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ASSESSMENT OF E-LEARNERS' TEMPORAL PATTERNS

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Assessment of e-learners' temporal patterns in an online collaborative writing task

ABSTRACT

E-learners are generally adults with work and family constraints who get involved in the virtual campus looking for temporary academic flexibility. However, they are often confronted with collaborative learning activities which lead to additional organizational efforts by reducing their individual time flexibility. In this paper, we argue that time is a major variable in Computer Supported Collaborative Learning (CSCL) activities, and that assessing students' use of time in these situations can help educational designers to propose adequate time scripting to plan these educational activities.

This case study presents an exploratory analysis of time patterns for 15 groups of students (n=66), involved in a collaborative writing task. The results reveal that (a), e-learners' time-on-task increased since the beginning of the activity, (b), they work more during week days than during weekends and (c), they tend to work during "conventional" hours of the day. The identification of these patterns is the first step toward the development of new methodologies and computer-supported tools to enhance organisation of time and social aspects in CSCL.

KEYWORDS

E-learning; Computer-Supported Collaborative Learning; Academic time; Time patterns.

INTRODUCTION

Students' coordination in collaborative learning requires an additional organizational effort (Kirschner, Paas & Kirschner, 2009). This coordination activity could reduce students' efforts in their learning task. Despite the interest of Computer Supported Collaborative Learning (CSCL), in studies (Dillenbourg, Järvelä & Fisher, 2009; Stahl, 2002; Strijbos, Kirschner & Martens, 2004), very few studies have examined the efforts required in regards to coordination when considering time as a focus variable (Gros, Barberà & Kirschner, 2010). This paper supports the idea that time is a major variable in CSCL activities, and that understanding the time factor in e-learning is important to help students succeed. The first part of this paper highlights the importance of time in CSCL activities. In part two, the notion, reporting and assessment of time patterns are discussed. Following this theoretical characterisation, we introduce an exploratory analysis. The empirical analysis leads us to identify the different kinds of student time patterns during a CSCL course. Afterwards, we discuss the relation between the students' time pattern and the students' learning task success.

TIME FACTOR IN CSCL

Students engaged in e-learning (and distant education in general), are often adult learners who have work and family constraints (Diaz, 2002; Pallof & Pratt, 2003). The time they can allocate to their learning activities is thus reduced (after a day at work, during their children's nap, etc). Time is thus a central aspect in e-learning activities due to the lack of time experienced by e-learners. The numerous problems encountered by e-learners can be attributed to time availability constraints both at an individual and a collective level.

INDIVIDUAL TIME MANAGEMENT DIFFICULTIES

We consider time management as a decision-making process and prioritising as regards time use. Students decide on their academic time use depending on the degree of flexibility allowed by the learning task and their own time constraints. Due to the scarcity of time perceived by e-learners, time flexibility is one of the main e-learners' expectations towards their decision to enrol in an online course (Petrides, 2002; Schrum, 2002; Sullivan, 2001). The major difficulty for these learners is therefore to conciliate all their professional, social, and academic activities. Frankola (2001) explains the high drop-out rate of e-learners due to the failure to achieve this conciliation. Temporal flexibility reduces the weight of the learning activity, enabling a better conciliation. This flexibility, which could be preserved during individual activities where the students self-regulate their time use, is dramatically reduced by the time organisation of the group in the context of collaborative learning.

COLLECTIVE TIME MANAGEMENT DIFFICULTIES

Time difficulties, which are already encountered on an individual level, remain at the collective level of CSCL. The level of interdependence in the organisation of collaborative activities as defined by the group reduces the individual time flexibility.

In collective activities where the group members had no previous knowledge about each other (*zero history groups*, Kreijns, 2004), planning and organising learning activities can be a costly task that may reduce progress in the learning activity. Indeed, on the basis of a given amount of time to perform the task, the time the learners spend on organization is directly deducted from the time remaining to do the task itself. During collective activities, e-learners not only have to find time for their learning activities, but also establish collective organisation, implying a certain level of inter-dependence. For example, if the group decides to collaborate in a synchronous way, they would need to find shared-time with their teammates to collaborate. In long term collective activities, the definition of an organizational pattern, could thus reduce opportune planning efforts and allow the students to focus on the learning task.

