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Improving Design Competences: Experiences in Group-based Learning Based on ICTs in a Blended Learning Environment*

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The aim of this research was to design and implement a learning methodology based on continuous assessment in group-based learning in a blended learning environment with a view to improving design skills and identifying the attitude of learners toward this methodology. This was achieved through a case study of the Industrial Plants course of the Degree in Industrial Scheduling at the School of Industrial and Aeronautical Engineering of Terrassa (ETSEIAT) of the Universitat Politècnica de Catalunya (UPC) during the 2008-2009 academic year. Qualitative and quantitative methods, including questionnaires, interviews and result analysis, were used in the case study. The findings show that the use of information and communication technologies (ICTs) for improving design skills in group-based learning is feasible and delivers good learning results. Students and instructors appreciated the opportunity for students to work in groups, in combination with face-to-face and ICT sessions, and to study using the written material and the correction protocol that was provided.

Keywords: cooperative/collaborative learning; distributed learning environments; teaching/learning strategies; evaluation methodologies

1. Introduction

Today's engineering education places an emphasis on design and practical applications for solving realistic problems and projects [1–3]. For this purpose, collaboration and group-based learning are becoming increasingly prominent in university courses.

Design skills are mainly acquired in design studio sessions in which a simulation of the real situation occurs. These sessions are not only given as lectures, but also encourage social interaction between the teacher and the students, and among the students. Communication is thus a keyword for defining the design studio sessions and acquiring design skills. As different design stages require different learning styles [4], and design is an open-ended problem-solving process in which the designer's experience is more important than the facts and rules, design education can be considered through Kolb's experiential learning theory [5]. The Kolb learning cycle summarises the stages of experiential learning as concrete experience, reflective observation, conceptualisation and active experimentation, which can be applied to student learning. The main feature is that students do not learn by simply being told facts. They need to be able to put these facts into practice and reflect on the way they are used in order to form connections in the brain, which can be regarded as knowledge.

Design activities are creative and complex, and require a great deal of information from different sources. Therefore, design learning requires collaboration among students to deal with complex design tasks [6]. Group-based learning gives students the opportunity to discuss their understanding of the subject with their peers, as they apply the theory to practice [7]. Furthermore, group-based learning enables students to experience multiple perspectives from other students with different backgrounds and to develop critical thinking skills through the process of judging, valuing, supporting or opposing different viewpoints [8]. The most recent studies on group-based learning focus mainly on virtual learning environments [1, 10–11]. In the area of design, building information modelling and collaborative environments are being developed and analysed [6, 12–14].

Although technologies provide resources for online team experiences, they are still not comparable with face-to-face interaction [15]. Therefore, the optimal situation is one of blended learning, in which students can share and resolve doubts during face-to-face sessions for organisational and social interactions, and also work individually and/or in groups using ICT tools [16].

Blended learning methods are effective in facilitating the process of online collaborative learning [17–19]. Introductory face-to-face meetings are often held to provide students with the opportunity to get to know other members and to build group cohesiveness for subsequent collaborative work.

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The main problems of blended learning are not related to technologies but rather to the self-motivation, group coordination and self- and time-management skills of the students. Therefore, blended formats do not necessarily provide students with interactive and flexible learning experiences.

Eijl, Pilot & Voogd [20] analysed the effects of collaborative and individual work in a blended learning context. They concluded that teamwork was predominantly face-to-face and occasionally virtual (by e-mail and telephone). However, e-resources are essential in a blended learning situation. Because technology only provides the platform for group interaction and that the properties of the medium do not determine the quality of the learning that takes place [21], a more careful analysis of learners, contexts and technologies is required [16].

In this article, we present a methodology for improving design skills through a group-based blended learning course, and analyse the student's perception of this methodology. The methodology provided the students with extra content with which to enrich their learning: self- assessment tests, bi-monthly design project deliverables and assignments, face-to-face sessions, ICT sessions, and e-learning tools such as chat rooms, forums, group document repositories and evaluation protocols.

The novel aspects of the case selection was based on three main criteria:

(1) new techniques and methodologies of group-based learning, such as continuous assessment and scoring rubrics, were implemented;
(2) face-to-face sessions were held and ICT tools were given to students to facilitate communication and collaboration;
(3) the course was mainly based on design topics which are difficult to exchange and communicate using ICT tools.

Pre- and post-qualitative and quantitative assessments were made to evaluate the learners' perception of this new methodology, which was then compared with their final results. The findings of the study provided practical guidelines for improving the implementation of group-based learning in blended learning design studies.

The main limitation of this methodology is that it is oriented to blended learning courses and restricted to improve design skills. However, the main criteria can be adapted to other learning methods such as e-learning.

2. Background

The Department of Construction Engineering of the ETSEIAT has been using the blended learning method in the Industrial Plants course of the Degree in Industrial Scheduling since the 2000–2001 academic year. Students enrolled in the blended learning modality are mainly starting engineers (mechanical, electrical, etc) who have a degree, are employed and want to improve their knowledge of industrial engineering.

