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Panayiotis Koutsabasis^a, Modestos Stavrakis^a, Thomas Spyrou^a & John Darzentas^a

^a University of the Aegean, Greece

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Perceived Impact of Asynchronous E-Learning After Long-Term Use: Implications for Design and Development

**Panayiotis Koutsabasis, Modestos Stavrakis, Thomas Spyrou, and
John Darzentas**
University of the Aegean, Greece

This article presents an evaluation of web-based, asynchronous e-learning in academic education, reflecting on its adoption and use in conjunction to teaching in the classroom. The principal aim of the study was to identify the implications of asynchronous e-learning to (a) students' and teachers' overall satisfaction and perceived performance, (b) the organization and management of learning, and (c) social interaction and collaboration between/among students and teachers. The results provide insights for important interaction design and development issues in e-learning such as note-taking and annotations on e-learning content, student comprehension and satisfaction, skipping courses, cost-effective educational and time management, social awareness, collaboration, "flaming," and "border-crossing." The study reports on issues that need to be considered by human-computer interaction researchers, interaction design practitioners, and usability professionals and are complementary to usability and accessibility work in e-learning evaluation studies.

1. INTRODUCTION

Over the last few years, e-learning has been widely adopted by academic institutions. E-learning takes many forms ranging from loosely directed distance learning and self-improving training software (usually offered in the form of multimedia CD-ROMs) to web-based e-learning platforms (e.g., Claroline [<http://www.claroline.net>]; Moodle [<http://moodle.org/>]; Blackboard Learning [formerly WebCT; <http://www.blackboard.com>]) that allow for asynchronous access to many types of learning content, real-time conferencing, online student assessment, and so on. For many academic institutions, a typical arrangement for education seems to be that of blended learning (Sharpe, Academy, & Britain, 2006), which includes the traditional teaching in the classroom supported with e-learning

Correspondence should be addressed to Panayiotis Koutsabasis, Department of Product and Systems Design Engineering, University of the Aegean, Hermoupolis, Syros, GR-84100, Greece. E-mail: kgp@aegean.gr

platforms that support various types of interactions between/among students and teachers.

The research on design and evaluation of e-learning reports on issues ranging from organizational and educational implications to usability, accessibility, and long-term user acceptance. In this respect, evaluation studies of e-learning that reflect its long-term use are particularly important: They indicate practices and experiences that yield knowledge about specific design and development situations. In a similar vein, Beetham (2005) reported her experience from the Joint Information Systems Committee e-Learning Pedagogy program and argued that "there was widespread demand among practitioners for evaluation studies and information that would allow them to make meaningful decisions about which technologies to use and how" (p. 85). Furthermore, e-learning is a major investment for any institution that requires a critical mass of users to adopt and use it and creates various organizational challenges, including "24/7" availability and support that change the current ways of work and cooperation among teachers, students, and administration.

The scope of the work presented in the article can be at first specified by that it is concerned with web-based, asynchronous e-learning. Web-based e-learning platforms are now widely used in conjunction to classroom teaching. At asynchronous e-learning situations, students interact with other students, instructors, and various types of learning content, and the asynchronous interaction allows them to plan their learning program according to their requirements. Second, asynchronous e-learning is essentially a collaborative endeavor and therefore has interdisciplinary implications that reflect at the individual, organizational, and social levels (Andriessen, 2002). In particular, we correspondingly refine these levels of concern to (a) students' and teachers' overall satisfaction and perceived performance, (b) the organization and management of learning, and (c) social interaction between/among students and teachers. These implications are particularly important for interaction designers and usability professionals of e-learning applications: They provide the professionals with knowledge about a range of issues at stake when designing and/or evaluating e-learning.

2. RELATED WORK AND SCOPE

E-learning has been evaluated in a number of contexts. We group these contexts in terms of the evaluation of (a) technical and functional aspects of e-learning systems and tools, (b) the impact of e-learning to user cognitive processes, (c) the impact of e-learning on group or collaborative processes (collaborative learning) and (d) the long-term user acceptance of e-learning.

2.1. Evaluation of Technical and Functional Aspects of E-Learning Systems and Tools

The evaluation of technical and functional aspects of e-learning systems and technologies yields knowledge for their characteristics, coming out mainly from comparative evaluations and user experiments and testing.

Some studies focus on the evaluation of functional and technical characteristics of asynchronous e-learning platforms. For example, Graf and List (2005) presented a comparative, empirical evaluation of open source e-learning platforms on the basis of the composite criteria of communication tools, learning objects, management of user data, usability, adaptation, technical aspects administration, and course management. Other studies emphasize on specific tools and technologies that can support asynchronous e-learning and investigate various aspects of their impact on users. For example, Schellens and Valcke (2005) investigated the impact of asynchronous electronic discussion groups on users' cognitive processing, drawing conclusions regarding the object of learners' discussions and the learning outcomes gained out of the use of this type of e-learning arrangement. Zhang, Zhou, Briggs, and Nunamaker (2006) presented an empirical study that examined the influence of interactive video on learning outcome and learner satisfaction in e-learning environments. The results of the experiment showed that students in the e-learning environment who were instructed by the use of interactive video achieved significantly better learning performance and a higher level of learner satisfaction compared to those in other settings. This type of studies provides insight for the design of particular types of e-learning systems and the possible inclusion of specific technology or media.

