Implementing learner-centred design:
The interplay between usability and instructional design practices

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New requirements for the design of interactive systems call for a human-centred approach. Learner-centred design has been considered as the equivalent of human (or user) centred design as it applies to the design and development of e-learning systems and applications. E-Learning is gaining momentum and the respective interest in design methods and practices for such systems is continuously increasing. Nevertheless it is not clear how learner-centred design can be implemented in practice; questions, such as what are the processes included in learner-centred design, what kind of activities should take place, how can existing human-centred design methodologies be combined with instructional design methods and techniques, remain unanswered. This paper stresses the need for an effective integration between usability – the ultimate goal for every human-centred design effort – and instructional design concepts, techniques and practices. It presents a case study where authors’ activities to design a web-based training curriculum are described. Problems and challenges of applying human-centred design and instructional design methods and techniques are discussed along with future research dimensions.

Keywords: Learner-centred design, user and organizational requirements, human-centred design, usability, instructional design, evaluation

1. INTRODUCTION

Emerging requirements for designing interactive systems are characterized by the increased focus on users, their idiosyncratic characteristics and reactions and their changing needs (Hudlicka, 2003). The user is in the centre of the process and his/her needs drive the nature of the interface and the allocation of tasks between the user and the computer. Human-centred design (HCD) is concerned with incorporating the user’s perspective into the software development process in order to achieve a usable system (ISO, 1999). The process of integrating user requirements, user interface validation, and testing into standard software design methods, is an approach which views knowledge about users and their involvement in the design process as a central concern (Preece et al., 1994). In a similar vein learner-centred design (LCD) is a development of HCD, which takes into account the special needs of learners (Brna & Cox, 1998). The increasing heterogeneity of the learners’ population, the diversification of their learning needs, the decreasing tolerance of learners’ frustration and the diversity of their learning tasks, impose that the human-centred design paradigm must be applied in e-learning design. The emerging question is how can the human-centred design techniques be specified and applied on e-learning environments? What are the processes included in a learner-centred design project? The
mere application of human-centred development methods and techniques is not enough. There is a growing body of researchers from HCI who think that learner-centred design is more than just applying HCD methods with learners as users (Brna & Cox, 1998). An e-learning application may be usable but not in the pedagogical sense and vice-versa. Designing e-learning may move designers and usability practitioners outside their comfort zone (Notess, 2001). An effective learner-centred design must be based on the effective combination of learning theories and usability principles (Zaharias, 2004). The problem is that most of the existing HCD and usability methodologies do not take into account the recent advances of learning theories and instructional design models so as to address the users as learners. This paper stresses the need for usable and effective e-learning design. It presents the efforts made by the authors to adjust HCD methods and techniques to e-learning projects. The whole work is based on the integration of HCD and instructional design methods where concepts of usability and instructional design are intertwined. The next section discusses other viewpoints regarding LCD approaches. Then a case study, in which a web-based training curriculum is developed, is presented. The paper ends with a conclusion and discussion of future research.

2. APPROACHES TO LEARNER CENTRED DESIGN

Going back to vital research questions, such as how humans learn, what knowledge consists of, what is the effect of teaching and training methods, seems more than necessary for researchers and practitioners who investigate the problems and challenges of the implementation of learner-centred design. For instance, Anderson and Draper (1991) discussed how to observe and measure learning while investigating thoroughly the subject of the evaluation of computers in education. Soloway et al. (1994) emphasized the following: (a) understanding (for the learner) is the goal, (b) motivation is the basis, (c) diversity of learners is the norm and (d) learners’ growth is the challenge. Spirulnik et al. (1995) further elaborated upon these dimensions and asserted that motivation is associated with an attractive and engaging interface, diversity is associated with the need to address different learning styles and different levels of expertise and growth is associated with the need to address the multiple goals that learners have when performing a task.

Ashby et al. (1999) stress the importance of stakeholders’ identification and they put emphasis on tutors’ role and needs. Tergan and Schenkel (2003) argue for a learner-centred approach regarding an evaluation checklist. Their learner-centred approach stresses the importance of instructional design models and theories. Holzinger and Motschnik-Pitrik (2005) propose a three-level approach for implementing learner-centred design where techniques from HCD are combined with instructional design guidelines and a person-centred teaching approach. Norman and Spohrer (1996) also put emphasis on latest developments of learning theories in their learner-centred approach: learners are motivated to seek out new knowledge when they confront real problems at hand. The goal is active exploration, construction and learning and not the passivity of the lecture attendance and textbook reading.

The goal for learner-centred design is to design software that makes people want to learn and know how to learn, beyond the computer task at hand. It is evident from the above analysis that metacognitive skills (learn how to learn etc.), constructivistic key tenets (authentic learning context, problem-based and situated learning), affect and motivation to learn, are crucial in the learner-centred design paradigm. Nevertheless it is not clear how such concepts, as well as techniques that instructional designers employ, can be effectively integrated with human-centred design methods. The case study, which is presented in the next section, documents an orchestrated effort to investigate the interplay between usability and instructional design concepts and techniques. This is not to say that this study presents a methodology or a best practice; this was not the purpose of this study. Rather, the study describes the work and the stages of an e-learning design project, presents an interpretation of the learner-centred design paradigm and discusses the main problems and findings.

