Problem-based Learning in an Online Course of Health Education

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Abstract

The objectives of this project were to: i) describe the experience of implementing Problem-Based Learning in an online course over three consecutive academic years, ii) analyse the learning environment generated, iii) discuss impacts on students' active participation, based on the analysis of their interactions. The participants were 30 students, working in five groups, and four tutors. All the interactions of each member of the five groups and their tutors in the discussion forums were identified and counted. The interactions identified were subjected to content analysis. The results showed a great variability in the degree of participation of each member of the group as well as the development of a group dynamic that did not appear to depend on the activity of each tutor. Moreover, in most groups, tutors reduced their participation during the semester. Regarding the ways students participated, and despite the individual variability observed, most students kept actively involved in the work contrarily to what research has shown about the uneven students' participation in online courses. Two categories of interactions were identified in the groups according to the underlying objectives: learning-problem solving and group functioning. Whereas all groups were able to solve the problems under investigation, only a few demonstrated self-regulation capabilities leading to a great cohesion among the group members. The discussion of the results generated some guidelines for future investigations regarding the use of PBL in online environments.

Key-words: problem-based learning, higher education, online teacher training.

Introduction

The highly variable and unequal participation of students in online courses is a recurring problem already addressed by several authors. Indeed in 1989 evaluation studies about the introduction of electronic communication tools in distance education courses led to the identification of three groups of students with different participation: a group with those who failed to participate; another group with the so-called "lurkers" who keep logging on and downloading "the information and comments provided by tutors and peers but contributing little of their own" (Gray, 1989, p. 188); and a third group of "regular contributors who participated fully and interacted with each other and with the system to good effect (Gray, 1989, p. 188). Gray's results with a sample of 34 students were comparable to the results of Robin Mason's study with a sample of 1,364 students (Mason, 1989). More recently Rosewell (2009) revisited these categories referring to the rule of "the three thirds" concerning students' participation in online forums: one third post many times; one third post very few times and one third are limited to glancing at the forums. In a preliminary study looking at patterns of messages, no content included, he analysed 4 courses, 36 forums containing 27,000 messages. The wide range of data were consistent with the three thirds rule, highlighting that in general students of online courses have unequal and extremely low participation rates. However, Miller and Corley (2005) summarized the principle, consistently supported by research and sustained by the constructivist theory that in every learning context, either in person or online ones, it is essential that students assume an active participation to be successful. Consequently, a question that has been raised is how to promote such involvement. Miller and Corley (2005) and Pallof and Pratt (1999) reported the importance of continuously monitoring students' participation and their level of activity, together with constant feedback from the teacher or tutor, for students to realize their progression throughout the course. However, how to promote and maintain such participation, while ensuring its quality, remains an issue for further study and research. Hrastinski (2008) claims the need for a clear definition of online participation. After a literature review of 36 articles centred on online participation available in the ERIC database he identified six levels of participation:

1. as accessing e-learning environments,
2. as writing,
3. as quality writing,
4. as writing and reading,
5. as actual and perceived writing,
6. as taking part and joining in a dialogue.

There is therefore a need to innovate pedagogical practices in online courses in order to achieve students' effective participation, which promotes critical thinking, autonomy and the ability to solve problems.

Problem-Based Learning (PBL) has been applied in online courses as a strategy to promote students' participation and collaborative work (e.g. Savin-Baden, 2007; Savin-Baden & Wilkie, 2006). According to Savin-Baden and Wilkie (2006), the diversity of operationalization of PBL, in both classroom and online contexts, requires research to clarify the use of different strategies and their effects on students' learning. Lou, Bernard and Abrami (2006) concluded that more research is needed to establish the educational strategies, based on PBL that would be appropriate to promote collaborative work in online learning environments.

PBL as a strategy for online collaborative work

PBL is a strategy that promotes active learning based on authentic and meaningful problems (Albanese and Mitchell, 1993). What is at stake is not to provide students the opportunity to solve problems but rather, the opportunity to perform meaningful learning based on the resolution of problems. Albanese and Mitchell (1993) argue that PBL, at its most fundamental level, is an educational strategy characterized by the use of real problems as a learning context for students to develop problem solving skills and to acquire scientific knowledge about the subjects under study.

