Issues in capturing the classroom experience Lessons from the trenches

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Abstract - **This paper describes our work in capturing, and evaluating the classroom experience as the hub for technology-assisted blended learning environments. In fact, we believe that much of the work that goes into preparing a class can be brought to fruition if there are means to record classes in the form of synchronized multimedia streams which can be webcast and archived. We tested this approach over the last three years, notably during last spring semester in a Multimedia Course at our university attended by over 143 registered students. We propose a practical technique to evaluate the usability of the learning support system and improve the design of this kind of experiences from pedagogical and technical perspectives. The main contribution of this research consists of a workable and empirically tested evaluation approach which allows project teams to diagnose and deploy cost-effective improvements to technology assisted learning experiences.**

Index Terms - E-learning , Educational Technology, Human-Computer Interaction, Technology-enhanced-learning, systems, Usability evaluation methods.

INTRODUCTION

In the past few years there have been substantial advances in b-Learning environments i.e. those combining presential with both on- and offline technology-supported learning. These advances were spurned by developments in Communications, Media, and Computing Technologies. However, technology itself is not the single most important driving factor in improving b-Learning experiences. As we gain more understanding on the dynamics of online learning, new challenges emerge. Indeed, there is a need for proper methodologies, tools and techniques to address these new challenges, as students and educators migrate from traditional classrooms to online environments. [1] This is because both Human Factors and Technology Investments need to be managed in articulation with learning strategies to explore new possibilities in a more cost-effective manner. For courseware developers this translates into requirements to speed up the development time of b-Learning materials that are both cost-effective and acceptable to students. These are challenging work practices in all kinds of education institutions. *Instituto Superior Técnico* (IST), of the Technical University of Lisbon, Portugal, is no exception. During the last two years, our research group has been developing a b-Learning system to support the transition from traditional class-room environments to technology enhanced-learning, whether online or offline. Our objective is to share the aspects of the experiential system in this approach to develop, implement, and test a b-Learning solution customized for our internal pedagogical practice. We are developing, through integration and customization of off-the-shelf components a SEaMless Integrated Online Learning Environment (SEMINOLE) and other new components. Its main goal is to support a cost-effective content-production process, student assessments, and online communication. New features have been identified and developed through a bottom-up and integrated evaluation approach.

CONCEPTUAL FRAMEWORK

The current wealth of b-Learning experiences indicates willingness of many higher-education institutions to assume this new paradigm as natural evolution of their strategy, culture, and internal practices. After a wreath of failed experiences with large-budget offerings, Universities and other higher-education institutions are slowly realizing that courseware design should cover not only production and distribution of teaching content, but also articulate learning content to internal organization processes, labor market dynamics and needs as well as specific characteristics and abilities of potential learners. As shown in Figure 1, four scenarios are possible for technology-supported learning. Currently these entail different tools (video-conferencing, collaboration tools, archival, webcast and LMS components). Indeed we feel that Learning-support systems should fit to the dynamics of an institution's pedagogical processes and a subset of these scenarios to address cost-effective content production.

Based on reviewed literature [2]-[8], Figure 2 shows the high-level learning-support system architecture. Conceptually, students interact with this system to perform learning tasks which they later evaluate. To improve such systems, we have long felt that effective creation of media content can

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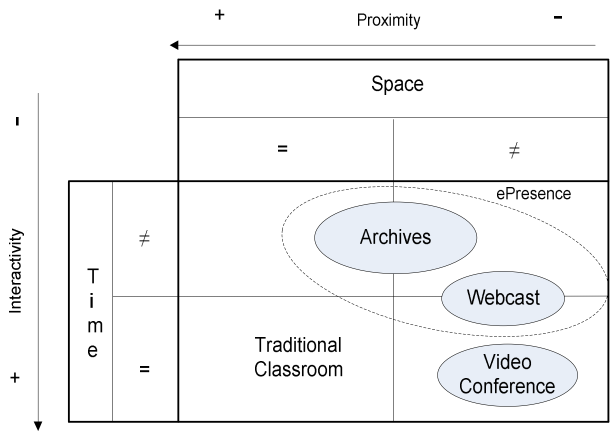

