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Web 2.0 Blended Learning to Introduce e-Business Contents in Engineering Education: a Pilot Case Study in Jordan*

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Blended Learning (BL) is considered a promising pedagogical approach. Some researches demonstrated that students' satisfaction is higher for BL courses compared to completely online or face-to-face (F2F) courses. Moreover, the explosion of web 2.0 tools and the success of the ''read-write Web'' are reconfiguring the individual and collaborative blended learning processes. Based on this assumption, this paper investigates the effectiveness of web 2.0 BL for the design and delivery of a pilot course on e-business topics. Two experimentations have been organized involving undergraduates engineering students of the University of Jordan. According to the obtained results assessing students' reaction, learning and behaviour, the BL model proposed in the article revealed more effective than traditional F2F learning. A survey conducted at the end of the course also showed that students were satisfied with the pedagogical approach, and their academic achievements were also significantly improved. Findings demonstrate that successful BL programs require innovative curriculum design strategy based on new principles such as: a) the involvement of heterogeneous stakeholders in the course's design phase; b) the focus on competence development rather than on knowledge transfer; c) the choice of team work as an additional component to evaluate individual students' performances; d) presence of remote and F2F interactions among peers and between teachers and students; e) the usage of web 2.0 tools as enablers of collaborative learning processes and social networking; f) continuous tutoring both for content and technological issues. These findings can help engineering colleges and universities to design and offer more effective learning courses.

Keywords: blended learning; web 2.0; engineering education; curriculum design; learning assessment, e-business

1. Introduction

In the last few years the emergence of blended learning has been influenced by the rapid changes in Higher Education, including the establishment of new universities and support given for the integration of e-learning [1], especially in MENA region. In particular, in Jordan, numerous e-learning projects and initiatives have been launched in the last decade to make more accessible educational services and to promote lifelong learning processes (i.e. Avicenna, Mednet'U, Arab Open University, Odiseame). Although e-learning was growing very fast promising big advantages to its adopters, nowadays, new methodologies and strategies are arising and integrate the strengths and advantages of Face-to-Face (F2F) teaching with the ones of e-learning environments [2].

These strategies are commonly denominated as *Blended Learning* (BL) [3–5], defined as an effective combination of different learning techniques, technologies, and delivery modes to meet specific communication, information needs, and knowledge sharing practices between learners and teachers, with the final aim to ensure better teaching-learning experiences [6, 7]. It is expected that there will be a dramatic rise in the use of BL in the coming years [8]. BL normally uses a rich mix of live synchronous training, asynchronous self-paced instruction, and instructor-led teaching to enhance quality and richness of learning experiences [9, 10]. Beyond this most traditional perspective of BL, it is possible to identify other perspectives which refer mostly to the combination of different pedagogical approaches (e.g. constructivism, behaviourism, cognitivism, and connectivism) to produce outstanding learning outcomes [11]. This conceptualization of BL is empowered by the diffusion of Web 2.0 technologies that allow more support for collaboration and networking, providing new opportunities to overcome many of the failings of traditional e-Learning solutions [12]. With Web 2.0 technologies, future learning models revolve around three core components: *networking and collaboration*, *intelligent search*, and *knowledge creation* [13]. *Networking and collaboration* are based on the recognition of the social aspect of learning and, as a consequence, put a strong emphasis on knowledge networking and community building to leverage, sustain, and share knowledge in a collaborative way. *Intelligent Search* allows a reliable access to information, services, communities, and expertise, overcoming

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the information overflow that is typical of the Web. *Knowledge creation* is the result of effective learning models and questioning activities that facilitate and enhance creativity [14] and give people the support for generating new content collaboratively. Through these three components, Web 2.0 tools support cooperative learning, so producing greater students' achievements than other traditional learning methodologies [15].

Empirical research indicates how web 2.0 technologies in learning environments have the potential to support collaborative learning processes, that result in a positive interdependence of group members, future face-to-face meetings, individual accountability, and appropriate use of collaborative skills [16, 17]. A social constructivist perspective has been also used to explain the success of Web 2.0 applications, especially wikis, in making the learning process more effective [18, 19].

The challenging task for today's educational institutions is to find the most suitable way to integrate these tools in the classroom experience and to design BL programs according to the target of the initiative, the contents to be delivered, and the technology used to support all the learning process [20].

Framed in these premises, this article aims at providing evidence on the design and development of a Web 2.0 Blended Learning initiative and, consequently, at evaluating its effectiveness. The initiative was focused on e-business topics and targeted to engineering students of the University of Jordan. With this purpose, two pilot BL programs have been designed and launched by the Mediterranean School of e-Business Management (hereafter Med School), a joint cooperation initiative among the University of Salento (Italy), University of Jordan (Jordan) and other public and private institutions located in Morocco and Tunisia [20].

The article is structured as follows: section 2 illustrates the literature background organized around four main topics (the understanding of BL, the role of web 2.0 in BL, the design of BL initiatives, and the e-learning effectiveness); section 3 describes the research method and the empirical context of the case study; section 4 illustrates the approach adopted for the BL program design. Then, section 5 presents the results about the overall effectiveness of the BL program in terms of students' reaction, students' learning and students' behaviour. Finally, sections 6 and 7 contain respectively the discussion and the conclusion of the article.

2. Background

Theoretical background and literature review at the basis of this paper are organized around four main issues, coherently with the research focus: the understanding of the BL concept, the role of web 2.0 in BL, the design of BL initiatives, and the concept of e-learning effectiveness.

2.1 Understanding Blended Learning concept

BL combines traditional F2F learning and distributed learning, by leveraging on the key role of Internet-enabled services for enhancing communication, interaction and collaboration among learners and teachers. In such a way, BL tries to obtain both the advantages of human-human interactions typical of F2F modality (such as socialization, trust and spontaneity), and the advantages of learner-content interactions and self-paced learning, typical of the distributed modality (such as flexibility, participation and reflection) [7].

Usually, "blended" can occur at four main levels [7]: at *activity level*, when a specific activity contains both F2F and computer-enabled elements; at *course level*, when a course is a combination of distinct F2F and computer-mediated activities, separated or overlapped in their sequence; at *program level*, when an entire program is the result of a combination of pure F2F courses and pure online courses; and, finally, at *institutional level*, when the presence of F2F lectures/courses and on line activities/modules represents a strategic direction of the organization, both academic and industrial one.

Another well-known classification of BL is based on media involvement, so obtaining four main models [7]: e-learning pure (100% on line, without any F2F events); e-learning with an initial F2F meeting; e-learning with an initial and a final F2F meeting; and e-learning with multiple F2F meetings.

