform was provided. A web forum allowed participants to have asynchronous discussions interacting with other students and/or the teacher. For each forum access, the following variables were considered: student identification, time of the contact (day/hour/minute/second) and type of the forum access (reading or posting). The temporal sequence of the forum accesses made between February 15, 2008 (when the course of Psychometrics began) and July 21, 2008 (the date of the course's second examination) was extracted from Moodle's records so that the daily number of accesses of each student was obtained and considered as a response variable. The following covariates were considered: student gender, final mark of the high school attended (this mark precedes the students enrolling in Cognitive Psychology) and outcome of the Psychometrics examination.

Forum accesses and academic achievement

The cohort of students was followed up till December 31, 2011, recording the graduation date for those who earned a degree in Cognitive Psychology. Therefore, for these students, the exact time of graduation was known. For the remaining students, the corresponding time was censored. The probability of obtaining a degree in Cognitive Psychology was considered as the response variable. The following covariates were considered: gender, Psychometrics examination outcome and level of forum activity.

Statistical methods

The pattern of forum accesses during the entire follow-up period was analyzed according to Lawless and Nadeau (1995). Their approach is based on the cumulative mean of the accesses and allows a pictorial representation of the access rate. Even if a different follow-up period is possible, when all subjects have the same follow-up time (as in the present case), the estimate of the cumulative mean function is straightforward. More specifically, if k is the number of students (constant over time) enrolled in the web forum and $N(t)$ is the total number of accesses observed over the interval $[0, t]$, the cumulative mean function of the number of accesses at time t is calculated as $N(t)/k$ (ie, as the arithmetic mean of the number of accesses observed up to time t). To compare proportions, the Fisher's exact test was employed.

The probability of obtaining a degree in Cognitive Psychology within 3.5 years from the end of the Psychometrics course was evaluated using the product limit method. The log-rank test (Mantel, 1966) with a significance level of .05 was employed to compare graduating probabilities in different subgroups. All the analyses were performed employing \mathfrak{R} (R Core Team, 2013). The cumulative mean function was estimated and plotted employing the set of \mathfrak{R} functions reported in Canal and Micciolo (2008).

Results

There were 119 students registered on the Psychometrics website in 2008. All the students were granted the same privileges in terms of the use of the web portal and forum. Overall, these students made a total number of 7628 forum accesses between February 15, 2008 and July 21, 2008 corresponding to a mean number of 64.1 accesses/student. There were 14 students who did not access the forum within this period; without considering these students, the mean number of accesses/student becomes 72.6. More details on the pattern of accesses can be

