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# Developments of e-Learning in Design and Architectural Education

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**Abstract**

Design and architectural education have unique teaching traditions and particular pedagogical needs. The utilisation of e-learning for design and architecture should address their exploratory characteristics. Therefore, e-learning for design and architecture should support the domain knowledge of the field and make it accessible through appropriate pedagogy. Currently, most of the strategies employed by online education in constructing the curricula and course content in e-learning environments are based on traditional approaches that are generally conceived in the framework of the creation and authoring of single course content modules. This paper analyses the impact of e-learning hypothesis on education and learning, addresses the uniqueness of learning design and architecture, and presents the developments of e-learning in design and architectural education including multi-user 3D virtual collaborative learning environments and adaptive learning environments; WINDS (Web-based Intelligent Design tutoring System).

**Abstrak**

Pendidikan rekaan dan senibina mempunyai tradisi pengajaran yang unik dan keperluan pedagogi yang tertentu. Kegunaan *e-learning* untuk rekaan dan senibina patut menepati ciri-ciri eksplorasi mereka. Dengan itu, *e-learning* untuk rekaan dan senibina patut juga menyokong domain pengetahuan bidang tersebut dan dapat diakses melalui pedagogi yang bersesuaian. Masakini, kebanyakan strategi yang digunakan dalam pendidikan *online* untuk membentuk kurikulum dan kandungan kursus dalam persekitaran *e-learning* adalah berdasarkan pendekatan tradisional dan secara amnya dilihat daripada kerangka pembentukan dan penulisan kandungan modul bagi suatu kursus tunggal. Artikel ini menganalisis impak hipotesis *e-learning* terhadap pendidikan dan pengajaran, mengambilkira keunikan pembelajaran rekaan dan senibina, dan mempersembahkan perkembangan *e-learning* dalam pendidikan rekaan dan senibina termasuk persekitaran

pembelajaran kolaboratif multi-pengguna 3D maya; WINDS (*Web-based Intelligent Design Tutoring System*).

## Introduction

The use of e-learning in the majority of universities has begun with the introduction of a Virtual Learning Environment (VLE), a system focused on the delivery and support of learning opportunities. Institutions whose use of VLEs is relatively mature are moving towards the establishment of Learning Management Systems which include all of the wider features of enrolment, course options, management, student record and profile keeping, the wider management, interchange and publication of content, and the features needed to allow learners to move or progress between courses and institutions and which must include both technological and manual elements (Stiles, 2003).

Distance education has witnessed three generations of development since its inception. The first generation was in mid 1980s whereby distance education students were provided with paper-based study guides and readers and materials are mailed to them. Access to teachers and instructors was comparatively infrequent using e-mail and by phone. There were no substantial subject oriented documents available. Other materials were enabling components such as compilers, manuals, program fragments and electronic submission software accessible only through a command line interface. In the 1990s, the second generation of online learning tools offered browser mediated access to the web across faster networks and software tools, such as word processors and email systems, became widely available. With richer document formats, substantial subject oriented materials started to appear in online repositories for downloading. As email and bulletin board facilities became more readily available, one-to-one interaction between student and lecturer and one-to-many between lecturer and class widened to include student-to-student interaction. This change permitted online students to discuss class materials and to develop better communications and interactions. Electronic submission of assignments, automated assessments and return of results became easier to use with the user-friendly interface. Nonetheless, there were considerable shortcomings in such web presence such as the lack of uniformity of interface across subjects, confusion in

site navigation due to little regularity in the interfaces, and use of a suite of software packages for the various functions. The third generation of distance education tools in the form of integrated Learning Management Systems is starting to appear since the beginning of the 21st century (Coldwell & Newlands, 2003).

Design and architectural education have unique teaching traditions and particular pedagogical needs. Present education paradigms in architectural education still largely rely on a two-century-old tradition, deriving from the French Academies. Several patterns from the Academies' tradition still persist in the present studios: design exercise as simulation, educator role, graphic formulation and continuous teacher-student interaction (Cuff, 1991; Schon, 1985). This paper analyses the impact of e-learning hypothesis on education and learning, addresses the uniqueness of learning design and architecture, and presents the developments of e-learning in design and architectural education including multi-user 3D virtual collaborative learning environments and adaptive learning environments; WINDS (Web-based INtelligent Design tutoring System).