Finally, a further categorization of BL can be based on the level of change it brings. Thus, it is possible to distinguish [7]: *enabling blends*, which allow for satisfying learners' needs, addressing their issues of time access and cost convenience, by providing an "equivalent" learning experience but through different modalities (F2F residential programs, completely on line programs, mixed F2F and on line learning programs); *enhancing blends*, which allow for incremental changes to the way teaching and learning occurs, by leveraging on the adoption of on line systems (i.e. Learning Management System) and the provisioning of on line supplementary materials; and *transforming blends*, which allow for a radical transformation of the entire learning experience, through the adoption of models where learners actively construct knowledge through dynamic interactions enabled by advanced ICT systems.

Thus, compared to the traditional education, BL improves pedagogy (mix of F2F and on line ses-

sions), increases access and flexibility (contemporary involvement of students with different learning styles and levels), and enhances efficiency (cost savings due to minimizing time away from the job and travel/classroom/teacher expenses). Then, it favours the reduction of the dropout rate thanks to the support provided by instructor and learning system, and, finally, it ensures the socialization process with face-to-face interaction among students and with teachers, that is fundamental for a successful learning experience [6].

Moreover, BL reveals valuable in engineering education since it allows for a good combination between on line mode and hands-on experiences and real-life system-level problems and decisions within physical laboratories [21]. Indeed, the application of theoretical concepts to the real world represents a fundamental issue of every engineering education programs; the usage of recent tools, such as simulators or virtual laboratories that can be manipulated remotely and provide resources at distance, makes the program more flexible, interactive and socially networked, but they cannot substitute the real experimentation and application within real world situation [22]. In such a way, BL guarantees the two major factors characterizing engineering education: digital content and real world practice [23].

2.2 Web 2.0 for active collaboration in Blended Learning

Web 2.0 technologies revealed very helpful in the online learning environment by engaging students in collaboration activities, using the web as a resource [24–26].

In particular, Web 2.0 and social software are affecting also the BL strategies. These technologies can really support the evolution of BL toward the second stage, overcoming the first stage characterised by the use of Web 1.0 tools such as web pages, course management systems, e-mails, and chat rooms [1]. Web 2.0 technologies are definitely improving the BL experience, facilitating student-faculty and student-student communication. Blended learning second stage is now emphasizing a more active learning, collaboration, and enhanced interaction through the use of:

- *Blogs*, webpages containing brief paragraphs of opinions, information, personal diary entries, or links, arranged chronologically in the style of an online journal [27].
- *wikis*, webpages that can be easily edited by anyone who is allowed to access [28].
- *Folksonomies*, shared and bottom-up taxonomies obtained as the result of a collaborative content tagging made by people [29].
- *RSS*, formats which allow users to find out updates to the content of RSS-enabled websites without actually having to go and visit the site, by using ''syndication'' mechanisms [30].

An increasing number of learners are expected to access to these tools, as they use them regularly to learn and communicate with their peers. Web 2.0 technologies meet the need for a more personalized and collaborative learning environment. In particular, wikis support knowledge sharing processes and active learning, improving students collaboration within and across communities of practice [31, 32]. Moreover, they enable the shift from a traditional teacher-centred perspective to a dynamic learner-centred approach, providing new methods for content co-creation and consumption, collaboration and interaction through web-based applications. This transition represents a profound change in the higher education sector.

2.3 Designing a Blended Learning program

Creating successful BL programs requires a rethinking and redesigning of teaching and learning processes [33–35], in order to integrate the strengths of F2F with the new possibilities offered by the media [2], so enhancing the overall quality and richness of learning environments [9]. This integration may engage the teachers in critical discourse, reflection, continuous learning, and construction of knowledge [33, 36]. As shown in Fig. 1, BL can be considered as an integrative approach incorporating the fundamentals of both face-to-face strategies and pure e-learning configurations, activating communication, interaction and collaboration dynamics among students, teachers and tutors, also by using Web 2.0 tools.

BL is considered a promising pedagogical approach [37]. Some researches demonstrate that final results of BL courses can be better than the results of completely online or traditional courses [38, 39]. There are, at least, six main trade-offs to consider for designing and delivering a BL program [10, 11, 24, 33, 40, 41]:

- *Offline vs. online:* offline is based on classroom, and online is based on the use of computers and Internet.
- *Self-paced vs. collaborative*: self-paced implies that learning processes are controlled autonomously by each student, while collaboration means that these processes involve group of students working together.
- *Structured vs. unstructured*: structured entails that there is a fixed scheduling of learning activities and a premeditated program with organized content in sequence, while in unstructured learning there is much more flexibility and a wider

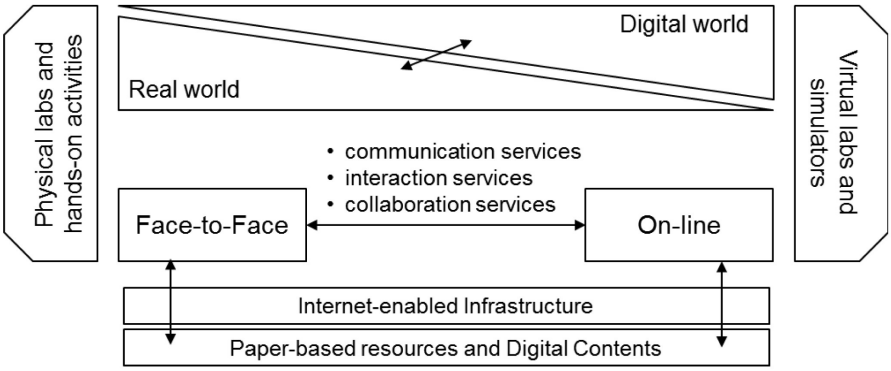

Fig. 1. Blended Learning as an integrative approach.

choice of contents, without a mandatory architecture of courses and activities.

- *Synchronous vs. asynchronous:* synchronous interactions are based on an immediate availability of involved people (students and teachers), while asynchronous interactions presume the presence of delays in the communication process.
- *Customized vs. off-the-shelf content:* customized content assumes a specific creation of learning material according to specific needs/requirements, while off-the-shelf content generally means that learning resources are standard and acquired from external sources/providers.
- *Theory vs. just-in-time*: theory usually aims at introducing contents at the beginning of the course according to a top-down approach (support perspective); whereas just-in-time delivers the contents to students during the course, with a bottom-up logic, just when they make specific request to solve a problem, develop an application, or make a real world experimentation (performance perspective).

As a result, a BL program tries to define a virtuous combination of the above listed "levers", by orchestrating individual work sessions, group work and classroom activities, homework and individual reflection, in which ICT and Web 2.0 tools play the role of enabling technology, in the final perspective to motivating and assisting students to complete the course successfully [43, 44]. In such a way, the role of teachers evolves from a simple knowledge transmitter towards a learning facilitator, so making students able to construct their own contextual knowledge, stimulating peer interaction, critical discussion, and cooperation [45].