Students' time use is thus valuable data for people trying to support collaborative e-learning activities. However, few studies focus on the time factor assessment in this kind of activities. We think that assessment of temporal patterns of e-learners' activities can provide us with essential information about how and when supporting e-learners in CSCL in particular and e-learning in general.

TIME PATTERNS

The concept of patterns in research is used to simplify complex phenomena (Bonthoux, Berger & Blaye, 2004). Regarding student activity, a temporal pattern refers to structures appearing periodically within a given temporal rhythm (Romero, 2010; Valax, 1986). One of the interests in patterns is that they enable understanding of past events and the anticipation of future actions (Valax, 1986). Students could plan their collective activity based on the knowledge they have of the their teammates' time patterns. Knowing how e-learners manage their time can thus enable researchers to better understand the learning process in CSCL and enable educational designers and teachers to better adapt the temporal characteristics of learning active-ties', (duration, milestones, synchronicity, etc.).

Time patterns have been largely used to describe the dynamics of group work but very few studies focus on CSCL. However, we think, that results from group work cannot be extended to those from the learning group for two major reasons. Firstly, in professional contexts, distributed virtual teams work within the temporal patterns shaped by their organisation (working hours of their respective offices and time zones, working calendar, etc.), and the temporal constraints of their shared objectives (project milestones and deadlines). In online education, learners most likely define their academic time, once they have solved their professional and social temporal constraints. This first difference makes the extension of results obtained in e-working to e-learning contexts improbable. Secondly, the group history is different in e-working and e-learning. The group history refers to whether the team mates know each other or not at the beginning of the task (Kreijns, Kirschner & Jochems, 2003; Kreijns & Kirschner, 2004).

In other words, it takes into account the relations between teammates. It appears that in e-working environments teammates often know each other before the start of the collaborative activity, whereas in an e-learning environment, the geographic distance between teammates, and the fact that groups are often randomly established by the teachers or e-tutor, often lead to the creation of groups with no history. This difference is important in the sense that, in a group with no

history, teammates need time to get to know each other (their availability, the way they work, their competence in the task), whereas in a group with a longer history this phase is shorter. This will necessarily result in different time patterns, at least if the activity is analysed at the task level.

For these reasons, we think that temporal patterns of e-learning activities need to be explored deeply. However, to obtain useful results, the durations of temporal patterns need to be acknowledged as a specific stage of the learning activity.

TIME MULTILEVEL ANALYSIS

Previous research using time patterns show a great disparity in the duration of the investigated time patterns. This spectrum explored in empirical studies considers durations of some seconds (Carreras, 2001) to decades (Gentleman & Whitmore, 1985).

Following the multilevel analysis approach recommended in CSCL by Cress (2008), and the micro and macro script differences proposed by Dillenbourg and Tchounikine (2007), we propose a time multilevel model with 3 levels. The first level is the collaborative activity duration as such. Most CSCL activities have a duration that is longer than one week (Reimann, 2009). However, this macro level is not always considered in the study of the evolution of organisational and learning processes in collaborative tasks. The second level is the weekly level; the week is the main time pattern in the organisation of human activities. Within the week, we can differentiate the time spent on week days or spent on the weekend (Fraisse, 1963). On the third level, we consider the time use during the day. Considering adult learners' chronotype and the professional constraints of adult students, we assume they will use the evening for their online learning activities.

METHODOLOGY

PARTICIPANTS

The participants,(n=66), are master students from Ghent University (Belgium), the University of Oulu (Finland), the University of Turku (Finland), and the Universitat Ramon Llull (Spain). The participants engaged in the International CSCL Course (ICSCLC), organised by the Learning and Educational Techno-logy Research Unit (LET), at the University of Oulu. During the collaborative phase of the work, students were organised into 15 groups (mean = 4.4; *SD* = 0.48). In consideration of the privacy policy set up by the Finnish universities, we were unable to access the demographics data of students engaged in these courses.