Blended learning for Industrial Scheduling is based on several face-to-face sessions and a digital campus called Atenea. This virtual platform is developed online, so instructors and students can access it from anywhere. Documentation can be shared and implemented, the subject programme and marks can be viewed, students can work together and instructors can mark deliverables; also there is a link for asking the professor questions and a chat room for students. The most important thing is for students to feel that they are not alone, and for the professor to monitor each student's learning process and evaluate progress.

The Industrial Plants subject is worth 4.5 European Credit Transfer System (ECTS) credits in the master's degree-level studies (worth 120 ECTS credits). The aim of the subject is to provide a basic knowledge of the relationship between economic activities—industry and commerce—and related areas, and it focuses on legal requirements and the need to choose an appropriate location. In other words, this subject provides engineers with the know-how to analyse, define and transmit the needs of an industrial building in a clear, concise and exhaustive manner and to attain criteria for choosing the best solutions of general and particular interest.

The subject is divided into six main modules. Module I deals with the complexity of finding new industrial locations and gives an overview of all the systems that are involved. Module II focuses on the design of the industrial process layout. Modules III and IV are about the materials and installations of industrial buildings. Module V is related to urban planning, and module VI looks at the main standards that affect industrial building design. Until the 2008–2009 academic year, students designed an industrial building by applying the knowledge acquired during each module and presented it on paper at the end of the course. Students were divided into teams of five and face-to-face sessions were organised to resolve doubts on the theory or the project. The evaluation system was based on theory (60% of the final mark) and the implementation project (40% of the final mark).

The experience gained over the years revealed that students who were enrolled in the blended learning modality had more communication difficulties when carrying out the implementation design project than traditional learning students [22]. This problem was also confirmed through comparative

questionnaires completed in the 2007–2008 academic year to determine students' satisfaction and their opinion of the key elements of the course, such as collaborative learning and group work (see Table 1 and Appendix 1 for the questionnaire).

The questionnaire was based on the Student Evaluation of Educational Quality (SEEQ) methodology [23] adapted to the specific necessities. SEEQ is an instrument used to obtain student feedback on teaching and to increase teaching quality through reflective practice.

The SEEQ questionnaire suffers from the same problems as any other: it is not suitable for all subjects or ways of teaching. For instance, the SEEQ questionnaire is not the most suitable for e-learning and thus for blended learning. Therefore, the study by Akar, Öztürk, Tunçer & Wiethoff [24] on how to evaluate a collaborative virtual learning environment was consulted with the aim of adapting the SEEQ questionnaire to our specific scenario.

The final questionnaire consisted of the following dimensions:

(1) learning,
(2) organisation,
(3) interaction with the professor,
(4) interaction with other students,
(5) evaluation,
(6) difficulty,
(7) others.

In order to assess these dimensions, an item pool was created using items derived from the literature, which were already validated and tested for reliability. Thirty-three of the available items were selected for the questionnaire and a five-point Likert scale (5 = strongly agree, 4 = agree, 3 = neither agree nor disagree, 2 = disagree, 1 = strongly disagree) was used to evaluate the students' responses to these questions. See Appendix 1 for the full questionnaire.

The questionnaire carried out in the 2007–2008 academic year, provided us with rich information about students' thinking and showed that 65% of the students who are enrolled in blended learning

Table 1. Before-and-after comparison of the continuous group-based learning methodology

