

Monitoring a b-learning PBL experience with students' learning styles

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Abstract:

The objective of this study is to evaluate if a pedagogical approach is equally effective for all students types, in spite of their learning preferences. The case study refers to a course in the field of Transportation Engineering, which is part of a Civil Engineering undergraduate degree program. The approach involves the combination of PBL (Problem Based Learning) with a LMS (Learning Management System). The following data were considered: i) the learning preferences shown by the Index of Learning Styles; ii) the grades obtained by the students in the PBL activities developed in the on-line platform CoL during three years. We found evidences that preferences in the active/reflexive and sequential/global dimensions may have affected the performance of the students.

Key words: *Learning Styles, Problem Based Learning; Education in Engineering.*

1 Introduction

Despite the clear evidence that engineers increasingly need to learn new techniques and to get additional skills to meet the labor market needs, the structure of most Civil Engineering undergraduate programs is still quite rigid in the first decade of the 21st century. Some university colleges, however, are going through changes in order to prepare professionals with a substantial capacity of adaptation and continuous preparation to serve the market. That is the case of some of the undergraduate degree programs offered at the São Carlos School of Engineering of the University of São Paulo (EESC-USP). Their curricula essentially try to introduce innovations without losing their strengths in providing a solid theoretical background and examples of good practice in Engineering. A way they found to cover all these issues while improving the teaching-learning process was to make use of pedagogical alternatives supported by information technology resources.

The case study explored in this paper refers to a pedagogical alternative applied to a course in the field of Transportation Engineering, which is part of the Civil Engineering undergraduate degree program offered at EESC-USP. The approach involves the combination of PBL (Problem Based Learning) with a LMS (Learning Management System), as described in [1]. The course essentially deals with concepts related to economic, social and environmental aspects of transportation and their influence in planning and operation of transportation systems. Therefore, the PBL approach was first introduced in 2006 through an issue that most students were quite familiar with: the parking problems within the university campus area. In 2007, the problem studied was expanded to the city-scale level, when data of an actual survey about the conditions of the main urban transportation modes, conducted with urban citizens, was brought into the classroom. In 2008, the problem was narrowed down to a particular transportation mode, although still at the city-level. The quality of pedestrians'

pathways in part of the urban area was then the focus of the PBL activity. In all three cases, the approach was centered on teamwork and blended learning.

The objective of this study is to evaluate if the pedagogical approach proposed is equally effective for all students' types, regardless of their learning preferences, or if it produces different performances as a consequence of different learning styles. We start the paper by reviewing the main theoretical concepts involved in the proposal. In the methodology section we briefly describe the pedagogical strategy used and introduce the elements considered in the analysis. The results of the analysis are presented and discussed in the subsequent section, followed by the conclusions and references.

2 Theoretical Background

The pedagogical strategy described in this paper is based on a combined use of three concepts: PBL, blended-learning, and learning styles. Although simultaneously applied here, they can be independently seen as autonomous theories that eventually complement one another. That is the way we choose to present the theoretical background of our study, as follows.

2.1 Problem Based Learning - PBL

PBL is seen as a complete approach for education, considering both the curriculum and the process [2]. The curriculum involves carefully selected and designed problems that demand from the students: the acquisition of critical knowledge, problem solving proficiency, individual learning strategies and communication skills, and teamwork ability. In such a way, the process replicates the systems approach usually applied to solve life problems or to face professional challenges.

One of the characteristics of PBL is that it is centered on the students. That refers to the learning opportunities that are relevant to the apprentices, which have their objectives partially determined by the students themselves. That characteristic does not imply that the professor should give up on his/her responsibility for judging which contents and skills might be important for the students to learn. However, it explicitly transfers to the students part of the responsibility of their learning process.

Education in Engineering is under a growing pressure for change. The traditional teaching-learning process, which is essentially based on classroom lectures complemented with the resolution of numerical exercises and practical classes in laboratories, implicitly makes lecturers and students to assume that the main goal of the process is to get the ability to pass in exams and tests.