3. THE TRAINSEE CASE STUDY: DESIGNING WEB-BASED COURSES FOR CORPORATE TRAINING

This study is based on an international e-learning project (see acknowledgments) aiming at enhancing ICT skills through the set up of an asynchronous e-learning service. The determination of the ICT skills and competencies was guided by the “Generic Skills Profiles for the ICT Industry in Europe”, (more details in www.career-space.com). The focus was on two job areas: “Software & Applications Development” and “IT Business Consultancy”. The e-learning service followed the Virtual University
paradigm, in which ‘virtual campuses’ are created with which trainees can register and take courses (web-based). The trainees were employees of four user organisations participating in the project. These organisations were from countries in South Eastern Europe (Greece, Bulgaria, Romania and Turkey) and operate in power supply, telecom, petroleum and IT industries respectively. Most of the trainees that participated in the project were IT professionals. The main goal was to build web-based training courses. Focusing on the principles of human-centred design, practically, means involving users in the design decision process of a particular product, understanding their needs and addressing them in very specific ways (Maguire, 2001). That was the main concern in this study, i.e. to involve trainees early in the design process in an active way that will engage them and thus make the design more learner-centred. The rest of this paper presents the efforts made to cope with the specificities of the e-learning design by integrating methods and techniques of human-centred design and instructional design. Work has been structured according to the five essential human-centred design processes (Maguire, 2001):

As exhibited in Figure 1, these processes are not linear in sequence. Rather, many sub-activities can go in parallel and the whole human-centred design process (and the learner-centred design as well) is an iterative one.

3.1 Plan the learner-centred design process

Usability planning and scoping: The main aim in this first phase is to bring together the several stakeholders to discuss the project objectives and to create a vision for how the learner-centred design approach and usability can contribute to the project objectives. During this phase several meetings were organized and representatives of all the stakeholders participated. Some of the main issues under discussion were the following:

- What is the overall objective of the project?
- Why is the e-learning service being developed?
- Who are the user organizations and what are their needs?
- Who are the trainees, what are their general characteristics as well as what is their experience and expertise?
- What are the available technologies and tools in the market?
- What are the technical and environmental constraints? What types of hardware and software do the user organizations use? etc.

3.2 Understand and specify the context of use

Identify stakeholders: Several meetings were held during the project. Almost every two months a plenary meeting took place in user organisations’ premises. Every user organisation hosted at least one such meeting, while some special trainees’ sessions were also organised. Representatives from all the project partners, representatives of the user organisations, functional heads, managers and supervisors of trainees, and several trainees (a) local group in each meeting) attended the plenary meetings. Such meetings were the main fora for stakeholders’ identification. It has to be noted this was not the complete list of stakeholders. Trainers in classroom-based training sessions and customers of the user organisations are also key stakeholders. Unfortunately there was minimum interaction with trainers and no interaction with representatives of customers.

Surveying the general characteristics of trainees: Since the trainee population was diverse and geographically dispersed, an email-based survey was distributed to the functional heads of the trainees in each user organization. Information requested was: a generic description of trainees’ background, their academic education, skills and competencies, their main job-related responsibilities, as well as an estimation of the number of trainees that would be trained during the project. According to the responses, 300 trainees in total would participate in this project. Table 1 presents their main characteristics.

Task Analysis: From a typical human-centred design perspective, task analysis is a method that identifies what a user is required to do, in terms of actions and
cognitive processes to achieve a task. This is quite feasible when it concerns the design of “typical” software applications: office productivity tools or e-commerce applications etc. In the case of e-learning design the main task for the user is to learn, which is rather tacit and abstract in nature (Zaharias et al., 2002). Mayes and Fowler (1999) state that “learning cannot be approached as a conventional task, as though it were just another kind of work, with a number of problems to be solved, and various outputs produced”. In addition learners’ successful completion of their tasks is greatly influenced by the development and the quality of the learning content. Therefore the instructional design perspective (Nelson et al., 1995; Gupta 1999) of task analysis was adopted. Task analysis from the instructional design view is a method of determining the knowledge, skills, tools and requirements needed to perform a job. Actually the so-called job and task analysis is an organisational type of requirement and will be discussed jointly with organisational requirements’ specification in the next section.

### 3.3 Specify the learner and organizational requirements

**Existing system/competitor analysis:** A market analysis for e-learning platforms and tools (Learning Managements Systems and e-learning authoring tools) was conducted. In addition the design team thoroughly inspected a sample of existing off-the-self e-learning courses. Numerous features and functionalities (such as course maps, guided-tours, interactive exercises, online simulations etc.) were identified, which facilitated the design of storyboards and prototypes (see section 3.4).