Another important stream of related work in this respect emphasizes the evaluation of usability and accessibility of e-learning applications. For example, Ardito et al. (2006) emphasized usability by adapting their Systematic Usability Evaluation methodology for usability evaluation of hypermedia to the evaluation of e-learning applications. In addition, Zaharias and Poulymenakou (2009) developed a questionnaire-based usability evaluation method for e-learning applications that proposes intrinsic motivation to learn as a new usability measure to evaluate e-learning designs. Furthermore, Cooper, Colwell, and Jelfs (2007) proposed an integrated accessibility and usability evaluation methodology drawn on a series of mini-case studies from e-learning projects undertaken over the past 10 years at the Open University. Burgstahler (2006) proposed a number of accessibility policy indicators for distance learning programs and presents their application to a number of schools in the United States. Because that usability and accessibility are well-established research areas within the field of human-computer interactions, it seems that the introduction of specific methodologies to e-learning can mainly contribute to designers' awareness of the major related principles and techniques in this particular domain. However, Tselios, Avouris, and Komis (2008) argued that different classes of e-learning applications require fundamentally different approaches in evaluating their usability and propose a classification of usability methods for taxonomy of types of e-learning applications. Thus, usability and accessibility may translate to different guidelines for different interaction styles and modalities that reflect the design of different e-learning applications.

This orientation of evaluation work provides insight for selection of e-learning systems and technologies upon particular technical, functional, and user requirements. Furthermore, it can inform user interface design and architectural design of new e-learning systems. However, it may not reflect on the longitudinal impact of e-learning to education, work, management, and social interactions of people involved, mainly due to that it is largely based on the user testing approach upon specific tools, courses, and technologies.

2.2. Evaluation of the Impact of E-Learning to User Cognitive Processes

The evaluation of the impact of e-learning on cognitive processes of students and/or instructors seeks to experimentally validate some underlying formal model. This type of e-learning evaluation is described according to Strijbos and Fischer (2007) as follows: "The study of the impact of e-learning on cognitive, social and/or motivational processes (e.g., knowledge acquisition or help giving) are typically conducted with a-priori expectations about instructional variations, and statistical testing" (p. 390).

Martinez-Torres et al. (2008) performed an evaluation of three e-learning tools according to an extended definition of the technology acceptance model (Davis, 1989). Their main result is that perceived ease of use does not posit a significant impact on student attitude or intention toward e-learning tool usage. The results of this study depend heavily on the students' background and the particular design of the specific e-learning tools. Also, Saadé, He, and Kira (2007) set out to identify important factors that contribute to the success or failure of e-learning by performing a factor analysis to explore the dimensions of student attitude, affect, motivation, and perception of an online learning tool usage. Their results suggest that affect and perception were found to have strong measurement capabilities, whereas motivation was measured the weakest. This study suggests generic directions for research from a specific case study and needs to be backed up with other similar work.

This orientation of evaluation work can provide insights about the cognitive processes of users during interaction with an e-learning system and can yield knowledge about the educational aims of their design. On the other hand, the results of these studies are heavily affected by the specific e-learning system and content, and unfortunately these are often treated as a "black boxes" in many cases. Therefore, they often do not succeed to link the user cognitive processes to specific design guidelines for the particular e-learning systems at hand. Finally, this type of evaluation usually lacks interpretation to wider contexts due to their experimental nature and therefore needs to be reviewed in an integrated way, complemented with contextual research methods and informed with results from longitudinal studies.

2.3. Evaluation of the Impact of E-Learning on Group/Collaborative Processes

The evaluation of the impact of e-learning on group or collaborative processes emphasises the observation and interpretation of user collaboration over e-learning platforms. Strijbos and Fischer (2007) described the evaluation of collaborative learning as "placing strong emphasis on the situated nature of collaboration and the impact of certain situational factors (with a few or as little as possible a priori expectations)" (p. 390). Furthermore, Stahl (2002) developed the argument that collaborative learning can be seen during interaction of learners with or through e-learning and that this is itself a collaborative product.

Examples of the evaluation of the impact of e-learning to collaborative processes include the work of Janssen, Erkens, Kirschner, and Kanselaar (2009), who investigated the effects of group member familiarity during computer-supported collaborative learning of three. The results of this study indicate that higher familiarity (a) led to more critical and exploratory group norm perceptions, more positive perceptions of online communication, and collaboration and (b) required less time to regulating their task-related activities, whereas the expectation that familiarity would lead to better group performance was not confirmed. In addition, So and Brush (2008) examined the relationships of the students' perceived levels of collaborative learning, social presence, and overall satisfaction in a blended learning environment. The results of their study indicate that student perceptions of collaborative learning have statistically positive relationships with perceptions of social presence and satisfaction.

The evaluation of collaborative e-learning emphasizes the assessment of collaboration and social interaction, and the methods employed are largely observatory and contextual in nature. Stahl (2002) emphasized the use of contextual methods for research in collaborative learning arguing: "Collaborative learning is by definition an intersubjective achievement that takes place in observable interactions among people in the world" (p. 177). These types of evaluation studies can provide rich interpretations of cognitive and educational aspects of user collaboration in specific contexts. These interpretations can provide useful examples for the identification and documentation of principles and guidelines for the design of collaborative e-learning systems.

2.4. Evaluation of the Long-Term User Acceptance of E-Learning

Studies that evaluate the long-term user acceptance of e-learning provide insight about a wide range of educational, organizational, and social issues. They complement interaction design and evaluation of e-learning mainly by enhancing knowledge about general research and development goals and about long-term impact in pragmatic situations, which is hard to identify with the user testing approach that typically occurs for a short time in a controlled environment.

This work is largely empirical, and it offers case studies that reflect long-term implications for users and organizations. Brotherton and Abowd (2004) presented a longitudinal evaluation of their platform of automated capture and access (symptomatically called eClass as well) and reported on a number of important issues including attendance (not impacted), performance (not measurable impact), note-taking (improved), and media augmentation (required) and salvaging and usage strategies. Their results with respect to the first four issues are similar and confirmatory to our study. Also, Deepwell and Malik (2008) presented a case study (including questionnaires to 250 students of an academic institution, focus groups, and follow-up interviews) of the students' use of e-learning technologies in their self-directed study time. Their results provide insights about technology uses for self-directed learning, perceived usefulness of technologies for skill development, and expectations from lecturers for facilitating learning through technology.

