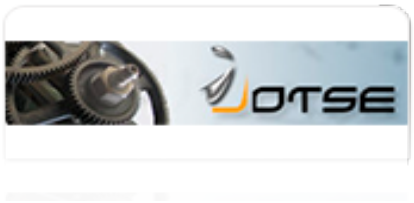

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PBL ON LINE: A PROPOSAL FOR THE ORGANIZATION, PART-TIME MONITORING AND ASSESSMENT OF PBL GROUP ACTIVITIES

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Abstract

This report presents the organisation of PBL (Project Based Learning) for a subject included in the IT engineering degree course. It is the result of 10 years of experience of the implantation and continuous improvement of the PBL class structure. The latest innovations include the experience of part-time monitoring with PBL groups using the Open Meetings tool in Moodle 2.0, the adoption of activities that improve learning and interdependence such as the jigsaw classroom, the clear definition of deliverables that students should present along the semester and the assessment criteria, both on groups and individuals. As a result of this experience, we present PBL student enrolment indexes, student assessment surveys and lecturers' opinions. We conclude with some topics for discussion about the PBL methodology.

Keywords – Monitoring and assessment in PBL, PBL on line, Virtual resources for cooperative learning, Moodle, OpenMeetings.

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1 INTRODUCTION

In the last 25 years, information technologies, Internet and mobile devices, among others, have revolutionised teaching methodologies in every field, and especially at universities. The fact that information is easily accessible to everyone for free has modified the role of the university lecturer as the only channel for accessing knowledge. It is no longer essential to attend lectures in order to acquire knowledge. MOOC's (Massive Open On Line Courses) are starting to offer information on the web that can be acquired whenever the students likes, not only during lecture hours, meaning they can decide when and how to learn, thus configuring the 2.0 student.

Meanwhile, in their job offers, companies are mainly demanding transversal skills and aptitudes (initiative, teamwork, leadership, etc.) rather than specific knowledge (which they also require), given that the latter can be provided within the company.

The above is motivating and compelling universities to reassess their teaching methodologies in order to adapt to these changes, scheduling fewer lectures and more activities that foster skills and attitudes. This is also a new motivation for lecturers, as they do not have to repeat the same material over and over again each year.

One of the methodologies designed to respond to these changes is PBL (Problem or Project Based Learning). There is an extensive bibliography on the pedagogic basis and foundations of PBL (Barrow, 1986; Albanese & Mitchell, 1993), which began in the field of medicine (Barrow & Tamblyn, 1980), followed by experiences in all

areas of knowledge and at different universities, some of them using this methodology for all degree courses, as is the case of the University of Aalborg.

Our experience of PBL started 10 years ago with two important circumstances. The first was the visit to our university by Dr Luis Branda of McMaster University (Branda, 2009), one of the pioneers behind this methodology. The second was how the lecturers started noticing a certain weariness with the lecture methodology in the final years of computer engineering at the UAB, which led to repeated absenteeism among students from such classes. But problem-based and practical sessions, with greater added value from the lecturer, were well attended.

In this report, we present the way we currently structure a PBL subject, the result of the developments and improvements of the last 10 years on the basis of lecturers' experiences and the opinions obtained from student surveys. The methodology used to validate the proposal is based on feedback from students and lecturers' perceptions of the process.

The report is structured as follows: in section 2 we present the context of the subject (degree, credits, content). In section 3 we explain how we currently organise PBL, justifying our proposal as much as possible. One of the latest ideas to be used is online or offline monitoring of group meetings using the OpenMeetings (OpenMeetings, 2014) tool, which is also used for remote tutorials. We highlight the deliverables that we request from students and the assessment criteria. The conclusions in section 4 present objective data, such as enrolment figures and the number of students that choose the PBL itinerary, as well as student assessments of their learning and the work they have done. We end by commenting on the opinions of lecturers and tutors and offering some topics for discussion in the field of PBL.