Generally, BL programs can follow two main design approaches: the *"program-flow"* and the *"core-and-spoke"* [6, 46, 47]. In the program-flow model, students participate to the learning activities step-by-step, by following a predefined and scheduled order. In the core-and-spoke model, instead, students have both mandatory and additional learning material (i.e. lesson contents, interactive applications, multimedia resources, web resources, physical books or e-books, tests and exercises, etc.) they can use over time, without any specific order and schedule, to complete the course. This last model reveals more effective when it is used for motivated and experienced students. Definitely, BL allows obtaining instructional richness, easy access to knowledge content, social interaction, and cost effectiveness [48]; it fosters communication and closeness among students and tutors [49] and improves students overall satisfaction [50].

2.4 Measuring the effectiveness of e-learning

The evaluation of an e-learning program represents a hot issue for scholars involved in technology-enhanced learning research field [51]. Moreover, in the engineering education field, the adoption of on line strategy and tools reveals to be more difficult because, usually, engineering disciplines may have special needs in terms of laboratories and manual work [52].

Although there is no one fixed and integrated way that can be used for evaluating the effectiveness of e-learning [52], a general convergence on the main efficiency-oriented benefits characterizing e-learning exists. Among these, there are time and cost savings in completing the course activities; a higher time and space flexibility due to the possibility to combine education with other activities and work; a higher number of students can be involved into a program, having fewer time and place constraints; fastest and personalized learning support through e-mail, chat and videoconferencing; a lower cost in course production due to a higher reuse of digital material; a better management of students' workload, thanks to a more flexible time management and collaborations [10, 12, 43, 53, 54, 55].

Many studies looked at evaluating e-learning from different perspectives. Some approaches used

to compare e-learning with traditional learning [56–58]. Some researchers focused on the financial impact and return on the investment related to e-learning [59, 60]; others focused simply on the performance of e-learning platform [61], or on the quality of contents and digital resources [62]. Other scholars, instead, specifically focused on evaluating student performance and student satisfaction [63–65].

3. Case Study: a BL course on e-business for engineering students

3.1 Research design

Starting from the above literature, this paper wants to investigate the effectiveness of the BL approach for designing and delivering a pilot course focused on e-business topic, and targeted to Jordanian students involved in engineering education at undergraduate level. In particular the work aims at answering to the following research questions: a) How to design a blended learning experience to introduce the e-business concepts to engineering students? b) How to assess the effectiveness of this experimental BL program?

To address these questions, a qualitative research method based on case study has been adopted, since it allows an emphasis on processes and meanings that are essential for investigating the design and assessment of a BL experience [66]. In general, case studies are the preferred strategy when 'how' or 'why' questions are being posed, and when the focus is on a contemporary phenomenon within some real life context. In this case, a multiple case study is adopted to investigate phenomena in its real context.

Specifically, our study is replicated in two BL courses characterized by the same contents and different students, in order to find similarities in the effectiveness of BL approach compared to traditional F2F teaching. In particular, two fundamental elements through which evaluating a BL program have been considered: from one side the *objective* measure of student performance based on the evaluation of the results of the final examination and, from the other side, the *subjective* measure of the overall perception of student towards teachers, contents, interaction and pedagogy/strategy [52, 67–69].

3.2 Empirical context

The case study has been designed and delivered by the Jordanian node of the Med School, hosted by the faculty of Information Technology at the University of Jordan, in Amman. The Med School is an Euro-Mediterranean cooperation initiative launched in 2005 by the University of Salento (Italy), aimed at promoting competence development initiatives, pilot projects and joint research actions focused on Digital Innovation domain [20]. The choice to consider Jordan as the context for this study is motivated by the fact that, in this country, there are favourable conditions to experiment innovative approaches into the learning and education domain. Indeed, the Jordanian Ministry of ICT has orchestrated and developed, in conjunction with the Ministry of Education (and supported also by the Canada International Development Agency, EUMEDIS and UNESCO), a comprehensive e-learning strategy that aims to provide teachers with training, project coordination and implementation, technical assistance, tools and systems to improve the infrastructure of schools and universities. Finally, for what concerns the e-business topic in particular, the Jordanian government has recently provided a strategic direction to introduce in universities and higher education institutions specific programs and courses devoted to develop e-business competencies and capabilities, so stimulating students to apply them in traditional and emerging industries.

3.3 Participants

The participants attending the two BL courses were 35 students of the Engineering Faculty of University of Jordan (15 in the first initiative held in June 2009, and 20 in the second one in July 2009), belonging to different Engineering Education programs, specifically Computer Science Engineering, Business Engineering, and Industrial Engineering. They participated to the program freely and voluntarily demonstrating all their motivation. Table 1 shows a summary of demographic characteristics of the participants.

The research population of this study is very small, and it is not a sample or a representative group; it is the entire group attending the two BL initiatives. The limited number of participants compels to be very careful in making any inferences and appropriate considerations [70].

3.4 Research methodology and data collection

Data were collected during the delivery of the two BL programs, in June 2009 and July 2009. Beyond the data collected through unstructured conversations held with all the 35 students and with the faculty members, and information gathered through the direct observation of the authors, the main sources used for evaluating the effectiveness of the overall BL experience were:

- Individual students' pre-assessment and post-assessment on e-business topics, obtained through surveys performed by a structured ques-

Table 1. Statistical overview of the participants to the BL programs

Sample Characteristics	Number of Students
Gender	
Male	15
Female	20
University Level	
Undergraduate	
1st year	0
2nd year	7
3rd year	12
4th year	14
Postgraduate (Master)	
1st year	2
2nd year	0
Departments	
Computer Science Engineering (CSE)	14
Business Engineering (BE)	19
Industrial Engineering (IE)	2
Working Experience	
No one	25
0–5 months	6
6–11 months	1
More than 1 year	3
Computer Literacy	
Beginner	4
Novice	1
Intermediate	11
Very knowledgeable	15
Expert	4
Internet Usage	
Not at all	0
0–5 hours per week	0
6–14 hours per week	5
15–24 hours per week	12
More than 25 per week	18

tionnaire composed by 15 questions (11 multiple-choice, 3 open and 1 matching question) and filled in 40 minutes.