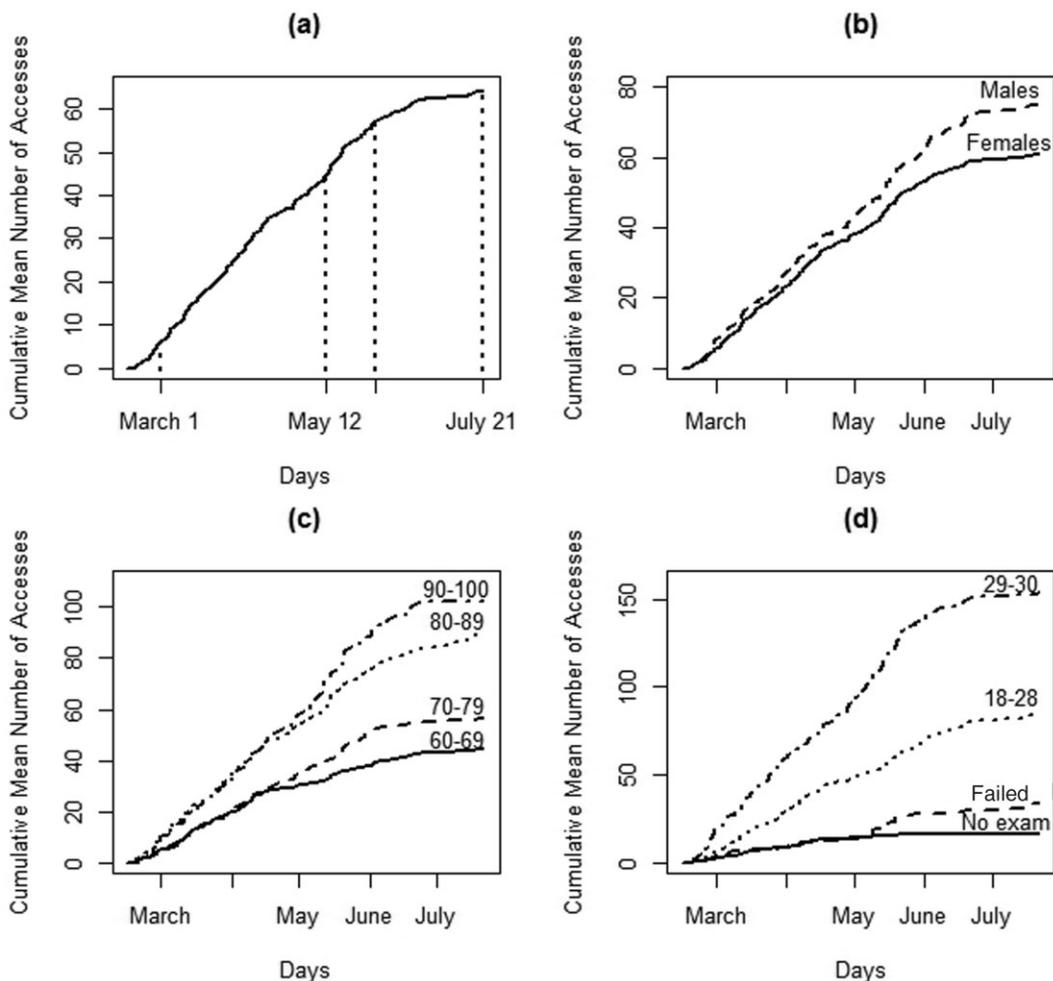


Figure 1: Cumulative mean function of the number of forum accesses between February 15, 2008 and July 21, 2008 for the whole sample (a) and for selected variables: gender (b), final mark of the high school attended (c) and Psychometrics course outcome (d)

obtained by calculating the cumulative mean number of accesses observed day by day, so obtaining an overall pattern of these accesses (see Figure 1a). For example, between February 15 and March 1, 1746 accesses were observed (ie, a mean of 6.3 accesses/student); between February 15 and April 1, 2853 accesses were observed (ie, a mean of 24.0 accesses/student); between February 15 and May 1, 4678 accesses were observed (ie, a mean of 39.3 accesses/student). These three figures correspond to the values of the cumulative mean number of accesses displayed in Figure 1a, after 15 days (6.3), 46 days (24.0) and 76 days (39.3).

About 2 weeks after the beginning of the course, the pattern of forum accesses is substantially linear up to the date of the first examination (June 3, 2008). This means that during this period, approximately the same number of accesses to the forum was made every day (about 0.53/day per student). At the date of the second examination (July, 21), the cumulative mean number of forum accesses/student was 64.1 so that during the period June 3 to July 21, the mean increase was about 0.17/day. The difference in the steepness of the curves between March 1 and June 3 and between June 3 and July 21 is clearly evident from Figure 1a.

Table 1: Characteristics of the students involved in the Psychometrics course and number of forum accesses between February 15, 2008 and July 21, 2008