Engineering courses are frequently good enough to produce technically competent professionals, who are able to provide services of quality to the society while facing the responsibilities of the professional life. However, the development of other professional attributes that are relevant for communication and for teamwork are often seen and accepted as an exclusive task of the individuals. Therefore, it depends on the maturity and initiative of each person. Nevertheless, the professional knowledge has grown so much that is nearly impossible for a student to master all available technical contents in a timeframe of four or five years. In addition to that, students are now being criticized for their lack of complementary skills. As a result, professionals and students in different parts of the world are currently trying to strengthen their skills through continuous learning, in some cases trying to go beyond the technical knowledge. Some universities decided to restructure their courses to meet those expectations and PBL is becoming an attractive way to effectively implement those changes.

2.2 Blended Learning

Computers have been traditionally applied as tools for processing and transferring information and as decision support elements. They assumed a new dimension when started to be intensively used for education, training and personal development. In the field of education, the technological advances of hardware and software allowed the introduction of new techniques for the improvement of the teaching-learning process [3].

Despite the potential of the new technological tools, some education researchers who are deeply interested in facilitating the teaching-learning process realized that neither on-line platforms nor pure theoretical approaches about the teaching-learning process can independently produce a scenario of effective learning. A strategy to overcome that limitation is to combine informatics resources with the traditional classroom approach, in what is now called blended-learning (or b-learning). So, b-learning can be simply described as an integration of the face-to-face classroom-like teaching-learning process with on-line experiences of distance education. A research-based class can then be developed in that sort of environment. In essence, the role played by the instructor is to motivate the students while showing them the value of the topics to be learned, as well as the importance of the process. Motivation and active participation are key elements in the development of the apprentices.

After an initial verbal and audiovisual presentation for stimulating the interest of the students, they can start searching, individually or in groups, for more information about the suggested topic. Useful sources can be the World Wide Web, books, and contact with actual experiences or professionals dealing with the subject. The “big picture” of the subject is provided by the instructor, but the particularities have to be explored by the students, either collectively or individually.

Part of the search for information can be done in a common location, in which the students are physically close together, while part can be done separately. In the latter case, each student decides his/her own pace and location to work on the topics. When instructor and students are altogether, the professor is able to observe the discoveries, the doubts, and the information treatment and interchange among the students. Students search for information and the instructor guides, frames the problems, provides incentives, and builds relationships. The instructor co-ordinates the exchanges while the students describe their findings, share their doubts with the group, and show the research results.

A selection of the best contents found by the students and by the instructor must be made available to everyone. The students can take the material with them, read more about the subject, establish new syntheses, identify the problems in the text and build relationships with their reality. Those outcomes are then brought back to the classroom, where the colleagues and the instructor can help in setting up the context in which the results fit in. That helps to widen the views reached so far, to identify the problems, and to find new meanings in the information gathered. The back and forth movements, in which everyone is invited to participate and to get involved with, is fascinating, creative, and full of discoveries and progresses. The knowledge built on self experiences then becomes stronger.

2.3 Learning Styles

The way an individual chooses or tends to face a learning situation has a huge impact on his/her performance and in the results of the learning process. Many researchers have dedicated a significant amount of time and effort trying to find out how individuals develop and why certain teaching methods work well with some students and do not work well with others.

Learning is a process with two phases, which involve information reception and processing. In the reception phase, the external information (i.e., that captured by the senses)

and the internal information (i.e., that appearing introspectively) become available to the individual, who selects the material for the processing phase and ignores the rest. Processing can involve simply memorization or inductive or deductive reasoning, action or reflection, introspection or interaction with other individuals [4].

Those ideas were the ground for the model of learning styles proposed by Felder and Silverman [4], which can be used to classify a student in relative scales that reflect the ways he/she prefers to receive and to process information. The model considers four learning dimensions: active/reflective, sensing/intuitive, visual/verbal, and sequential/global. Each one of the dimensions covers two opposite learning styles. An active learner is a “hands-on” type of student, who often likes to discuss facts and results, while reflective students prefer the introspection. A sensor learner uses the five body senses to carry out his/her tasks, while intuitive students rely on the “sixth” sense. Visual learners like to receive information through pictures, graphs and diagrams; verbal learners prefer words and sounds. Sequential learners follow a linear and gradual reasoning while global learners like to see the “big picture” right at the beginning of the learning process.