In addition, a considerable number of evaluation studies concerning long-term user acceptance are related to particular disciplines or courses. Smith, Torres-Ayala, and Heindel (2008) conducted a survey among e-learning instructors across a number of disciplines and suggested that solutions of e-learning should be differentiated by disciplinary clusters due to diverse educational needs. Kamp, De Jong, and Ravesteijn (2008) presented the experiences out of e-learning of a design engineering studio course revealing various pragmatic user acceptance issues that had not been addressed effectively with e-learning. Despite that this type of work is largely influenced by the particular content and requirements of specific courses or disciplines, it offers practical insights for design and evaluation that stem out of long-term experience in specific context and therefore be considered for other similar situations.

The orientation of this type of evaluation and assessment work is wide in scope. It is not concerned with functional aspects of asynchronous e-learning systems, cognitive or group processes in isolation, but attempts to integrate these by reflecting on practical implications of long-term user acceptance. The method of research is largely empirical and situated: They employ observation and contextual methods of inquiry and involve real users who report on their experiences. Thus, the results may be interpreted to general design principles or more specific guidelines for interaction design and evaluation of e-learning systems, provided that the context of the study is clearly presented and the goals are interesting and important for the community.

3. EVALUATION STUDY

In this section, we discuss contextual information about the evaluation study that should be taken into account when assessing the findings later on (section 4: Results). The evaluation study reflects on the specific context of an academic department and an asynchronous e-learning system adopted and used for a long time (9 academic years), which are described in section 3.1. The goals of the study are wide-ranging, reflecting on important issues in the fields of e-learning and collaborative learning and are presented in section 3.2. Finally section 3.3 describes the method used and the participants of the evaluation.

3.1. Context of the Study

The department of product and systems design engineering. The Department of Product and Systems Design Engineering (<http://www.syros.aegean.gr>) at the University of the Aegean aims to provide graduates with skills and knowledge that will enable them to use creatively new technologies, sciences, and arts for the design of products and systems that are usable and functional for various applications from varying areas covered by the graphic and applied arts, product design, industrial design, and interaction design. The program defines and supports the creative processes of design in line with modern international trends that consider design as the art of communication for the recognition of problems and the conception and creation of products and systems that are

appropriate with regards to their form, their content, their functionality, and their value for human use and action. The basic subjects, which result in key themes linked to the program of the department and that characterize the department's main directions, are industrial product design, human-computer interaction, and organizational design.

EDU/e-class: An open source asynchronous e-learning platform.

EDU/e-class is an open source e-learning platform that aims to provide asynchronous e-learning services at the academic community of the University of the Aegean. The platform is a project fork of the Claroline and the GU-net e-class (<http://eclass.gunet.gr>) educational open-source platforms. The goal is to integrate at the university's educational and research context (graduate, postgraduate, research), and its specific goal is, by following specific e-learning standards, to provide complete Course Management System based on fixed educational structures (data and communication / collaboration based) for supporting the department's e-learning context.

EDU/e-class is an integrated system for the structuring of electronic educational material via a web browser. It supports the electronic management, storage, and presentation of teaching materials, independent of the spatial and time limiting factors of conventional teaching and creating the necessary conditions for a dynamic teaching environment. Its basic general characteristics and structure include

- user and role management
- easy course creation, management, and use
- open and restricted access
- structured course presentation according to e-learning standards.

In particular, the elements that comprise an electronic course and define the tutor-material- platform-student interaction include educational content management (e.g., file type management—text, presentation, multimedia/audio/video), discussion forums for exchanging opinions and ideas on matters related to the course, collaboration areas and storage points where the students can upload their project material, student workgroups focused on special projects, announcements concerning the course for the specifically enrolled students, calendar functionality which presents in chronological order the module key events (lecture meetings, exam dates, etc.), and course description with extensive information about its outline.

3.2. Goals of the Study and Related Issues

The goals of the study can be identified as the evaluation of

1. Overall satisfaction and perceived performance of students and instructors.
2. Organization and management of learning.
3. Social interaction and collaboration between/among students and teachers.

More specifically, the first goal of overall satisfaction and learning performance was related to the following issues:

- Diverse types of information and content about courses: Multiple formats and modalities of information and content can allow different learning styles (Zapalska & Brozik, 2006) increased user satisfaction (Jaimes & Sebe, 2007) and can enhance usability.
- Support for note-taking and annotation on course content: Note-taking is a typical learner function (Reimer, Brimhall, & Sherve, 2006) especially in academic environments, and many systems (most usually synchronous) support it (Brotherton & Abowd, 2004).
- Student comprehension is an ultimate goal of any educational system and process.
- Skipping courses has been referred as a potential side effect of e-learning (Zhang, Zhao, Zhou, & Nunamaker, 2004). We wanted to investigate students' experiences about this option.

The second goal of organization and management of learning was related to the following issues:

- Critical mass of users: Any successful collaborative system needs to be adopted by a critical mass of users (Grudin, 1994). The argument of the critical mass is also related to long-term adoption and use that significantly enhances the reliability of the results of user-centered evaluations.
- The impact of asynchronous e-learning to tasks related to the organization and management of learning (e.g., course enrollment, announcements, distribution of documents, etc.) and to personal time management in general has been referred to as one of the major advantages of these systems. Edwards (2009) noted in this respect that asynchronous e-learning "maximizes flexibility in timing and access for the learner by allowing learner control of pace, schedule, and location" (p. 1).
- Traditional reading in-print is continuously challenged by reading on-screen/online; this has also wider implications for students and readers in general (Anderson & Elloumi, 2004). We wanted to see whether asynchronous e-learning can contribute to this trend an issue considered highly beneficial in an academic environment for (among others) considerable savings, compared to printed material.