TASK

During the first weeks of the International CSCL Course, the students were engaged in an individual writing task. At the end of the individual phase, the students could choose their subject preferences for the collaborative tasks according to three main topics (Motivation and Emotion in CSCL, Structuring and Scripting CSCL, The Structure of Communication). Once they had chosen their topic preference, the course coordinator at the University of Oulu composed the groups and assigned them a specific subtopic. During this collaborative phase of the work, students were invited to write a paper on a topic related to CSCL. Each

group was invited to use its own Knol for the collaborative-writing task.

Knol is a Google web-based collaborative publication platform oriented to the production of user-written articles based on wiki technology. Manber (2007) defines the Knol as a "unit of knowledge", defined by the end-user without the editorial supervision of Google. During the activity, each group of students had to write their collaborative paper on their Knol and use it to organize their activity (by sending messages through the comments' section). The duration of this collaborative task was five weeks.

The choice of analysing data coming from collaborative writing task was motivated by two concerns. Firstly, a writing task (collaborative or not), is an open-ended task by nature (Galegher & Kraut, 1996). In other words, this task does not have one single solution and students need to decide when the text they are writing is good enough to stop the task. Generally, the end is thus defined by the deadline, which guarantees that students will work during the entire duration of the task. In our study, the learning task has a common start date and deadline, allowing us to compare all the groups by the same temporal perimeter.

Secondly, collaborative writing is communication-dependent because it requires teammates to exchange their ideas on the task. In online environments, this type of task is an ideal test bed for evaluating the impact of Computer-Mediated Communication (CMC), and computer-supported collaborative tools in the student group collaboration process. The exploratory results obtained in this exploratory analysis could contribute to progress in this line of research.

DATA

Data about the learners' use of time in the activity by weeks and days was collected through the Knol logs of each group of students (n=15). The data collection aims to analyze the differences between groups during the three levels of activity: the five week duration of the activity, as well as the weekly and daily time use in each of the students' groups. Knols logs describe the type of contribution made by each group member, with its date and time of publication. For the exploratory analysis in this case study, we considered the date of the contribution in relation to the beginning of the task, (day after the start of the activity), the day of the week when the contribution was made and at what time.

In the five week longitudinal activity level analysis, we added up, for all the students of a group, the number of notifications made each day from the beginning to the end of the activity. For the weekly level analysis, the contributions of each student of a group were summed up according to the day of the week they were published. Finally, on the daily level, the contributions of each student of a group were added according to the time of their publication. A distinction between contributions published on week days and week-end days was also made.

In order to obtain more precise patterns and to compare each group, we choose to divide each level of analysis in shorter, uniform time slots according to the usual time slots considered culturally.

According to Gersick's punctuated equilibrium model (1988, 1989), and the results from Michinov and Michinov (2007) in an on-line environment, a major change appears in e-learners' behaviour at the mid-point of a task.

This mid-point period corresponds to a negative period where e-learners reduce their work on the task (Michinov & Michinov, 2007; Reisslein, Seeling & Reisslein, 2005). Following these results, the comparison of the groups in the longitudinal activity level was conducted over three periods: the beginning of the activity,(day 0 to day 10), the mid term of the activity (days 11 to 21), and the end of the activity (day 22 to day 32).

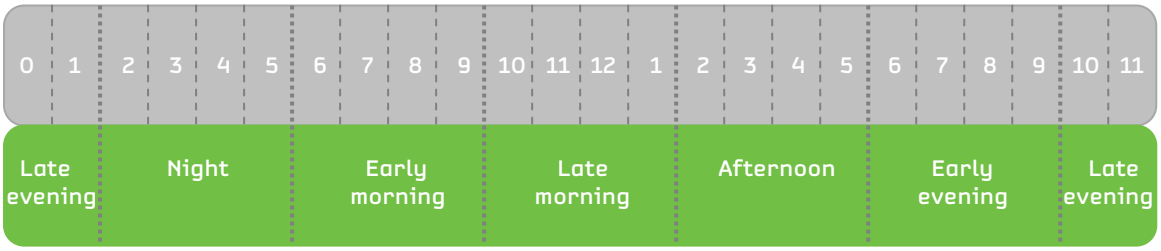
The weekly level was also divided, according to Fraisse (1963), into week days (Monday to Friday), and weekend days (Saturday and Sunday).

This distinction is particularly relevant in an e-learning context where adult students usually have work constraints during week days.