## Concept and Hypothesis of E-Learning

The concept of e-learning refers to a specific format of distance education and online learning in which students, teaching personnel, researchers, administrative personnel and even technical staff mainly communicate through technical and remote links. New network technologies are used to create, foster, deliver, and facilitate learning, without the limits of time and place. Various definitions of e-learning introduce a wide set of applications and processes, such as web-based and computer-based learning, virtual classrooms, and digital cooperation. The idea of e-learning is aimed at increasing accountability, accessibility, and opportunity, allowing people and organizations to keep up with the rapid changes that define the present. The practical objectives of e-learning are to involve learners in real-time, information technology (IT)-based learning processes, produce and deliver individualized, comprehensive, dynamic learning materials and contents. From a pedagogical point of view, e-learning is viewed as a means to concentrate on learners' individual differences in the pace and forms of cognitive skills to increase their autonomy and freedom. Collaborative learning, facilitated by the availability of advanced information technology processes and new

theories to learning and education, is leading towards a shared experience (Rubin, 2002).

Even though much has been written about e-learning practice, little attention has been given to e-learning theory. The vast bulk of literature in e-learning is practice-based and is typically presented in a descriptive format. A theory can be described as a set of hypotheses that apply to all instances of a particular phenomenon, assisting in decision-making, philosophy of practice and effective implementation through practice. Theory provides a yard stick for evaluating practice, though it in turn may be adjusted by findings from practice that show the theory to be inadequate. As e-learning is practiced, it is essential that those transferable principles of practice are reflected upon which will be beneficial. Nichols (2003) presented ten hypotheses for e-learning in an attempt to focus attention on the underlying principles that apply to e-learning in all situations. The impact of these ten principles on education and learning is conceptualized as illustrated in Table 1.

**Table 1** The impact of e-learning hypothesis on education and learning are conceptualized based on Nichols's ten hypotheses (Nichols, 2003).

| | ***e-learning Hypothesis*** | **Impact on Education and Learning** |
|---|---|---|
| 1 | e-learning is a means of implementing education that can be applied within varying education models (for example, face to face or distance education) and educational philosophies (for example behaviorism and constructivism). | e-learning as a means of education opposed to a mode of education; i.e. a means by which face to face delivery or distance education models can be implemented. |
| 2 | e-learning enables unique forms of education that fits within the existing paradigms of face to face and distance education. | e-learning can be used in blended learning (mixed mode) and distance education (fully online). |
| 3 | The choice of e-learning tools should reflect rather than determine the pedagogy of a course; how technology is used is more important than which technology is used. | Technology is pedagogically neutral and can therefore be applied quite merrily to varying pedagogies (Constructivism, Resource based learning, Collaborative learning, Problem based learning, Narrative based teaching and Situated learning). |

| | *e-learning Hypothesis* | **Impact on Education and Learning** |
|---|---|---|
| 4 | e-learning advances primarily through the successful implementation of pedagogical innovation. | Future progress in e-learning will come from a better understanding of the dynamics of teaching and learning and not from more improved or functional technology. |
| 5 | e-learning can be used in two major ways; the presentation of education content, and the facilitation of education processes. | e-learning can both make information available and play a part in students' self-construction of knowledge. |
| 6 | e-learning tools are best made to operate within a carefully selected and optimally integrated course design model. | Attention must be given to the contribution e-learning can make to learning so that any use of e-learning becomes a seamless component of the overall course design and delivery package. |
| 7 | e-learning tools and techniques should be used only after consideration has been given to online vs. offline trade offs. | Allow students to continue their studies if they are off-line; i.e. communications such as notices, updates, asynchronous and synchronous discussion are available online while digital subject matter materials should also be accessible offline. |
| 8 | Effective e-learning practice considers the ways in which end-users will engage with the learning opportunities provided to them. | Understand end-user behavior and consider it in the construction and execution of e-learning courses. |
| 9 | The overall aim of education, that is, the development of the learner in the context of a predetermined curriculum or set of learning objectives, does not change when e-learning is applied. | The curriculum should be the point of reference. |
| 10 | Only pedagogical advantages will provide a lasting rationale for implementing e-learning approaches. | Technologies and media can be successfully exploited provided that the educational need to which it is applied is identified first. |