**Focus group:** A focus group was organized (in the Greek user organizations’ premises) that brought together five trainees and their supervisors, the project manager and the head of the design and development team. During this focus group a brief introduction of the main concepts of the project and its outcomes took place. The first part of the focus group was accompanied by further discussion focused on prior training experiences of the trainees, their learning styles and preferences, their opinions and attitudes towards web-based training methods and their expectations regarding the e-learning service within the project. In the second part of the focus group (which was six months later), the head of the design and development team presented the main features of the learning management system, where the e-learning courses would be uploaded, and a low fidelity course prototype. This was an effort to initiate a participatory kind of evaluation known as evaluation walkthrough. More details can be found in section 3.5.

**User-level requirements:** Regarding the specification of user-level requirements, special emphasis has been given on the issue of diversity. A web-based survey (see annex) was conducted for assessing individual learner characteristics followed by interviews. This survey incorporated several variables related to individual differences that affect successful implementation of e-learning applications, such as prior learning experiences and background knowledge, preferred learning styles, metacognitive skills and learning independence, emotional aspects towards learning and motivation to learn. The survey targeted only the trainees who are the end-users of e-learning services. Each trainee was asked to fill in this web-based survey. Finally about 160 valid responses were received and the subsequent analysis revealed useful information that guided the formulation of design strategy. Some interesting results are the following:

- Concerning background knowledge, most of the trainees responded that they had average-level knowledge in advanced IT issues, while only 6% of the respondents claimed to be experts in the IT field.
- Regarding past training experiences, 80.4% of

### Table 1 General characteristics of trainees

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Skills</th>
<th>Experience</th>
<th>Job roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor degree</td>
<td>Communication</td>
<td>Working experience of 1 to 5 years</td>
<td></td>
</tr>
<tr>
<td>Master degree</td>
<td>Analytical thinking</td>
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<td>English language as second language</td>
<td>Customer focus</td>
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<td>Problem solving</td>
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<td></td>
<td>Curiosity to novelties</td>
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<td></td>
<td>Collaboration</td>
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<td>Planning</td>
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<td>Result oriented</td>
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<td>Representation of company</td>
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<td></td>
<td>Innovation</td>
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<td></td>
<td>Initiative</td>
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<tr>
<td></td>
<td>Product managers</td>
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<td></td>
<td>Project managers</td>
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<td></td>
<td>Sales specialists</td>
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<td></td>
<td>IT managers</td>
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<tr>
<td></td>
<td>IT analysts and programmers,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>database &amp; network administrators</td>
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</table>

90
the respondents had received computer-based training at least once.

- Assessment of trainees' preferred learning styles was based upon two dimensions: Perceptual Modality (36.91% of the respondents were "visuals", 18.35% were "auditory" and 42.96% were "kinaesthetic") and Information Processing (25.77% were "reflectors", 36.08% were "theorists", 18.56% were "pragmatists" and 19.59% were "activists"). Interpretation of results was focused on the design implications and facilitated by the relevant literature (Kolb, 1984; Honey & Mumford, 1992). According to these results, certain instructional features and methods were selected. For "theorist" learners, case studies, theoretical readings and reflective thinking exercises were considered more appropriate, while for "kinaesthetic" learners, business simulations, interactive exercises, provision of multiple learning paths and opportunities for social interaction were identified as most appropriate.

- Concerning motivation, it is interesting that 67% of the respondents stated that they were highly motivated when they attend a training program, because after completing the course they feel better with themselves. They also feel that they perform better in their work. Working towards job advancement is another important reason for attending training; almost 80% of respondents stated that this is an important or a very important reason for training. Less than 20% seem to have low levels of motivation because "they are tired and busy or the lesson is boring". 42% of the respondents stated various problems regarding past training experiences, such as (a) lack of practice during training that resulted in boredom, (b) the level of topic was very difficult or was not relevant with learners' interests, and (c) the period of time available for training was quite short, so the trainees were "bombarded" with big amounts of new information, which could be not easily absorbed.

The analysis of the web-based survey was followed by semi-structured interviews with a small sample of trainees in each user organisation. Key questions ranged from the functionalities of the e-learning service in general, to the elaboration of the instructional strategy to be followed during the implementation of the e-learning service etc. According to the trainees' opinions and preferences it was decided that a blended approach would be implemented: interaction with e-learning courses and service should be accompanied by group assignments and discussion topics and activities such as web search, library visits, further readings, presentations with other colleagues and open discussions with industry experts.

**Organisational-level requirements:** The process of capturing organisational-level requirements was quite critical and tough to complete. The focus was on a systematic assessment of training needs and a subsequent job and task analysis. Therefore techniques, methods and instruments were borrowed from instructional design literature. A well-known framework for training needs assessment (Ostroff & Ford, 1989) was selected in order to specify the organizational-level requirements. This framework combines the dual perspectives of content (person, task, organizational) and levels (individual, subunit and organizational). The methodology for conducting training needs assessment was basically guided by (a) "Content levels" framework (Ostroff & Ford, 1989) and (b) "Generic Skills Profiles for the ICT Industry in Europe" (Career Space project, 2000).