In 1991, Felder and Soloman developed a self applicable tool (the Index of Learning Styles, or ILS) for identifying the students learning preferences in the four dimensions discussed above. The respondents are asked to choose one out of two answers for each of the forty-four questions formulated. Based on the selected answers, the respondents receive a score for each dimension, what shows the preferred style in that dimension. Scores 1 and 3 show a weak or almost inexistent preference, what means a balance in the preferences within the dimension under consideration. While the scores 5 and 7 show a moderate preference, scores 9 and 11 show a strong preference for one of the styles in the dimension examined.

3 Methodology

This study focus on the analysis of the results of three sequential experiences with a pedagogical alternative developed at EESC-USP for teaching Transportation Planning for Civil Engineering students. The approach consists in the combination of PBL techniques with a Learning Management System, as summarized below and discussed in details in [1] and [5]. The main aspects of the proposed strategy were:

- 1) Introduction of PBL as the selected teaching-learning approach, with a strong focus on teamwork.
- 2) Intense use of a Learning Management System. In the experiences described here, we relied on the LMS platform named CoL (it stands for Courses on-Line), which was developed at the University of São Paulo. The system provides dynamic tools for promoting the users (i.e., instructors and students) interaction through forums, electronic communication (mail and chats), and collaborative activities. It can be used for both distance learning and b-learning.
- 3) Adoption of a b-learning strategy to combine topics (1) and (2) above;
- 4) Complementation of the traditional methods applied in the discipline with the following strategies:
 - Teamwork;
 - Individual and group research in the world wide web;
 - Use of a computer laboratory for part of the course activities;
 - Use of Geographic Information Systems for developing the project activities.
- 5) Use of quizzes, exams, transcripts of the students, access information recorded by the LMS, and performance of the students throughout the semester as data for evaluation and monitoring the pedagogical proposal;
- 6) Evaluation of the results by means of quantitative and qualitative methods.

The goal of the approach is not only to produce significant improvements in the learning process, but also to positively affect the attitude of the future professionals. The implementation of the innovations is gradual but constant. That allows the identification of problems in periodical evaluations and the correction of any flaws detected, as discussed in [1] and [5].

One of the evaluation processes feasible in our case is based on the analysis of the performance records of the students, along with their individual learning styles and personality types. The cross-comparison makes possible to detect individuals with particular personality types and learning preferences that are not being adequately served by the method. In the specific case of this study, we present and discuss only the results referring to the learning preferences.

4 Presentation and analysis of the results

The analysis is done by confronting data of each learning dimension with the performance of the students in the PBL activities. In order to make it easily understandable, bar charts are built in a particular manner for highlighting any existing relationships. Those charts are then used for identifying the likely contribution of each dimension to the performance of the students in the proposed activities. As all analyses are based on the learning styles and performance records of the students in the specific activities of the pedagogical experience, the data is presented separately for each of the four learning dimensions.

The combination of the students' grades with their individual learning characteristics is done through bar charts, in which each student is represented by one bar. The students are organized in the graphs according to their grades, with the highest grade located on the extreme left side of the graph and the lowest grade on the opposite right side. The heights of the bars indicate the intensity of the students' learning preferences and the vertical straight lines indicate the average of the grades (per year). Figures 1 through 4 show the data of 2006, 2007, and 2008 for the four learning dimensions.