The third goal of social interaction and collaboration was related to

- Communication between students and instructors and general awareness: Increased asynchronous communication can result to improved awareness about events in an academic environment. On the other hand, it may result to "flaming" in communication (Dix, Finlay, Abowd, & Beale, 2003) and "border-crossing" (Grudin, 1994). Border-crossing occurs when the use of a collaborative system violates organizational structure or other conventions for social interaction. Flaming in written communication occurs when

people fail to express emotions in text due to the medium's constraints in this respect: Written communication does not allow for back channels (e.g., tone of voice, body language, and gestures are not present) that convey the affective aspects of communication.

- Student collaboration: E-learning impacts student collaboration in many aspects (Stahl, 2002). We mainly wanted to investigate whether asynchronous e-learning contributed to the enhancement of student collaboration through the long-term use of the platform.

Certainly, many of these particular issues that were related to the overall aims of evaluation are quite complex themselves, and they have been further refined and investigated in other studies. Also, there may be other specific issues related to each aim of the evaluation; however, we have highlighted several important ones based on related work and motivation. On the other hand, the wide scope of this evaluation allows the integrated examination of these issues in a particular case study in a manner that stems out of user practice that allows interpretations to a large number of similar contexts.

3.3. Method and Participants

The method of the evaluation study involved logfile analysis, semistructured interviews, and questionnaires to instructors and students.

First, the analysis of the log files of the e-learning platform provided insight about usage statistics and patterns. The log files provided data about the use of the asynchronous e-learning platform since its 1st year of operation.

Second, semistructured interviews were conducted with a considerable number of instructors (15 of 37; 40.5%) as well as with a number of students (10 students). The interviewed instructors included both users/adopters and nonusers of the e-learning platform, whereas the selected students were two for each year of study. The semistructured interviews were conducted with participants after they filled in the questionnaire. The overall themes of the semistructured interviews were the goals of the study, but new questions came up during the interviews. The semistructured interviews were necessary for providing interpretations and validations to the participants' responses. They are also more suitable when the participants are motivated to speak about their experiences and explain their views and actions, in comparison with statistical methods.

After the interviews, all instructors and students were asked to complete a questionnaire survey that examined specific issues. The questionnaire was announced to all students via e-mail (except for the MSc students), allowing completion within a specific time frame of 3 weeks; it was made available and completed electronically via the web. Also, it was completed by those students that were interviewed. A total of 131 students filled in the questionnaire, 85 of them female (64.5%) and 46 male (35.1%). This proportion is quite similar to the total number of students: Female students are considerably more than male. The number of participants constitutes about one fourth (25.6%) of the total active student population.

4. RESULTS

This section presents the results of the evaluation study in terms of usage data, the goals of the evaluation as described in section 3.2, and recommendations for extensions of the e-learning platform. The results are based on log file analysis, questionnaire responses, and the semistructured interviews sessions. The detailed record of questionnaire responses is provided in the appendix.

4.1. Usage Data

All students are enrolled in and use the e-learning platform from their 1st year of study.

The total number of enrolled instructors is 37, out of which 28 (75.7%) actively use EDU/e-class to support their courses (two of them in combination with their personal web pages), whereas nine (24.3%) do not use the platform.

EDU/class supports 140 courses: 91 undergraduate, 27 (of two) master's, and 22 other group spaces devoted mainly to diploma theses development.

The number of (unique) visits per day differs considerably upon the academic period. During the exams period there is high number of visits (> 300 visits/day); during normal course work periods there is an average number of visits (150–230 visits/day); during the holiday period there is low number of visits (< 30 visits/day).

4.2. Perceived Impact on Overall Satisfaction and Learning Performance

Asynchronous e-learning should support management of many types of information and content about courses. A particular strength of web-based asynchronous e-learning platforms is that they allow for access and management of various types of information and learning content. An important concern for evaluation was whether the content available was satisfactory and therefore aided student performance.

A relevant question (Q1, appendix) to instructors was about the types of content that they upload to the asynchronous e-learning platform. A first finding was that there is a range of different types of content, and information available in the courses (including lecture notes, multimedia content, applications, external links tests/exercises, past exam papers, and results) is well received by students.

However, another finding was that instructors are not accustomed to uploading multimedia content such as video and audio files related to examples, demos, other presentations or lectures, and so on. This happens mainly because most instructors do not have the know-how to produce this content themselves and require assistance. Some of them compensate for this by providing external links to other relevant multimedia resources; however, most instructors simply do not produce and upload videos related to the course.

On the other hand, students ask for considerably more content (Q2, appendix). This is mainly related to the types of content that are not lecture notes, and more specifically to multimedia and past exam questions and results. With respect to

the latter, it is the policy of some instructors not to publish past exam papers on the e-learning platform.

Asynchronous e-learning should support notes-taking and annotation on course content. When participating in a class, students typically take notes on important things being said or discussed, when possible integrating them into printed course material like slides, papers, books, and so on, to access these in the time of their study. E-learning can support note-taking by students in various ways (Brotherton & Abowd, 2004), many of which can significantly support students' and instructors' learning and enhance the quality of courses.

In our case, the platform course content is available on the web with a fairly simplified function to add comments. Therefore, a relevant question (Q3, appendix: Does e-learning content availability reduce time for note-taking during lectures?) was received in a neutral manner by students: Half of them (51.2%: yes: 16.8%; considerably yes: 34.4%) have seen a positive effect, and the other half have not particularly or have not at all. Furthermore, both students (79.3%: yes: 36.6% + considerably yes: 42.7%) and instructors (86.6%: yes: 53.3% + considerably yes: 33.3%) feel that relevant functionality should be enhanced in the asynchronous e-learning platform.