| | Students | | Accesses | | Mean access/ student |
|---|----------|------|----------|------|-------------------------|
| | n | % | n | % | |
| Gender | | | | | |
| Female | 92 | 77.3 | 5601 | 73.4 | 60.9 |
| Male | 27 | 22.7 | 2027 | 26.6 | 75.1 |
| Final mark of the high school attended* | | | | | |
| 60–69 | 44 | 38.9 | 1956 | 26.3 | 44.5 |
| 70–79 | 28 | 24.8 | 1572 | 21.1 | 56.1 |
| 80–89 | 22 | 19.5 | 1970 | 26.5 | 89.5 |
| 90–100 | 19 | 16.8 | 1950 | 26.2 | 102.6 |
| Psychometrics examination outcome | | | | | |
| No examination | 45 | 37.8 | 738 | 9.7 | 16.4 |
| Failed | 7 | 5.9 | 234 | 3.1 | 33.4 |
| Passed (18–28) | 52 | 43.7 | 4356 | 57.1 | 83.8 |
| Passed (29–30) | 15 | 12.6 | 2300 | 30.2 | 153.3 |

*For six foreign students, the final mark was not available.

Table 1 shows the characteristics of the students involved in the Psychometrics course as well as their total number of accesses. Female-to-male ratio was about 3.4:1; only 17% had a final mark from the high school attended between 90 and 100 (the final mark, in Italy, can range between 60 and 100). Finally, about 56% of the students passed the final examination of Psychometrics by July 21. Table 1 also shows the total number of accesses observed between February 15, 2008 and July 21, 2008 within each of the considered categories. Figure 1 shows the cumulative mean plotted against time according to gender (Figure 1b), school leaving marks (Figure 1c) and the outcome of the Psychometrics course (Figure 1d).

When students were subdivided according to the school leaving marks (Figure 1c), during the first part of the course (descriptive Statistics), the pattern of forum accesses of the categories 80–89 and 90–100 appeared nearly identical; this was also true (with a lower rate) for the categories 60–69 and 70–79. After the beginning of the second part of the course (inferential Statistics), the students of the category 90–100 maintained the same rate observed during the first part, whereas the rate of the students of the category 80–89 decreased; this was also true for the students of the categories 70–79 and 60–69.

Access rates differed also according to the outcome of the Psychometrics course (Figure 1d). In Italian universities, students are not required to complete the exam at the end of the course; as a matter of fact, 45 students did not sit the final exam (until July 21). These students showed the lowest access rate. On the other hand, the highest rate was observed for students who passed the exam with the highest grade. This group accounted for 30.3% of the total accesses, whereas the group of students with a score between 18 and 28 accounted for 57.1% of the total accesses (Table 1). The former accounted for 2.6% of all the students, whereas the latter accounted for 43.7% of all the students. Therefore, the cumulative number of accesses was higher in the less numerous group. Up to the end of the lessons, the cumulative mean for the students who did not pass Psychometrics was quite similar to that observed for the students who did not sit the examination within July 21. From then on, the cumulative mean for the students who did not pass Psychometrics increased, whereas that for the students who did not sit the exam remained substantially constant. This pattern is not evident from the data shown in Table 1, where only the final means are reported. They appear quite different (16.4 vs. 33.4), but this difference is mainly

Table 2: Results of the log-rank test comparing graduating probability between categories of selected variables

| | <i>n</i> | <i>Observed</i> | <i>Expected</i> | <i>Chi-squared</i> | <i>p</i> |
|-----------------------------------|----------|-----------------|-----------------|--------------------|----------|
| Gender | | | | 0.39 | .534 |
| Female | 92 | 45 | 43.1 | | |
| Male | 27 | 11 | 12.9 | | |
| Psychometrics examination outcome | | | | 18.50 | <.001* |
| No examination | 45 | 7 | 19.5 | | |
| Not passed | 7 | 2 | 2.6 | | |
| Passed (18–28) | 52 | 34 | 27.6 | | |
| Passed (29–30) | 15 | 13 | 6.4 | | |
| Forum activity | | | | 0.35 | .555 |
| No | 14 | 5 | 6.33 | | |
| Yes | 105 | 51 | 49.67 | | |
| Forum activity | | | | 1.33 | .249 |
| No posts | 87 | 37 | 40.7 | | |
| Posts | 32 | 19 | 15.3 | | |
| Forum activity | | | | 8.44 | .004 |
| Less than three posts | 107 | 47 | 52.18 | | |
| Three posts or more | 12 | 9 | 3.82 | | |

*Test for trend.

because of the period immediately before the examination (Figure 1d). There were 14 students who made no forum access at all between February 15 and July 21. Only three of these students passed the examination compared with 64 out of 105 students who participated in online activity. The two proportions (.21 and .61) were significantly different at the Fisher's exact test ($p = .008$), and the odds of passing the examination for the students who participated in online activity were about sixfold (5.72) higher than those of students who made no forum access at all.