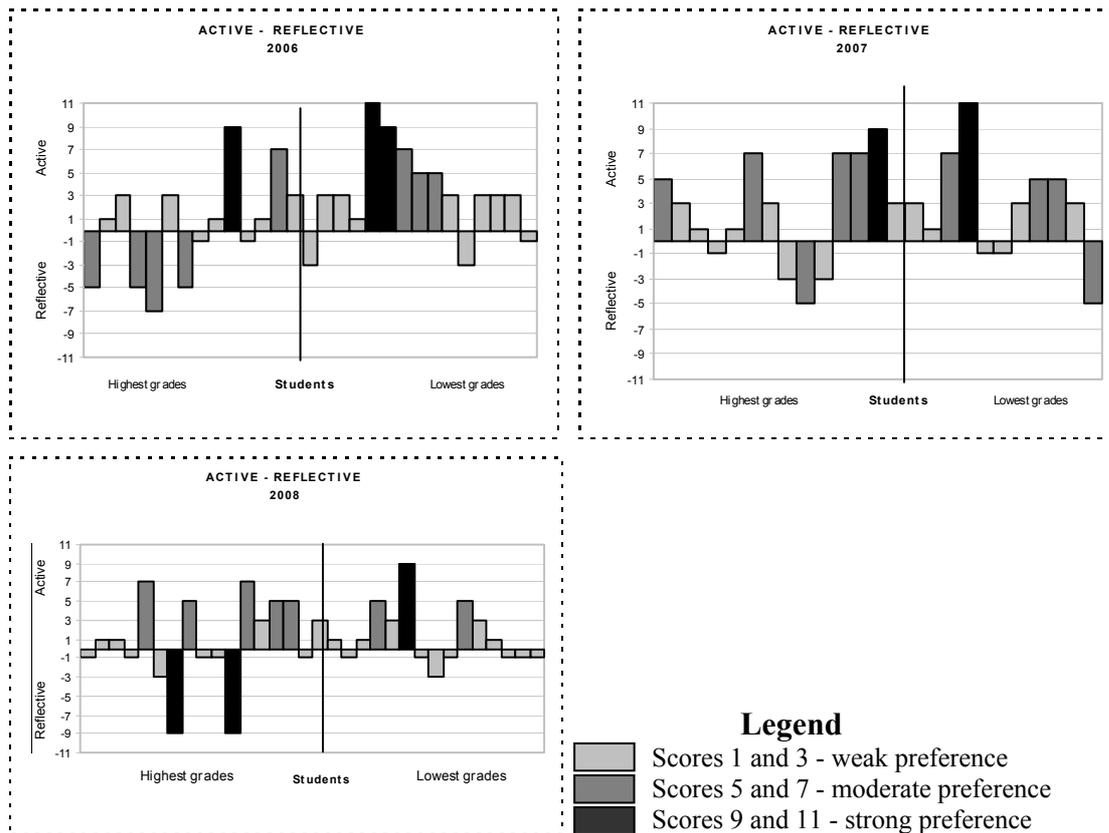


Figure 1 - Performance of active and reflexive students in the three classes examined.

In the graphs of Figure 1, a reasonably high number of strong (9 and 11) and moderate (5 and 7) active students with grades below average can be seen in 2006. In the class of 2007, most strong and moderate active students are close to the average. In 2008, the single strong active student is below average, as well as two (out of seven) moderate active students. The results suggest that the changes introduced in the methodology along the years for particularly addressing active students were effective. In general, students with strong or moderate preference for that learning style were gradually improving their performance from the first to the third experience.

In the dimension observed in Figure 2, sensing individuals are the majority of the students in the three classes considered. In addition, students with a strong or moderate preference for that learning style are balanced above and below average in all cases. Also, the number of intuitive students is too low for finding clear relationships between the intensity of their learning preferences and their performances.

According to the data displayed in Figure 3, most students prefer to receive information through their visual channel. The homogeneous distribution of intensities in the preferred learning dimensions around the average does not indicate any likely relationship with the students' performance. The same happens to the few verbal students, except in 2007, when the single case was slightly above average.

Regarding the fourth dimension, sequential students are predominant in two out of the three classes (2006 and 2008). In 2007, the proportion of global students (56 %) is slightly higher than the proportion of sequential students (44 %). In general, most strong and moderate global students are below their respective class averages.

