ABSTRACT
In this paper, a design methodology for the development of networked collaborative learning environments for Higher Education is discussed. It takes into consideration the educational theories as a strong foundation to draw upon, but also explores architectural design theories as a way to guide and inform the process. Based on a non-positivist epistemology, with an emphasis on critical reflection and complemented by an understanding of knowledge as socially constructed, a conceptual framework for the use of information technology in Higher Education (HE) is presented. This framework generates the background for the design methodology. It is argued that a more holistic approach on the design of networked collaborative environments for Higher Education should facilitate the integration of this type of environments into the structure of HE institutions and also the integration of these institutions with the external communities they are supposed to contribute to.

Keywords
Networked collaborative learning, design of networked learning environments, design methodology, constructivist framework.

INTRODUCTION
Networked collaborative learning environments have been increasingly used, but there are still concerns related to issues such as: appropriation by users, integration into the overall organisation structure, and lecturers’ involvement (Leron and Hazzan, 2000; Gibbs, Skinner at al., 1998; Payne, 1997; Wilson, 1995). The difficulties found are of various orders: technical, organisational, and pedagogical. Very frequently the barriers are of psychological nature and involve motivational issues. There are several ways of facing these difficulties, but this paper looks especially at the design process used to develop a learning environment in order to overcome or minimize these difficulties.

Looking at a networked collaborative learning environment as an ‘inhabited’ space where people learn through interaction and the execution of various activities, this paper argues that its design poses an architectural problem together with an educational one. Therefore, it advocates the combination of educational theories and architectural principles to generate a ‘participatory and reflective design methodology’. This methodology should favour the design of a learning environment more in touch with the users’ needs and expectations and also flexible enough to continually adapt itself to these expectations and to organisational and technological change.

NETWORKED LEARNING ENVIRONMENTS
The use of networked environments for learning and teaching has been rapidly increasing since the Internet boom of the 1990’s, which was mainly caused by the flexibility of use brought about by the World-Wide Web. This flexibility allows the creative use of multimedia combined with several communication tools, bringing new possibilities for its exploration in education (Pereira, 2000; Perkins, 1996).

It is via computer networking that the great potential of computers as a means for socialisation can take place. They can allow stimulation between people’s knowledge to happen. Networked environments are in fact spaces within which people navigate, interact with each other and with information and tools, collaborate, co-operate. They are, therefore, ‘inhabited’ spaces.

THE DESIGN OF NETWORKED COLLABORATIVE LEARNING ENVIRONMENTS
Considering networked collaborative learning environments as ‘inhabited’ spaces, this paper argues that a holistic approach which takes into account educational theories and architectural design issues should be used during the design process of these environments.

Educational Theories
Moving from a Behaviourist to a Constructivist paradigm, educational research changes from a transmission-model that emphasises teaching methods to one that is learner-oriented. Within the view that the knower actively constructs knowledge, efforts are put on the facilitation of the learning process.
Within the Constructivist approach, different theories contribute to bring new dimensions to the learning process. Particularly, the Socio-Cultural Theories, Critical Pedagogy, and Reflective Practice nicely complement and reinforce each other, as shown below:

**Socio-Cultural Theories**
sharing the constructivist commitment towards active learning, they stress the importance of social interaction in supporting cognitive change. Inspired by the Soviet socio-historical movement of the 1930s and enriched by other lines of theory such as cognitive science and anthropology, these theories provide the basis for the work on collaborative learning, emphasising the importance of motivation, social cognition, situated learning, and the appropriation of mediational means. (See Vygotsky, 1962; Crook, 1996)

**Reflective Practice**
it encourages the development of metacognitive strategies which facilitate the understanding of the learning process and the development of responsible lifelong learners. According to Schön, it involves ‘reflection-in-action’ and ‘reflection-on-action’. It also emphasises the importance of dialogue, generating collaborative and critical reflection, where both learners and teachers are reflective practitioners, seeing the learning institution as an environment for reflective practice. (See Schön, 1987 & 1991; Pereira, 1999)

**Critical Pedagogy**
mainly based on the work of Paulo Freire, it also draws upon the work of others such as Gramsci, Foucault, and Merleau-Ponty. It sees education as a process of development and empowerment, involving stages of awareness and transformation. It combines the assets of reflective practice with those of socio-cultural theories and goes further, highlighting the importance of situating the learning within the context of the learner and of the agents and institutions of learning, constantly reflecting on them. (See Freire, 1979 & 1985; Freire & Macedo, 1987; McLaren and Leonard, 1993)