	2007–2008 N (number of students) = 79 % of respondents							**2008–2009 N (number of students) = 56 % of respondents**								
	1	**2**	**3**	**4**	**5**	**Mean**	**Var**	**1**	**2**	**3**	**4**	**5**	**Mean**	**Var**	**T-score**	
1	0	4	16	53	6	3.77	0.43	0	2	13	33	7	3.75	0.33	0.19	
2	0	3	11	53	12	3.94	0.44	0	0	9	35	12	4.05	0.26	–1.04	
3	0	5	28	32	14	3.70	0.69	0	2	21	27	5	3.57	0.34	0.91	
4	1	3	27	32	6	3.11	0.70	0	1	11	40	4	3.84	0.22	–5.62	*
5	3	6	13	33	24	3.87	1.10	0	4	16	10	23	3.77	0.73	0.58	
6	0	12	21	42	4	3.48	0.65	0	4	15	30	7	3.71	0.42	–1.67	*
7	3	10	25	34	7	3.41	0.90	0	5	12	33	5	3.63	0.40	–1.43	
8	0	7	17	43	12	3.76	0.66	0	1	13	34	7	3.79	0.29	–0.20	
9	0	9	26	34	10	3.57	0.73	0	5	22	22	5	3.38	0.43	1.34	
10	7	8	38	18	5	2.96	0.94	0	1	28	19	5	3.34	0.34	–2.47	*
11	14	31	19	13	2	2.47	1.08	7	27	18	1	2	2.30	0.51	0.97	
12	27	27	17	5	0	1.92	0.82	27	16	9	2	0	1.68	0.51	1.58	*
13	20	19	27	4	1	2.03	0.90	33	8	9	3	1	1.66	0.75	2.11	*
14	31	18	10	10	3	1.92	1.39	23	14	7	5	5	2.09	1.19	–0.76	
15	2	11	20	36	8	3.39	0.88	2	3	10	26	12	3.61	0.66	–1.28	
16	17	12	38	4	2	2.29	0.95	15	3	23	4	3	2.16	0.94	0.71	
17	2	8	31	32	4	3.28	0.69	1	4	21	25	2	3.25	0.42	0.20	
18	1	13	34	23	5	3.11	0.72	2	4	30	13	4	3.07	0.50	0.29	
19	2	5	36	28	5	3.25	0.65	2	3	21	25	3	3.32	0.48	–0.48	
20	2	11	33	27	5	3.24	0.76	2	8	29	11	2	2.84	0.47	2.69	*
21	8	16	31	15	3	2.63	0.97	0	3	22	26	2	3.32	0.32	–4.50	*
22	3	8	29	30	4	3.11	0.78	1	2	21	22	5	3.23	0.48	–0.78	
23	4	5	24	36	4	3.16	0.82	0	2	27	11	1	2.39	0.58	4.85	*
24	0	1	31	38	2	3.25	0.39	0	0	17	33	5	3.71	0.25	–4.28	*
25	0	0	39	25	8	3.25	0.52	0	0	4	23	27	4.27	0.29	–8.41	*
26	0	2	29	33	8	3.33	0.56	0	3	27	22	3	3.39	0.33	–0.50	
27	10	25	17	13	8	2.57	1.39	5	20	17	5	5	2.52	0.79	0.26	
28	0	6	14	27	24	3.57	0.93	0	4	6	19	23	3.88	0.61	–1.83	*
29	2	4	42	18	7	3.08	0.69	1	6	23	24	1	3.27	0.41	–1.36	*
30	1	4	23	40	6	3.39	0.60	0	3	17	31	5	3.68	0.36	–2.17	*
31	0	1	22	51	0	3.44	0.28	0	0	16	35	3	3.63	0.21	–1.92	*
32	1	8	58	7	0	2.77	0.27	0	2	21	26	2	3.23	0.33	–4.42	*
33	0	1	62	11	0	2.94	0.17	0	0	36	17	0	3.14	0.17	–2.63	*

* The rows of this table relate to the 33 questionnaire items.

studies communicate mostly face-to-face rather than virtually. The same conclusion was reached by Eijl, Pilot and Voogd [20].

Students argued that they use the time following the face-to-face sessions to arrange the work to be done and share information on the design project to be delivered at the end of the course. It was easier for them to print out their work, show it face-to-face and explain it verbally than by using ICTs.

In addition, students preferred to use Atenea for accessing information and contacting the instructor rather than for interacting with the other members of their group or with the instructor. The main problem of not using Atenea for communicating with other team members was the difficulty of transferring design ideas. Students had to communicate with one another but Atenea services were not fully designed to share resources such as CAD drawings. As regards the workload, students considered that the work evaluation methods were unfair and inappropriate (M=2.74).

In terms of difficulty compared with other subjects, students found it to be medium-hard (80%). The workload was heavier than that of other subjects (81%) but the pace was about right (83%). In view of this situation, the coordinator of the Industrial Plants subject decided to modify the work evaluation methods and include a bimonthly part of the project deliverable, a scoring rubric, a correction protocol and a methodology for delivering drawings and changing the weight of the exams and deliverables.

Although the Atenea platform was limited and scarce in terms of transferring and communicating design resources, we decided not to include another communication and collaboration platform so as not to overwhelm the students. Therefore, modifications and adaptations to the current ICT tools and to the communication and collaboration methodologies were included.

3. Methodology

From the results of the questionnaire carried out in the 2007–2008 academic year and the instructor's experience, this study proposes a methodology for improving the learning path and design skills of the students enrolled in the Industrial Plants course of the Degree in Industrial Scheduling at the ETSEIAT given in a blended learning environment. It also adapts it to the European Higher Education Area. This research is a case study from the 2008-2009 academic year.

As design learning is best conceived as a process rather than in terms of outcomes [5], students were given a theme every two weeks, a chapter of a book to read, many references, web links with regulations and extra information, self-assessment tests and a design task.

Several researchers have suggested that design learning needs to be carried out in groups [6] and that information exchange and interaction with others enhance student performance and achieve high levels of satisfaction [11]. Face-to-face sessions are also formulated as a design studio session to enable students to communicate and collaborate on the bimonthly task.

Figure 1 shows a schematic representation of the teaching design of the course.