In PBL, students are faced with a problem-situation they need to solve. Working in a group, they engage in a process in which they clarify, define and investigate the problem; access, process and apply information from a variety of resources available; interpret the results of their research and propose solutions; and share the information obtained with the other elements of the group in order to build a collective answer. It is a student-centred process, in which the responsibility of each individual is to ensure an active participation, not only for his/her own learning but also for the learning of the other members of the group.

The basic working unit in PBL is the tutorial group, in which students are organized in groups of six to eight with a tutor. Visschers-Pleijers, Dolmas, Wolfhagen and Van der Leuten (2005) stressed the crucial role of the interactions among students during the tutorial group meetings. These authors emphasized the importance of 'elaboration and co-construction' by students for an effective functioning of the group. The elaboration, which is an individual process as a result of the interactions with others, takes each student to a much richer and broader viewing about the topic under study. Co-construction occurs when two or more students discuss in a way that enables them to reach a shared understanding of the problem. The lack of elaboration and co-construction, which usually results from disorganized tutorial discussions, is recognized by tutors and students as an obstacle to learning and to motivation (De Grave, Dolmans & Van Der Vleuten, 2001; Visschers-Pleijers et al., 2005). Tutors play the role of learning facilitator rather than a knowledge transmitter and their role is to stimulate group discussions and to monitor social interactions that occur in the group.

With the intention to promote interactions among all members of the group, different roles are assigned to each member (moderator, scribe, and member). In each tutorial group, these roles are rotary. The moderator assumes the role of guiding the discussion, encouraging all members of the group to participate and assuring that the different steps of the process of solving the problem are experienced by all members of the group. The scribe summarizes the contributions of the members in group discussions and the remaining members of the group participate in the tutorial discussions, collaborating to solve the problem under study (Visschers-Pleijers et al., 2005).

Since its creation in the 1960s for use in medical courses, PBL is a strategy which has been evolving very rapidly (Savery, 2006). The author states that currently, it is not limited to higher education, and it has been used at different school grades, and in various subjects. Its wide adoption by teachers, in both classroom and online courses, has given rise to a diversity of practices showing that PBL has developed and changed over time as a successful method for learning in a wide range of educational contexts (McDonald & Gibbons, 2009). At the University of Maastricht a model for PBL implementation has been developed and disseminated (Visschers-Pleijers et al., 2005). The "seven jumps" model applies to tutorial groups of 6 to 8 students in the presence of a tutor. It unfolds according to the following steps:

1. clarification of terms;
2. definition of the problem(s);
3. analysis of the problem(s) (brainstorm);
4. structuring of ideas;
5. formulation of learning objectives;
6. collect new information (off group);
7. report, synthesis and evaluation of the information acquired.

During the first steps, students activate relevant prior knowledge by identifying what they already know, organize their common knowledge and discuss what new knowledge they need to acquire. They identify the learning objectives they have to pursue through self-directed study. The results of the self-study are discussed, appraised and schematized in order to solve the learning-problem (Moust, Roebertseni,

Savelberg & De Rijk, 2005).

The model has been systematically tested and validated, and so it remains true to the essential principles of PBL, as well as reveals an internal and organizational cohesion that makes it accessible for application in different contexts.

When applied to online environments, research evidences have shown PBL affordances as a pedagogical strategy (e.g. Donelly, 2009; Savin-Baden, 2007; Savin-Baden & Wilkie, 2006) enabling interaction, collaboration, discussion, and participation. Garrison and Anderson (2003) consider that PBL in an e-learning context is not significantly different from PBL in a classroom setting. However, it requires specific tools enabling group synchronizations, document management, discussion and task assignment in order to engage students in group investigations as required in PBL activities. Designing such activities and tutoring students throughout their investigations are demanding tasks for the development of any e-learning course.

The project reported here is part of a broader investigation of the implementation of PBL in an online training course for graduate students in the context of health education. Its objectives were to i) describe the experience of using PBL in three consecutive academic year groups ii) analyse the learning environment generated and iii) discuss the impacts of this learning environment on students' active participation, based on the analysis of their interactions throughout the course.

Methodology

Participants

The participants in this study were 30 Portuguese students of an online course on health education, in three successive academic year cohorts (2007/2008, 2008/2009, 2009/2010). All students were graduates and, in most cases, they were teachers currently working in a school. The professional areas were diverse, including both the Humanities (Philosophy, Languages) and the Natural Sciences. All school grades were covered, from kindergarten teachers to secondary teachers. In addition to the students involved, four tutors were involved in the first academic year (A, B, C, D) (2 males – A and C, and two females – B and D), two tutors were involved in the second year (C and D), and one tutor was involved in the third year (Tutor D) (see Table 1). The reason for this selection in the 2nd and 3rd year relates with the fact that in these academic years, some of the groups chose communication tools other than those provided by the MOODLE Learning Management System. In this study only those groups that used the tools available by MOODLE were considered.