All the 119 students registered on the Psychometrics website were followed up to December 31, 2011. By this date, 56 (47%) earned the degree in Cognitive Psychology, whereas 32 (27%) withdrew; the remaining 31 (26%) were still enrolled. The log-rank test was employed to test the difference in the probability of graduating in Cognitive Psychology according to selected variables. The results are reported in Table 2.

There was no gender difference, whereas a significant trend with Psychometrics course outcome was found. Students were divided in four groups according to their level of forum activity in the web support of the course. Students in group 1 were those registered in the website but did not access to the forum. Students in group 2 were those who accessed to the forum only for reading but without posting. Students in group 3 made one to two posts. Students in group 4 made three posts or more. No difference was found either when comparing the students who accessed the forum (groups 2, 3, 4) with students with no forum accesses (group 1) or when comparing students who left one or more posts (groups 3, 4) with students without posts or without accesses (groups 1, 2). Students with three or more posts (group 4) showed a significantly higher probability of graduating compared with the students of the other three groups.

Discussion

Several studies have analyzed the students' participation degree in an online discussion. Some of them have shown positive relations with their learning and performance (Cheng *et al.*, 2011; Cho *et al.*, 2007; Naranjo *et al.*, 2012; Palmer *et al.*, 2008; Webb *et al.*, 2004; Yang & Chang, 2012). Other studies found that greater online participation was not associated with better academic achievements (Reisetter & Boris, 2004; Sadik & Reisman, 2004; Song & McNary, 2011), even if

students who failed in their courses tended to interact less frequently (Davies & Graff, 2005). According to Ramos and Yudko (2008), only page hits account for students' success.

These conflicting findings could be partly due to the different indicators employed to summarize the results. However, in our opinion, another possible explanation could be the lack of a methodology which explicitly accounts for the effect of time, whereas according to Barbera *et al* (2012), "there is a need to use events as units of analysis, which not only allows qualitative research methods but also augments quantitative methods including computational data analysis methods." Following this suggestion, as well as the request for a more quantitative orientation of the researches about online communities (Arbaugh *et al*, 2008), this study aimed to analyze the forum activity by evaluating the pattern over time employing methods of multivariate survival analysis. Plotting against time the number of accesses registered per day conveys an impression of the frequency and patterns of events. Such a graph has limitations, however, because it is often not easy to determine visually whether a trend or other pattern exists (Cook & Lawless, 2007). A more useful plot is the plot of the cumulative number of accesses, an increasing step function with jumps at each distinct access, which "integrates" the number of daily accesses and "smooths" their erratic variations. The cumulative mean number of accesses (similar to the cumulative failure rate in survival analysis) gives a sense of how the access rates vary with time. Periods in which the instantaneous access rate keeps fairly constant correspond to linear increments of the cumulative curve. Conversely, a nonlinear increment will be observed where the rate increases or decreases. This is evident in Figure 1c, where at the beginning of the second part of the course, students with 60–69 and with 80–89 school leaving marks decelerate their access rate. Therefore, taking into account the times at which events (ie, accesses) occur, it is possible to achieve a more accurate and more sensitive assessment of the value of predictive variables. A regular participation in forum activity (as shown by the slope of the first part of the cumulative mean function) is associated with achievement of highest final mark, whereas an irregular, weak participation is related to a failure. This is particularly evident in Figure 1d where it is shown that students who increase their access rate to the forum only a few weeks before the date of the exam do not achieve a positive outcome. These results are in agreement with those of Davies and Graff (2005) which highlighted the importance of both promoting and ensuring the participation of the students in online forums as learning support.