The main features of the new methodology are:

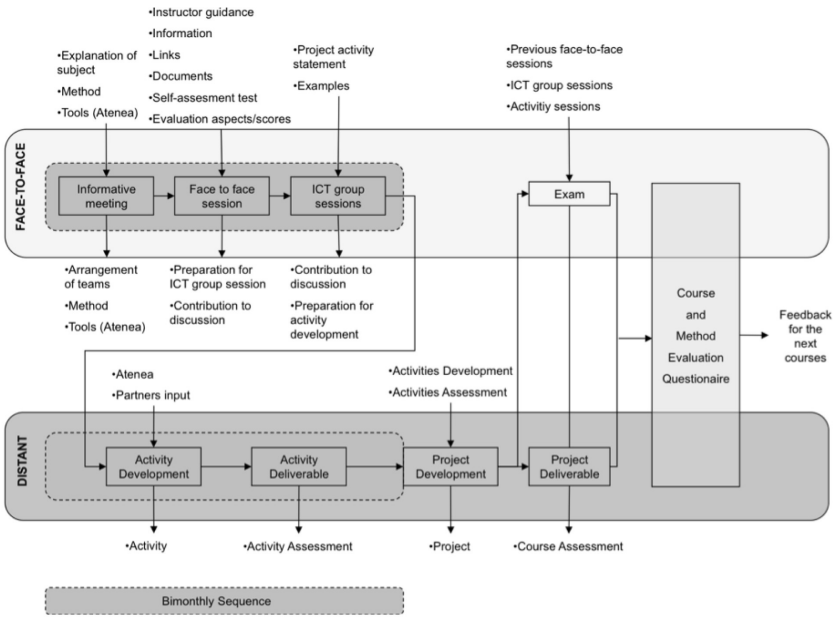

Fig. 1. Structure of the course.

- Students have an initial session (Informative meeting) and face-to-face design studio sessions (face-to-face sessions) to resolve doubts related to the topic and ICT sessions (ICT group sessions) to apply the concepts to a real case. ICT sessions are mainly individual to promote independent learning. Questions can also be formulated using the virtual campus. Students can then use the knowledge acquired during independent study, the face-to-face session and the ICT session to work on the design implementation project in groups.

Table 2. Course methodology

Action	Interface
1. The student registers for the Industrial Plants subject using the academic management application.	Student—Academic management application
2. The managers of the Atenea Virtual Campus register the students to Atenea.	Managers—Atenea platform
3. The instructor uploads the course methodology and presents the implementation project, which should be delivered in groups of 4 and is divided into mini-deliverables throughout the course.	Instructor—Atenea platform
4. The instructor explains the objectives of the course and the learning methodology to the students. The instructor asks the students to team up into groups of 4 for the project and to choose a productive process, which will be the starting point of the project.	Face-to-face session
5. To facilitate the creation of the team, the instructor creates a team creation forum in which students can discuss forming a group. This forum is open for two weeks.	Instructor- Atenea platform—student
6. Students team up and draw up a document with the names of the team members and the project title.	Students—Forum—face-to-face meetings—E-mail—etc.
7. Students upload the document with the names of the team members and the project title to Atenea.	Students—Atenea platform
8. The instructor uses the information on the documents that were uploaded by the students to create groups in Atenea. General course resources will then be made available to all students but any other project material will only be available to the members of each group.	Instructor—Atenea platform
9. The instructor creates a discussion forum on general aspects of the course, which can be accessed by all of the students. The instructor creates as many forums as there are groups and assigns team members in a different group with the aim of facilitating the communication between team members when they develop the implementation project.	Instructor—Atenea platform
10. The instructor creates 8 tasks with the 8 subparts of the project, which are related to the ICT sessions. The task is to share files with the instructor and to deliver the subparts of the project. The instructor corrects them using the scoring rubric and the correction protocol and publishes the assessment and feedback. Each task will be published after the corresponding ICT session and will be available for one week.	Instructor—Atenea platform
11. The instructor creates a chat activity for each team group. The purpose of the chats is to improve and foster communication among team members. Students can send their questions to the instructor, who decides the day and time of the chat. In addition, during the course the instructor creates three general chat rooms, in which students can discuss issues related to the course with the instructor.	Instructor—Atenea platform
12. The instructor uploads the general documents, links, etc. to the general space that can be accessed by all students.	Instructor—Atenea platform
13. The instructor uploads the specific documents, links, etc. for each team to the group space that can be accessed by all students.	Instructor—Atenea platform
14. Students access the digital campus and download the information they need.	Student—Atenea platform
15. Theory session The instructor responds to the students' queries.	Face-to-face session
16. ICT session Students work on a hypothetical case that is similar to the task to be delivered. Students have two weeks to deliver the task.	Face-to-face session with computers
17. Chat session Students can ask the instructors questions on the task to be delivered.	Instructor—Atenea—Student
18. The instructor corrects the tasks following the scoring rubric and the correction protocol and uploads the comments and marks to Atenea.	Instructor—Atenea platform
19. Students access the digital campus and receive feedback on the task from the instructor. Students can use this information to incorporate the instructor's comments in the final project and improve it.	Student—Atenea platform
20. Project follow-up To respond to general and layout queries related to the project presentation, a face-to-face session helps students with scale, printing, etc.	Face-to-face
21. Project deliverable Students enter the digital campus to upload the final project.	
22. The instructor corrects the project and uploads the comments and marks to Atenea.	Instructor—Atenea platform

- The final project is divided into eight tasks (deliverables) that, after correction by the instructor, can be incorporated into the final project deliverable. This provides students with feedback and makes them feel more confident. Each part of the project is strictly linked to the part of the theory discussed in the previous face-to-face session. A scenario with face-to-face sessions, ICT sessions and deliverables was created. Table 2 details the steps in this scenario.