- Students' group assessment, conducted through the evaluation of the group work focused on a case studies analysis and presentation (case studies' analysis has been evaluated considering the relevance of analysed topics, the degree of deepening, and the quality of conclusive remarks; whereas, the evaluation of group presentation was made on the basis of clarity and effectiveness of talk, time handling and questions handling capacities).
- Structured and anonymous overall evaluation of four specific dimensions of the BL program (relationships with teachers/tutors, contents, level of collaboration and interaction, and educational strategy), carried out through structured questionnaires composed by 21 statements. Students were asked to express their opinion on a five-point Likert scale, so minimizing respondent refusal, reducing cost for data collection and data processing, and avoiding common methods bias [71–73]. This questionnaire included also an additional section reserved to express an overall evaluation of the technological system used into the program [74] in terms of number of system errors and blocks, the internet connection speed, the availability of different communication tools, the availability of technical support.

For the evaluation purposes, the involved teachers and tutors were the same for both courses. Figure 2 illustrates the whole structure of the research methodology presented above.

4. BL course design and delivery

Course design and delivery for both BL initiatives have been prepared according to the program-flow model described before. Features of program-flow model are more suitable for the characteristics and objectives of this study. In the next paragraphs we examine in detail the contents, pedagogy and technological infrastructure of the BL course.

4.1 Course design: learning objectives and contents

The final set of e-Business competencies to be developed in the future engineers have been defined by a joint Italian-Jordanian committee composed by professors and researchers of University of Salento (Italy) and University of Jordan (Jordan) operating in the domain. The committee was the responsible for the overall course design and imple-

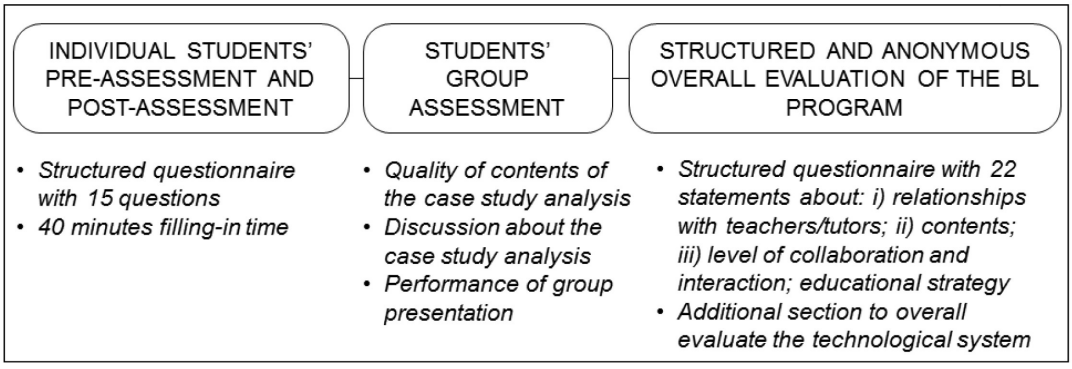

Fig. 2. Research methodology architecture and data collection methods.

mentation. Specifically, the committee considered two main sources to define the list of competencies and the related learning objectives and contents: from one side, the almost ten-year experience of the Italian partner in the design and delivery of International Masters and PhD programs in e-Business Management, in collaboration with prestigious universities and research centres; from the other side, the requirements of the Jordanian private and institutional communities very interested in diffusing very fast and at a large scale the e-business culture and services. The pilot program was realized according to a *competence based approach* in the sense that the final goal was not simply the deepening of a certain amount of contents, but the development of a specific set of competencies, where competence is here intended as a mix of knowledge, skills and attitudes [75]. Table 2 details the competency framework, by highlighting the correspondence between competencies, learning objectives and knowledge/contents.

Besides the specific learning objectives, the course was also aimed at developing the following skills and attitudes: presentation and communication skills, networking and team-working, capacity to learn, curiosity and intuition.

4.2 Course delivery: learning plan and activities

For both BL programs, a learning plan scheduled on a timeline of 9 days, for a total of 18 contact hours (2 hours per day) has been developed; students required additional time to deepen concepts and develop competencies through individual learning, workgroup activities and collective discussions. Table 3 shows daily details of learning activities.

The typologies of actors involved into the learning process were: a) 35 students attending the two pilot programs; b) 1 tutor helping students for technological issues; c) 2 tutors supporting students for contents comprehension and analysis; d) 1 professor of the University of Salento connected through the video conference system and on line services; e) 1 professor of the University of Jordan as main supervisor of the course delivery.

The program's plan ensured, on a daily basis, the presence of face-to-face interactions, besides the use of ICT. Then, in addition to the 2 hours per day of the official time scheduling, a videoconference connection between the University of Salento and the Jordanian centre was activated for 2 hours more, to support interactive discussion and request of clarification expressed by the students during the extra-time. Figure 3 shows a videoconference

Table 2. Course competency framework

Competencies/Learning Objectives	Knowledge/Contents
To understand the importance to introduce e-business into an organization	• The "Digital Economy" and the "Digital Organization" • The impact of Internet on the organization • e-Commerce and e-Business • The e-Business trends in Jordan • Creating value through e-Business
To recognize and analyse the main components of an e-business model	• e-Business model definition • Taxonomies of e-business models
To choose an e-business systems able to support the competitive strategy of the organization	• CRM suite • ERP system • SCM tools
To assist an organization in adopting an e-business configuration	• e-Business strategy and roadmap

Table 3. The course learning plan

Days	Learning Activities
Day 1	Welcome message; presentation of contents and activities of the BL program; pre-assessment; introduction on how-to-use the e-learning system; questions & answers.
Day 2	Videoconference seminar on the fundamentals of e-business management with Professors of University of Salento; questions & answers.
Day 3	Online module (part A); questions & answers (face-to-face, chat, forum, videoconference, web 2.0 tools).
Day 4	Online module (part B); questions & answers (face-to-face, chat, forum, videoconference, web 2.0 tools).
Day 5	Videoconference with Professors of University of Salento to introduce some demos of e-business systems; face-to-face session about the situation of e-business in Jordan; questions & answers.
Day 6	Collective discussion about the contents of the online modules; Case studies assignment and workgroup; questions & answers (web 2.0 tools).
Day 7	Case studies discussion and workgroup; questions & answers (web 2.0 tools).
Day 8	Case studies presentation and interactive discussion (in classroom and via video conference); questions & answers.
Day 9	Final test and course closing (collection of feedbacks and satisfaction level); questions & answers.

Fig. 3. A videoconference session between Jordan (big picture) and Italy (small picture).

session where it is possible to see in the main picture the contents transmitted into the Jordanian centre, whereas, in the small picture, a professor who presents and explains, remotely from Italy and in real-time, the transmitted contents.