FIGURE 1
CONCEPTUAL FRAMEWORK

best happen if we focus on capturing the classroom experience. Indeed, traditional learning settings have evolved around the teacher student relationship in what is effectively a rich shared interaction supported by group dynamics. Traditional e-learning efforts have focused in content per se, while ignoring or abjuring the classroom experience. We feel that the long string of failures attest to the need of changing this approach. Indeed, our experience has evolved around this basic paradigm, supported by integrated evaluation methods so that process can be monitored both from learners, designers and managers' perspectives. Such an approach features easier identification of improvements required and easy assessment of progress towards set goals. The key issues involved in capturing the classroom experience go beyond the physical presence and pre-determined schedules. Interactions and knowledge are always present and every contribution enriches the overall community. During the last two years, our research group, In-Context E-learning (ICE), has developed a learning support system to augment traditional class-room learning by technology enhanced-learning. This system has been improved and new components have been developed based both on the demands of our group and student feedback. Current features include learning content management, class webcast and archival functions, integration with videoconferencing and access data extraction as illustrated in Figure 2. This system, called SeaMless INtegrated Online Learning Environment or SEMINOLE for short, will gradually cover not only blended-learning classes but also, virtual ones. Students evaluated SEMINOLE usability by using online questionnaires which included closed and open questions. This learner's feedback was content-analyzed and weekly project meetings were held to identify candidate areas of improvement, assess short-term feasibility of changes and plan change deployment over the course or next releases.

The following sections present the strategies and progress of our research work with b-Learning at the *Departamento de Engenharia Informática* (DEI) at IST.

SYSTEM ARCHITECTURE

Three main system objectives were defined in order to achieve our goals to support our internal pedagogical practice: (a) content management; (b) webcasting, and (c) evaluation of the learning experience. The first system prototype was tested during the Fall semester 2003, giving a e-lecture to 77 Human-Computer-Interaction students from three Portuguese universities. This first approach to webcast consisted of a software tool, supported by FCCN (Portuguese Foundation for Science and Research), that enabled audio and video streaming with support for synchronized presentation slides. The software was mainly used for archiving purposes. During that semester, three live webcasts were performed, where students could remotely view the class, contribute and interact with other students and the speaker, through the use of email messages and an IRC (Internet Relay Chat) online session. This tool, in its simplicity, had shortcomings in both human resources, time spent with pre and post-production processes, and media that could be integrated in the class lectures. In an attempt to get users' feedback, the last live webcast session was evaluated. Based on participants' responses to open questions, improvement areas were identified on learning content; process-related aspects and technology aspects [8]. This initiative continued during Spring semester of 2004 introducing class video recording and live webcast of invited speakers into class dynamics.

With these experiences, we defined priorities; university's teaching process and analysis of strengths and weaknesses of available Learning Management System (LMS) platforms, system requisites and functionalities were identified, and a open-source LMS was selected. Then, the e-learning system was architected during the Fall 2004 semester, by integrating the selected LMS with full webcast and video archive features. The system was tested during Spring semester 2005. The learning content management process was tightly supported by a LMS called Moodle [9], whose development was oriented towards an easy navigational scheme, clear structure of activities and resources and easing of communication amongst students. Furthermore it embraces the social constructivism as an educational philosophy [7]. Moodle provided the necessary tools for building and managing the course Web site (http://immi.inesc-id.pt/pcm05/) in a more efficient and collaborative manner, since it includes a Content Management System, which facilitates, among others: (a) programmed delivery of learning content in different formats, (b) possibilities of diverse resources and tasks supporting different learning methods, and (c) fast feedback to students after doing quizzes online.

For the webcast feature, we chose to use ePresence [10],[11] from KMDI Labs in the University of Toronto, along with additional customization. The webcasting component in the system currently supported lectures by audio and video synchronized with slides, integrated and moderated live chat, question submission and the semi-automated generation of structured, navigable and searchable lecture archives.