Asynchronous e-learning seems to have positive impact on student comprehension. An important concern about asynchronous e-learning is that it may not significantly enhance student comprehension and learning, at least in contrast to synchronous media. There are studies that report that asynchronous e-learning is not effective as a stand-alone method for learning. For example, Laine (2003) reported in the context of evaluating asynchronous e-learning for Information Technology professionals that a significant amount of learning takes place as users "assimilate information, apply knowledge to problem solving, and interact with the instructor and other learners" (p. 1).

Both students and instructors were asked about their perceived impact of asynchronous e-learning to student comprehension (Q4, appendix). The majority of instructors believe that there is a positive effect to student comprehension; however, this does not seem to be fairly evident (only 20% answered definitely positively). Students' experiences also tend to be positive; however, there is a considerable 19.8% that is not sure. In both cases, approximately one third of the respondents felt that there is no significant impact. Overall, the picture is not negative: Asynchronous e-learning seems to contribute to student comprehension, despite that the impact of other rich e-learning media in this respect may be more evident or significant. This finding is similar to Brotherton and Abowd (2004), who reported that their platform "does not have a measurable impact on performance (based on grades), but seems to encourage review activities that are considered helpful for performance" (p. 153).

Asynchronous e-learning does not encourage skipping courses. Another concern with asynchronous e-learning is that some students may misunderstand its complementary nature to lectures and choose to skip courses,

rest assured that they will study all required material in a more convenient time and place.

The answers to the first question about skipping courses (Q5, appendix) show that the large majority of students do not verify this concern: 67.2% (no: 19.1% + not particularly: 48.1%) of respondents are negative to the possibility of skipping courses in general, whereas the remaining 29.8% (yes: 13% + considerably yes: 16.8%) might take their chances. These results are more encouraging for not skipping in comparison to Brotherton and Abowd (2004); however, their work involved a synchronous e-learning platform.

The second question about skipping (Q6, appendix) was particularly about the diploma thesis when students are in their final year of study; some prefer to work on their thesis from their hometown and travel to the university only when appropriate for economic and other personal reasons, not to mention that the diploma thesis of an engineering department is highly demanding (it corresponds to 15–20% of the total diploma grade, and the best theses become high-level scientific publications). A first view of students' responses reveals that 67% (yes: 29% + considerably yes: 38%) believe that this is a reasonable option; however, most of them have not yet started their thesis. When this question was further examined for the students that are in their final year of study, we saw that only 29.8% of the total have actually taken this option, which corresponds to exactly 50% of the students who are in their final year. Thus, the option remains, but it is clear that losing personal contact with the supervisor during the process of a thesis is not good practice.

4.3. Perceived Impact on Organisation and Management of Learning

Asynchronous e-learning requires a critical mass of users. A major organizational challenge of any collaborative system is that it must be endorsed by a critical mass of users (Grudin, 1994). This is also the case with asynchronous e-learning. It was noted in section 4.1 that the e-learning platform has been adopted by all students and by a large majority of instructors (75.7%). Blended learning is typical practice, and the e-learning platform is generally considered an inextricable subsystem for the department's normal operation.

The fact that some instructors do not use the e-learning platform is mainly attributed to the nature of their courses (e.g., mathematics, early courses on Product Design Studio that require sketching). Also, some of them are reluctant to use the e-learning platform because that they believe that some computer literacy is necessary. Furthermore, a few of them (three of 37) were recently employed by the department and they did not have significant experience in using the platform in their courses.

Asynchronous e-learning is cost-effective for organizational tasks. Students have several administrative responsibilities and organizational tasks to carry out as members of the academic community, such as registration for courses, various applications requests (e.g., for certifications), participation in academic

initiatives, keeping track of announcements and news, and so on. An e-learning platform can support these tasks, and in particular our platform supports many such tasks.

The vast majority of students (90.1%: yes: 58% + considerably yes: 32.1%) believe that the e-learning platform saves time for administrative tasks (Q7, appendix). Furthermore, almost all students use the platform to communicate with instructors (95.5%)—some aspects of this communication may also be related to organizational issues about a course, and about one third (36.6%) communicate directly to administration (Q8, appendix). These results are encouraging regarding the role of asynchronous e-learning platforms to an academic environment. It seems that the support for organizational tasks is one of the most perceivable impacts of asynchronous e-learning on academic education.

Asynchronous e-learning improves personal time management. In principle, one of the advantages of asynchronous e-learning is related to time savings for both instructors and students regarding search, access, and use of learning content. On the other hand, the user tasks of access and management of content, configuration of the environment, and so on, on the e-learning platform may require additional time that may cancel the benefit.

The answers to the related questions by instructors and students are almost identical (Q9, appendix). Some of them (about one fifth in both cases) have found that they need to devote some time during interaction with the e-learning platform. However very few actually feel that this time does not compensate for their work in total. The percentage of this group is higher for instructors (6.7%): This can be largely attributed to the fact that some instructors are not acquainted with technology and are still reluctant to use the e-learning platform.

Furthermore, a large majority of students (86.3%: 39.7%: yes + 46.6%: considerably yes) have reported that the e-learning platform helps them to organize their time for study (Q10, appendix) versus a 13.8% (11.5%: not particularly + 2.3: no) that responds negatively to this question. This is mainly attributed to that the e-learning platform helps students to maintain course notes and other learning material organized along with related announcements as well as to use the platform for uploading their own projects. These results strongly indicate that asynchronous e-learning improves personal time management.