Finally, for the daily level, we choose to follow the cutting used in Nie and Hillygus (2002). In their study, they examine the time spent on the internet according to six time blocks: night, early morning, late morning, afternoon, early evening and late evening. In our context, we defined the times of these six blocks according to a standard day of work: night corresponds to 2 a.m. to 5 a.m.; early morning corresponds to 6 a.m. to 9 a.m.; late morning goes from 10 a.m. to 1 p.m.; afternoon from 2 p.m. to 5 p.m.; early evening from 6 p.m. to 9 p.m. and late evening from 10 p.m. to 1 a.m.. See table 1.

Table 1

Ditribution of the six time blocks for of the daily level.



RESULTS AND DISCUSSION

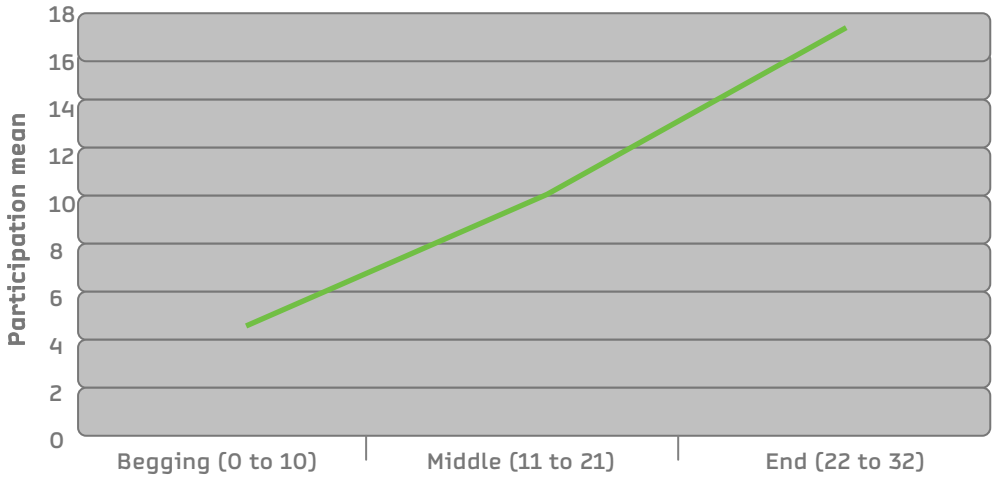
Results were analysed using within-subject ANOVA, including a group of students as a between subject factor.

LONGITUDINAL ACTIVITY LEVEL

Results of the within subject ANOVA reveal a main effect of longitudinal activity [$F(2,46) = 13.09$, $p < .001$, $\eta^2 = .14$][1], no group effect [$F(13,47) = 1.03$, $p = .44$], and no interaction effect between longitudinal activity and groups [$F(26,94) = 1.44$, $p = .10$].
Post hoc tests revealed that students' time-on-task increased constantly until the deadline.

The mean of participation on the Knol goes from 4.43 (SD = .80), at the beginning of the task (days 0 to 10), to 10.93 (SD = 1.65), at the mid-point of the task (days 11 to 21), $p < .001$, and to 17.04 (SD = 2.91), at the end of the activity (days 22 to 32), $p = .004$. See figure 1.

Figure 1. Temporal pattern for the longitudinal activity level.