## Learning Paradigms Within The E-Learning Perspective

Within the perspective of e-learning there are two major and interrelated paradigms. The first paradigm represents a continuing shift in the understanding of knowledge, towards seeing knowledge as a continually changing and evolving quality with emergent properties. In defining

knowledge, the emphasis is on time and the social and cultural contexts. The ability to carry out activities is dependent on how individuals experience the reality. The nature of a chosen activity or decision is dependent on the elements of the actor's personal knowledge storage and experiences and how they are interpreted in that specific situation. While the first paradigm concentrated on knowledge and its social and educational dimensions, the second paradigm emphasizes the individual learner by conceptualising learners as proactive and self-confident social actors (Rubin, 2002). The second paradigm relates to the concept of constructivism, which also is interconnected with lifelong learning, in which knowledge is viewed as temporary, developmental, and relying on social and cultural factors. Constructivism is a philosophy that encompasses knowledge, learning, and thinking.

The ideal of constructive learning and knowledge is achieved by enhancing learners' ability to work in cooperative groups of human activity, practice and discourse. This challenge creates the needs to increase pro-activity, belief in the human possibilities, and personal and social commitment in creating a future which best fulfils people's expectations. In this context, the constructivist paradigm evolves into a social theory of learning whose main components are meaning, practice, community, and identity (Wenger, 1998). While the first paradigm deals with knowledge and its dimensions and the second paradigm with the abilities of individual learners, e-learning provides forms and means through which education and learning are implemented. Therefore, e-learning can be viewed as an enabler for both learning paradigms depending on the way e-learning is approached (pedagogy), method by which the e-learning environment is developed (instructional design).

**Uniqeness of Learning in Design and Architectural Education**

Design stimulates and values learners' creativity. It encourages them to question existing knowledge, create new knowledge, take risks, manage failure and work in and through a range of materials and media. Learners express, share and communicate ideas, values, aspirations and feelings. Both practical problem solving through manipulating materials and enhancing creativity through developing lateral thinking skills help promote inventiveness. Design is central to developing knowledge and understanding of cultural heritage. The subject promotes trans-cultural

understanding, especially through the critical study of artifacts in different contexts. Through design, learners explore feelings and are guided by their intuition in a way that is not easily achieved elsewhere (QCA, 2005).

Design has unique teaching traditions and particular pedagogical needs. The utilization of e-learning for design should address the exploratory nature characteristic of this field. Therefore, e-learning for design should support the domain knowledge of the field and make it accessible through appropriate pedagogy. Currently, most of the strategies employed by online education in constructing the curricula and course content in e-learning environments are based on traditional approaches. Traditional e-learning approaches are generally conceived in the framework of the creation and authoring of "single course content modules". In such an approach each single course is a holistic structure that is constructed and organized independently according to the teacher's educational philosophy. Each course represents a "closed world" and is not linked directly with other courses. This approach supports the traditional expository style of learning. However, design teaching should be based on the ability of the learner to explore and find relevant knowledge according to learner needs or design ideas. This kind of exploratory learning is usually associated with the traditional design studio framework (De Grassi et al, 2000).

## Developments of E-Learning in Design and Architectural Education

### *Multi-User 3D Virtual Collaborative Learning Environments for Design and Architecture*

Existing online learning events lack the social dimension that characterizes learning in the real world. This social dimension extends beyond the traditional classroom into the university's common areas where learners build knowledge and understanding through serendipitous and collaborative exchanges both within and across traditional subject area boundaries. Multi-user 3D virtual learning environments provide the capacity to merge the institutional infrastructure for academic subjects with the educational principles of constructivist pedagogy. The educational aims of higher education form a constructivist pedagogy may be divided into the categories of: (a) Knowledge and skills acquisition, including competence with tools and techniques; (b) Socialisation,

particularly induction into the canons of particular communities, disciplines or professions; and (c) Development of intentional learning, a form of learning in which learning itself is the goal and the individual becomes a self-organised learner, capable of critical thinking, reflective practice and active open-ended inquiry. Of these three broad educational aims, current e-learning tools have managed to address only the first, most transactional goal, with any degree of success. The text-based discussion tools embedded in current commercial learning/course management systems help educators to build some sense of social cohesiveness into the online learning environment yet they fall short of providing the necessary scaffolding for active, evolving, and self-organised learning within communities of practice (Lombardi & McCahill, 2004). The multi-user 3D virtual collaborative learning environments provide immersive, learner centered educational environments that are based on the constructivist pedagogy.