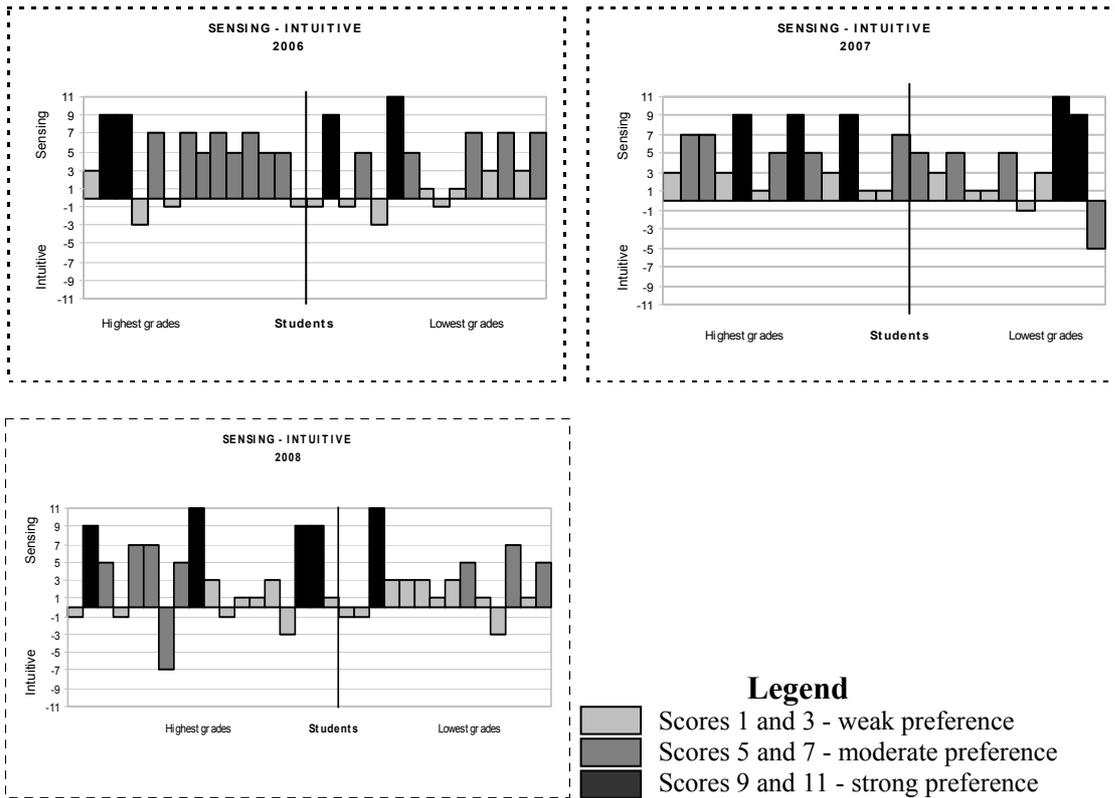


Figure 2 - Performance of sensing and intuitive students in the three classes examined.