Based on these theories a Socio-Constructivist Pedagogical Model (Pereira, 2000 & 2001) is proposed (see Figure 1). The model basically recommends:

- a learner-oriented approach;
- the development of individual cognition, with emphasis on active and independent learning (via exploratory and highly interactive activities) – metacognition – reflective practice;
- the development of systems of cognitive activity: social interaction and collaborative learning – critical & collaborative reflection;
- the construction of flexibly structured learning environments, which allow different learning experiences – within learning organisations;
- the development of learning as situated in real context, not just in terms of associating learning with real-world contexts, but also developing in the learners and other agents involved in the learning process, the consciousness of the social and political context where the learning experience takes place.

**Architectural Design Theories**
Networked environments or virtual environments are spaces which are ‘inhabited’ by people, where they interact, communicate and collaborate, using tools, and performing different activities in order to pursue various goals. Therefore, nothing is more pertinent than an exploration of the architectural design knowledge in order to identify similar issues which can be considered in the design of both, virtual and real spaces. This view is also shared by other authors such as Bridges and Charitos (1996), Cabral-Filho (1996), Winograd at al.(1996), and Benedikt(1992).

Some of the basic issues considered in architectural design and similarly important to the design of virtual environments are the identification and understanding of:

- clients’ and users’ needs;
- history of the activities which will take place in the environment to be designed and how they evolve in time, as well as an understanding of the social and political context where they take place;
- technical aspects involved in the construction of the environment;
- aesthetic and symbolic aspects which can be explored in the construction of the environment;
- legislation and economic constraints.
Figure 1: Critical Socio-Constructivist Pedagogical Model

The identification of characteristics and qualities of spaces can be based on the contribution of various theorists, such as:

- Vitruvius’ attributes of good architecture: commodity, firmness and delight (Vitruvius, 1960), which are related to how friendly and functional users feel the space to be; how reliable the technology is, how transparent the processes are, and how enjoyable the overall use of the space is;

- Lynch’s concepts of paths, nodes, boundaries, and landmarks (Lynch, 1960), which are responsible for the ‘legibility’ and transparency of the space, allowing users to easily identify the different parts of the environment, where they are, and how to navigate within the space;

- Hertzberger’s discussions on territoriality, form and appropriation, accommodating and stimulating spaces (Hertzberger, 1991). These concern the definition of private and public areas, the possibility of customising the space to attend different needs and develop a sense of ownership, the use of form as inspiration via the exploration of metaphors that induce appropriation, exploration, sense of familiarity, safeness, confidence, and allows different learning processes.

Other important issues that can be borrowed from the architectural design knowledge and applied to the design of networked collaborative learning environments are closely related to the design process itself:

- Participatory Design: this methodology involves users in the design process, attempting to generate more meaningful spaces, which more efficiently answer the users’ needs and expectations, facilitating the development of a sense of ownership and, therefore, a better appropriation of spaces.

- Reflective Practice: the view of the design process as a ‘reflective dialogue’, in a conversation where the situation talks back and the uncertainties and unpredictability of the situation are considered was developed by Donald Schön when analysing the architectural design process. This notion of design as a reflective practice reflects a non-positivist approach and, when combined with the Participatory Design methodology, can generate results which have more chances to fulfill users’ needs and expectations.
A Conceptual Framework
Based on these ideas and on the fundamental premise that knowledge is constructed by the knower, a conceptual framework for the design of networked collaborative learning environments was proposed (Pereira, 2000). Its main points are:
- a critical-reflective epistemology – essentially non-positivist, this is an ‘epistemology of practice’ (Schön, 1991) based on artistry and able to accommodate change, via reflection-in-action and on-action;
- a socially constructed view of knowledge – where not only the interaction with tools and content is important, but mainly the interaction with other individuals, in a collaborative learning process;
- an architecturally informed methodology – within a participatory and reflective design approach, which involves the analysis of activities and qualities of spaces.

Design Methodology
The proposed design methodology is based on the conceptual framework principles. It is, therefore, participatory and reflective: it involves users’ participation and evolving evaluative stages. The methodology attempts to build collaboration from the very beginning of the design process, putting people together to discuss their ideas and expectations. The collaborative reflection is supposed to take place in several instances, among different kinds of users, project team, specialists, etc. Figure 2 attempts to illustrate the methodology and its developmental character.