It was tested by 28 MCP registered students to execute course learning tasks and evaluate its usability. Improvement areas were identified and deployed in the second version of the system. This new version was tested and evaluated by 143 students registered for Spring semester 2005/06 in this course. 85% of these were 4th-year students of a 5-year undergraduate study course. The other 15% are students enrolled at 3rd and 5th years of the same course. 79% of remaining students evaluated this blended-learning experience by using an online questionnaire with closed and open questions. 21% were female. 57% were registered at Campus A, the other at Campus B. 79% reported spending more than 2 hours/day using the Internet. 26% were majoring in Multimedia & Intelligent Systems and 55% major in Information Systems. 82% reported never having previously participated in a similar blended-Learning. Almost a quarter of the students held part-time jobs. 87% of students reported to access Internet at speeds greater than 512 Kbps and 9% at speed under 512 Kbps. All used their personal computers for class purposes, and accessed SEMINOLE by using mainly IE browsers.

Participating students used SEMINOLE as the sole tool to perform main learning tasks. Learner evaluation was done in two specific moments after using the system: (a) at the 6th (April 2006) and (b) 11th weeks of the course (May 2006). They filled out an online questionnaire, indicating their opinions regarding what they liked the most and the least about this e-learning experience, the usability of learning tasks performed on the system and their satisfaction with this learning experience. Students took a quiz and filled out the online questionnaire during the same week, spending, on average, around ten minutes. Anonymity and confidentiality were both assured. Major differences with last semester MCP course are the number of enrolled students in both campi: 5 times more. In order to assure a satisfactory quality level of this MCP Online learning experience, this increase in the number of registered students required: (a) having a system administrator allocated to this project, (b) greater involvement of ICE research group in pedagogical tasks, and (c) extra attention during planning and implementation phases to timely deal with institutional constraints and ease the change process. These constraints had to do with making available the necessary technological and physical facilities across campi to support students in performing the defined learning tasks (face-to-face lectures, project checkpoints, exams). Learning methodology, tasks, contents, allocated instructors and the e-learning system, though improved, remained the same.

SEMINOLE evolution has been driven by qualitative and quantitative results garnered from student evaluation and lessons learnt. In fact, enriching the class capturing capabilities of the system was one of the main concerns since rich multimedia content contributes both for the pedagogical value and post- production cost-effectiveness and time savings. Indeed, the class webcast and archival component now supports additional media streams such as digital ink, streams of pointer positions (which can be both webcast and archived), demonstration videos, java applets and other interactive content. One interesting feature is that this rich content can be viewed using standard web browsers and thin clients in a marked departure from similar approaches which feature rich media content and synchronization of different media streams. Furthermore, new distance learning scenarios have driven us to integrate the system with video-conferencing systems, to provide greater interactivity.

To empower instructors we are currently developing a one-person scenario to control both lecture recording and capture. While this is demanding in terms of teacher attention resources and hardware installation, we feel this is a most necessary step towards e-Classroom scalability.