Asynchronous e-learning contributes to reading on-screen and online. The traditional desktop reading of books, printed papers, or handwritten notes is gradually complemented with reading the computer screen using electronic annotations/comments. This is especially true for today's students, who are well accustomed to the Internet from their childhood, and the trend is growing: Many universities offer open access to online courses (e.g., Open Courseware Consortium [<http://www.ocwconsortium.com>]), whereas many young people even read literature online (Rich, 2008).

In our case, it seems that reading on-screen and online is preferred in comparison to reading print (Q11, appendix). The vast majority of students (85.5%) reported that they tend to store learning material and read offline (on-screen),

whereas about half of them (58%) still want to print electronic material to study it. Furthermore, about one in four students (24.4%) studies course content online. The impact of reading online can be further studied from many perspectives, including culture, literacy, economics, and consequences for paper consumption and the environment. However any such study should use data in the long term.

4.4. Perceived Impact on Social Interaction and Collaboration

Asynchronous e-learning contributes to increased communication between students and instructors and general awareness. Asynchronous, web-based learning is essentially a medium for supporting communication and possibly other forms of interaction such as awareness and collaboration. The possibility of communicating directly with others in an educational environment may be quite useful and enhance the quality of study, especially in the cases where students want to pose instant queries to other students and instructors during their study.

It seems that asynchronous e-learning can increase the number of interactions between students and instructors contributing to their direct communication. Most students report that (Q12, appendix) the e-learning platform has enhanced their direct communication with instructors (54.2% in total: yes: 9.9% + considerably yes: 44.3%), and this view is shared by the very large majority of instructors (80%). Some instructors have reported that keeping in track with student requests related to courses or diploma theses through the platform is quite difficult, resulting to information overload or to what is known as the “disparity between who does the work and who gets the benefit” (Grudin, 1994, p. 96). It was validated during the interviews with students and instructors that the content of this communication was related to the course indeed, and that the platform in general did not encourage other purposes of communication that could distract one’s study. Furthermore, the vast majority of students (91.6%: yes: 59.5% + considerably yes: 32.1%) feel that the use of the asynchronous e-learning platform has increased their awareness of events in general (Q13, appendix). This is mainly due to that announcements are published on the platform and are forwarded to their e-mail accounts (when they are related to a course in which they are enrolled).

Asynchronous e-learning may result to considerable flaming in communication and border-crossing. The possibility of direct communication via asynchronous e-learning may also result in circumstances of border-crossing (Grudin, 1994) or flaming (Dix et al., 2003) in communication.

Both students (59.6%; yes: 13% + considerably yes: 46.6%) and instructors (46.7%, all considerably yes) have experienced that the asynchronous e-learning platform contributes to flaming and border-crossing (Q14, appendix). Some cases of border-crossing were referred by instructors when students are making requests that cannot simply be addressed in text communication (e.g., requests for guidance on the progress of the diploma thesis) or when they ask for “bending the rules”

regarding the organization of a course, especially regarding possible extensions of deadlines or other exceptions. On the other hand, flaming in communication has been noticed more evidently by students who are perhaps less experienced with the particular difficulties and norms of written communication.

Asynchronous e-learning may not have significant impact on student collaboration. Asynchronous e-learning can incorporate a large variety of collaboration tools. In particular, our e-learning platform incorporates e-mail, document management (for uploading and downloading documents), student group spaces (where they can also upload/download project files as well as organize their discussion into a web forum), file exchange tools (where a user can send/receive files to/from other users), forum, and chat. These tools can be used by students to collaborate on a group project. However, social interaction and collaboration should not be taken for granted when related tools are present (Kreijns, Kirschner, & Jochems, 2003).

Students are required to deliver projects by uploading them on the e-learning platform for a rather large number of courses. The large majority of students (87.8%; yes: 56.5% + considerably yes: 31.3%;) prefer this way of delivering projects for reasons of convenience. This possibility is preferred also by instructors to avoid e-mailing or printed material; the platform also allows for uploading up to a deadline. A relevant issue is that the e-learning platform allows students to communicate with each other through e-mail.

However, enhanced communication has not evolved into student collaboration. Few students use the collaboration tools of the asynchronous e-learning platform in order to develop group projects (Q16, Q17 appendix). A substantial 56.6% (no: 6.9% + not particularly: 49.6%) do not feel that the platform encourages them to collaborate with other students, whereas 59.5% (no: 32.1% + not particularly: 37.4%) argue that collaboration tools do not help them with their studies. It seems that only one of five students believes that collaboration tools can be of help (yes: 4.6% + considerably yes: 13.7%).

These facts relate to a number of reasons. The first is that students prefer face-to-face interaction and collaboration, which in general is convenient in the academic environment. Second, when they need to use collaborative tools to carry on, most of them prefer open access tools, for example, for sharing large files. Also, when it comes to real-time collaboration (e.g., chat, conferencing, collaborative writing), they again use open services, and especially applications of social network sites.

Thus, it is quite challenging for asynchronous e-learning to support these types of interactions: It has to compete with other open systems used for social networking and collaboration. Some of the collaborative tools that are integrated into an asynchronous e-learning platform may look obsolete and unused in comparison to a state-of-the-art, open-access, web content management system or a crowded social network. Furthermore, in a collaborating group there are other important notions like trust and community building, which have a decisive role regarding the user acceptance of a particular technology.

4.5. Recommendations for Extensions of the E-Learning Platform

The evaluation study of the asynchronous e-learning platform has produced various recommendations for extensions. The large majority of students (94.6%: 22.1%: many improvements + 72.5% few improvements) and instructors (86.7%: 6.7%: many improvements + 80%: few improvements) believe that the platform needs improvements (Q18, appendix). However, the distribution of views in favor of “few improvements” indicates that both groups would prefer not radical changes but selected actions.