Another strength of this study is the long follow-up period which permitted the evaluation of the graduating probability of participants. In this case, only students who had a greater online participation showed higher graduating probability. These results can be considered in agreement with those found by Palmer *et al* (2008), which showed that the number of postings was positively related to the students' final mark but that the number of postings read did not significantly contribute to student learning outcomes. These results can be considered also in agreement with those of Romer (1993) who, in a face-to-face context, found that regularly attending class led to improved assessment outcomes for students. Moreover, Yang and Chang (2012) showed that interactive blogs were associated with positive attitudes toward academic achievement.

Palmer *et al* (2008) addressed the very important question if the correlation between student online participation and learning outcomes can be considered causative or if online participation is a *proxy* for the ability/motivation of the students involved. We think that our results can provide a partial answer. Although both active participation (posting) and passive participation (reading without posting) were associated with the final marks of the course in Psychometrics, only posting activity was associated with graduating probability. Although we cannot definitely rule out the possibility of a causal effect in the first case (final marks of the course in Psychometrics), it is very unlikely that a causal effect exists in the second case (graduating probability) so that posting has to be considered a *proxy* for the ability/motivation of the students.

Final grades and graduating probabilities were considered in this paper as a measure of student learning; some authors suggest to take into account cognitive, affective and social processes of learning (Garrison, 2007), as well as the actual content of the communication using the thematic analysis of the online forum participation.

Conclusions

The methodology in this study sought to measure the level of online participation employing an event-centered approach and to investigate whether online participation is associated with an improvement in student learning. A regular participation in forum activity was associated with achievement of highest final mark, whereas an irregular participation was related to a failure. Furthermore, posting activity was associated with graduating probability.

Therefore, important implications for practitioners are to promote and ensure a regular participation of students in forum activities and to establish/negotiate with the students the objectives, lectures, assignments, time scale and course pace, evaluation strategies, and the individual and collaborative tasks (Ghislandi, 2012). Furthermore, as the technique proposed is based on a simple descriptive index, it could be employed by all the practitioners to obtain a graphical visualization of the pattern of the accesses over the time (possibly within selected subgroups of students).

This is an observational study that focuses on a single course; therefore, the results found may be valid only for the population considered. Future research studies should be extended over multiple courses to confirm our results from microlevel to mesolevel (ie, curricular) and macrolevel (ie, organizational). Furthermore, no attempt was made in this paper to take into account the correlation between accesses of the students enrolled in the forum. To deal with this aspect, as well as to make adequate inferences, mixed effects models, generalized estimating equations and time series techniques would be employed in future researches.

Finally, the main suggestion for future research studies in e-learning is to give the due attention to temporal issues and to employ methods suitable for longitudinal studies as the use of cross-sectional measures could give biased results.

References

- Arbaugh, J. B., Cleveland-Innes, M., Diaz, S. R., Garrison, D. R., Ice, P., Richardson, J. C. *et al* (2008). Developing a community of inquiry instrument: testing a measure of the Community of Inquiry framework using a multi-institutional sample. *Internet and Higher Education*, 11, 133–136.
- Barbera, E., Gros, B. & Kirschner, P. (2012). Temporal issues in e-learning research: a literature review. *British Journal of Educational Technology*, 43, E53–E55.
- Canal, L. & Micciolo, R. (2008). The proportional means regression model for the analysis of recurrent event data. *BioMedical Statistics and Clinical Epidemiology*, 2, 157–169.
- Cheng, C. K., Paré, D. E., Collimore, L. M. & Joordens, S. (2011). Assessing the effectiveness of a voluntary online discussion forum on improving students' course performance. *Computers & Education*, 56, 253–261.
- Cho, H., Gay, G., Davidson, B. & Ingraffea, A. (2007). Social networks, communication styles, and learning performance in a CSCL community. *Computers & Education*, 49, 309–329.
- Cook, R. J. & Lawless, J. F. (2007). *The statistical analysis of recurrent events*. New York: Springer.
- Davies, J. & Graff, M. (2005). Performance in e-learning: online participation and student grades. *British Journal of Educational Technology*, 36, 657–663.
- Dillenbourg, P., Järvelä, S. & Fischer, F. (2009). The evolution of research on computer-supported collaborative learning: from design to orchestration. In N. Balacheff, S. Ludvigsen, T. de Jong, A. Lazonder & S. Barnes (Eds), *Technology enhanced learning: principles and products* (pp. 3–19). Houten: Springer.
- Emerson, L. & MacKay, B. (2011). A comparison between paper-based and online learning in higher education. *British Journal of Educational Technology*, 42, 727–735.
- Fink, A. (2010). *Conduct a research literature review—from the internet to paper* (3rd ed.). Thousand Oaks, CA: Sage Publication.