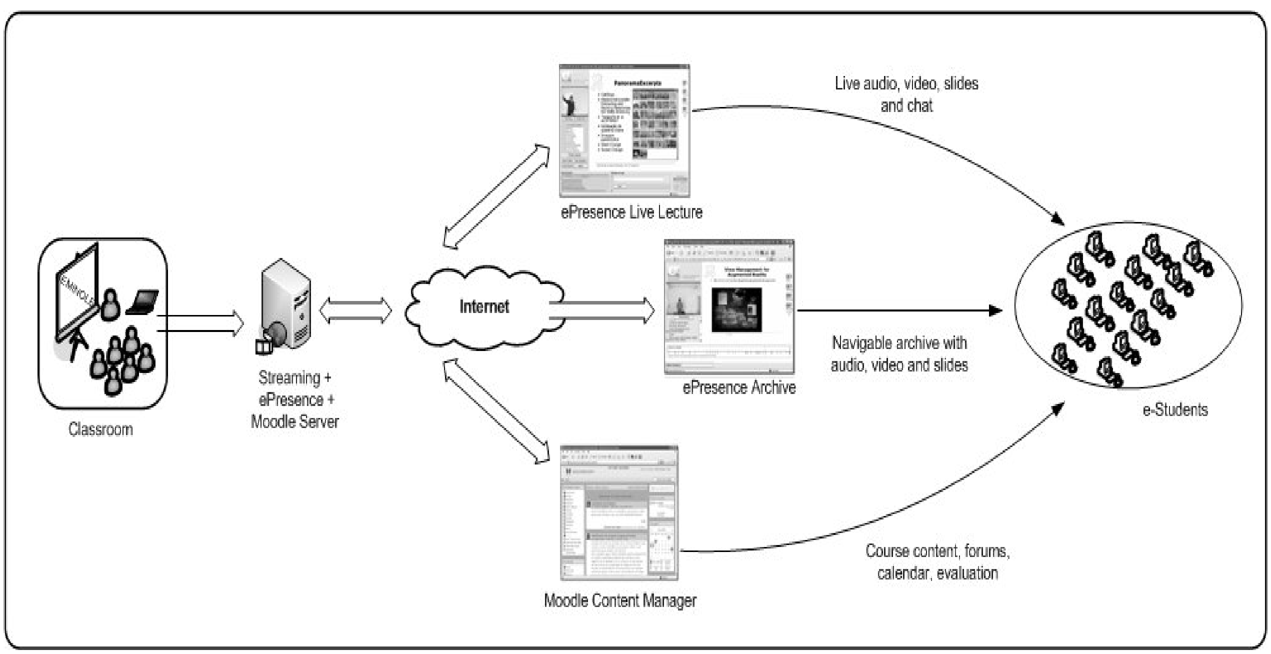

FIGURE 2
SYSTEM ARCHITECTURE

RESULTS

Our set learning and system goals for this experience were: (1) obtaining at least similar learning results when compared to previous years; (2) moderate-to-high learners' online participation, and (3) easy and cost-effective identification of improvement areas . Regarding the first objective, 93% of the students got a passing grade. This was well-above the results in the course the year before, where failing rate stood at about 18% of 28 enrolled students. Class attendance was 65% per student, on average with a standard deviation of 26%. This showed that communication with instructors, online and offline acted complementarily and reinforced the need for consistency in communicative acts and instructor support. At the end of the course, drop-out rate was around 2%.

Along this blended-course, learners' system usage was registered and students concerns on system availability were quickly attended. We set three main periods for data analysis purposes: being the 2nd, 6th and 11th weeks of the course. We refer to these periods as Habit formation (first six weeks of course), Consolidating habit (next five weeks of course) and Habit formed (last weeks of course). In relation to online communication, out of 158000+ total accesses, 87% were performed by students. On average, each post from an instructor generated six posts from students. Indeed, based on system data, each student accessed SEMINOLE at least two times per week on average. These patterns held across the three defined periods, thus reflecting the characteristics of adopted learning methodologies by students, and stressing the most relevant aspects that instructors must timely take action on due to their impact on student behaviors, actions and performance. Learners' participation in *wiki* sessions, posting in fora and consulting the course's information and resources were the most frequent tasks performed in SEMINOLE. Overall, all learner tasks on the system were perceived as easy to perform, according to the two user evaluations performed at the 6th and 11th weeks of the course.

Regarding usefulness of the system, learners' perceived participation in fora, in chat and watching archived webcast videos as having been moderately useful for them. After applying non-parametric tests, watching archived webcast videos and consulting information resources about the course were significantly different across evaluation sessions; both decreasing. This may be related to the fact that this learning experience was a combination of face-to-face and online modes. Furthermore, providing information resources about the course's structure is more helpful at initial stages helping to form learners' mental models. Conversely, these may be less valuable then the learning experience evolved. Indeed, most students were slightly satisfied with this learning experience. Their satisfaction significantly increased regarding the realized learning and received feedback towards the end of the semester. Realized learning and received feedback were the elements that significantly differ in both evaluation sessions, both increasing. Grades in both moments were around 60%. This reveals how important it is for instructors to have strong communication and people skills to be able to manage assertively relationships in online learning environments.