Table 1: Number of students' and tutors' interactions.

	Problem 1	**Problem 2**	**Problem 3**	**Total**
Group 1. Tutor A	6	5	11	22
student 1	6	4	5	15
student 2	4	3	1	8
student 3	4	5	7	16
student 4	16	6	8	30
student 5	24	1	5	30
Students' total	54	19	26	99
Group 2. Tutor B	12	5	6	23
student 1	4	2	1	7
student 2	9	7	3	19
student 3	5	4	11	20
student 4	12	2	3	17

Students' total	30	15	18	63
Group 3. Tutor C	9	4	6	19
student 1	9	4	8	21
student 2	5	7	4	16
student 3	4	8	5	17
student 4	4	12	8	24
student 5	7	7	8	22
Students' total	29	38	33	100
Group 4. Tutor D	16	12	11	39
student 1	7	1	3	11
student 2	7	4	15	26
student 3	15	12	17	44
student 4	7	9	11	27
student 5	7	11	8	26
student 6	8	3	15	26
Students' total	51	40	69	160
Group 5. Tutor D	12	6	4	32
student 1	10	23	18	51
student 2	18	31	24	73
student 3	15	22	27	64
student 4	4	14	15	33
Students' total	47	90	84	221
Group 6. Tutor C	8	6	2	16
student 1	6	2	1	9
student 2	2	0	0	2
student 3	1	12	1	14
Students' total	9	14	2	25
Group 7. Tutor D	14	3	0	17
student 1	26	2	6	34
student 2	11	8	0	19
student 3	11	5	2	18

Students' total	48	15	8	71

All the interactions of each member of the five groups and their tutors in the discussion forums, used to solve each research problem, were identified and counted. The interactions identified were subjected to content analysis (Milles & Huberman, 1994). Through an iterative process of reading and rereading the data, categories were assigned to the different types of interactions.

Course structure

The first edition of this course on health education took place in the second semester of the academic year 2004/2005. Since then, it has been implemented in all academic years up to the present time, as an online optional course for the 2nd semester, as part of a graduate program that follows the usual face-to-face model. MOODLE has been the learning management system used since 2005/2006, since the students of the course, mostly school teachers, are familiarized with it due to its extended presence in Portuguese schools as a result of the government decision to encourage the use of MOODLE in schools. PBL was also first applied in 2005/06 in the health promotion course as a way to address the unequal participation of students observed in the previous year (Chagas & Mourato, 2007). Since then the process of PBL implementation in the course has been improving over the years, based on evidence from our own research, as well as on theoretical principles such as the "seven jumps" model (Visschers-Pleijers et al., 2005) and the guidelines of Savin-Baden and Wilkie (2006) and Savin-Baden (2007). For example, we added a new role to the tutorial group, the "reporter", who writes the group decisions and conclusions and posts them in the forum dedicated to his/her group; moreover, smaller tutorial groups were formed than face-to-face ones. The role of the tutor has also been analyzed and evaluated by us, resulting in some guidelines for their performance in the tutorial group (Chagas, Faria, Pereira, Sousa, Mourato & Santos, 2009).

In each one of the three consecutive years in which this study is focused – 2007/2008, 2008/2009 and 2009/2010 – three problem-situations were presented to students: a problem of practical nature which focused on a research on health-promoting practices of a particular school; a problem of reflective nature which focused on a research about the cultural and historical evolution of some concepts related to health education; and a problem of an interventional nature which focused on the development of a proposal of action to promote health education in a particular school.

The general structure of the course was maintained throughout the three years. There were three sessions' face-to-face, in accordance with Lou et al. (2006) who argue that when students are unfamiliar with PBL it is advisable to follow a blended model, with both online and face-to-face sessions. In the first classroom session, the program of the course as well as the methodology of PBL was presented to students. Additionally, the first problem-situation was presented and analysed through a tutorial session. In this tutorial session, students organized in groups, defined the rules of conduct of the group and the roles assumed by each member of the group for the resolution of the first problem. Based on the analysis of the problem-situation presented, each group defined its own learning objectives to be achieved through the resolution of the problem proposed.