2 OUR SUBJECT

Computer Graphics 2 is an optional subject in the fourth year of IT Engineering, with content covering 3D graphics, including transformations (geometric and display), the modelling of 3D objects, realism (lighting, textures, shadow, colour) and computer animation. There is an extensive bibliography on the subject and the chosen reference in our case is (Hearn & Baker, 2003) because it covers the subject using the Open GL graphic library, which is used in practical work. The subject is worth 6 ECTS, and throughout the semester includes 2 classroom hours a week on theory and 1 one on problems, as well as 6 practical sessions lasting 2.5 hours each.

From the 2004-05 academic year we have implanted a PBL system, which is made compatible with the classic itinerary of theory, problem-based and practical sessions, and the students could choose one of the two itineraries. The idea was to use the 2 hour theory sessions for PBL tutoring and dedicate the problem-based sessions to explain theory matters and exercises, providing the theory notes and problem exercises at the start of the course and giving to students who chose the classic itinerary more autonomy in their studies. All of the students did the practical sessions, some to pass (classic itinerary), the others (PBL itinerary)to learn techniques to use in their projects. Success and satisfaction with the PBL itinerary led the number of students choosing this itinerary to increase each year.

In PBL, the project forms the basis for learning. Each project involves certain learning objectives that the lecturer defines and hopes that the students will discover and work on.

The instructions for the projects are short and aim for the students to assume a professional role (they are asked or 'commissioned' to develop an application) and they have considerable freedom of decision regarding the objectives, through the use of such expressions as "the most realistic display possible" or "the most realistic movements possible" so that it is they who set the limits.

The experience of applying PBL (Martí et al., 2009) has been positive, and some excellent work has been produced, but we have thought about ways of improving the method. These deliberations have led us to the following conclusions:

- To give them more freedom and initiative in their learning we dedicate all monitoring sessions to getting the students to progress with their projects, without organising activities that are more aimed at fostering learning, which we also believe to be important.
- The work groups attend a face-to-face session every 2 weeks, so in intermediate weeks we did not monitor their work.
- We were not sure what skills to assess or how (assessment criteria) in tutored sessions.

In this report, we wish to detail the progress made in recent academic years (2010-11 and 2013-14) regarding each of the three aforementioned conclusions: definition of project deliverables, use of OpenMeetings to hold online PBL group meetings and better definition of the assessment criteria.

3 OUR PBL APPROACH

The students form groups of 4 or 5 people. Teachers don't decide the group members, they form the groups, assuming some responsibility in case there was any problem in the in the operation of the group. Each group chooses a weekly timetable (G1 or G2) for attending class and they are tutored every 15 days.

In the first session, the lecturer proposes 3 projects, and the group chooses one. The projects ask the groups to produce a graphic application that would be useful in a specific area for displaying graphic information and, if possible, analysing it numerically. Examples we could cite are graphic simulation applications (zebra crossings and cars, arrival and departure of aeroplanes at airports, driving or flight simulators, Formula 1 races, representation of the planets and satellites of the Solar System),graphic representations of mathematical functions (2D and 3D fractals, mesh deformations), games (pool, 3D Tetris, chess) or representations of articulated objects (cranes, fairground rides, virtual characters).

Figure 1 shows images of the work on two projects done by the students. The picture on the left shows a 3D chess game, where the learning objectives are modelling the scene (board and pieces), a realistic 3D display and the definition of the movement and capture of the pieces (animation). The project on the right shows a simulator of motor racing at Montmeló, the track near to Barcelona, where the most important learning objectives are the modelling of the track and cars, views of the race through different cameras and realism, including the movement of the cars on the track (animation).

Figure 1. Examples of PBL work on this course: Chess and motor racing simulator

In this first meeting, the students decide what project they would like to do and analyse what they know, what they don't know, and what they need to know in order to progress with the project. In recent years, students have taken the initiative and proposed projects (usually 3D video games) and the lecturer analyses whether they are adequate for the course's learning objectives. As long as it is possible, their proposals are accepted in order to encourage motivation and implication in the project. A report of the first meeting (and all later meetings) is made detailing the discussion, agreements and tasks assigned to each member of the group, which are reported on in the following session.