Figure 2: the Participatory and Reflective Design Methodology

Needs Identification
This initial stage involves the definition of goals, target audience, organisational and political context, users’ needs and expectations, and the study of available technologies and how well they can be integrated into existing systems and into the organisation. This can be done via: literature review, interviews, questionnaires,
Activities Analysis & Spatial Qualities Definition

Needs analysis and identification of needed and/or desirable spatial qualities are carried out at this step, considering the organisational, technical and pedagogical issues.

Based on the identified users’ needs, the main activities which shall take place within the environment to achieve those needs are defined, together with: the actors who will be involved in these activities; the objects of action/content; the qualities of the content; the qualities of the space which would favour the realisation of these activities; the functionality which should be developed to promote these activities; and the main features of the environment. It is important that these issues are discussed by the whole project team, from IT specialists and learning technologists to the project leader, as it facilitates the understanding of the situation and the definition of clear goals.

Table 1 shows examples of how the identified needs were used in the process of activities’ analysis and the definition of spatial qualities during the design of the Virtual Learning Space (VLS). Funded by the Scottish Higher Education Funding Council (SHEFC), the VLS is a collaborative learning environment for the development of information and communication technologies (ICT) skills among staff from three HE institutions in Northeastern Scotland (for more information about the VLS see Harris at al.,2000 and Pereira at al., 2000 – http://itlearningspace-scot.ac.uk).

Conceptual Model

It consists of a general model which reflects the exploration of metaphors related to the context and findings of the previous stages, a general definition of hierarchy and navigation systems, definition of private and public spaces (territoriality issues), general content grouping, and the kind of technologies which should support these. Figure 2 illustrates the conceptual model developed for ArchCAL, a networked collaborative environment for learning and teaching technical subjects in architectural education (see Pereira, 2000). The ArchCAL conceptual model combines the users’ needs, teachers’ roles and metaphors identified via interviews and literature review with different forms of learning, content organisation and technologies.

Prototype and First Version

Ideally, at this stage a prototype of the learning environment would be developed, where the issues considered in the conceptual model are contemplated in more detail and implemented in a small scale, with examples of the main areas and functionality. The following are defined:

- hierarchy and navigation systems;
- degree of interaction with tools and content;
- degrees of privacy within private and public spaces;
- content organisation, with the use of consistent groups and labels;
- general contextual information for the whole environment and for each main section and page, according to the functionality and characteristics that space should have, with the definition of gateways and thresholds.
Table 1: Simplified example of the activities’ analysis done during the design of the Virtual Learning Space (VLS).