The recommendations for extensions of the asynchronous e-learning platform are mainly directed toward enhancements for synchronous/real-time services, collaboration, and “live” content. More specifically, these recommendations included enhancements or creation of new

- Conferencing tools (new) (Q20, appendix): Students are slightly in favor (48.8%; 10.5% are not sure) of adding synchronous conferencing tools to the platform, mainly to carry out project collaborations with other students or instructors. This finding is in strong contrast to the opinion of instructors (74.4%) who prefer face-to-face interaction.
- Evaluation tools (improvements) (Q21, appendix): Both groups request improvements in current online evaluation tools that are rarely used in practice (students: 64.8%; instructors: 66.7%).
- Shared workspaces (new/improvements) (Q22, appendix): There are some shared workspaces in the platform that are moderately used, mainly for file exchange. Of course there are limitations to file exchanges that are stricter compared to open access content management systems. Furthermore, workspaces are required by both groups (students: 77.1%; instructors: 57.2%) regarding synchronous collaboration like collaborative writing.
- Synchronous note-taking and blogging (new/improvements) (Q23, appendix): The existing functions for commenting on course material are severely underused. The need to enhance note-taking and in general to allow for frequent updating and commenting of content has been identified in many contexts. Both groups also strongly agreed to this need (students: 79.3% in total; instructors: 86.6%).

Other issues that were examined for possible improvements and did not get considerable scores included personalization—there are some quite useful personalization features to the platform; awareness mechanisms—there are some related to content updating; and online help—not required.

5. DISCUSSION AND CONCLUSIONS

Asynchronous e-learning platforms are a particular type of collaborative systems and the difficulties of evaluation of these systems are often underestimated (Grudin, 1994). Evaluation studies may not be concerned only with technical or functional issues (including accessibility and usability) but need to extend their

scope to provide assessments of the wider impact of systems on people's work and cooperation. As noted by Hochheizer and Lazaar (2007), "human-computer interaction is much broader than the study of interface design and input devices . . . including considerations of the social, political, ethical, and societal implications of computer systems" (p. 339). This impact may not be safely assessed in the short term (e.g., with "expert" judgement or user testing) but by the use of a user-participatory approach. Thus, evaluation case studies that reflect long-term use are complementary to short-term user testing and can offer insights to human-computer interaction researchers, interaction designers, and usability professionals about the general goals of user-centered design and evaluation of systems and technologies.

This article presented the results of an evaluation of asynchronous e-learning to an academic department operation. The results are inevitably affected by the particular context that can be specified by the specific platform for e-learning, the particular academic department and the environment to which it operates, and the people that participated in the study. The evaluation study has produced a large number of specific results regarding the impact of asynchronous e-learning.

With respect to overall satisfaction and learning performance:

- Asynchronous e-learning should support management of many types of information and content about courses.
- Asynchronous e-learning should support note-taking and annotation on course content.
- Asynchronous e-learning seems to have positive impact on student comprehension.
- Asynchronous e-learning does not encourage skipping courses.

With respect to organization and management of learning:

- Asynchronous e-learning requires a critical mass of users
- Asynchronous e-learning is cost-effective for organisational tasks.
- Asynchronous e-learning improves personal time management.
- Asynchronous e-learning contributes to reading on-screen and online.

With respect to social interaction and collaboration:

- Asynchronous e-learning contributes to increased communication between students and instructors and general awareness.
- Asynchronous e-learning may result to considerable flaming in communication and border-crossing.
- Asynchronous e-learning may not have significant impact on student collaboration.

The main recommendations that stem out of the evaluation study are related to the enhancement of the e-learning platform with more synchronous and "live" content. Asynchronous e-learning can incorporate more interactive and

live content and services, such as multimedia content including videos of examples, lectures, and demos, as well as integration of note-taking and/or blogging characteristics. Furthermore, asynchronous e-learning should further support synchronous collaborations between/among students and instructors, like collaborative writing and conferencing (audio/video). Finally, asynchronous e-learning raises technical requirements for instructors, who need assistance from dedicated administrative personnel. A more general conclusion is that asynchronous e-learning can significantly contribute to the perceived quality of education in a number of aspects; however, it needs to be enhanced with tools and services that can allow for synchronous collaboration and user-generated content creation and update.

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6. APPENDIX

Questionnaire

Table A1: Questions and Answers Regarding Overall Satisfaction and Perceived Performance

1. Overall satisfaction and perceived performance of students and instructors				
1.1. Types of information and content about courses				
Q1. You upload on the e-learning platform . . . (instructors)				
Lecture notes / slides	13	86.7%		
Multimedia content	3	20.0%		
Applications	5	33.3%		
External links	9	60.0%		
Tests/exercises	11	73.3%		
Exam questions	8	53.3%		
Exam results	8	53.3%		
Q2. Would you need more content on the e-learning platform? (students)				
Yes	66	50.4%		
Considerably yes	54	41.2%		
Not particularly	10	7.6%		
No	0	0.0%		
I don't know / Not sure	1	0.8%		
1.2. Support for note-taking and annotation on course content				
Q3. Does e-learning content availability reduce time for note-taking during lectures? (students)				
Yes	22	16.8%		
Considerably yes	45	34.4%		
Not particularly	47	35.9%		
No	15	11.5%		
I don't know / Not sure	2	1.5%		
1.3. Student comprehension				
Q4. Does extra learning material (such as videos, applications and external links) contribute to better comprehension of courses? (students)				
		Students		Instructors
Yes	17	13.0%	3	20.0%
Considerably yes	43	32.8%	6	40.0%
Not particularly	41	31.3%	5	33.3%
No	4	3.1%	0	0.0%
I don't know / Not sure	26	19.8%	1	6.7%
1.4. Skipping courses				
Q5. Can you cope with skipping lectures since that learning content is available on the e-learning platform? (students)				
Yes	17	13.0%		
Considerably yes	22	16.8%		
Not particularly	63	48.1%		
No	25	19.1%		
I don't know / Not sure	4	3.1%		
Q6. Do you think that the e-learning platform helps you carry out your diploma thesis remotely? (students)				
Yes	29	22.1%		
Considerably yes	38	29.0%		
Not particularly	30	22.9%		
No	15	11.5%		
I don't know / Not sure	19	14.5%		