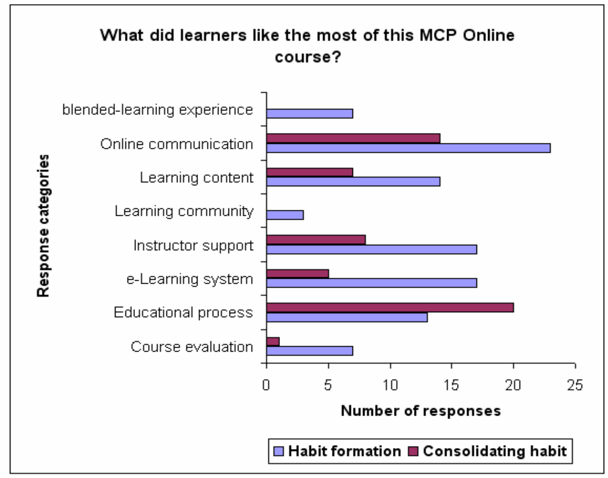

FIGURE 3
LEARNER EVALUATION: LIKED-THE-MOST ASPECTS

After processing and analyzing learners' responses to the online questionnaires, the ICE research group identified and prioritized improvement areas. During evaluation sessions, learners were also asked about what they liked the most and the least about their participation in this experience. Responses from open questions were content-analyzed

Regarding the most liked aspects, at first students pinpointed online communication, instructor support, e-learning system and the educational process. However, as the semester went by and workload increased, students liked the structured educational process more and the online communication less. It is worth noting that few students went to the trouble of reporting that they liked the course evaluation because their "voice was heard" in this change process even though this meant some work on their part. Amongst the least liked aspects, in the beginning (habit formation), most responses indicated that students did not like the system and class dynamics. This related to the fact that the technology-enhanced learning experience was the only one within their course and introduced changes in their study habits and routines. In addition logistic concerns to accommodate five times more students than the last semester caused some anxieties at first. After several weeks of working with the SEMINOLE system, students pointed out that the learning content and educational process should be improved, therefore shifting their concerns from technology to pedagogical issues. Planning the deployment of the experience from both technical and pedagogical perspectives, cost-effectiveness of students´ involvement in the development process, the interoperability of usable and accepted learning-support systems, the articulation of the project's progress and situational context factors were some of the main lessons learned along this research work. It allowed us to narrow the differences between development and learning context while setting a solid basis for an integrated educational management system.

CLASSROOM ISSUES

The undertaken b-learning experiences provided pointers on key issues concerning both participants' behavioral differences and class dynamics:

Knowledge Reutilization. The amount of information available through online resources, both static and dynamic, is enormous. Not only the chats and fora provide the students the access to knowledge in a persistent and always available manner, as also the instructors can use it, i.e., to prepare and improve the course. Indeed, it is common for the instructor to check previous year's frequently asked questions along several course topics, allowing him to be preventive and improve topic presentation.

Class Collective Memory. A blended-learning experience is characterized by both presential and online components. These components complement each other across the several course topics. One of the main consequences of an active online communication component is the class persistence across time. Indeed, considering the class archive and the available communication resources (*fora*, chat), all the intervenient parts can contribute long after the class is finished, enriching the overall knowledge and improving the learning experience: although a presential class marks the start of a new topic the discussion around it (and available to all) continues as long anyone wants to clarify any doubt or want contribute with new information.

Student profiles. Our system provides three diffusion channels concerning classes: scheduled physical class, webcast scheduled class and the archived class. These three different diffusion channels and subsequent communication opportunities (presential, online synchronous and asynchronous) are suitable to different student profiles which can clarify doubts using the mean that makes them comfortable.

Communication Channels and Proximity. As the communication channels increase also does the proximity between the different participants in the course, both students and instructors. Besides classes, one has constant contact with other participants whether by participating in the chat whether in the fora. Furthermore, by subscribing to a forum, the system sends mail notification for every new post. In the presented learning experience, 1100+ posts were received by the subscribed participants, with an average of approximately 8 posts per day. These messages are illustrated with the user info, including photo, reinforcing the proximity between the intervenient parts.

Expectation management. The communication bandwidth between participants grows and so does the instructor's perception on general and particular student learning status. Besides a large amount of available resources the learning management system also provides detailed activity reports. Therefore, although the LMS works as a good explicit communication platform gathering several types of resources, it also provides the instructors with implicit information on student issues. In a first stage, this activity reports were used to assess online participation and to verify if the participants were having any kind of problem when accessing a resource. Soon, the instructors started using the reports to manage expectations concerning a certain topic or class. Assessing student's out-of-class preparation gives the instructor the opportunity to adapt his class, preventing further damage and focusing on learning goals.