Every fifteen days the group holds a two-hour meeting with the tutor. Each tutor usually attends to some five groups in each two-hour session, in which the group proceeds with its discussions and work. The tutor monitors the group's behaviour, both individually and as a group, and deals with any doubts that they might have, trying to guide them without conditioning either their work or the objectives of the project, as long as they are in line with the proposed learning objectives, as much as possible encouraging new ideas and learning (Sotjcevski & Du, 2009).

In one of the tutored sessions, the jigsaw classroom dynamic is employed, i.e. one member of each group joins an 'expert group' and these are given an article on computer graphics to read, understand and discuss. Each student then makes a summary of what they have understood about the article and comments on whether what they have learned might be useful for their own project. In a 'jigsaw' session, 5 or 6 expert groups are

formed and once the activity is over they pool the knowledge learned with that of their project colleagues. This activity provides new ideas for the project and is highly valued by the students.

Throughout the semester, in two specific periods, the students are asked to specify their objectives, what we call 'controls'. In these, the group defines clear objectives about what they want to do (type of graphic application, functionalities, etc.), define the tasks to be done and which member of the group will be responsible for them and also the time schedules for these tasks, using a Gantt chart or other method. The first control is done 3 or4 weeks after the project has started, and the second control is done 4 weeks before the final presentation. At the first, ambitious objectives are required and appraised, the second asks about completed and outstanding tasks and suggests realistically defined objectives in order for them to be ready in time for the final presentation. These documents are delivered using the Moodle Cerbero platform (Cerbero, 2014).

The oral presentation and defence of the project take place in the final session of the semester, at a session that is open to all students at the School.

We can classify the three improvements made in the last few years in the three areas: deliverables, online tutorials and assessment.

3.1 Deliverables

Once the groups have been formed and the projects chosen, the students must present the following deliverables (for which we provide electronic templates), which are sent via Cerbero in digital format:

- Meeting report: At the end of each group meeting (in the presence or not of the lecturer) the students should draft a report showing how the discussion developed and any project decisions made.
- Jigsaw: In the third week, in order to provide the groups with tools and ideas, a two-hour jigsaw session is held on subjects related with the course. At the end of the session, each student delivers a report.
- Control: In two specific weeks (the third and tenth out of a total of 13 weeks) the students deliver a control as a group.
- Co and self-assessment: After delivering the control, the students answer a co-assessment survey on their fellow group members and a self-assessment survey based on a template of questions.
- Monitoring report: Following delivery of each control, the lecturer sends the groups a project monitoring report, which presents his/her assessment of the work at this stage.
- Oral presentation and delivery of the project: In the final class, a student from each group has 15 minutes to present their project to three lecturers, two of which are from outside of the course, in a similar manner to the presentation of a degree project. Each group hands in the following documentation: written report, slides from the oral presentation and the computer application.

The meeting report is intended for the students to learn to summarise the progress made with their project and to reach agreements on the organisation of their work. In 2012-13, we decided to include a jigsaw session, which provides them with new ideas for their project and also enables better intercommunication between the groups. The control deliverable enables the students to specify ideas, objectives and tasks, and the tutor to assess the level of organization, ambition and innovation in the group's proposals for the project, while weighting this against the number of students, given that the objectives of a group of 4 students cannot be viewed in the same way as those of a group of 6.

To monitor how the group operates on an internal level, outside of tutorial sessions, they are asked for three co and self-assessments over three separate periods of the semester in order to find out how the group is working. In most cases, these surveys may not be reliable, but in conflictive cases that have arisen, these co-assessments have raised warnings of the problems occurring in these groups. These assessments also foster a critical sense and raise demands among the students.

The monitoring reports made by the lecturer are designed to provide feedback to the students about their learning and the quality of the group's work, trying to have as little influence as possible on their initiative with regard to the development of the project and their learning. This survey involves textual answers with test options, without evaluable numeric assessments.

3.2 Online tutorials and PBL Meeting Rooms

The organization of the course and the number of students means that each group attends tutorial sessions every 15 days, which we did not feel gave us enough time to properly monitor the work they were doings. However, the heavy teaching requirements on this course meant that we were unable to provide any more face-to-face classes, so we recurred to new technologies.