The second classroom session occurred about a month later during which analysis of the outcome of the first problem-situation took place. The main objective was for the whole class to analyse and discuss the perceptions and difficulties experienced by each participant. Finally, the third classroom session occurred at the end of the course and provided an opportunity for each group to present their work to the whole class. This session was organized as a workshop, in which each group was not just limited to presenting the work they did, but organized activities for their colleagues to perform and identified issues for discussion.

The remaining sessions (n=12) were online. The MOODLE platform was organized into repositories of documents and forums. In the repositories of documents, all the information concerning the functioning of the course (e.g. schedule, evaluation criteria, important dates) was available, as well as some relevant resources for solving each problem (research articles, national and international reports, chapters books, websites). Two types of forums were created - general forums and discussion forums. In the general forums, a space for news was created, where general news associated with the theme could be shared, a space for questions (open to any type of question about the functioning of the course) and a shared space, where students could post information and documents they considered relevant. The discussion forums were the space that each group could use to solve the problems presented. Each group therefore had its own discussion forum.

The work within each tutorial group was organized according to two types of online sessions: synchronous sessions (using Windows Live Messenger) through a chat room, and Google Docs, used as a whiteboard where students could write their main ideas discussed during each chat session; and asynchronous sessions, using the discussion forums created in MOODLE.

The synchronous sessions were scheduled in advance by the group. Usually the tutor started the conversation room with all members present. During the session, a document was opened in Google Docs, to which all group members had access, which acted as a traditional classroom whiteboard, and in which

the scriber could summarise the discussion. The entire session was audio-recorded so that all interactions remained available. In general, synchronous sessions such as these were used to start the discussion of a new problem-situation, in this case the second and third scenarios. Following the "seven jumps" model (Visschers-Pleijers et al., 2005), students used to begin by clarifying the terms or expressions they were unsure concerning the statement of the problem-situation that was presented to them. After this phase, they defined the problem or problems they were expected to solve, discussed the strategies to follow, structured the key ideas involved and formulated their learning objectives. They also defined the roles that each member should assume in the group and discussed difficulties they felt regarding the on-going process.

For the asynchronous sessions, a group and a shared forum were created for each problem. The group forums were used for the presentation of the individual research of each member of the group, and were the actual place where the entire process of elaborating and preparing the answer to the problem by the group occurred. In the shared forum, after the end of the project, each group presented to the other members of the class the solution they proposed for the problem presented. The aim of this forum was to compare and discuss the paths followed by each group, the strategies developed, the knowledge applied and the results achieved.

Results and discussion

The number of interactions made by each member of the groups was highly variable between groups (Table 1). Although five groups showed a mean number of interactions per student that was relatively similar (from 16 to 27 interactions/student), two groups showed extremely different mean values (8 interactions/student and 55 interactions/student) (see Figure 1). Moreover, in most cases, the number of students' interactions performed over time (Table 1) also varied greatly between groups, although there was not a very marked tendency to decrease (Group 3, 4 and 5). However, two of the groups (Group 6 and 7) seemed to be an exception, showing a very sharp reduction in the number of interactions over time. These two groups were very small (three members) and they reported that they had also begun to meet in person to work on the on-going problem, so the number of interactions in the forum was no longer an accurate reflection of the actual work performed by these groups.

With respect to the tutor, it appeared that the number of interactions was not correlated with the level of participation of students in the group (Figure 1) (Spearman rank correlation: $R=0.631$, $n=7$, $p>0.05$). Each group presented its own dynamic which did not seem to depend exclusively on the activity of the tutor. Finally, it appeared that in most groups (except in Group 1) the tutor significantly reduced their number of interactions over time, which may reflect an increasing autonomy by students in solving the problems.