- Garrison, D. R. (2007). Online community of inquiry review: social, cognitive, and teaching presence issues. *Journal of Asynchronous Learning Networks*, 11, 61–72.
- Ghislandi, P. (Ed.) (2012). *eLearning. Theories, design, software & applications* (pp. 91–106). Rijeka: Intech. ISBN 978-953-51-0475-9.
- Hrastinski, S. (2008). What online participation is? A literature review. *Computers & Education*, 51, 1755–1765.
- Lawless, J. F. & Nadeau, C. (1995). Some simple robust methods for the analysis of recurrent events. *Technometrics*, 37, 158–168.
- Mantel, N. (1966). Evaluation of survival data and two new rank order statistics arising in its consideration. *Cancer Chemotherapy Reports*, 50, 163–170.
- Michinov, N., Brunot, S., Le Bohec, O., Juhel, J. & Delaval, M. (2011). Procrastination, participation, and performance in online learning environments. *Computers & Education*, 56, 243–252.
- Naranjo, M., Onrubia, J. & Segué, M. T. (2012). Participation and cognitive quality profiles in an online discussion forum. *British Journal of Educational Technology*, 43, 282–294.
- Palmer, S., Holt, D. & Bray, S. (2008). Does the discussion help? The impact of a formally assessed online discussion on final student results. *British Journal of Educational Technology*, 39, 847–858.
- R Core Team (2013). *R: a language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing. Retrieved from <http://www.R-project.org/>
- Ramos, C. & Yudko, E. (2008). “Hits” (not “Discussion Posts”) predict student success in online courses: a double cross-validation study. *Computers & Education*, 50, 1174–1182.
- Reimann, P. (2009). Time is precious: variable- and event- centred approaches to process analysis in CSCL research. *Computer Supported Collaborative Learning*, 4, 239–257.
- Reisetter, M. & Boris, G. (2004). What works: student perception of effective elements in online learning. *The Quarterly Review of Distance Education*, 5, 277–291.
- Romer, D. (1993). Do students go to class? Should they? *Journal of Economic Perspectives*, 7, 167–174.
- Rourke, L. & Kanuka, H. (2009). Learning in communities of inquiry: a review of the literature. *Journal of Distance Education-Revue De L'Éducation À Distance*, 23, 1, 19–48.
- Sadik, A. & Reisman, S. (2004). Design and implementation of a web based learning environment: lesson learned. *The Quarterly Review of Distance Education*, 5, 157–171.
- Song, L. & McNary, S. (2011). Understanding students' online interaction: analysis of discussion board postings. *Journal of Interactive Online Learning*, 10, 1, 1–14. ISSN: 154-4914. Retrieved April 14, 2012, from <http://www.ncolr.org/jiol>
- Webb, E., Jones, A., Barker, P. & van Schaik, P. (2004). Using e-learning dialogues in higher education. *Innovations in Education and Teaching International*, 41, 1, 93–103.
- Yang, C. & Chang, Y. S. (2012). Assessing the effects of interactive blogging on student attitudes towards peer interaction, learning motivation, and academic achievements. *Journal of Computer Assisted Learning*, 28, 126–135.