Firstly, the "Content levels" framework was used, and efforts made to adjust it for the purposes of this work, taking into account the strategic goal of the project and the basic characteristics and particularities of the user organisations. Additionally, the basic tool for devising a common business language and the linkages to organisational needs were provided by the “Generic Skills Profiles for the ICT Industry in Europe". The analysis work focused on determining and verifying the skills and competencies that would be trained during this project. The selected user organisations, being major players in the region's industry, operated as a starting point for the analysis. They provided significant input concerning their own needs, as well as feedback on the proposed skills profiles as they had been described by the Career Space initiative.

A combination of data gathering methods (see annex) such as interviews and two questionnaires (consisting both of open-ended and closed-ended questions) were used. The main respondents were the functional heads or managers of the trainees, and senior managers. The first questionnaire referred to organisational issues, incorporating questions regarding workplace productivity, the focus job areas and general information about the target audience. The general objective was to:

- Elicit broad understanding about how the lack of training in the focus areas is affecting workplace productivity.
- Develop better understanding about what the training needs assessment should accomplish.

The second questionnaire refers mainly to the job
and task analysis procedure. The objective was to gather information about the scope, responsibilities and tasks related to the focus job areas: Software & Applications Development and IT Business Consultancy. Numerous parameters were identified such as technology areas of common interest (between the four user organisations) and tasks for which user organisations perceive that there is a gap between expected and actual performance. Table 2 exhibits the relevant findings along with several constraints of the whole process.

Furthermore, the training needs assessment revealed the need to develop executive level courses. This meant practically that the content would have to be developed so as to cover all the important sub-topics of the two broad areas (S/W & Applications Development and IT Business Consultancy) at a high level. For more details (e.g., How to program in Java) in each sub-topic, the learners were guided to other resources. The following words, as captured in an interview with a functional head of trainees, highlight this need: “...Most of the employees are engineers and they focus on their specialisation, therefore sometimes the ‘big picture’ is missed”. The whole process of training needs assessment and job and task analysis was quite complex and hard to complete. The main reason was that the four user organisations were very different, each one with its own goals, perspectives, problems and particularities. Finding the common denominator was not always easy. In addition, a major limitation of the whole process was the small number of key informants upon which it was based.

While trying to enhance organisational and task-level analysis, no line staff were interviewed and the main findings reflected the views of the leadership of the user organisations.

3.4 Design

Design guidelines: Design guidelines have long been used to capture design knowledge and to help designers in using that knowledge when designing user interfaces. There are numerous design guidelines but their validity or appropriateness always depends on a context. In this case, the main driver for selecting appropriate design guidelines was the issue of combining web design with instructional design guidelines. A literature review was conducted in web design (Nielsen, 2000; Lynch & Horton, 1997) and instructional design (Weston et al., 1999; Johnson & Aragon, 2002; Patsula, 1999; Lee & Owens, 2000) as well as in learning theories and their practical implications for design (Knowles, 1980; Sweller, 1988; Gustafson & Tillman, 1991; Mayer, 1962; Gagne et al., 1992; Horn, 1967; Reigeluth, 1983; Merrill, 1983). Fourteen design guidelines were selected in a manner that fits the user-level and organisational requirements. The design guidelines were the following:

- Guideline 1: “Use of highlighting to avoid split attention effect”
- Guideline 2: “Learners should control their own

<table>
<thead>
<tr>
<th>CONSTRAINTS</th>
<th>TECHNOLOGY AREAS OF COMMON INTEREST</th>
<th>COMMON GAPS – SELECTION OF TASKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>- The four user organizations operate in different industries. The level and the purpose of ICT use is very different in each user organization.</td>
<td>- SW &amp; Applications Development</td>
<td>- Tasks for “SW &amp; Applications Development”</td>
</tr>
<tr>
<td>- User organisations had difficulties in specifying the exact target audience.</td>
<td>- IT Business Consultancy</td>
<td>- Tasks for “IT Business Consultancy”</td>
</tr>
<tr>
<td>- The questionnaires haven’t been filled by the same department in each organization.</td>
<td>- Two out of the four user organizations faced the problem of deliberation of state monopoly so they are in a state of reengineering</td>
<td>- Internet (Web Applications)</td>
</tr>
<tr>
<td>- Maintaining applications</td>
<td>- Analyzing system routines/ modules, performance, memory size, etc. of (embedded) technical systems (when applicable).</td>
<td>- Defining IT strategy for the business (which might be, for instance, the best ways to capitalise on the latest internet or mobile phone technologies).</td>
</tr>
<tr>
<td>- Databases systems for data-exchange with the applications</td>
<td>- Building prototypes of (parts of) the system</td>
<td>- Participating in business needs planning &amp; strategy process.</td>
</tr>
<tr>
<td>- Financial Systems</td>
<td>- Specifying user requirements and functional requirements</td>
<td>- Defining business requirements for the IT solution.</td>
</tr>
<tr>
<td>- Network technology in real-time systems</td>
<td>- Applying modern design methods and associated development tools</td>
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</tbody>
</table>
• Guideline 3: “Allow learners to discover things for themselves”
• Guideline 4: “The learning objectives are clearly presented”
• Guideline 5: “Informative feedback must be provided”
• Guideline 6: “Learning content must be sequenced properly”
• Guideline 7: “Learning must enhance retention and transfer”
• Guideline 8: “Learners’ guidance and support must be provided”
• Guideline 9: “Gain learner’s attention”
• Guideline 10: “Hierarchical organization of the course”
• Guideline 11: “Use of visual means to enhance learning”
• Guideline 12: “Learning must encourage use of transferred knowledge”
• Guideline 13: “Social learning must be facilitated”
• Guideline 14: “Provide various resources”