<table>
<thead>
<tr>
<th>Actor</th>
<th>Needs</th>
<th>Activities</th>
<th>Objects of action/Content:</th>
<th>Qualities of the content:</th>
<th>Qualities of the space:</th>
<th>Functionality/Functional requirements:</th>
<th>Main features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturer</td>
<td>Communication via a supportive/collaborative community</td>
<td>Finding information &amp; learning about: how to put teaching material on the Web; online assessment; specialized IT skills &amp; software; via:</td>
<td>Advanced training</td>
<td>Comprehensive</td>
<td>Easy to use</td>
<td>Index (resources &amp; site)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>Accessing evaluation of software &amp; equipment</td>
<td>Accessibility</td>
<td>Accessibility-friendly</td>
<td>Use content and other individuals</td>
<td>Search (site &amp; WWW)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>Accessing software (how to use, where to find, how to access);</td>
<td>Appraisal schemes and rewards</td>
<td>Appraisal</td>
<td>Supportive, reassuring</td>
<td>Easy maintenance: easily updateable, in terms of content and technology</td>
<td>Newsletter (periodically)</td>
</tr>
<tr>
<td></td>
<td>Advanced</td>
<td>Motivational issues (e.g. how to encourage students to use IT resources)</td>
<td>Combination of innovative teaching and research</td>
<td>Combination</td>
<td>It facilitates communicatio</td>
<td>Efficient access to material/info (quick access to relevant material)</td>
<td>News Board (recent news)</td>
</tr>
<tr>
<td></td>
<td>Main concern: making material available for students on the Web</td>
<td>Making material available for students on the Web</td>
<td>Making</td>
<td>Reliable</td>
<td>Relevant &amp; useful</td>
<td>Chat (scheduled and informal) discussions)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Online assessment</td>
<td>Motivational issues (e.g. how to encourage students to use IT resources)</td>
<td>Motivational issues</td>
<td>Motivational</td>
<td>Reflective, from others</td>
<td>Discussion groups (threaded and non-threaded)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Specialized IT skills &amp; software</td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Pedagogical support (via discussions and resources)</td>
<td>Pedagogical</td>
<td>Critical, up to date</td>
<td>Use of appropriate tools</td>
<td>Personal profile</td>
</tr>
<tr>
<td></td>
<td>Access to material</td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Plagiarism/cheating</td>
<td>Plagiarism</td>
<td>Functional</td>
<td>Use of reliable technology</td>
<td>Calendar</td>
</tr>
<tr>
<td></td>
<td>Motivation</td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Special needs training</td>
<td>Special needs</td>
<td>Well organised</td>
<td>Well administered</td>
<td>Scheduling facility</td>
</tr>
<tr>
<td></td>
<td>Support (institutional, pedagogical, technical)</td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Specialised IT skills and software</td>
<td>Specialised</td>
<td>activity</td>
<td>Well administered</td>
<td>Poll facility</td>
</tr>
<tr>
<td></td>
<td>Combination of innovative teaching and research</td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>List of specialists – pockets of expertise</td>
<td>List of specialists</td>
<td>Directive</td>
<td>Personal involvement</td>
<td>Registration facility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Resources pool</td>
<td>Resources pool</td>
<td>Good</td>
<td>and management of the system (human administrator(s)/moderator(s))</td>
<td>Uploading and/or submitting facility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Frequently asked questions and answers</td>
<td>Frequently asked questions and answers</td>
<td>Good</td>
<td>Highly accessible</td>
<td>Bibliography</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Useful links to other sites</td>
<td>Useful links to other sites</td>
<td>Quality</td>
<td>Allowing constant evaluation</td>
<td>Customisation facility (choice of different metaphors?)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Common sources</td>
<td>Common sources</td>
<td>Quality</td>
<td>Consultant type of advice, immediately accessible</td>
<td>Delphi tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Suggestions of courses, strategies, material and locations.</td>
<td>Suggestions of courses, strategies, material and locations.</td>
<td>Accessibility 'Continuity'</td>
<td>Help desk type of advice</td>
<td>Whiteboard/Application and File sharing (sharing material/application s/presentations synchronously)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Case studies/best practice</td>
<td>Case studies/best practice</td>
<td>Fun and exciting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Useful links to others with similar interests</td>
<td>Useful links to others with similar interests</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Open discussions</td>
<td>Open discussions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Solutions to common problems</td>
<td>Solutions to common problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Institutional support issues (e.g. institutional readiness)</td>
<td>Institutional support issues (e.g. institutional readiness)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Good examples, to reduce skepticism (e.g. examples of C&amp;IT use in teaching, which reduces administrative time)</td>
<td>Good examples, to reduce skepticism (e.g. examples of C&amp;IT use in teaching, which reduces administrative time)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Self-assessment</td>
<td>Self-assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Reflective discussions/conversations</td>
<td>Reflective discussions/conversations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessing evaluation of others’ experience/case studies</td>
<td>Directive answers</td>
<td>Directive answers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2: Diagram illustrating the conceptual model of the ArchCAL learning environment.

However, depending on the amount of implementation which has to be done and if existing tested software and web tools will be used, it may be possible to develop a first implementation version of the environment already. This first version would include the ones previously mentioned in its full extent, plus more detailed considerations such as:

- software definition, installation and application (e.g. for database structure and management, interface design, webtools, etc.);
- content definition - even if the content is supposed to be put together with users’ participation during the learning process, methods and strategies to obtain, store, organise and access the content should be defined at this stage;
- detailed contextual information for the whole environment and for each section and page, according to the functionality and characteristics of the space.

Figure 3 shows examples of the interface design at this stage for the ArchCAL prototype and the VLS first implementation version.

**Evaluation**

The evaluation stage consists of consultation with users and specialists on design and on the application of ICT into education to identify if the learning environment fulfills the previously defined needs and expectations. This evaluation can involve the same users who took part on the ‘needs identification’ stage and/or other stakeholders who could also confirm the validity of the previously obtained data. The evaluation can be done via demonstrations, focus groups, online workshops, questionnaires (on-line or on paper), interviews, etc. It is...
important to have opportunities for collaborative and reflective evaluation, be it via face-to-face focus groups or via online workshops and discussions. Ideally, a combination of methods should be used and the data cross-examined.

Figure 3: Snapshots of the interfaces of the ArchCAL prototype and the first version of the VLS.

Further development and Implementation
Considering the feedback received during the evaluation, changes in the learning environment are implemented. Figure 4 shows snapshots of the second version of the VLS.