Even during the two days in which students accessed to on line modules (days 3 and 4), an interactive session of "questions & answers" has been scheduled to give students the opportunity to deepen some concepts, clarify some doubts, discuss about possible applications of theoretical concepts into Jordanian contexts. During this phase, students interacted locally with the tutors, but also remotely by using chat, forum and videoconference. Web 2.0 tools allowed them to have a central role in the creation, editing and updating of generated contents; in particular, each workgroup was supported by a wiki used for creating a common glossary and for collecting students-generated knowledge according to the template of the deliverable to produce. In this way, students collaborate each other to populate and fill in the wiki, under the supervision of local and remote tutors. Indeed, both programs have been supported by an efficient *tutorship,* both at technological level and at content level. Indeed, tutors supported students in accessing to the online services, in understanding the main contents related to the course program, in analysing the case studies through the identification of the most significant parts, in discussing the students' questions and elaborating the respective answers, and in supervising user-generated content through the wiki.

All the learning activities have been completely supported by an *e-learning system* that is described in the next section. In this way, besides the two daily hours scheduled for the program, students had the opportunity to continue in a virtual setting their learning experience according to their personal styles and habits.

To summarize, the most relevant learning activities characterizing the BL initiatives can be identified in: (a) pre-assessment; (b) face-to-face lecture; (c) videoconference seminar; (d) access to on line modules; (e) team working; (f) presentation of workgroup results; (g) post-assessment. A description of these activities is here reported.

Pre-assessment

A pre-test has been prepared to evaluate individually the initial level of knowledge that students had about the issues and contents characterizing the course. It consists in a 15 item questionnaire, divided in 11 multiple-choice questions, 3 open questions and 1 matching question. Time dedicated to fill in the questionnaire was 40 minutes. More details about the assessment methodology and results are provided in the next paragraph.

Face-to-face lecture

A welcome face-to-face lecture aimed at providing students with a general overview about the e-business has been held on the first day. The main objective was to introduce students to the main issues and trends of e-business, creating motivation and making them aware about the key issues to be deepened in the remaining part of the course, both at individual and group level. Moreover, the tutors provided a general overview about the organisation of the course and explained students how to access to the on line learning system, through a live demo of the services.

Videoconference seminar

A two-hour seminar on the topics of *e-business fundamentals* has been held by a professor of University of Salento using the video conference system. The main topics illustrated were around the concepts of Digital Economy and Digital Organization, the impact of Internet on the value chain of the organizations, the relationships between e-commerce and e-business. Moreover, some cases of e-business successes were briefly introduced and presented with the aim to identify the sources of value creation in virtual markets. Finally, data about the e-business in Jordan and some examples of well-known companies adopting e-business have been also presented. During the videoconference, the teacher assumed the role of a mentor, stimulating students to make comments, ask questions, to interact and discuss each other through ad hoc sessions of questions and answers managed locally by the tutors.

Access to on line modules

Topics discussed in the face-to-face sessions have been deepened during the on line sessions available

through the e-learning system. Learning object and digital contents, including interactive elements like flash animations and videos, have been played by students. Students completed also some exercises through answering to multiple choice questions, as well as some quizzes and interactive games to check the comprehension of the delivered contents. At the end of the on-line modules, students guided by the tutor, discussed about the topics in order to be fully aware about all the concepts.

Team working

Team working experience was mainly based on case study analysis and discussion. The first step was to organize the students into groups. Group size is an important determinant of the success of the activity: groups should be large enough to support the workload, but small enough to facilitate communication and organization [6]. In our experience, three students per group was a suitable number. We also encouraged the random creation of groups to prevent overdependence. We have seen that teams whose members had not a close relationship, improved their communication skills, autonomy, and time management capabilities. Each group received a different case study with a template to be used for the analysis. The final aim of the team working was to identify and illustrate the company's specific factors that brought the company to choose an e-business model and to adopt specific e-business solutions, and also to understand the sources of value characterizing the company's growth. A last part of the analysis was reserved to provide with specific recommendations to formulate innovative ideas to the board of the company in order to reinforce and develop the e-business strategy. During the group work, students could access to on line contents, could contact local tutors and teachers, and could use videoconference to discuss with professors located in Italy. Web 2.0 tools revealed very powerful during this activity, specifically wikis which enhanced students' motivation [76]. Students used mainly wikis to elaborate the case study analysis, generating contents according to the structure defined by the tutors. They also produced collaboratively a glossary related to the main keywords used during the course. Through this approach, students were not only readers or writers, but also editors, reviewers and collaborators.

Presentation of team working results

The results of the group work were presented both in front of the local tutors and professors, and in front of the professors located in Italy and connected through the videoconference channel. Each group presented their analysis using just 10 slides, organized according to the template was provided them; available time was of 15 minutes, plus other 15 minutes for further comments, questions and personal interpretations. In such a way, besides the specific contents regarding e-business and the case study, also presentation and communication skills, time handling and critical thinking had the opportunity to be developed and evaluated.

4.2.1 Post-assessment

Besides quizzes and exercises included in the on line learning modules, post-assessment allow for a trustworthy measure of the students' progresses. Indeed, this activity is based on the same test has been prepared to evaluate at individual level the initial knowledge of the students (pre-assessment). Thus, students repeated the same initial questionnaire and the analysis of pre- and post- answers provide a reliable evaluation of the competences increment. More details about the assessment methodology and results are provided in the next paragraph.

4.3 Technology: e-Learning System

Whereas face-to-face lectures have been organized at the e-Competence Centre hosted by the University of Jordan, the on line activities have been delivered through a set of e-learning services based on Moodle, an open source Learning Management System. The system, named APOLLO (APplied Open Learning LabOratory), has been set-up and customized by the multimedia "i-learning" lab [77] of the University of Salento. It is based on open source software by using a LAMP server configuration (Linux-Apache-MySql-PHP), and integrated with web 2.0 tools, as well as with other applications. To access to the system, each student, teacher and tutor received a computer with Internet connection and an individual system account (login and password) for the entire duration of the course; so he/she could access both at the Jordanian centre and at home. Figure 4 shows the welcome page of the system; after the login phase, a set of services coherent with the user profile appears. The system is compatible with any browser and it does not require any additional software.

After the first login that has been executed all together during the first day of the course, a brief introductory session was organized to ensure that each student was able to access to the system, to use the services and to access to the digital contents. Once logged in, the central part of the screen is dedicated to list the on line courses to be accessed; the left side lists the available services organized into six categories characterizing the APOLLO system, whereas the right side contains the latest news and messages posted by students, tutors and teachers.