It can be seen that the underlying philosophical assumptions for the selected design guidelines reflect a synthesis of key tenets of behaviourism, cognitivism and constructivism. Moreover, the guidelines were compatible with the main dimensions of learner-centred design as already described, such as understanding, growth, motivation and diversity. The problem with the design guidelines was that some of them were quite abstract and sometimes conflicting, a common drawback of design guidelines. Nevertheless, they provided a roadmap for constructing storyboards and e-learning course prototypes.

**Storyboarding:** Storyboards are sequences of images that show the relationship between user actions and system outputs (Nielsen, 1991). A number of storyboards were developed and the main purpose was to gather information regarding the structure of the e-learning courses, their functionalities and navigation options. Practically, the technique of storyboarding was very useful and facilitated constructive discussions among the members of the design team and the subject matter experts.

**E-learning course prototype:** A high fidelity prototype exhibiting the interface and content of two e-learning modules was developed (as presented in Figure 2). The purpose was to have a small set of trainees interact with a more realistic subset of the e-learning application; therefore a high fidelity was considered as most appropriate. Trainees from the Greek user organisation were asked to freely explore (no specific tasks or scenarios were given at this phase) the prototype. Then interviews were conducted with each one of the trainees. Questions considered the following: (a) relevance of the content with the trainees’ needs and job tasks, (b) the content difficulty level, (c) the navigational fidelity, (d) the interactivity level, (e) the clarity of learning objectives and (f) the general impressions of trainees (what they liked most, what they didn’t like).

The general impression was quite positive. The
prototype was considered as easy to navigate and all the trainees were satisfied with the interactivity level, though most of them asked for more examples and interactive exercises. Learning objectives were perceived as very explicit while most of the complaints had to do with the difficulty level of content. Two participants stated that content was very generic and not relevant enough to their job tasks. At the end of the process, significant feedback was received to allow enhancements prior to the final implementation and release of the courses. The main problem was the access to a rather small sample of trainees.

3.5 Evaluation

Evaluation was considered as a very critical phase and the focus was on gathering as much qualitative and quantitative information from the stakeholders, especially from the trainees themselves. Evaluation efforts were continuous and several usability evaluation methods and techniques were used, formative and summative ones. The evaluation techniques and their main outcomes are the following:

1. Evaluation walkthrough
As mentioned in section 3.3 (in the focus group description) a presentation was made exhibiting main features of the learning management system and the e-learning course prototype. A participatory kind of evaluation took place, known as evaluation walkthrough. The presentation was a process of going step-by-step through the interfaces of the learning management system and the course prototype, aimed at receiving feedback from the stakeholders (in this case, the trainees’ supervisor) and the trainees themselves. The process was valuable for two main reasons: (a) the first emotional reactions of the trainees were captured and (b) feedback was given by key stakeholders such as the supervisors of trainees. The most important gain (as in the focus group as well) was the face-to-face interaction with some of the actual end users of the e-learning service and the intense dialogue, which cannot be provided by other techniques. The main problem was the small number of trainees that participated in this activity.

2. Interaction with course prototype
The second step in evaluation was having trainees to interact with the e-learning course prototype accompanied by interviews as described in the previous section.

3. Content quality control
This is not a typical usability evaluation technique but it is a crucial quality determinant for the production of any e-learning application. Five subject matter experts (academic professors who teach Information Systems Management and Systems Analysis & Design) conducted this evaluation activity. They inspected the content, resources and materials (exercises etc.) of the courses with the use of a short checklist instrument. The checklist (annex) was composed of 12 criteria for instructional quality of the content and the pedagogical quality of the media used, while there was an open space for comments. According to the results the overall instructional quality of the content was good and the use of media was quite appropriate. It was also found that (a) specific course modules were identified as poor in content and too academic and (b) some interactive parts of the content did not provide enough opportunities for practice and constructive feedback.