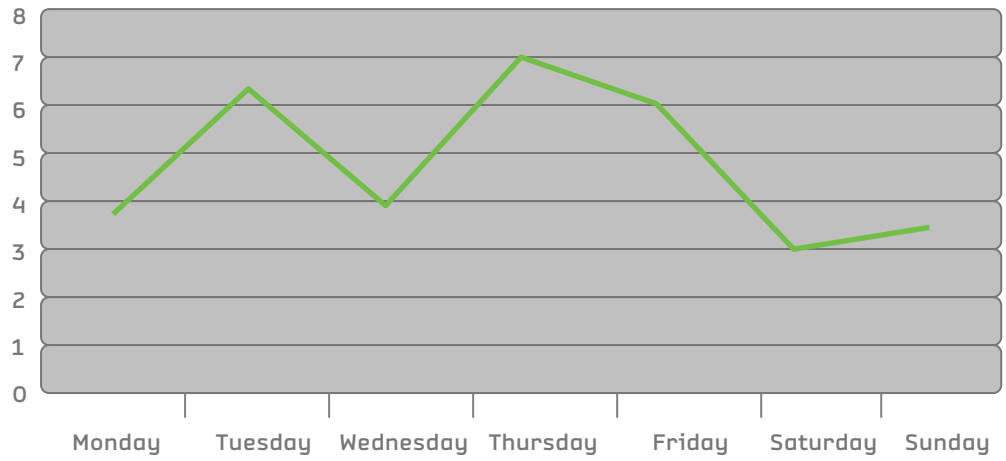


WEEKLY LEVEL

Results of the ANOVA revealed one main effect on the days of the week [$F(6,42) = 2.44$, $p = .04$, $\eta^2 = .005$], without effect of the group [$F(13,42) = 1.02$, $p = .44$], and no interaction effect between the day of the week and the groups [$F(78,282) = 1.27$, $p = .08$].

A post hoc test revealed only one significant difference in the amount of student participation between each day. This difference is between Thursday (mean = 6.85, $SD = 1.51$), and Sunday (mean = 2.85, $SD = 0.77$). See figure 2 for the general trend of data.

Figure 2. Temporal pattern for the weekly level.



In order to explore more specifically the difference between week days and weekend days, we conducted a within subject ANOVA on the basis of the participation mean of each participant during week days (Monday to Friday), as well as weekend days. Results show that e-learners tend to work more during week days (mean = 5.36, $SD = 6.57$), than during weekend days (mean = 3.07, $SD = 4.72$) [$F(1,47) = 7.15$, $p = .01$, $\eta^2 = .04$] . Again, no effect on the

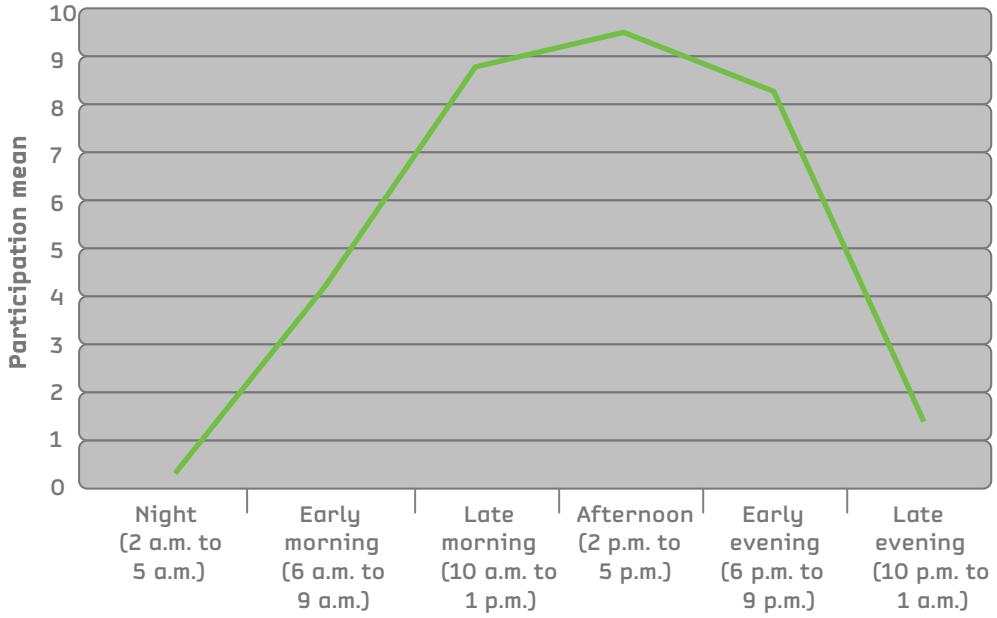
groups was detected [$F(13,47) = 0.71$, $p = .17$], nor interaction effects between week days/weekend days and groups [$F(13,47) = 1.62$, $p = .11$].

DAILY LEVEL

Results from the ANOVA revealed one main effect on the time [$F(5,43) = 7.61$, $p < .001$, $\eta^2 = .20$], no effect on the group [$F(13,47) = 1.08$, $p = .40$], and no interaction effect between the time and the group, [$F(65,235) = 1.26$, $p = .11$].