In the 2012-13 academic year, we updated the Cerbero document manager by incorporating OpenMeetings (OpenMeetings, 2014).

OpenMeetings is a free software tool that enables web-based online communication. Using a camera and microphone, online student-lecturer or student-student communications can be established in meetings between two or more people at the same time. It also allows documents to be shared on a virtual blackboard (Figure 2), where we can add handwritten notes and record communications or meetings. We have installed the software in our new Moodle server, which means we can define communication activities as part of a Moodle course. OpenMeetings works in two modes: meeting with fixed moderator (who controls the board) or meeting in which everyone is a moderator, regardless of when they connect.

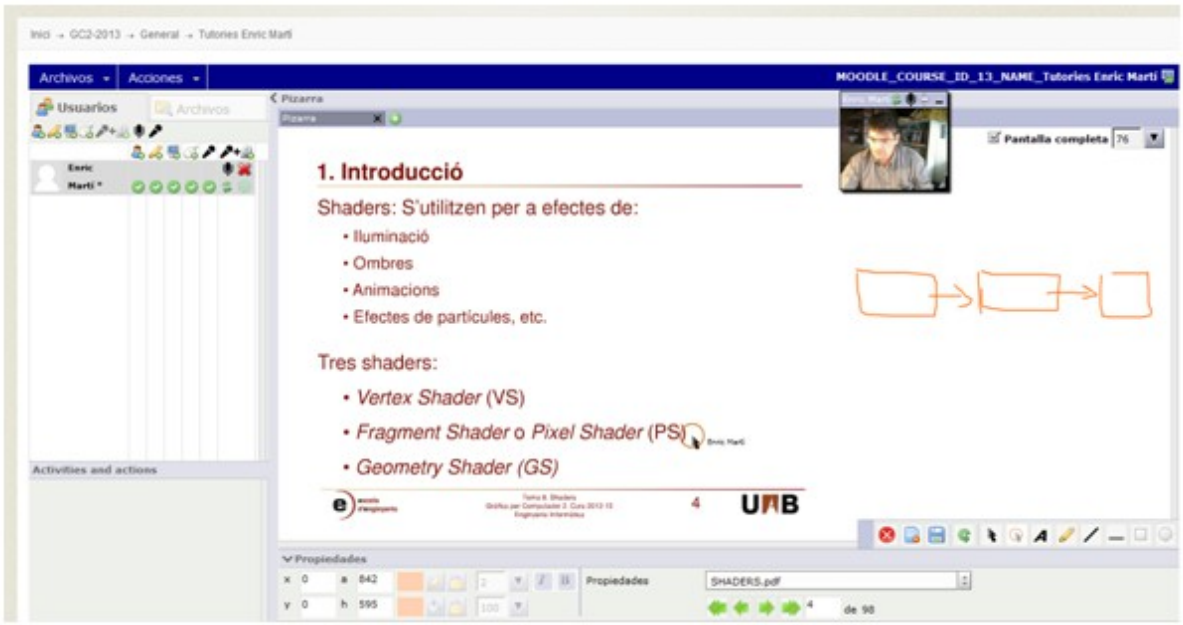

Figure 2. Screenshot from on-line tutorial on OpenMeetings

In the 2012-13 academic year, we used OpenMeetings for the following activities:

- Virtual tutorials with lecturer: During the lecturer's tutorial periods with the students, he/she opens the OpenMeetings tutorial activity, where any student can connect in order to resolve doubts.
- PBL Meeting Rooms: For each PBL group, an OpenMeetings session was opened for the holding of online work sessions if the students could not meet up, or in the week with no attendance of class. A video recording of the meeting is generated, which the lecturer is able to watch and assess (Figure3).

The results of the experience were positive but not spectacular. The students did not use the group tool as much as was hoped, mainly because they already had their own methods of communication (Skype) and had certain difficulties learning how this one worked. On a teaching level, it did not provide different indicators to those from face-to-face sessions, merely confirming the group dynamics perceived in face-to-face sessions.