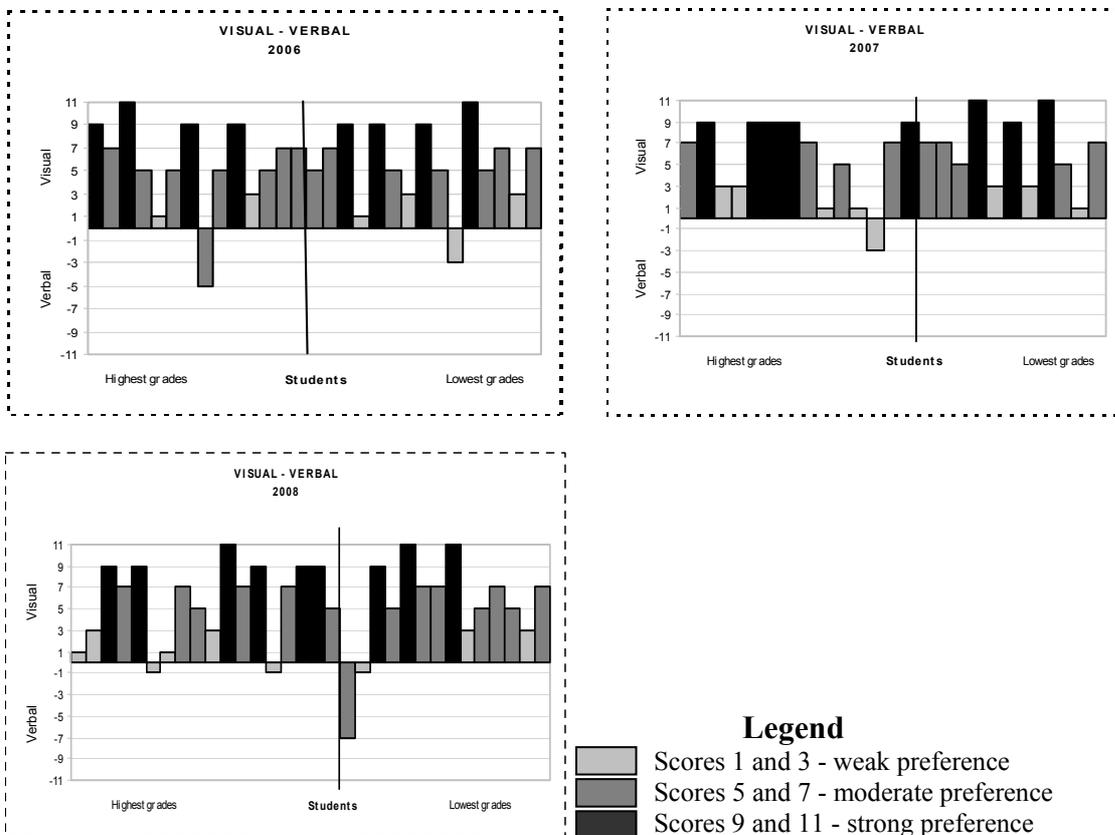


Figure 3 - Performance of visual and verbal students in the three classes examined.

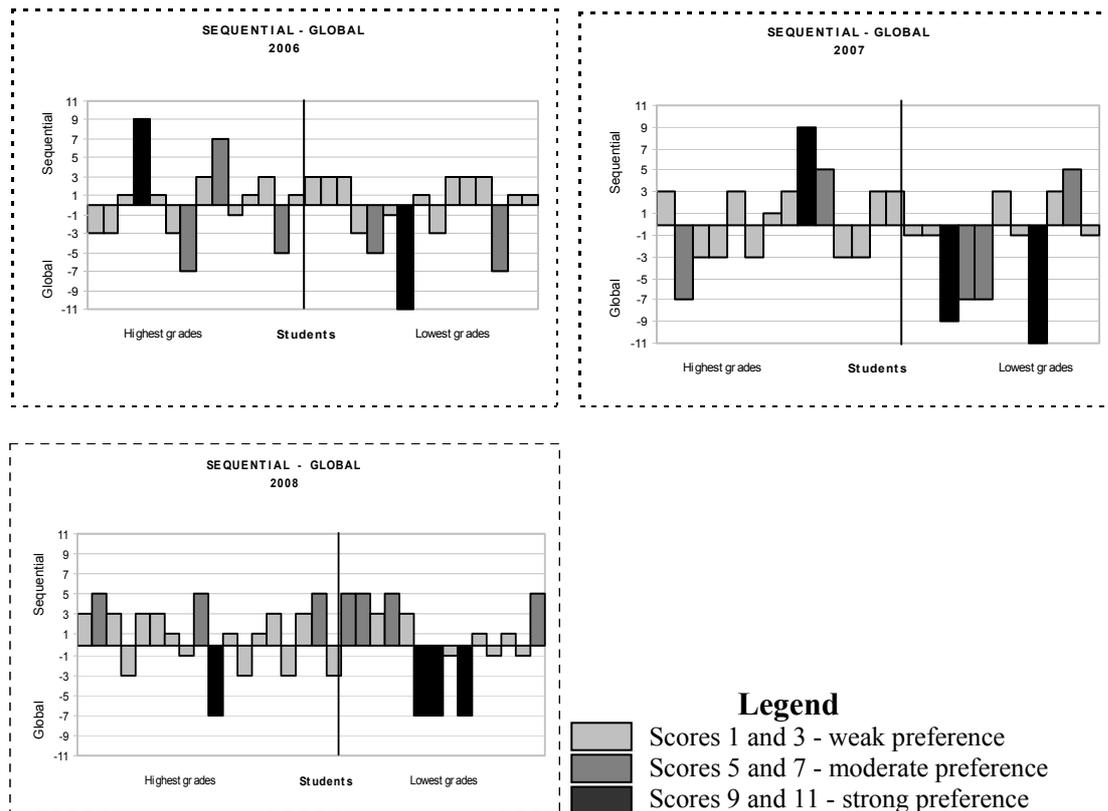


Figure 4 - Performance of sequential and global students in the three classes examined.