Sessions 12 to 19 are repeated eight times for each of the tasks to be delivered.

- Every two weeks the students receive an assignment that will be part of the final mark. The aim is to give students an idea of the mistakes made and what needs to be reinforced.
- The instructors have created a scoring rubric for these assignments (see Table 3 for an example). It gives students information on what is going to be evaluated and the score of each aspect. Students can then modify and/or correct it for the final project deliverable and improve the final assessment.
- Some face-to-face sessions are organised during the course as a design studio session in which students can communicate and interact.
- The instructor creates a forum for each task in which students can clarify doubts and write comments on specific areas of the course/project.

Table 3. Example of scoring rubric for 'Plant drawings'

	Good (2 points)	**Fair (1 point)**	**Poor (0 points)**	**Total**
1. Stairs drawing				
Calculation	The stairs are calculated according to the formulas given in class.	The stairs calculation contains some errors.	No calculation of the stairs has been carried out.	
Stairs drawing	The drawing corresponds to stairs that begin on the ground floor.		The drawing corresponds to stairs that begin on an intermediate floor.	
Stairs drawing	The tread line is properly drawn.	The tread line is drawn but the way up is not indicated.	The tread line has not been drawn.	
2. Dimension marks				
Units and precision	Dimension marks are represented in metres and numeric values are expressed with 2 decimals.	Dimension marks are not represented in metres or numeric values are not expressed with 2 decimals.	Dimension marks are not represented in metres and numeric values are not expressed with 2 decimals.	
Levels of dimension marks	The three levels of dimension marks are defined: (1) holes, (2) interior layout and, (3) total dimension mark.		The three levels of dimension marks are not defined: (1) holes, (2) interior layout, and (3) total dimension mark.	
Existence of dimension marks	Contains all the necessary dimensions in a construction drawing.	Contains almost all the dimensions but some are missing.	Many dimension marks are missing.	
3. Formal printing aspects				
Drawing scale	The scale is written on the drawing and it matches the drawing.	The scale is written on the drawing but it does not match the drawing.	The scale is not written on the drawing.	
Normalised scale	A normalised scale is used.		A non-normalised scale is used.	
Line thicknesses	All lines are black and the different printing line thicknesses can be distinguished.	Lines have different grey tonalities or the different printing line thicknesses cannot be distinguished.	Lines have different grey tonalities and the different printing line thicknesses cannot be distinguished.	
Dimension orientation and visibility	Dimensions are well orientated and visible.	Dimensions are not well orientated or not visible.	Dimensions are neither well orientated nor visible.	
Dimension line-up	Dimensions are properly lined up.		Dimensions are not properly lined up.	
Intersections	None of the dimension mark lines are intersected.	There are a few intersected dimension mark lines.	There are many intersected dimension mark lines.	
TOTAL				