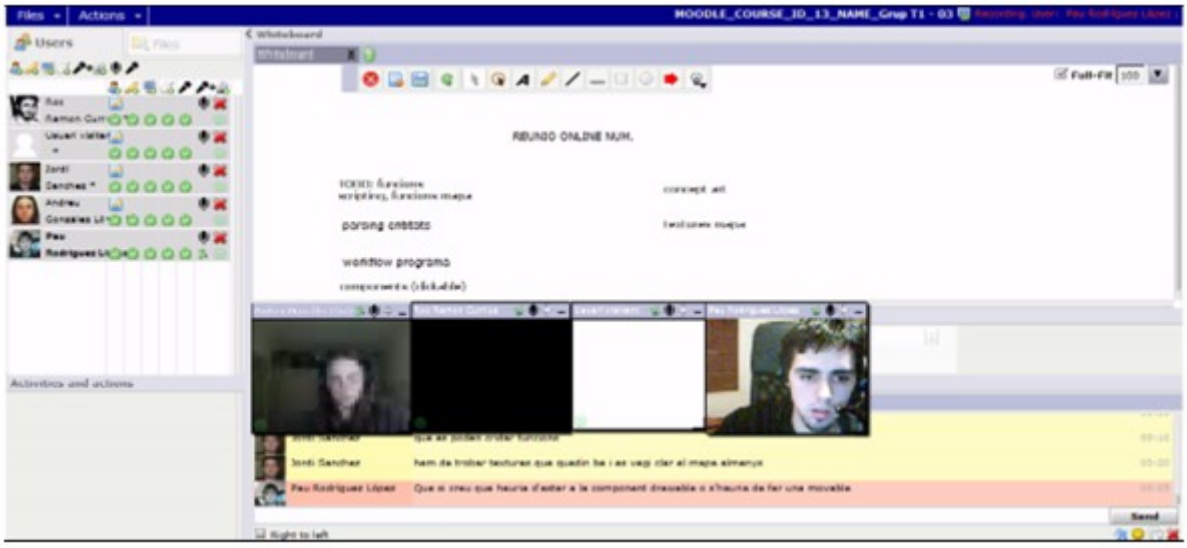

Figure 3. Screens hot of a PBL Meeting Rooms session held by a PBL group

3.3 Student assessment

PBL assessment is an important matter, for which we have references, and especially (O'Shea, Verzat, Raucent, Ducarne, Bouvry & Herman, 2013). On the basis of all of these, we have defined student assessment as two elements: group assessment, assessing the final work produced by the group, with an equal grade for all members, and an individual assessment, obtained from observations in tutorial sessions, peer assessments, etc., from which each student's individual grade is drawn. In the final grade, we weight both parts (group and individual) equally, without having found arguments for one to be valued higher than the other.

In the group assessment, we sought indicators that foster interdependence among students when working in a group, and in the group criteria we opted to evaluate the aspects that we consider to be the most important or that are most valued in a company environment in the field of engineering.

We sought to foster interdependence rather than competition between groups, so in both group and individual assessments we valued collaborations between groups, the exchange of information and knowledge between them, and individual initiatives within the group. All of these assessments added up to the final grade, and a student's grade could surpass the maximum of 10 of the university system.

The assessment is based on different indicators:

- Group assessment (7 points): The assessment indicators are equal for all members of the group. They are as follows:
    - Group work (4 points). The members of the tribunal attending the oral presentation assess the complexity and innovation of the work, functionalities, user interface and quality of the application in accordance with software standards. They use an assessment template.
    - Deliverables at the presentation (2 points): Assessment of the organization, clarity and presentation of the project report and the slides used in the oral presentation.
    - Reports (1 point): Clarity, presentation and coherence of the delivered reports and controls.
    - Merits (0.5 points, maximum of 1 point): Assessment of whether the work has been referenced by other groups, or whether it has been scored in the top three by classmates at the oral presentation.
- Individual assessment (3 points): Particular to each member of the group, obtained during face-to-face sessions (a total of 5-6) and PBL Meeting Rooms sessions. Assessed by the course lecturer. They are as follows:
    - Attendance and punctuality (1 point): Punctual arrival and departure from sessions.
    - Attitude (1 point): Whether the student takes part in discussions, and whether they behave actively or passively.