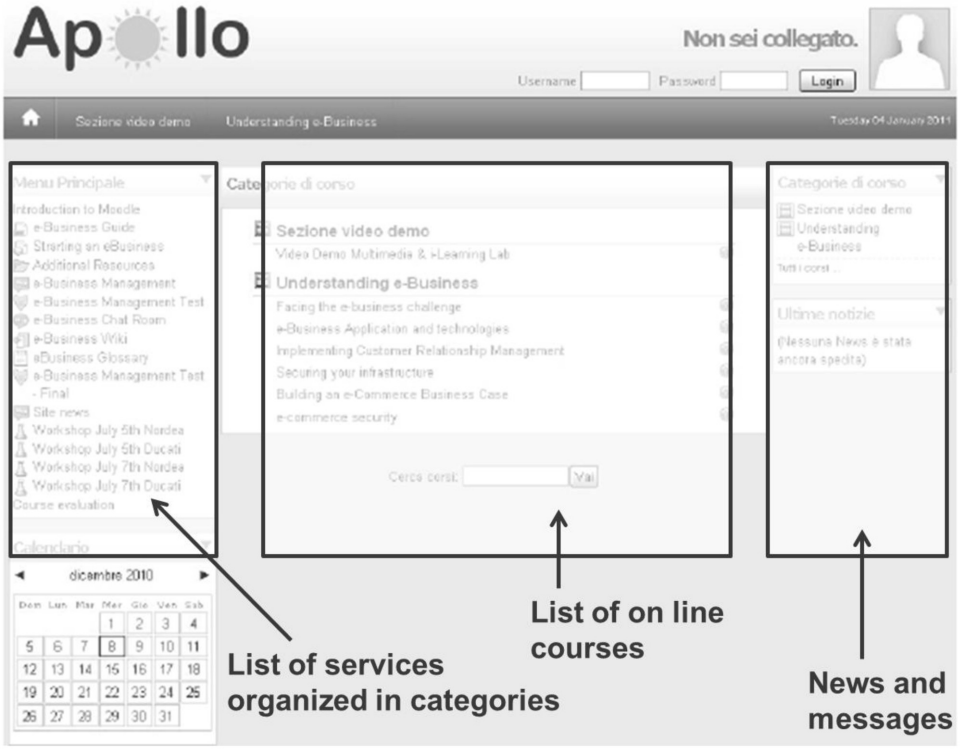

Fig. 4. The welcome page of APOLLO system.

Specifically, the categories of services available to students were:

- *document management*, to offer a personal and community area to store and share documents, e-books and other digital resources and links;
- *project management*, to provide with a set of functionalities for setting up and monitoring on going initiatives such as job scheduling, task management, workload control, Gantt chart (this category has not been activated for the course described in the article);
- *web learning*, to deliver SCORM compliant on line courses, digital contents and multimedia resources (i.e. streaming seminars), and also to make and evaluate students' assessment through on line exercises, quizzes, and questionnaires (with single choice and multiple choice questions), including the generation of a detailed report on the overall evaluation;
- *collaboration*, to ensure the access to videoconference (with application sharing features), chat (public or private), and forum;
- *web 2.0*, to support content development in collaborative way, through the usage of wikis, blogs, RSS and folksonomies, enhancing interactivity and social experiences among students, tutors and teachers;
- *e-business*, to give the opportunity to experiment a virtual laboratory focused on the specific domain of the course, through the access and the usage of ERP functions (Enterprise Resource Planning), CRM services (Customer Relationship Management), and SCM tools (Supply Chain Management).

In such a way, students can access directly to a specific application or service, or they can enter into a specific on line module and, through it, they can use other applications and services according to their specific needs and requirements. This approach allows students for self-regulating their learning time, so becoming the main actor of their learning process. Figure 5 illustrates *content-specific* and *context-specific* functions to which a student can access during the delivery of an on line module. The former are strictly related to the student-content interactions, whereas the latter refer to the student-student or student-application interactions.

Indeed, the bottom part of the picture includes specific functions related to the content; whereas, the right side hosts links to access to external applications and services more related to the learning context (i.e. simulator tools, personal or shared area to store and retrieve documents, collaboration services, web 2.0 tools). Finally, each module is developed by using Macromedia Flash mainly, and then uploaded into the Learning Management

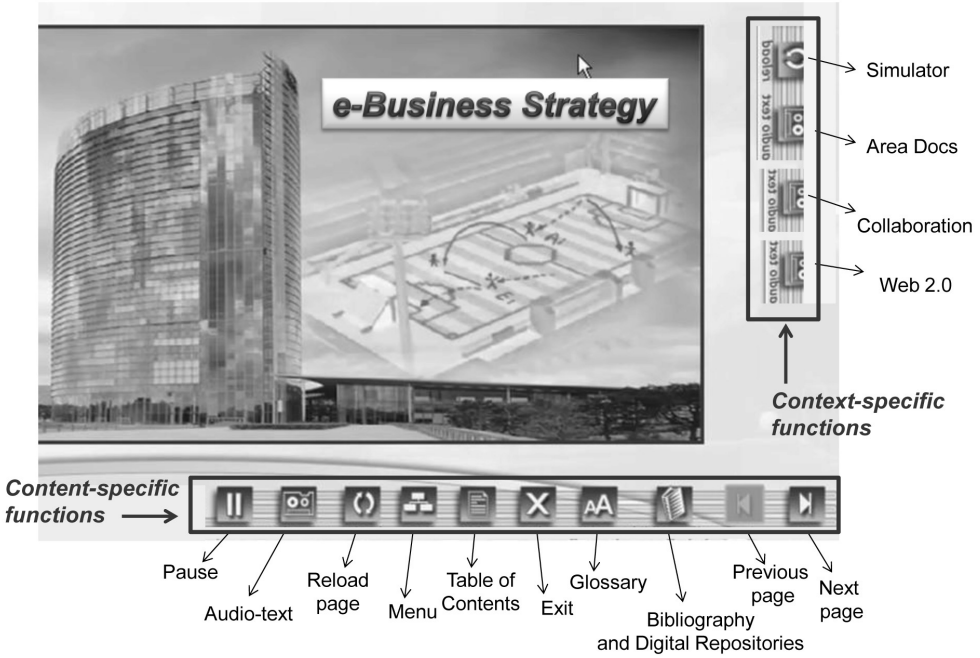

Fig. 5. e-learning services embedded in the on line modules.

System after the transformation into a SCORM learning object.

5. Results

Assessing the progress of students and measuring the impact of the BL on students' satisfaction is a fundamental issue of any learning initiative. The Kirkpatrick's model for learning evaluation, that is widely accepted and used, is based on four levels, such as reaction, learning, behavioural change, and organisational results [78].