4. Heuristic evaluation
This is an expert-based inspection of the e-learning courses. Many e-learning studies have used Nielsen’s heuristics without any further adaptation to the e-learning context. Although such heuristics have proved their validity in several e-commerce and other studies, they are not customised to e-learning and do not consider the user as a learner. Reeves et al. (2002) suggested specific heuristics for e-learning projects and these were used for performing the heuristic evaluation: (1) Visibility and System Status, (2) Match between System and Real World, (3) Error Recovery and Exiting, (4) Consistency and Standards, (5) Error Prevention, (6) Navigation Support, (7) Aesthetics, (8) Help and Documentation (9) Interactivity, (10) Message Design, (11) Learning Design, (12) Media Integration, (13) Instructional Assessment, (14) Resources, and (15) Feedback. Heuristics are accompanied by two kinds of ratings according to (a) degree of conformance to the heuristics and (b) severity of potential usability problems. Two human factors experts and an experienced instructional designer evaluated the e-learning courses’ interface against these heuristics. Each expert was provided with the URL of the e-learning courses’ prototype and they were asked to provide their comments within 10 days. The head of the design and development team collected the three individual contributions and consolidated the analysis.

The heuristic evaluation revealed, in total, 19 flaws in the e-learning course prototype. The most important conformance problems were found in the criteria “Match between System and Real World” and “Help and Documentation”. Additionally, usability problems that concerned the aforementioned crite-
ria and criterion “Visibility and System Status” were judged as the most important ones and were given a priority when changes and revisions of the design took place. Some of the suggested revisions of the design focused on the following features:

- The structure of the menu was redesigned so overlapping menu items were eliminated and more suitable terms were used to express the different functions.
- Some very long sections of text that obliged users to scroll down were separated in smaller sections.
- The diagrams of the e-learning course were presented only in their higher resolution form while the other forms were excluded.
- The help pages included in the web course were updated according to changes in structure and navigation.
- Some business simulations i.e. “real-life situations” and resources were produced and added in the e-learning course, etc.

It was felt that performing heuristic evaluation with these tailored to e-learning criteria, facilitated the work of human factor experts in order to focus not only on web design but also on instructional design issues and thus to make more balanced redesign suggestions. It is critical, though, that at least one expert with an instructional design background should participate in the evaluation.

5. Questionnaire-based Usability Evaluation

Questionnaires have been extensively applied in usability evaluation experiments. For the purposes of this study, an on-line questionnaire was developed, which is particularly useful in web usability evaluation when the users are distant. The aim of this questionnaire was to assess trainees’ perceptions of e-learning courses’ usability. The selection of the usability attributes included in the questionnaire was based on wide review and synthesis of several previous relevant studies. This questionnaire was developed according to widely-known and valid HCI methodologies and was based on the effective integration of web design and instructional design field (Zaharias, 2006). However the authors consider that there are some more important dimensions to measure when it comes to e-learning context. Therefore the development of the questionnaire moved beyond the well-known satisfaction questionnaires since it was designed in order to cover an important – probably the most important – affective learning consideration, which is motivation to learn. Anderson and Draper (1991) have long stated the need for measures to cover issues such as affect and motivation. For the assessment and interpretation of intrinsic motivation to learn, Keller’s (1983) motivation theory was used. This model – a widely used and recognized model in instructional design literature - supports that there are four dimensions and strategies to ensure motivation to learn: Attention, Relevance, Confidence and Satisfaction.

A brief description of the usability criteria parameters is presented:

- **Navigation**: the way learners move through the instruction and how the instruction is designed to facilitate understanding of organization and structure of content
- **Learnability**: the ease with which new or occasional learners may accomplish some learning task using the interface
- **Accessibility**: loading time, browser compatibility, visual preferences etc.
- **Consistency**: the consistent use of fonts, text, and various design features’ placement (navigational aids, menu bar etc.)
- **Visual Design**: the design features’ placement in order to minimize cognitive overload, attract learner’s attention etc.
- **Interactivity/engagement**: content-related interactions and tasks that support meaningful learning
- **Content and resources**: the design of learning content and resources necessary to support effective learning.
- **Media Use**: the use and inclusion of several media in the e-learning design; must serve clear pedagogical and/or motivational purposes
- **Learning strategies design**: interactions that have been designed in accord with sound principles of learning theory
- **Feedback**: the provision of feedback that is contextual and relevant to the problem or task in which the learner is engaged
- **Instructional Assessment**: the design of assessment opportunities that are aligned with the learning objectives and content
- **Learner Guidance and Support**: the design of online help, documentation, and other tools that support and may guide the learner
- **Motivational Usability**: relates usability with motivation to learn, a very important factor while designing and evaluating an e-learning interface.