The generation of 3D online MOOs (multi-user object orientated) environments has been made available for Internet-based distributed learning. These new interfaces have strong ties to their text-based cousins of the early 1990s but now provide highly collaborative, immersive environments that promote interactions among students and with the instructor. With the current emphasis on offering courses via web-based delivery systems, the importance of real-time face-to-face communications between course instructor and student and among the students is more apparent than ever. An online 3D virtual environment supporting text, audio, and overheads allows for immersive environments to be created so that the students and instructors can interact as if they were in a physical class (Jones et al, 2004).

Educators have often been attracted by the features of gaming software, which are highly collaborative, interactive, and intrinsically motivating. Virtual environments model based on game engines enable users not only to gather, discuss, and analyze information, but also to actively construct it. They can manipulate and annotate and even make 3D objects, and eventually will be able to attach behaviors to those objects. A Virtual Community on the Web (for instance, Activeworlds' Web site (www.activeworlds.com) alone has around 500 different VR worlds), can be accessed using a medium powered PC with an internet connection. A multi-user, shared, and collaborative virtual environment is a 3D computer

generated environment on the Internet where participants represented as avatars can meet each other, walk or fly around together and communicate using text, gesture, voice or preprogrammed emotions, e.g. happy, sad, etc. The multi-user 3D virtual collaborative learning environments have been extensively used in schools of design and architecture around the world for conducting virtual design studios, e-learning in design and architectural courses for both undergraduate and graduate students, design collaboration and communication, and carrying out online design juries. An example of a multi-user 3D virtual collaborative learning environment in design and architectural education at the University of Sydney is shown in Figure 1.

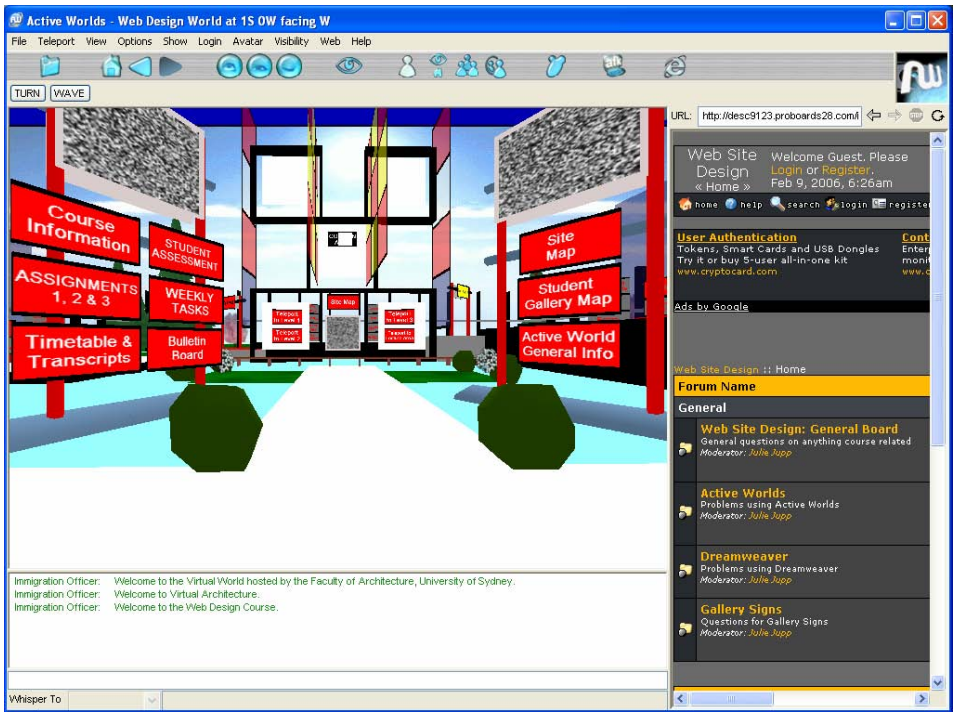


**Figure 1** The Interface of a multi-user 3D virtual collaborative learning environment in design and architectural education at the University of Sydney using Activeworlds platform.