Figure 4: VLS interface after the re-design stage.

Population and Dissemination
The population of the learning environment concerns users and resources. Depending on the nature of the networked learning environment this population can be done via organised events such as online workshops, hands-on face-to-face workshops, online courses or support activities for specific courses, etc. The strategies for population and dissemination should have been defined all the way along the design process, with all the collaborative events being an opportunity to disseminate and attract users and ideas for resources.

Involving different stakeholders in the design process should facilitate the collection of different points of view within the institution, providing designers with valuable information to integrate the environment within the organisational context. Moreover, the organisation of evaluative events that go beyond the institution itself, but involves participation of other specialists in the area and others involved in similar projects can also help to populate and disseminate the environment. A good example was the organisation of an on-line workshop in collaboration with the Online Tutoring Skills project (OtiS http://otis.scotcit.ac.uk) in the VLS, which was part of the evaluation of the first implementation stage. The online workshop brought participants from various parts of the world that submitted and discussed case studies reporting their experiences in using ICT in education. They not only tested the interface design, navigation and functionality of the VLS answering an emailed questionnaire, using discussion groups and chats, filling in profile information and interests, but also contributed to its resources’ area, entering information about relevant reference material, commenting and rating them.
**On-going Evaluation and On-going Development**

A truly networked collaborative learning environment should be flexible enough to allow constant development, following changes in users' needs and expectations, organisational development, and technology. Therefore, there should be constant open channels for evaluation and users should always be encouraged to manifest their opinions about the learning environment. This can be done in various ways, but having the evaluation mechanism embedded in the learning environment itself is probably the most efficient, as it is easily accessible. The embedded evaluation can be done via an online questionnaire, a dedicated bulletin board, pools, together with the most commonly used feedback via an e-mail message to administrators.

Having an ongoing evaluation and ongoing development, done via collaboration, also reinforces users’ sense of ownership of the environment and makes easier the insertion into the institutional context.

**DISCUSSION**

This methodology has been used twice, in the design of ArchCAL and the VLS. The evaluation of both has been very positive. Despite the fact that ArchCAL was only developed at the level of prototype, its evaluation which was done with the participation of students from several architectural schools in the United Kingdom and via interviews with IT experts on educational technologies, was very positive. 96% said they were interested in using a networked environment like ArchCAL in their learning, and most of those who cited the reasons for the good acceptance of the environment mentioned its useful features, easy accessibility and user-friendliness, how it would improve learning and designing among others, suggesting the achievement of important goals set during the conceptual development (see Pereira, 2000).

The Virtual Learning Space (VLS) also had a very positive evaluation, which will be published in a future paper. Its community continues to grow (more than 1300 members from more than 50 countries), with continuous collaborative discussions via interest groups, using bulletin boards and online chats, exchanging ideas, experiences and resources. Staff from the partner institutions take part in the activities and seem to be encouraged by the broader participation of specialists. Moreover, a good administration makes sure that contact with users is always maintained, their opinions are always required, and the activities are constantly organised and advertised.

**CONCLUSIONS**

Within the view that networked collaborative learning environments are spaces where people meet and interact with tools and other individuals in order to learn, this paper departs from the principle that the design of such environment poses educational and architectural problems. Therefore, a proposed conceptual framework that combines educational theories and design principles is discussed.

This framework is based on a non-positivist epistemology, with an emphasis on critical reflection and complemented by an understanding of knowledge as socially constructed. It provides the background for a design methodology for the development of networked collaborative learning environments for Higher Education, which main characteristics are users’ participation and collaborative reflection. The participatory and reflective methodology is discussed and examples of its application were shown. However, it is important to emphasize that a main characteristic of this methodology is that it proposes a continuous process of evaluation and development, generating an environment which is flexible enough to adapt to the users’ needs and expectations and to the necessary organisational and technological changes. Moreover, involving different stakeholders from the beginning of the design process, it favours its integration within the institution, while the participation of external specialists and related researchers facilitates its integration in a wider context.

Finally, it seems that collaboration should be a concern from the beginning of the design process of networked learning environments, in order to build a significant learning community, allowing a more effective integration within HE institutions and with external communities as well.

**REFERENCES**


Leron, U. and Hazzan, O. IT in Higher Education: why is it so hard and why there is still hope after all? *British Journal of Educational Technology*, 31, 3, 243-245.


Pereira, M.A. (2000) *ArchCAL: a conceptual basis for the application of information technology into learning and teaching technical subjects in architectural education*. Sheffield, University of Sheffield.