Post hoc tests revealed that students worked more in the late morning (10 a.m. to 1 p.m.), mean = 8.65, $SD = 1.52$, afternoon (2 p.m. to 5 p.m.), mean = 9.41, $SD = 1.65$, and early evening (6 p.m. to 9 p.m.), mean = 8.18, SD = 1.48, than in the early morning (6 a.m. to 9 a.m.), mean = 4.15, $SD = 0.89$,(respectively $p = .001$, $p = .002$ and $p = .011$), the late evening (10 p.m. to 1 a.m.), mean = 1.31, $SD = 0.52$ (all $p < .001$), and at night (2 a.m. to 5 a.m.), mean = 0.27, $SD = 0.24$ (all $p < .001$). The difference between early morning and late evening is significant at $p = .009$, also between early morning and night at $p < .001$, and between night and late evening at $p = .04$. There is no significant difference between late morning, afternoon, and early evening. Figure 3 illustrates the data presented above.

Figure 3. Temporal pattern for the daily level.



CONCLUSION AND IMPLICATIONS FOR PRACTICE

The results from the longitudinal activity level contradict the previous findings of Michinov and Michinov (2007) and Reisslein, Seeling & Reisslein (2005), which showed a decrease of work at the mid- point of the task. Our exploratory analysis shows, on the contrary, that students' time-on-task increased from the beginning to the end of the activity. Our results are however, consistent with the findings of Orvis, Wisher, Bonk, & Olson (2002).

Indeed, working on a synchronated problem-solving task, they showed a decrease in socio/emotional-oriented interaction to the benefit of the task-oriented interaction at the mid-point of the task. In the collaborative writing task we analyzed, the teammates had little previous group history, because most of the teammates did not know each other before the task. For this reason, we can suppose that the beginning of the task is used by teammates to get to know each other better, and to organize themselves (see, for example, the work of Hobaugh, 1997; Kreijns, Kirschner & Jochmens, 2002, 2003, highlighting the importance of this phase in collaborative learning). The increase in work is thus be explained by the fact that the end of the organizational/social phase gives more time to the teammates to work on the task.

The results of the weekly analysis were not really conclusive regarding the general trends of worktime during the whole week, as they only show a significant difference between Thursday and Saturday. However, we have shown that e-learners tend to work more during week days than weekend days. This result is consistent with Valax's (1999) work suggesting that people are more effective in planning and performing tasks in a structured environment because the time constraints enable people to set their possible autonomy margins. The week days are more structured than the weekend days due to work and family constraints. In these conditions, it is not surprising that teammates spend more time working on the task during weekdays.

The results of the daily activity show that e-learners do not tend to work very early or very late as could be expected given their work and family constraints. As for the weekly level, this result can be explained by the higher constraints occurring during the "conventional" time of day (i.e. from 10 a.m. to 9 p.m.), limiting the work on the learning task.

For people with many constraints, as is often the case with e-learners, these results raised the question of the quality of time spent on the learning task. Indeed, if e-learners principally work during the residual time left by their others activities, we can suppose that this time is segmented in quite short intervals and that they are not totally focused on the learning task. This can potentially be problematic in terms of the quality of the work, and therefore the success of the learning task. The quality of the time spent on the learning task should thus be taken into account in further research to better understand its impact in e-learning.

This first exploratory analysis of e-learners' time patterns allows us to make some primary recommendations and ramifications for computer-mediated tools supporting time organisation. Firstly, regarding the results of the longitudinal activity level and considering them as the result of a decrease in organizational/social interaction, a tool enabling teammates to get to know each other (e.g. via profiling), and organize their activeties more quickly should enhance the time allocated to the learning task itself, and thus potentially improve the performance of e-learners.

Secondly, if we consider that e-learners use residual time to work on the learning task (both on the weekly and daily level), helping them to organize themselves in another way may help them to free better quality time for the learning task.

However, some additional results are needed before being able to make precise recommendations. The concepts of the quality of time, e-learners' sensations, and the organizational/social phase of group construction, need to be analysed deeper to have a clearer view of their impact on CSCL.

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Footnotes

[1]In all the results sections, we report *semi partial* η^2 , which are more appropriate and more conservative when using within-subject ANOVA.

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