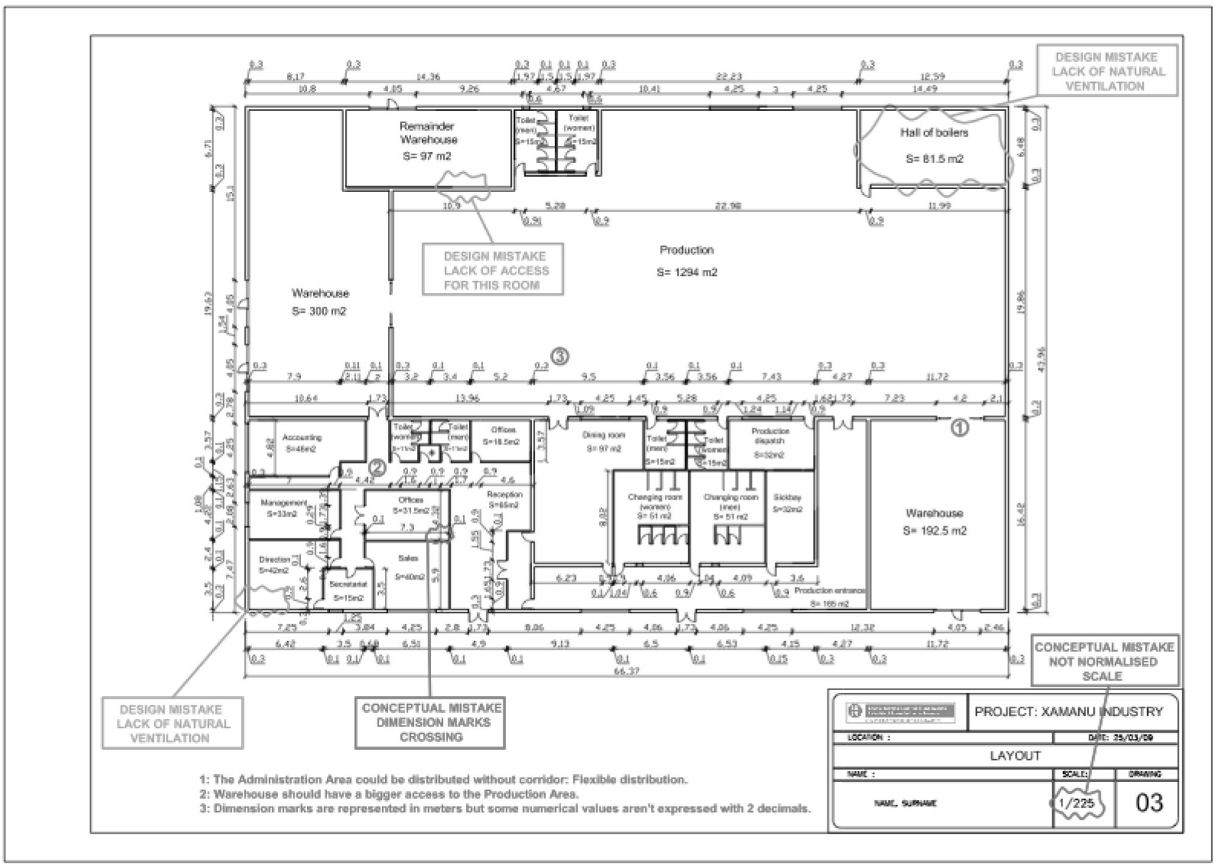

Fig. 2. Example of .dwf drawing, corrected by instructor using correction protocol.

Forums provide a search tool with which to look for similar questions and avoid repeating the same questions.

- The instructor creates a chat room in which students can ask questions and write comments on specific areas of the course/project. Teams can use the chat rooms that are available to communicate with one another.
- Students deliver each task through the .dwf format, which is lighter than .dwg and can be used to create notes and marks. Figure 2 shows a CAD drawing converted to the .dwf format and corrected by the instructor using the scoring rubric. A correction protocol is created to facilitate the understanding of the instructor's comments and marks.
- The instructor delivers assets and guidance, encourages participation in online communities, chats and forums, improves group-based learning, promotes flexible options (blending enables people to receive a response regardless of the location, time and learning preferences), and puts people at the centre of the blend.
- At the end of the course, students deliver the project using the virtual campus.
- The evaluation system (continuous assessment) consists of theory (60% of the final mark), course deliverables (20% of the final mark) and the final design project implementation (20% of the final mark).

To serve the 80 students and the three instructors (who may vary in each academic year) with the methodology, both a guide for instructors and a guide for students were uploaded to the virtual campus.

4. Results and discussion

Results were obtained using a quantitative and qualitative analysis approach to evaluate the use and acceptance of this new methodology. This method allows researchers to capture and synthesize data from multiple sources in order to gain more in-depth and comprehensive understanding [25].

A quantitative evaluation was carried out following the completion of the course by using the same questionnaire that the questionnaire used in the 2007–2008 academic year with the aim of comparing the results and analysing student perception of the proposed methodology. We applied T-tests to analyse the significance of the comparison.

A qualitative evaluation of the methodology was carried out during the course. During face-to-face sessions, instructors informally asked students

Table 4. Comparison of student results

	2007–2008	2008–2009
N (number of students)	79	56
Results	6.3	7.3
Dropout rate	12%	1%

about the problems they had encountered, the use of ICT tools and their thoughts and feelings. Lastly, the coordinator conducted interviews with the instructors during and after the course.

4.1 Marks evaluation

A comparison of student results in the 2007–2008 academic year (before this methodology was implemented) with those of the 2008–2009 academic year (following implementation) reveals that their final marks improved by 1 point, from an average of 6.30 to 7.30 ($t = -3.05$, $p<0.05$). Furthermore, the dropout rate was lower in the 2008–2009 academic year (1%) than in the 2007–2008 academic year (12%). This might be caused by the continuous work carried out during the course and the responsibility of the members of the group towards one another. This result is encouraging and supports the use of the methodology in future academic years. Table 4 shows a comparison of the marks and dropout rates between the two academic years.

4.2 Quantitative evaluation

To facilitate comparison, the quantitative evaluation was based on the questionnaire used in the 2007–2008 academic year.

Students who used the methodology were of the opinion that they had understood the subject materials more ($t = -2.37$; $p<0.05$).

As regards the organisation of the course, students found that the proposed objectives concurred more with those actually taught ($t = -1.67$, $p<0.05$) and that the class material was better prepared and more carefully explained ($t = -1.86$, $p<0.05$).

Regarding the interaction with the instructor, neither face-to-face ($t = -1.68$, $p<0.05$), nor via Atenea ($t = -3.12$, $p<0.05$) decreased. This means that the continuous assessment and the constant feedback from the instructor improves the knowledge of the students and reduce the number of doubts related to the design project and the theory related to the project.