Table A2: Questions and Answers Regarding Organization and Management of Learning

2. Organization and management of learning.				
2.1. Impact of asynchronous e-learning to tasks related to the organisation and management of learning				
Q7. Does the e-learning platform save time for administrative tasks like registration and applications-requests? (students)				
Yes	76	58.0%		
Considerably yes	42	32.1%		
Not particularly	9	6.9%		
No	2	1.5%		
I don't know / Not sure	2	1.5%		
Q8. You use the e-learning platform to communicate with ... (more than 1 answer) (students)				
students	32	24.4%		
instructors	125	95.4%		
Administration	48	36.6%		
Q9. Do you think that the interaction with the e-learning platform requires enough time, distracting you from other activities?				
	Students		Instructors	
Yes, but I don't mind (there's overall benefit)	24	18.3%	3	20.0%
Yes	4	3.1%	1	6.7%
No	103	78.6%	11	73.3%
26				
Q10. Does the e-learning platform help you with organizing your time for study? (students)				
Yes	52	39.7%		
Considerably yes	61	46.6%		
Not particularly	15	11.5%		
No	3	2.3%		
I don't know / Not sure	0	0.0%		
2.2. Traditional reading in-print versus reading on-screen/online				
Q11. How do you study e-learning course material?				
Online	32	24.4%		
Printouts	76	58.0%		
Store and offline	112	85.5%		

Table A3: Questions and Answers Regarding Social Interaction and Collaboration

3. Social interaction and collaboration between/among students and teachers				
3.1. Increased asynchronous communication and awareness				
Q12. Has the e-learning platform resulted to direct communication between students and instructors?				
	Students		Instructors	
Yes	13	9.9%	11	73.3%
Considerably yes	58	44.3%	1	6.7%
Not particularly	44	33.6%	3	20.0%
No	14	10.7%	0	0.0%
I don't know / Not sure	1	0.8%	0	0.0%

(Continued)

Table A3: Continued

Q13. Do you think that the e-learning platform has contributed to your awareness about events? (students)					
Yes	78	59.5%			
Considerably yes	42	32.1%			
Not particularly	9	6.9%			
No	1	0.8%			
I don't know / Not sure	1	0.8%			
3.2. "Flaming" and "border-crossing" in communication					
Q14. Do you think that the e-learning platform contributes to "flaming" or "border-crossing" in communication?					
	Students		Instructors		
Yes	17	13.0%	0	0.0%	
Considerably yes	61	46.6%	7	46.7%	
Not particularly	42	32.1%	6	40.0%	
No	7	5.3%	1	6.7%	
I don't know / Not sure	4	3.1%	1	6.7%	
3.2. Impact on student collaboration					
Q15. Is submitting projects to the e-learning platform useful? (students)					
Yes	74	56.5%			
Considerably yes	41	31.3%			
Not particularly	8	6.1%			
No	5	3.8%			
I don't know / Not sure	3	2.3%			
Q16. Does the e-learning platform encourage students' interaction and collaboration? (students)					
Yes	12	9.2%			
Considerably yes	35	26.7%			
Not particularly	65	49.6%			
No	9	6.9%			
I don't know / Not sure	10	7.6%			
Q17. Are collaboration tools of help to your study? (students)					
Yes	6	4.6%			
Considerably yes	18	13.7%			
Not particularly	49	37.4%			
Not particularly	42	32.1%			
I don't know / Not sure	16	12.2%			

Table A4: Questions and Answers Regarding Recommendations for Extensions of the E-Learning Platform

4. Recommendations for extensions of the e-learning platform					
Q18. To what degree does the e-learning platform need improvements?					
	Students		Instructors		
It doesn't need improvements	2	1.5%	3	20.0%	
It needs few improvements	95	72.5%	12	80.0%	
It needs many improvements	29	22.1%	1	6.7%	
I don't know / Not sure	5	3.8%	0	0.0%	

(Continued)

Table A4: Continued

Q19. Would you like more conferencing tools in the e-learning platform?				
	Students		Instructors	
Yes	24	18.3%	1	6.7%
Considerably yes	40	30.5%	2	13.3%
Not particularly	45	34.4%	10	66.7%
No	8	6.1%	1	6.7%
I don't know / Not sure	14	10.7%	1	6.7%
Q20. Would you like more evaluation/assessment tools in the e-learning platform?				
	Students		Instructors	
Yes	26	19.8%	4	26.7%
Considerably yes	59	45.0%	6	40.0%
Not particularly	19	14.5%	3	20.0%
No	5	3.8%	1	6.7%
I don't know / Not sure	22	16.8%	1	6.7%
Q21. Would you like more types of shared workspaces (like collaborative writing or file sharing) in the e-learning platform?				
	Students		Instructors	
Yes	40	30.5%	5	33.3%
Considerably yes	61	46.6%	4	26.7%
Not particularly	22	16.8%	5	33.3%
No	2	1.5%	1	6.7%
I don't know / Not sure	6	4.6%	0	0.0%
Q22. Would you like to be able to add notes/comments in real time and/or blogging in course material?				
	Students		Instructors	
Yes	48	36.6%	8	53.3%
Considerably yes	56	42.7%	5	33.3%
Not particularly	17	13.0%	1	6.7%
No	3	2.3%	0	0.0%
I don't know / Not sure	7	5.3%	1	6.7%