The questionnaire targeted the whole trainee population and it was released right after the end of the training period. Sources such as heuristics, guidelines, checklists and other questionnaires were used as an initial pool of items for possible inclusion in the ques-
tionnaire. Items were used in the form of statements that should be evaluated by the trainees, with the scale 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, and 5= Strongly Agree. For the purpose of evaluation, a mean rating of each usability criterion above the value of 3.00 was considered satisfactory. The analysis revealed that all usability criteria were perceived as satisfactory (≥ 3.00). In more details “Consistency”, “Navigation”, “Content and Recourses” and “Visual Design” were evaluated with the highest scores while “Accessibility”, “Feedback” and “Interactivity” with the lowest ones. Consequently a list of recommendations for future developments was made:

- Regarding “Accessibility”, most problems were a result of the low-speed Internet connections that were used in order to access the e-learning service. Higher-speed connections should be used, while at the same time “lighter” versions of e-learning courses should be designed (focusing on the careful selection of specific media formats).
- Feedback should also direct learners to additional materials in order to help them understand what they are missing, even if they demonstrated mastery of the learning objectives; feedback must direct learners to more advanced and challenging tasks, or other courses and materials.
- For Interactivity/Engagement, several potential enhancements were suggested such as development of open exercises and essays, inclusion of direct links to existing online communities or subject matter experts, further development of interactive case studies and business simulations, or even games, that engage learners actively in the learning process.

The use of the questionnaire was considered as the most appropriate and convenient method within the geographical and temporal limitations of the project. Moreover the multitude of trainees who responded, provided the opportunity for further quantitative analysis of data. Analysis revealed a strong quantitative relationship between the aforementioned usability criteria and motivation to learn (Zaharias et al., 2004) which supports the authors’ argument that this can be a new type of usability measurement for e-learning. The use of such technique could be further enhanced if it was combined with interviews with trainees but this was not feasible at the end of the project.

4. CONCLUSIONS AND FUTURE RESEARCH

Learner-centred design aims at making people more effective learners. Although communication chan-

nels have been established between HCI scholars and Educational Technology researchers, it is not clear which processes are fundamental to learner-centred design. There is no consensus on what kind of activities should take place or how the findings of each activity must be presented, documented and communicated. There is always more than one perspective on the learner-centred design process and there is a large spectrum of design methods and techniques with which designers should be familiar.

We stress the need for designers to be fully aware of the interplay between usability engineering and instructional design in order to address the users as learners and to build systems that will be both usable and pedagogically meaningful. This paper presents an implementation of the learner-centred design paradigm, exploits concepts and techniques from usability engineering and instructional design and exhibits a practical way of their integration (table 3 summarizes the main phases, methods used, stakeholders, challenges and/or problems-limitations of this study). A plethora of different data gathering methods were employed and developed. Problems and challenges of applying those methods were identified and discussed. Special attention was given to user-level and organizational-level requirements where methods and techniques from instructional design were used. Training needs assessment models and task analysis procedures have a prominent place in the development of corporate e-learning interventions. Evaluation was also a major concern. Both formative and summative techniques have been applied. Such evaluation techniques are characterized by the interplay between usability attributes and instructional design aspects. A new questionnaire-based evaluation method was developed and motivation to learn, a critical parameter for learner-centred design success, is proposed as a new usability measure of e-learning designs. Future work will focus on further empirical validation of the method, which implies its use in other research settings with different goals, learners and context of use.

A limitation of the study is that it mainly focuses on learners’ needs. However, the learner is one stakeholder amongst many others. In addition the organisational analysis was based on a small number of key informants. There was limited interaction with other key stakeholders such as trainers or external customers of trainees. Concerning future research dimensions, we suggest intensive work towards the formulation of a unified framework of learner-centred design. Brna and Cox (1998) argue that learner-centred design is more a metaphor than a detailed framework. Little has changed since then. Special attention must be paid to capturing organi-
Implementing learner-centred design: the interplay between usability and instructional design