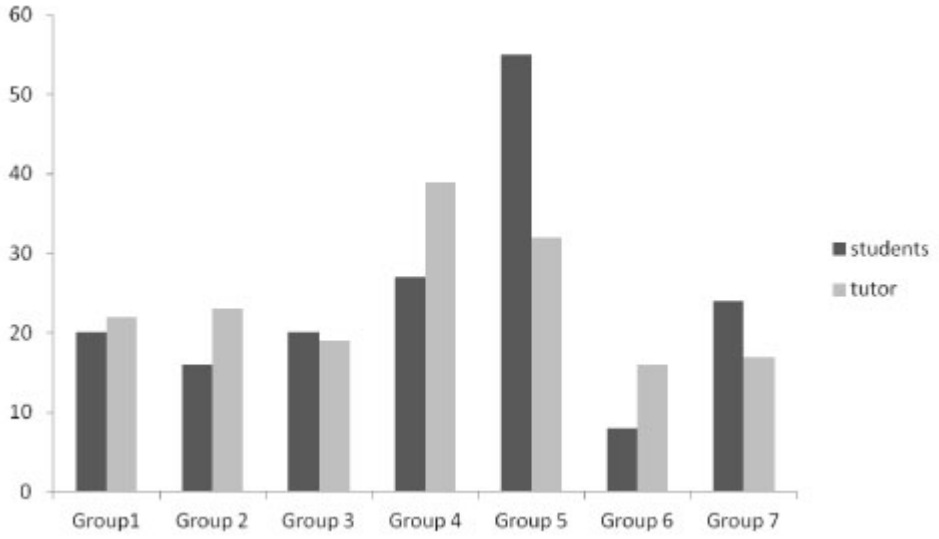

Figure 1. Average number of interactions per student and total number of interactions by tutor.

The interactions identified and analysed were organized in two different categories, according to their main objective: one related to the resolution of the problem itself and the other related to the internal functioning of the group (Table 2). Considering the sum of all interactions, in most groups (with the exception of Group 7) the largest number of interactions was related mainly with the resolution of the problem (first category considered) (70 % to 80 %). This is an expected result since the students' final evaluation on the course depended of this, namely by presenting the individual research done by each student. In most groups (except for Groups 1, 2 and 6) a large number of interactions were also observed in which a member of the group produced work based on the work of others and in which he/she shared new resources with the other members. This is reflective of the presence of collaborative working in the production and/or reorganization of knowledge (see Table 3).

Table 2: Number of students' interactions in each group according to the categories considered.

Categories	G1	G2	G3	G4	G5	G6	G7
I. Problem resolution							
Showing scientific content	23	32	38	61	96	14	27
Elaborating over others work	8	5	22	28	63	6	13
Presenting new resources	8	4	1	8	2	1	3
II. Group Functioning							
Giving positive feedback	5	5	10	15	11	2	16
Informing about its own progression	1	10	7	16	3	1	34
Encouraging to work or to participate	1	2	3	1	3	1	5
Organizing the group work	1	3	9	9	15	1	6
Deciding with the group what to do	1	1	1	1	5	1	5

Concerning the second category, group functioning, a wide range of interactions was observed. With the exception of Groups 1 and 6, the interactions associated with this category achieved a relatively high percentage (20 % to 30 %). For most groups, the largest number of interactions of this kind was related to giving positive feedback on the work already done by the other members and keeping the entire group informed about what each individual member were doing. These interactions are associated with the creation and maintenance of group cohesion, reflecting a sense of belonging to the group and an engagement by all. Other interactions were also observed that intended to promote a more active participation of all elements or of some in particular, such as "collective calls" to search for specific information needed to pursue the work, and some attempts to organize the next working steps (see Table 3).

Table 3: Example of students' interactions according to the categories considered.

Categories	Examples
I. Problem resolution	
Showing scientific content	"I leave you the summary of what I've read."
Elaborating over others work	"I built a scheme based on the issues you have raised..." "I was thinking about what you said ... I think..."
Presenting new resources	"I am sending you a link to a site I found."
II. Group Functioning	
Giving positive feedback	"I agree with what you said." "That is an excellent summary of the situation."
Informing about its own progression	"I am going to start the lectures about ..." "I am going to search for the definition of..."
Encouraging to work or to participate	"I think it is lacking look up the definition of..." "Contributions are expected..."

Organizing the group work	"It is time to distribute tasks..." "I think now we should focus on ..."
Deciding with the group what to do	"Let's decide what we will consider hereafter ..." "It seems to me that it is a good idea, but how can we do it?"

Finally, considering all the data obtained, two of the groups (Groups 1 and 6) seemed to have developed a somewhat different dynamic. In the case of Group 6, formed by three students, all of them showed a marked difficulty in the use of technology and so they had difficulty in using the discussion forums. This explains the low number of interactions observed. As a result of the different digital skills possessed by each individual, students failed to develop a sense of belonging to the group, presenting a great imbalance in the level of participation of each member (almost only one element intervened in the forum). In the case of Group 1, the group seemed from the outset to be divided into two distinct sub-groups, showing no internal cohesion. This group appeared focussed only on solving each problem-situation presented in order to achieve the course final assessment.