The case study documented in this article evaluates the BL program covering the first three levels, specifically:

- students' *reaction*, representing the evaluation of students about the teachers/tutors, contents, interaction/collaboration and pedagogy/strategy of the program, that is based on a comparison with that one of a traditional course held within the university;
- students' *learning*, representing the knowledge of students verified through the same test submitted before and after the program (students were not aware of this repetition), and through the evaluation of the group work focused on case studies analysis and presentation;
- students' *behaviour*, representing the progresses made by the students referring to their capacities to effectively talking, time and questions handling.

5.1 Assessment of students' reaction

As for the assessment of students' reaction, at the end of each course a questionnaire was distributed to all students to register their evaluation about several aspects of the BL program (relationships of students with teachers/tutors, contents, level of collaboration/interaction, adopted pedagogy/strategy), comparing these aspects with the ones characterizing a traditional face-to-face course held within the university. A list of 21 statements, which formed the core of the survey, was prepared taking in consideration the most relevant aspect of a curriculum, that is conceived as a particular way of ordering content and purposes for teaching and learning [79].

Table 4 presents the detail of these statements. The students were asked to express their opinion on a five-point Likert scale (from 1, if their perceived judge was very low, to 5, if their perceived judge was very high). The survey was anonymous and all 35 students participated to the survey.

Data have been collected, elaborated and included in Table 5 which highlights a quite positive students' reaction to the BL program respect to a traditional F2F learning initiative, from all the perspectives have been analysed and measured. Indeed, the Δ Blended value is always positive for all the items, with a sensible improvement in the second initiative rather than the first one.

Similarly, as for the overall evaluation of the technological system used into the program, the feedback provided by the students was quite posi-

Table 4: Questionnaire for the survey comparing Traditional Learning vs Blended Learning

Dimensions and statements for evaluating the learning experience
1. Teacher/Tutor
1.1 I'm able to contact the teacher/tutor.
1.2 The teacher/tutor is available all the time for advice.
1.3 The teacher/tutor is the primary source of knowledge.
1.4 Time for asking questions to teacher/tutor is sufficient.
1.5 I received a prompt answer form the teacher/tutor.
2. Content
2.1 I'm able to access to further learning materials and source of information (books, web sites, etc.).
2.2 The course objectives were clearly stated.
2.3 Exercises and activities are clearly declared at the beginning.
2.4 There was too much learning material during the course.
2.5 The course learning material were accurate and "just enough".
3. Collaboration
3.1 There are many occasions to interact with my colleagues/ peers.
3.2 There are several ways and different technologies to interact. with the teacher/tutor.
3.3 There are numerous meetings with my peers for working group exercises.
3.4 My classmates were friendly and supportive.
4. Pedagogy
4.1 Group working is encouraged and fully supported.
4.2 The course is flexible and can be personalized.
4.3 I have been asked to discuss/solve challenging and practical problems and cases during the course.
4.4 Time for comparisons and discussions with other colleagues is sufficient.
4.5 Time to deepen the topics was sufficient.
4.6 Course was motivating and I gave my best effort and full attention.
4.7 The program delivery considered my learning style.

tive. Specifically, using always the same five-point Likert scale, the number of system errors and blocks achieved an average value of 1.7; the average value associated to the internet connection speed was 4.3; the availability of different communication tools achieved 4.4; and the availability of technical support was evaluated with a value of 4.3. Such positive evaluation could contribute to the success of the experimentation.

5.2 Assessment of students' learning

As for the assessment of students' learning, a pre-assessment and post-assessment test was submitted to the students through a structured questionnaire, completed by the evaluation of the group work focused on case studies analysis and presentation.

For pre- and post- assessment, the test consisted in 15 questions, divided in 11 multiple-choice questions, 3 open questions and 1 matching question. Time dedicated to fill in the questionnaire was 40 minutes.

As for the group assessment, each workgroup was evaluated by the teachers according to the contents elaborated during the discussion and to the analysis of the case study, as well as to the performance of the group presentation. As for the case studies analysis and presentation, the criteria used for the evaluation impacted both on contents (relevance of analysed topics, the degree of deepening, and the quality of conclusive remarks and lesson learned), and on presentation (clarity and effectiveness of talk, time handling and questions handling capacities). Total evaluation has been equally weighted on test evaluation (50%) and case study evaluation (50%). Table 6 shows the average of the results obtained by all the students at the end of their participation to the BL program. At level of single BL course, it has been calculated an average increment (the Δ value)

Table 5. Students' evaluation of the Traditional Learning Vs Blended Learning (1 = Very Low; 5 = Very High)

	1st BL Program (June 2009)	**2nd BL Program (July 2009)**	**Δ 1st–2nd BL Program**
Teacher/Tutor (Traditional)	3.5	2.9	
Teacher/Tutor (Blended)	3.6	4.0	
Δ *Blended*	*+ 0.1*	*+ 1.1*	*+ 1.0*
Content (Traditional)	3.6	3.4	
Content (Blended)	3.8	4.0	
Δ *Blended*	*+ 0.2*	*+ 0.6*	*+ 0.4*
Collaboration (Traditional)	3.1	3.2	
Collaboration (Blended)	4.0	4.4	
Δ *Blended*	*+ 0.9*	*+ 1.2*	*+ 0.3*
Pedagogy (Traditional)	3.3	3.0	
Pedagogy (Blended)	3.9	4.1	
Δ *Blended*	*+ 0.6*	*+ 1.1*	*+ 0.5*

Table 6. Pre-Test and Final Test Comparison (1 = Very Low; 5 = Very High)

Average values	**Pre-Test (out of 5)**	**Final Test (out of 5)**	**Δ**	**Case Study Analysis (out of 5)**	**Final Evaluation (out of 5)**
Average value for the 1st BL program	2.14	2.95	0.81	3.33	3.14
Average value for the 2nd BL program	2.42	2.98	0.56	3.47	3.22

of 0.81 for the first program, and of 0.56 for the second program; moreover, the average value of the final evaluation has been incremented going from 3.14 of the first to 3.22 of the second one.

5.3 Assessment of students' behavioural change

As for the assessment of students' behavioural change, the progresses made by the students referring to their capacity of efficacy talking, time handling and questions handling have been observed by the teachers during the case study presentation and discussion. Every student reported a score greater than 3 out of 5; 60% of them were superior to 4.