***Adaptive Learning Environment for Design and Architectural Education: WINDS (Web-based INtelligent Design tutoring System)***

The WINDS project aims to contribute to the sustainable growth, environment conservation and quality of life of the European Community by promoting new forms of design education to produce better designers. New technologies are rapidly transforming the design process and at the same time are being changed by it. The WINDS builds a comprehensive virtual university for architectural and engineering design. It includes 28 partners from 10 European countries. WINDS provides a framework related to curricula design and the production, delivery, and evaluation of educational material in a virtual school for design. WINDS seeks to implement a unique electronic learning environment in the domain of architectural and engineering design, to create a rich ensemble of courses, and to develop within the course construction a domain knowledge-base that is oriented towards conceptual content. The interface of WINDS project is illustrated in Figure 2.

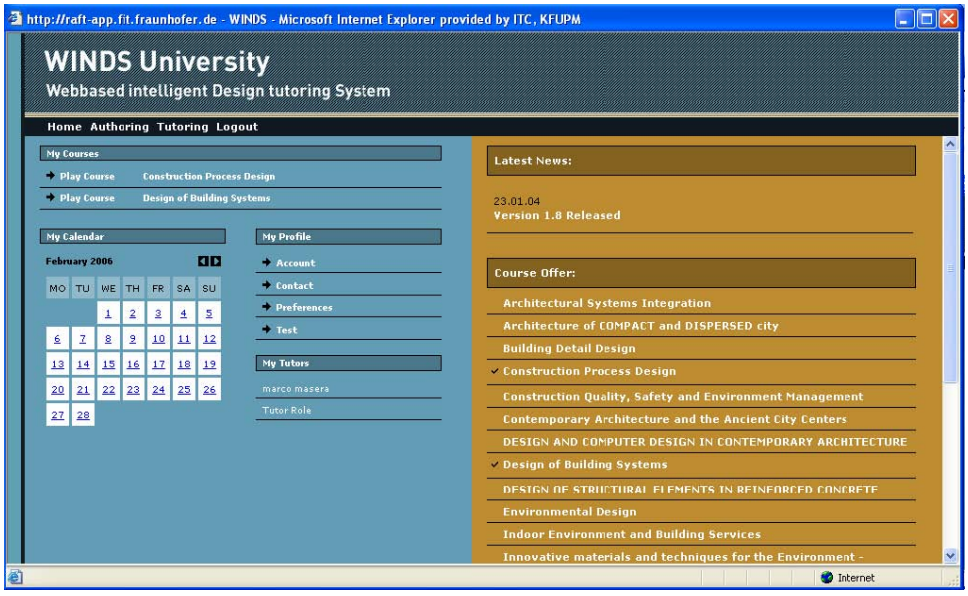


**Figure 2** The Interface of WINDS (Web-based Intelligent Design tutoring System).

The WINDS system is divided into two functional modules: Collaboration Spaces and Intelligent Design Tutoring System. WINDS provides a set of specialized collaboration spaces to implement the metaphor of Virtual School. Collaboration spaces are the foremost interface of the system and provide a collaborative environment where different users interact within these spaces: administrative office, teachers, students, library, courses and communication. WINDS envisages two types of courses: basic courses and advanced design courses. Basic courses are sets of Learning Units. They contain conventional teaching material and are arranged in hyper-books. Design Courses are made up of a design task and a sequence of course units. A design task, the general assignment of the course, is described by means of a design theme, a set of requisites and a context. Learning Units are the building blocks of the WINDS courses. They are sets of self-contained educational material aimed at the acquisition of a well-defined set of skills. Learning Units are designed to pursue well-defined pedagogical goals (i.e. acquisition of skills on design, diagnosis, discovery, control, pure knowledge transfer, etc.) Learning Units are activated when their set of preconditions is satisfied. Learning units are controlled according to two pedagogical strategies. They can be either expository or exploratory: (a) expository learning units are traditionally conceived as a quite fixed path among different learning objects, and (b) exploratory learning units are built of a set of strategies and support free exploration of the conceptual space they define (De Grassi et al, 2000). Within WINDS teachers can arrange assignments on the basis of the whole WINDS knowledge-base, within a wide range of possibilities such as strong multidisciplinary, collaborative design, multiple teacher reviews and peer tutoring. An example of a course structure and e-learning facilities within WINDS is shown in Figure 3.