Instructor's role implications. For online communication to be effective, the instructors must participate actively and frequently. The students must be confident on getting an answer when they participate online. Therefore, the communication increase implicates higher availability from the instructors. Furthermore, a learning management system offers lots of information on student performance, resource usage and overall community issues. In order to have available statistics the instructors must follow some publication standards and be organized, because the data will not be organized if the publisher isn't.

LESSONS LEARNT

Our experience identifies five main lessons learnt. First, from a pedagogical point of view, planning operational deployment of the experience is crucial for its success in terms of institutional context, educational process, instructional design and system requirements. Start-up investments are necessarily high to structure the experience and later manage the relationships that evolve around it.

Second, from an evaluation standpoint, involving students in the development lifecycle more than a cost-effective tool is also a key factor in sustaining a constructive climate to support active learning. This contributed to recast the roles of students and instructors within the new paradigm of learning. Observing and understanding users reflections on the learning process as they experience it is key variable to our proposed evaluation framework. These techniques will allow us to diagnose, learn from practice and plan next steps both as a key point to work in organizations, as well as a cornerstone to the whole process. Data collection tools must be fine-tuned and be reliable to capture information the least intrusive possible for learners.

Third, from a technical standpoint, making available new system functionalities should be done when the learning tasks require them. This observation comes from understanding what users know in context of use to adjust system functioning to perceived (real), rather than postulated user needs.

Fourth, usable and acceptable systems are not enough to make a successful transition; they also have to be interoperable with existing institutional systems.

Last, cost-effectiveness results come from: (a) task simplification such as edition / re-edition is done directly on the platform; production and post-production of classes on video (live and archive), quizzes and standard communication instruments (e.g. program, course details, etc.) and events (e.g. meeting with students, orientation sessions, etc); and (b) involving learners to report their perceptions as they experience it and their actions, as they perform them on the system, and (c) estimating the usefulness, effectiveness, articulation of results and strategies, return of investment of this kind of initiatives to support later business-driven decisions regarding skill development.

Conclusions and Future Work

As previously mentioned, the goal of this work was to present results from designing and evaluating a technology-supported approach to evaluate the usability of an e-learning system within a real instructional setting. Results showed that design tools addressing the creation of a structured and iterative communication space between designers and users is a cost-effective approach to integrate courseware development. While a considerable amount of work still lies ahead, evaluating technology-supported learning experiences in such a way allows for focusing on the development effort in a multidisciplinary manner. Using diagnostic tools which explore the technical and pedagogical issues as well as considering the impact of usability in context of use on users' learning behaviors and actions.

Five areas for future work were identified to assist courseware designers in developing high-quality cost-effective learning materials and interactive courseware. First, collaboration and personalization are considered to be two essential requirements for learning effectiveness. SEMINOLE currently lacks the capacity to: (a) allow students to specify personalized features and therefore contextualizing their individual learning; (b) enhance the publication workflow, (c) transmit webcast videos without significant delays, (e) support learning process monitoring views of learning across demographic cognitive and affective variables, and (d) support instructors in analyzing/assessing online participation and the anticipating of students' typical doubts and problems with subject-matter, (e) automatically monitor online participation, and (f) anticipate or predict improvement areas regarding system usability and satisfaction within the learning experience across student groups. Therefore, further work is required in these areas to improve the system's effectiveness. Second, building basic learning objects from previous unprocessed classes' contents is required to improve content and navigation structure, interoperability and reusability. Third, proving timely and comprehensive feedback for learners in intermediate evaluation results as the course progresses can greatly increase their sense of participation. Furthermore, this could better support students' role in finishing the original design of the experience. Fourth, sustaining learning community dynamics should be further explored for a better understanding of the group's influence on the individual behaviors and actions online. For instance, how well does double blind peer-review work when students grade each others participation in fora? Lastly, understanding the dynamics of technology-supported learning based on the proposed framework should be later validated across different contexts and learning situations to confirm the empirical evidence before making any claims that our results are generically applicable.

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