- Initiative and leadership (1 point): Whether the student's opinion is appreciated by peers, whether peers turn to him/her when they have doubts.
- Merits (0.5 points, maximum of 1 point): Whether they made the oral presentation, scores highly in peer assessments.

In the individual section, we chose three of the criteria proposed in (Doucet, 2004) that we believe to be among the most important in engineering studies: Initiative, perseverance, punctuality. We proposed the assessment of few competences but the use of many indicators to assess them. We are working on rubrics for assessment in the future.

One of the controversial issues was that of publicly announcing the assessment criteria to the students at the start of the course. Our position has always been not to disclose the details of the assessment method beforehand, other than that there is a group and an individual assessment, in order not to 'contaminate' spontaneity and the way the group organises its work. However, at the end of the course the criteria were explained to justify the final grade to the students. We understand that some were in favour of this and others against, and this is not an issue that we believe to be closed in terms of PBL.

4 RESULTS AND DISCUSSION

In this report we present the latest developments in a 9-year experience of applying PBL methodology to the Computer Graphics course on the IT Engineering degree, which we have developed and improved by implanting the methodology, improving assessment and finally using online remote communication applications such as OpenMeetings as a means to assess group meetings outside of the classroom, which students hold in order to work on their projects. In this section, we present some quantitative results and some matters for discussion, initiated both by lecturers and by students.

The results of our work are shown in two tables. In Table 1 we show developments in student enrolments, and those that opted for a PBL itinerary. In 2006-07, the course had fewer students as it went from being third year optional to fourth or fifth year optional. From 2009-10, the five-year engineering degree was replaced by the four-year engineering degree, so the number of enrolled students fell due to the gradual disappearance of the degree up until 2012-13, the final year with a significant number of students. However, it can be seen that the percentage of student opting for PBL increased from 2007-08, which is especially remarkable considering that this is an optional subject, which supports the idea that the PBL methodology attracts student interest.

Academic Year	*Students enrolled*	*# PBL*	*% PBL*
2004-05	*148*	*60*	*40,54*
2005-06	*155*	*95*	*61,29*
2006-07	*65*	*25*	*38,46*
2007-08	*76*	*34*	*44,73*
2008-09	*81*	*51*	*62,96*
2009-10	*68*	*46*	*67,64*
2010-11	*67*	*50*	*74,62*
2011-12	*58*	*48*	*82,75*
2012-13	*55*	*47*	*85,45*

Table 1. Students enrolled. Number enrolled for the subject and students that chose (#PBL) and percentage with respect to the total enrolled students (%PBL)

At the end of the course, the students were surveyed with regard to their assessment of the course and what they had learned. The results are shown in Table 2.Out of a score of 10, we perceive a medium-high assessment of the use of this methodology. In the final year of the course (2012-13) we put the decrease in the assessment of the methodology down to the desire among students to finish their studies, the fact that many of them were already working and how the degree was disappearing year by year. Students confessed in interviews that it

was an exhausting experience, as they had to dedicate a lot of hours to the project, but they had a very high opinion of it in terms of the results obtained and what they had learned about computer graphics techniques.

Academic Year	*Tutoring by lecturer*	*Methodology*	*Overall assessment*	*# samples*
2004-05	*7,6*	*8,0*	*8,2*	*46*
2005-06	*8,06*	*8,1*	*8,35*	*63*
2006-07	*8,3*	*8,35*	*8,6*	*20*
2007-08	*8,04*	*8,28*	*8,8*	*25*
2008-09	*7,17*	*8,3*	*8,44*	*40*
2009-10	*8,13*	*8,41*	*8,55*	*29*
2010-11	*8,08*	*8,36*	*8,48*	*38*
2011-12	*8,22*	*8,34*	*8,44*	*25*
2012-13	*8'96*	*7'42*	*8'42*	*35*

Table 2. Results of student surveys: Student assessment of the lecturer's tutoring, the methodology used and overall assessment of the course (all scored out of 10), and in the final column the number of students that answered the survey

5 CONCLUSIONS

This degree of satisfaction is more subjectively noted as the demand increases among these students for the course lecturers to direct their end of degree projects, and in some cases they do so as part of a group. We therefore believe that PBL fosters positive learning aptitudes in students.