6. Discussion

Referring to each dimension used for evaluating the students' reaction (Teacher, Content, Collaboration, and Pedagogy), as shown in Table 5, the Δ Blended registered better results for the second program, respectively with an increment of +1.0 for the Teacher dimension, +0.4 for the Content dimension, +0.3 for the Collaboration dimension and +0.5 for the Pedagogy dimension. The increase in the students' satisfaction is also supported by some comments collected during the two BL courses:

> *". . . the program allowed a more involving classroom experience. Overall I was positively surprised by the experience. It was more effective than I expected. I wish to have the other modules and courses like this . . .".*
>
> *". . . using different synchronous and asynchronous technologies and web 2.0 tools to contact teachers and tutors, and socializing with colleagues in the same course, or discussing and elaborating innovative outcomes, generate motivation, help to study harder and to be more critic . . . and to have fun . . .".*

Moreover, analysing the evaluation and scores registered for all the 35 students, it is possible to observe that:

- referring to pre-test and final test results listed in Table 6, the average increment was specifically of +0.81 for the first course involving 15 students and +0.56 for the second one involving 20 students;
- referring to the final students' score, the results revealed that only 7 students (20% of the population) obtained a score less than 2.5 out of 5, whereas the remaining 28 students (80%) obtained a score superior than 2.5. Still referring to the final evaluation, 24 students (69% of the entire population) overcame the threshold of 3.0, and 8 students (23% of the entire population) reached a score greater than 4 out of 5. Table 7 shows the above presented data.

Data are supported by the positive attitude of students towards the usage of BL modalities. Here it is reported a comment expressed by a student

Table 7. Ranges of final students' score (1 = Very Low; 5 = Very High)

Range	Total
Students with score X:	
$0 \leq X < 2.5$	7
$2.5 \leq X < 3$	4
$3 \leq X < 4$	16
$X \geq 4$	8
Total	35

> *". . . the utilization of reusable and accessible learning objects allows me to use more flexibly my time, so balancing effectively working time with study time, having access to further materials and sources of information to improve my knowledge . . .".*

Moreover, focusing on the web 2.0 dimension, a general positive feedback has been registered; it can be summarized through the following student's comments that confirm the main benefits of wiki as an e-learning tool [80]:

> *". . . interacting with my colleagues by writing on wikis and blogs allowed me to learn more and faster . . . I learnt a lot from my colleagues' inputs . . . ".*
>
> *". . . looking at what I wrote on wiki made me feel good because I saw my contribution to the final work . . .".*
>
> *". . . writing on wikis encourages me to deepen the topics before, and then to post a high quality of knowledge . . .".*
>
> *". . . listing of recent changes through RSS service makes evident the latest updates to the whole wiki . . .".*

The students' statements communicate a positive attitude and behavior towards BL and the adoption of web 2.0 features; they provide useful insights to diffuse innovation practices and approaches in the education industry.

Looking at the results of the two courses, a further consideration can be done concerns the role of teachers and tutors. The positive increment of all the indicators registered for the second program can be explained by the fact that teachers and tutors were the same for both programs. Indeed, the feedback of the first program represented an important element that teachers and tutors have considered for the preparation of the second program. Suggestions and evaluation given by the students about the role of teacher and tutor, the accessed contents, the collaboration dynamics, and the pedagogical strategy have been deeply analysed, in the perspective to extract valuable insight to improve the second course.

Overall, this case study refers to e-business contents, even if the success of blended learning does not normally depend on the course content. Indeed, it is possible to find other positive experiences of application of blended learning in other domains (e.g. computer science, computer engineering, electronic engineering, telecommunications, engineering mechanics) [6, 81, 82]. These experiences,

however, have an invariant represented by the following basic principles [11]: i) the establishment of a social relationship based on F2F meeting before the start of the course in order to align learners' interests to learning objectives and contents; ii) a clear and immediate communication to be held at the beginning of the course about learning objectives, program structure, assignments and expected outputs; iii) a brief training session on how to use effectively technological services and web 2.0 tools; iv) the on-site support given by the tutor; v) the availability of teachers to give feedback to students' questions and doubts, also beyond the normal "teaching time"; vi) time handling made by the teachers for each phase of the program. The consideration of these aspects brings to the definition of a right balance among three complementary components: *content* (mainly referred to the knowledge and information that are embedded in the F2F lectures and digital learning objects), *communication* (understanding of concepts and relationships exiting among them; communicating personal opinions; learning from discussions and feedback), and *competence* (knowledge for effective actions and applications).

7. Conclusion

This paper investigates the effectiveness of the BL methodology for the design and delivery of two courses focused on e-business, and targeted to Jordanian students involved in engineering education programs at undergraduate level.

In particular, the study focused on the design of a blended learning experience and on the assessment of its effectiveness. At this aim, the study has been replicated in two BL courses characterized by the same contents and different students, in order to find similarities respect to traditional F2F teaching. The results collected in the two initiatives revealed that a BL approach to education is more effective than the traditional one based on F2F interactions, and reinforce the goodness of adopting the BL approach in engineering education.

Findings demonstrate that successful BL programs require new paradigms and innovative design approaches, with the technology as catalyst and enabler of the entire process, and innovative curriculum design strategy based on the following key principles: a) the involvement of heterogeneous stakeholders in the course's design phase; b) the focus on competence development rather than on knowledge transfer; c) the choice of team work as an additional component to evaluate individual students' performances; d) the integration of face-to-face lectures, on line seminars, e-learning activities, collaborative work, individual study and group presentation; e) the presence of remote and F2F interactions among peers and between teachers and students; f) the role of tutor as a coach, able to guide students in finding their own paths of knowledge discovery and in developing critical thinking and problem solving attitudes; g) the usage of e-learning system and interactive ICT tools with web 2.0 features also during the face-to-face meetings.
Referring to this last point, both initiatives highlight the dimension of collective content development, that requires some basic enabling conditions such as: i) the presence of a template that helps students to structure their own contributions; ii) the engagement of tutors to provide regular feedbacks and to operate as active reviewers; iii) the use of web 2.0 tools both outside and inside the classroom.

With regard to the assessment methodology, findings demonstrate that a complete approach through which evaluating a BL program should consider two fundamental elements: from one side, the *objective* measure of student performance based on the final examination and, from the other side, the *subjective* measure of the overall perception of student towards teachers, contents, interaction and pedagogy/strategy dimensions. These two elements allowed to measure the program's effectiveness along three levels, specifically i) the students' *reaction* (that is the evaluation of students about the teachers/tutors, contents, interaction/collaboration and pedagogy/strategy of the program), ii) the students' *learning* (that is the knowledge acquired by the students), and iii) the students' *behaviour* (that is the progresses made by the students about some soft skills such as effective communication, time handling and question management).

Findings can help engineering colleges and schools to offering blended learning courses to make aware students about the on-going e-business revolution.

A limitation of the study refers to the sample size. The experimentation involved an initial selected target of 35 students that represented a first nucleus of participants that should be able to diffuse the positive results of the experiences in their university and personal network.

Next research will be dedicated to assess the effectiveness of the BL experience for a greater sample of students in order to have statistical significance data and results. This could contribute to making universities and engineering schools more exciting, creative, motivating and empowering environments.

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