In reference to the interaction with the group, surprisingly, students still declare a preference for face-to-face communication with other team members ($t = -2.00$, $p<0.05$).

In reference to the evaluation method, students expected higher marks with the continuous assessment methodology. These results can be contrasted with the real marks of the students (an average of 7.30 compared with 6.30 in the previous year). However, the students of the 2008–2009 academic year thought that the workload was heavier than in the 2007–2008 academic year ($t = -7.63$, $p<0.05$) and the total number of hours required to prepare the project were higher ($t = -1.29$, $p<0.05$).

On other aspects of the course that came up in the questionnaire, students from 2007–2008 academic year did not answer significantly differently from students from 2008–2009 academic year. This involved e.g. preparation of documentation, completeness of course material, fairness of the method of evaluation.

4.3 Qualitative evaluation

For the qualitative evaluation, instructors conducted interviews with six students who were selected randomly after face-to-face sessions.

The nature of these interviews was to explore the attitudes and feelings of students in greater depth than the questionnaire. Interviews were conducted face-to-face and written notes were obtained.

Informal questions were generated as part of continuous assessment and correction protocol, the ICT available tools to improve collaboration and communication among students and with the instructor during the course.

The coordinator also conducted interviews with the instructors during and after the course to gather their views on the new pedagogical methodology.

The ideas expressed by students to the instructor and the interviews conducted between the coordinator and the instructors reveal that:

- Any change in a subject elicits scepticism, so the instructors and the students initially felt that a lot of extra work would be necessary. However, at the end of the course, the instructors were very proud of how the learning had evolved using this new methodology. During the course, most of the students took into account the professor's comments and corrections, which led to an improvement in the final project deliverable.
- Use of the scoring rubric and correction protocol was well received by the students and the instructors. The instructors unified the evaluation methodology and the students were aware of the evaluation content from the beginning. Therefore, the idea of continuous learning was well received by all the parties involved.
- Students used the Atenea virtual campus to download course documents, deliver tasks and clarify doubts with the instructor using the forum. However, when discussing the tasks with other team members, most students still found that it was easier to communicate design ideas face-to-face rather than through virtual repositories.

- As regards the task deliverables, projects were delivered on paper at the end of previous academic courses. During the 2008–2009 academic year, students had to deliver each task in a specific format (.dwf) using Atenea. To do so, they had to install free software for converting CAD files (.dwg) to .dwf. Some students did not do so and uploaded the task deliverables in CAD files. This causes Atenea to crash and makes it difficult to review the students' deliverables in the previously defined protocol. Moreover, some students ended up sending the tasks to the instructor by e-mail due to connection problems. It is clear that connection problems will have to be corrected for future academic courses.
- Students used group forums instead of general forums because they did not want others to know what they had asked and because questions were mainly related to specific projects. However, students used this tool more often at the beginning of the course than at the end and preferred to resolve doubts using face-to-face sessions. It is believed that students would have used forums and chats more if it had been a distance learning course rather than a blended learning course. Moreover, students did not use the search tool to find similar questions in the forum, which meant that the instructor had to answer the same questions many times.
- Although the chat rooms were not compulsory, 73% of the students participated in them. They found it to be a good tool for addressing design doubts by sharing a CAD drawing and asking the instructor questions. However, instructors complained about the difficulty of running a chat when more than 5 students take part in it and ask different questions. It is difficult to respond to all the questions simultaneously because answers normally include sketches that need to be drawn and uploaded to Atenea and then discussed.

Although several researchers suggest how to successfully form groups to promote interaction among group members [11], [26], in this academic year we decided not to modify this aspect until the new methodology was well adapted in the course. This methodology was based on continuous group-based learning but further work is required to explore the possibility of including project-based learning (PBL). PBL covers any learning environment in which the problem drives the learning. This means that before students acquire knowledge, they are given the problem. The problem is posed in such a way that the students discover that they need to learn something new before they can solve the problem [27].

This methodology can also be extended by including a web-based curriculum environment that allows students to develop their learning portfolio and interact with peers through a web learning system [28]. Such systems can record learning activities on weblogs.

5. Conclusions

Comparison of students' results and feedback in the 2007–2008 academic year (before this methodology was implemented) with those of the 2008–2009 academic year (following implementation) reveals that the continuous group-based learning methodology in combination with blended learning proved to be feasible and produced good learning design results. Students and instructors who followed the new learning methodology greatly appreciated the opportunity for the students to work in groups, in combination with face-to-face and ICT sessions, and to study using the written material that was provided.

This study concluded that students prefer a formative assessment during the course rather than a final summative assessment. They generally feel more confident when they receive feedback from the instructor throughout course, even though it means that they have to work during the entire semester rather than only at the end. A formative assessment throughout the course keeps students more on track than in traditional courses with only one final, summative assessment. However, the workload of the students following the new methodology was perceived to be heavier.