Final considerations

In this study, there were two main aspects that deserve to be highlighted. One relates to the level of participation of each student. Although some interpersonal variation observed, the majority of students seemed to be actively involved in the group work. The other aspect, relates to group autonomy and functioning. Indeed, it was evident that some groups revealed a very good capability for self-regulation.

Concerning the first aspect, students' participation, the experience of using PBL in an online course, described and analysed in this study, revealed a learning environment where most students actively participated, worked collaboratively and, in most cases, reinforced their autonomy in solving problems. The variability in the average number of interactions by individual group members is consistent with the literature in this area (see for example Lindblom-Ylänne, Pihlajamäki & Kotkas, 2003; Wun, Tse, Eileen, Lam & Lam, 2007; Visschers-Pleijers, Dolmans, Wolfhagen & Leuten, 2004) although these participation rates were very different to those proposed by Mason and Kaye (1989). There were indeed some students that participated very often, but the majority presented a moderate frequency of participations and only very few of them were silent, remaining just like to be "lurking". Moreover, as they became more familiar with PBL and the online technology, they appeared to need less support from the tutor, even though he/she remained available to give the necessary guidance to help solving the problem and to assure that learning objectives were achieved.

These results showed the potential of online PBL as a strategy, not only for promoting students' autonomy in managing the work needed to accomplish the activities, but also to promote significant participations from the majority of students, based on the knowledge they acquired, through the researches they made, the analysis of the resources they posted in the forums, and the interactions they established between them.

These results are consistent with the work of Wun, Tse, Eileen, Lam and Lam, (2007) which, when comparing the performance of students with a PBL curriculum *versus* students with non-PBL, observed a more active participation and interaction among students during the group tutorials. According to Ronteltap and Eurelings (2001) this type of strategy may have a decisive role in promoting a greater involvement of students in their learning because it provides a wider range of situations that triggers reflection and discussion. It also provides more time to explore in more depth the resources available. Other studies have already shown that students consider PBL as an effective way to enhance their confidence in judging alternatives for solving problems, help them acquire social study content, improve their learning of basic science information, and develop thinking and problem-solving skills (see Hung, Bailey & Jonassen, 2003).

With regard to the final evaluation of students' performance in the course it was observed that, during the three years under review, students developed strategies for addressing the problem-situations proposed that were highly pertinent, relevant and diverse. These findings are consistent with the observations of Valaitis, Sword, Jones & Hodges (2005) in a study of a group of medical students and their perceptions of the PBL learning environment in an online course *versus* a classroom context. According to these authors, students recognized that PBL favoured greater flexibility in the learning process, increased their capacity to learn the scientific content involved and promoted access to a wider variety of important resources for their learning. Yip (2002), in a study about students' perceptions of the technological support to assist problem-based learning, also found that students remarked favorably on what they learned including better problem analysis, understanding how to formulate a project plan and subsequent control of their work, better written and oral communication, teamwork, practicing leadership skills, and better information searching via the Internet.

So, engaging students with a PBL online learning environment could help to promote all students active participation and involvement in the learning tasks, a difficulty usually present in online courses, while promoting critical thinking, autonomy and the ability to solve problems.

Concerning the second aspect under discussion, group autonomy and functioning, the PBL tutorial groups are self-regulative in nature. Groups are expected to solve their communication difficulties and to find solutions to problems that arise spontaneously. However, there were differences among groups in their skills in self-regulation and in solving communication problems (Lindblom-Ylänne et al., 2003). Indeed, in this work it was evident that some groups showed a capability for self-regulation, being able to maintain cohesion in different situations, namely in those in which students are generally more fragile and insecure (for example at the beginning of a new approach to a problem). Particularly in short intensive courses, as in the case of the present study, self-regulative, well-functioning groups could have a substantial advantage over groups who lack these skills. So, the investigation of the different dynamics of the groups and the identification of the factors that could be responsible for this differentiation (e.g. the familiarity with the use of technology), as well as the clarification of the role of the tutor in these different situations, are topics that deserve further investigation, constituting the subject of future studies on the implementation of PBL in online contexts.

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