In terms of teaching, the level of satisfaction is also high, for the tutoring work is less monotonous than it is in lectures and the students' motivation regarding their projects also motivates lecturers to help them by providing sources of information and influencing their decision-making as little as possible. The tutors comment that it is not always easy to maintain this balance between helping with and influencing the students' work. They all describe how the students perceiving their tutors as facilitators or advisors is much more gratifying and stimulating than serving the role of evaluator and corrector.

The use of online tools allowed us to maintain much more direct contact with the students when they were not in class, and made it easier for students to meet and work on their projects even though they were in different places. In the first year of implantation, the expected results were not achieved, so we worked on improving the way the method is used.

Directed activities, such as the jigsaw, deliverables and the assumption of roles represent additional work, but help students to organise the project and encourage greater interdependence and socialization among groups.

One of the matters for discussion among lecturers is how the current assessment system provides a numeric grade, and hence the student report does not properly reflect the skills and competences worked on in PBL, which on the other hand are specified in the course's teaching guide. We believe that course assessment systems should be adapted to changes in teaching methodologies, to incorporate assessments of skills and competences in the student report.

Our experience has been and is highly positive, and we feel encouraged to continue improving it and adapting it to the changing profile of students entering university. We are offering our templates to the community and are open to discussion, the aim being to promote, share and improve our experience with PBL.

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Debora Gil

Debora Gil has over ten years of experience at graduate and post-graduate levels. At graduate level, the candidate has taught at the Mathematics (Statistics, Projective Geometry) and Computer Science (Computer Graphics, Programming Languages, Data Structures) Departments of the UAB. Since 2012, she is in charge of the Data Base course within the Bologna grade of Computer Science Engineering. At post-graduate level, she gave a lecture on Optical flow Techniques in the Computer Vision and Artificial Intelligence Master from 2009-2013 and currently cooperates in the definition of the contents of the Graphical Systems and Multimedia course of the Computer Science Master. She has also supervised 12 Master projects (Computer Vision and Artificial Intelligence) and 4 doctoral thesis.

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Antoni Gurguí received his degree in Computer Science from Universitat Autònoma de Barcelona (UAB, Bellaterra, Spain) in 2010. In 2011 he received his M.Sc. in Multimedia Technologies from the UAB. Currently, he is a PhD student at the Computer Vision Center doing his research in 3D mesh and volumes non-rigid registration. Since 2011 he is the lab teacher of Computer Graphics course.

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Aura Hernández-Sabaté, received her degree in mathematics from Universitat Autònoma de Barcelona (UAB, Bellaterra, Spain) in 2002. In 2005 and 2009, respectively, she received her M.Sc. and PhD degrees in computer science from the UAB. Currently, she is an active member of the ADAS group in the Computer Vision Center and a lecturer in the Computer Science Department in the UAB. Her research interests are focused on image processing techniques for biomedical images, optical flow techniques, performance evaluation and human behaviour analysis.

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Jaume Rocarías has experience on programming interfaces for undergraduate students focused in personalization of several Moodle environments. He has also given formation courses for PDI staff from several departments.

Ferran Poveda

Ferran Poveda holds a Computer Vision and a Multimedia Technologies Master's degrees. His interest on mixing Vision and Graphics lead him to apply them together to Medical Imaging in the study of heart architecture during his PhD. He also employed his passion for teaching during 5 years as a lab teacher of Computer Graphics and Computer History at the Universitat Autònoma de Barcelona. Being a technophile, but also interested in design and user experience, today he is embarked in a role closer to end-users as an iOS developer.

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