From the qualitative analysis it can be concluded that the effective integration of face-to-face sessions and ICTs is the basis for a successful design group-based blended learning course, as confirmed during the informal interviews with the students. The rapid advance of web technology has enabled universities to facilitate learning processes. Although this technology promotes collaborative learning activities, the adaptation of these technologies to the specific necessities of each course, such as those related to design, is still a critical issue. Thus, students still prefer to interact face-to-face than virtually as could be noticed in the quantitative analysis. Students who met face-to-face had little need for digital chat sessions or other forms of digital collaboration, and argued that face-to-face interactions are much faster and more stimulating.

To conclude, although this new methodology of continuous group-based learning for improving design skills is relatively new at the UPC, students evaluate it positively; it could be implemented in other subjects or university courses after further studies have been carried out.

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Appendix A: Evaluation Questionnaire

					Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Learning									
1. You find the subject intellectually challenging and stimulating.					1	2	3	4	5
2. You have learned something that you consider valuable.					1	2	3	4	5
3. Your interest in the subject has increased as a consequence of this subject.					1	2	3	4	5
4. You have learned and understood the subject materials.					1	2	3	4	5
5. Your learning grade would have improved with more face-to-face sessions.					1	2	3	4	5
Organisation/Clarity									
6. The proposed objectives were in line with what was actually taught so you understood the direction of the course.					1	2	3	4	5
7. The class material was well prepared and carefully explained.					1	2	3	4	5
8. The instructor's presentations were clear.					1	2	3	4	5
9. The instructor gave presentations that facilitated note-taking.					1	2	3	4	5
Interaction with the instructor									
10. The instructor was suitably accessible to students during office hours or after class.					1	2	3	4	5
11. The number of queries posed to the instructor during the face-to-face sessions was:					1	2	3	4	5
1. None	2. Between 1 and 3	3. Between 3 and 5	4. Between 5 and 7	5. More than 7					
12. The number of queries posed to the instructor outside the face-to-face sessions was:					1	2	3	4	5
1. None	2. Between 1 and 3	3. Between 3 and 5	4. Between 5 and 7	5. More than 7					
13. In relation to the queries posed to the instructor, you contacted the instructor face-to-face:					1	2	3	4	5
1. Never	2. Rarely	3. Sometimes	4. Almost always	5. Always					
14. In relation to the queries posed to the instructor, you used Atenea resources, e-mail, etc.:					1	2	3	4	5
1. Never	2. Rarely	3. Sometimes	4. Almost always	5. Always					
Interaction with the group									
15. When working in a group, you contacted the other members face-to-face:					1	2	3	4	5
1. Never	2. Rarely	3. Sometimes	4. Almost always	5. Always					
16. The Atenea platform is a good tool for group-based work					1	2	3	4	5
Documentation									
17. The basic course material is well prepared.					1	2	3	4	5
18. The reading list and complementary course material is complete and appropriate.					1	2	3	4	5
19. The homework, reading list, basic and complementary material, etc., facilitate the comprehension of the subject.					1	2	3	4	5
Evaluation									
20. The methods for evaluating student work were fair and appropriate.					1	2	3	4	5
21. In general, the evaluation requirements were clear.					1	2	3	4	5
22. Exam and project contents correspond with the subject content.					1	2	3	4	5
23. Examination contents were in line with the professor's emphasis in each module.					1	2	3	4	5
Workload/Difficulty									
24. In relation to other subjects, this subject was:					1	2	3	4	5
1. Very easy	2. Easy	3. Average	4. Difficult	5. Very difficult					
25. In relation to other subjects, the workload of the subject was:					1	2	3	4	5
1. Very light	2. Light	3. Average	4. Heavy	5. Very heavy					
26. The subject pace was:					1	2	3	4	5
1. Too slow	2. Slow	3. About right	4. Fast	5. Too fast					
27. The average number of hours per week required to prepare for the exam outside the classroom was:					1	2	3	4	5
1. Between 0 and 2	2. Between 2 and 5	3. Between 5 and 7	4.Between 8 and 12	5. More than 12					
28. Total number of hours required to prepare the project outside the classroom:					1	2	3	4	5
1. Less than 10	2. 10–25	3. 25–35	4. 35–50	5. More than 50					
Other information									
29. Your level of interest in the subject before starting the classes was:					1	2	3	4	5
1. Very low	2. Low	3. Normal	4. High	5. Very high					
30. Your level of interest in the subject after finishing the classes was:					1	2	3	4	5
1. Very low	2. Low	3. Normal	4. High	5. Very high					
31. The final mark you expect to achieve for the project is:					1	2	3	4	5
1. Less than 3	2. Between 3 and 5	3. Between 5 and 7	4. Between 7 and 9	5. More than 9					
32. The final mark you expect to achieve for the exam is:					1	2	3	4	5
1. Less than 3	2. Between 3 and 5	3. Between 5 and 7	4. Between 7 and 9	5. More than 9					
33. Your average mark at the university is:					1	2	3	4	5
1. Less than 3	2. Between 3 and 5	3. Between 5 and 7	4. Between 7 and 9	5. Higher than 9					