<table>
<thead>
<tr>
<th>LCD phases</th>
<th>Methods / Techniques</th>
<th>Stakeholders</th>
<th>Challenges / problems/limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand and specify the context of use</td>
<td>1) Face to face meetings 2) Email-based survey 3) Questionnaire, interviews</td>
<td>All</td>
<td>1) The main challenge is to find a common language and to set the “right” expectations</td>
</tr>
<tr>
<td>Specify the user and organizational requirements</td>
<td>1) Market survey, searching on the web 2) Focus group, web-based survey, semi-structured interviews 3) Questionnaires and interviews</td>
<td>1) Members of the design &amp; development team 2) Head of the design &amp; development team + instructional designer + trainees, supervisors of trainees 3) Senior managers, functional heads, supervisors of trainees</td>
<td>1) LMSs and e-learning courses abound in the market – difficult to differentiate 2) Focus group facilitated to capture first emotional reactions of the trainees and feedback supervisors of trainees – a problem was the small number of trainees that participated - The web-based survey was a convenient method to assess individual learner characteristics 3) Heads of several departments were involved – good coordination is needed - there was no common view for identification of important tasks - no line staff were interviewed - the main findings reflected only the views of the leadership every user organization</td>
</tr>
<tr>
<td>Design</td>
<td>1) Design guidelines 2) Storyboards 3) Course prototype</td>
<td>1) &amp; 2) Members of the design &amp; development team 3) Head of the design &amp; development team, trainees</td>
<td>1) Design guidelines are quite abstract and sometimes conflicting 2) Storyboarding is a good technique in early design stages and promotes fruitful discussions amongst members of the design &amp; development team 3) The problem was the small number of trainees that interacted with the course prototype</td>
</tr>
<tr>
<td>Evaluation</td>
<td>1) Formative evaluation 2) Summative evaluation</td>
<td>1a) Evaluation walkthrough, 1b) interaction with course prototype, 1c) content quality control, 1d) heuristic</td>
<td>1a) First impressions and emotional reactions of trainees were captured, live discussions and dialogue with trainees</td>
</tr>
<tr>
<td></td>
<td>2) Questionnaire-based evaluation</td>
<td>1e) Head of the design &amp; development team, trainees, supervisors of trainees, 1h)</td>
<td>1b) same as in course prototype</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1c) very good collaboration between subject matter experts and instructional designers is needed 1d) e-learning design heuristics need further validation – one expert must have instructional design background/knowledge 2) Convenient and cost-effective method when users are geographically dispersed – An innovative aspect was proposed: motivation to learn as a new usability dimension – further assessment of validity is needed</td>
</tr>
</tbody>
</table>

Table 3: Implementing learner-oriented design: the interplay between usability and instructional design

Zaharias and Poulymenakou: Implementing learner-centred design

Zaharias and Poulymenakou: Implementing learner-centred design

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REFERENCES


ANNEX

In this annex excerpts from instruments and techniques used throughout the learner-centred design process are provided. Presentation order follows the main Human-centred design stages.

**User level requirements**

Excerpt from the Web-based survey:

Please rank the following modes of delivery (1 = most preferred and 4 = least preferred).

- On-site training (with instructor/trainer)
- Classroom training (with instructor/trainer)
- Teleconference (synchronous with instructor/trainer)
- Computer-based training (self study and/or interactive)

How do you most prefer to learn about something new? (Check as many as apply)

- Attend a live lecture or demonstration (workshop, seminar, conference)
- Listen to a lecture on audiotape or radio
- Watch a lecture or demonstration on TV, video, or film
- Participate in a teleconference (also interactive via phone and/or fax)
- Discuss topics in small groups
- Read on your own (articles, books, manuals, reports, etc.)
- Read on your own and then practice new skills
- Learn from another individual (one-on-one instruction)
- Practice new skills on your own without reading

Please rank the following reasons for pursuing training opportunities in order of importance to you (1 being most important):

- To obtain business credit/ certificates
- To work towards job advancement
- For consideration on (annual) evaluations
- For personal growth/greater job satisfaction
- Other (please describe):

**Organisational-level requirements**

Excerpt from Organizational Training Needs Assessment Questionnaire:

1. Describe the most important business opportunity or pressure currently facing your department/unit/organization.

2. Why do you think training in focus job areas (see annex) is needed? (List 4-5 main reasons)

<table>
<thead>
<tr>
<th>IT Business Consultancy</th>
<th>Software &amp; Applications Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
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<td>2.</td>
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<td>3.</td>
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<td>4.</td>
<td>4.</td>
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<td>5.</td>
<td>5.</td>
</tr>
</tbody>
</table>

Excerpt from Job and tasks analysis questionnaire:

3. Rate each task as 1 through 5 for the following:
   (a) frequency on the job (how often do the trainees perform each task),
   (b) difficulty to do (how difficult is each task for the trainees),
   (c) importance of this task for completing the job, and
   (d) how difficult it will be to train the trainees to do this task. The higher the number, the more frequent, difficult, important, and difficult to train the task is.

<table>
<thead>
<tr>
<th>Task</th>
<th>Frequency</th>
<th>Difficulty</th>
<th>Importance</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 = Not at all frequent 5 = Very frequent</td>
<td>1 = Not at all difficult to do 5 = Very difficult to do</td>
<td>1 = Not all important 5 = Very important</td>
<td>1 = Not at all difficult to train 5 = Very difficult to train</td>
</tr>
</tbody>
</table>

**EVALUATION**

Content quality control - Excerpt from the checklist:

Questionnaire-based usability evaluation – An excerpt from the questionnaire:
Dr. Panagiotis Zaharias holds a Ph.D. degree in Information Systems (specialization in HCI) from the Department of Management Science and Technology of the Athens University of Economics and Business. His main research interests are focused on user-centred design, usability evaluation and e-Learning design. He is a research associate of the Electronic Trading Research Unit (ELTRUN) and has participated in various European and national-level research projects. He has published more than 20 papers in scientific journals and conference proceedings. Panagiotis is a member of ACM’s SIGCHI and AACE (Association for the Advancement of Computing in Education) organization.