The analyses of the results presented in this section suggest the existence of relationships between students' performances in the PBL activities in at least two learning dimensions: active/reflexive and sequential/global. Active and global students seem to be the groups negatively affected by the approach used, as can be implied by the proportion of grades below average found in those style groups. In order to adapt and to improve the proposed strategy, corrective actions have to address the problems detected.

The active/reflexive learning dimension is related to the way students prefer to process the information - either actively or reflexively. Active learners are practical individuals that enjoy new experiences and like to be with other people. In contrast, reflexive learners are theoreticians, mathematical modelers, and like to work alone. Active students represent the largest group in our sample. The problems faced by the active students may have been caused by the on-line discussions carried out in the forums. That condition did not allow them to be in direct contact with their classmates for evaluating and discussing eventual alternatives to solve the proposed problems. The adoption of a teamwork approach already in the phase of evaluation and selection of alternatives for data acquisition could eventually get active students soon involved with the PBL activities. Also, a preliminary classroom discussion of how the selected alternatives could be put in practice can also be helpful to active learners.

The sequential/global dimension refers to the way students get the information and understand the presented materials. Sequential students feel more comfortable with a step-by-step presentation of the contents, in which the difficulty level increases gradually. Global students, however, cannot learn in such a way, because they first have to understand the overall idea and subsequently get the details of the intermediate topics. Our pedagogical approach apparently penalized the latter group. An explanation for that may be in the absence of a previous presentation of the contents and of the solutions to be developed in the LMS. Thus, a strategy to reach the global students could be to start the course by presenting the contents, the instructional objectives, and the programmed activities. In addition, it could be

useful to have discussions, from time to time, for pointing out the current position in the program or schedule and to show the students what is still to come. That small change in the strategy will eventually help to establish the bridges for filling the gaps that hinder the comprehension of the course contents by global learners.

5 Conclusions

The following data were used in the analysis carried out in this study: *i*) the learning preferences shown by the students when answering the Index of Learning Styles questions; *ii*) the grades obtained by the students in the activities developed with a PBL approach in the on-line platform CoL. By comparing the datasets, we found no evidence that preferences in the verbal/visual and sensing/intuitive dimensions could have affected the performance of the students in the three years studied. There were no verbal and intuitive students with strong preferences in the classes considered, and even students with moderate preferences for those styles were rare. There was only one moderate verbal learner in each of the classes of 2006 and 2008. In the case of intuitive learners, we found one moderate student in 2007 and another one in 2008. When looking at the predominant characteristics of those dimensions (i. e., verbal and sensing learners), we found no evidence of relationships between the performance of the students and the intensity of learning preference (i. e., strong, moderate, or weak).

In contrast, the preferences in the active/reflexive and sequential/global dimensions may have affected the performance of the students considered in our study. That has been already detected for the class of 2006 [6], when it was observed that not only strong and moderate active students showed performance problems in the PBL activities, but also strong and moderate global students. The characterization of the problem at that point was quite appropriate, because it showed us the need for change in some points of our approach. Based on the results we have discussed in this paper, the changes we introduced after 2006 were at least partially successful. They might have been effective for active students, but did not make any clear difference to global learners.

Even considering that the proportion of global students facing problems was relatively low (around 10 % of the classes), something has to be done for tackling the problem. Given that the absolute number of global students with problems was around three per year, individualized actions can be taken. As we detect the learning preferences right at the beginning of the semester, it is not difficult to call the students separately from the class and provide them with a global view of the process at the very beginning of the activities and after each phase is concluded. That initiative shall be implemented already for the class of 2009.

It is important to stress the fact that the needed changes are not difficult to implement. They shall create the conditions to serve the students with problems due to their learning preferences. We have to do it carefully, though, in order to avoid problems for the students with opposite styles in the same learning dimensions.

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