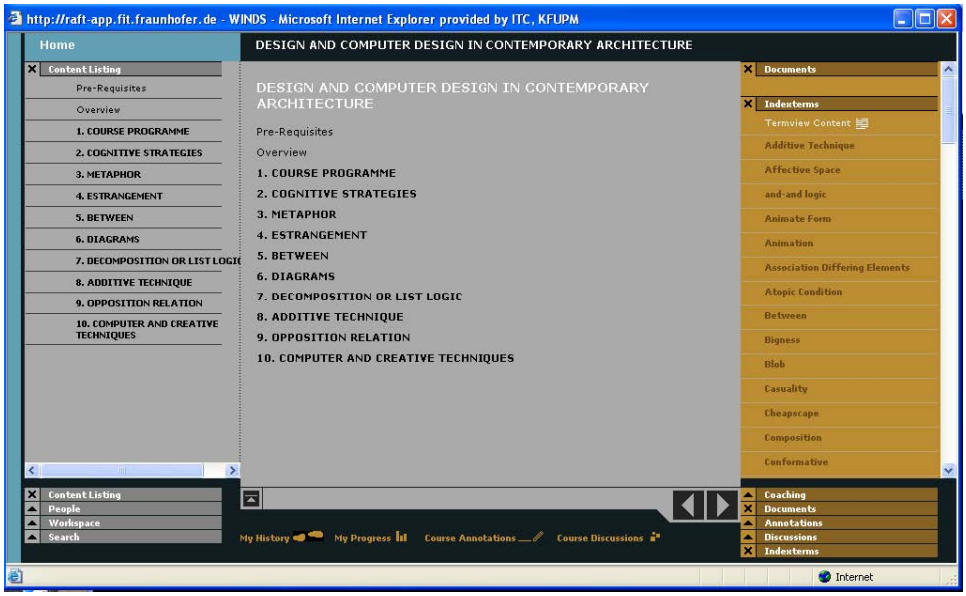


**Figure 3** An example of course structure and e-learning facilities provided within WINDS.

The focus in WINDS is on motivation while learning is a goal driven activity, where the goals are chosen to fit the interests and requirements of the learner. Learner's needs are in the central focus while going through structured learning material. Adopted strategies in WINDS include learning by exploring, learning by reflection, and case-based teaching. The course structure in WINDS allows the dynamic definition of special curricula according to students' profiles and training needs. A WINDS personalized learning profile can be built on demand arranging learning units. Figure 4 illustrates the capability of WINDS to accommodate various learning styles and utilize them to situate students' access and exposure to knowledge. In learning, students are involve in design activities, generate questions, issues, and new topics and learn from them through exploring whatever follows up questions and issues they have generated via exploration. WINDS provide students with support for free associative exploration of concepts, issues and solution examples, providing a measure for the relevance of conceptual associations and giving insights for building explanations. Figure 5 illustrates an example of WINDS capacity to support associate relationships of concepts, e.g.

digital architecture in a graphical presentation. In learning by reflection, students may not need to be told something but rather reflect on what they are doing. This process allows students to rationalize the design process and criticize it for better solutions. WINDS provide students with a tool called Design Pad aimed at fostering design process elicitation and reflection. The Design Pad is a smart design rationale capture tool which students can use to develop and document their designs at a conceptual level. Using Design Pad students enter the concepts they are considering and connect them to the documents and CAD models they are producing. The case-based teaching paradigm assumes that experts are repositories of cases and good teachers are good storytellers. Disjunctive knowledge might be difficult for students to integrate into their memories, hence useful knowledge is typically best presented in the form of design cases (De Grassi et al, 2000).

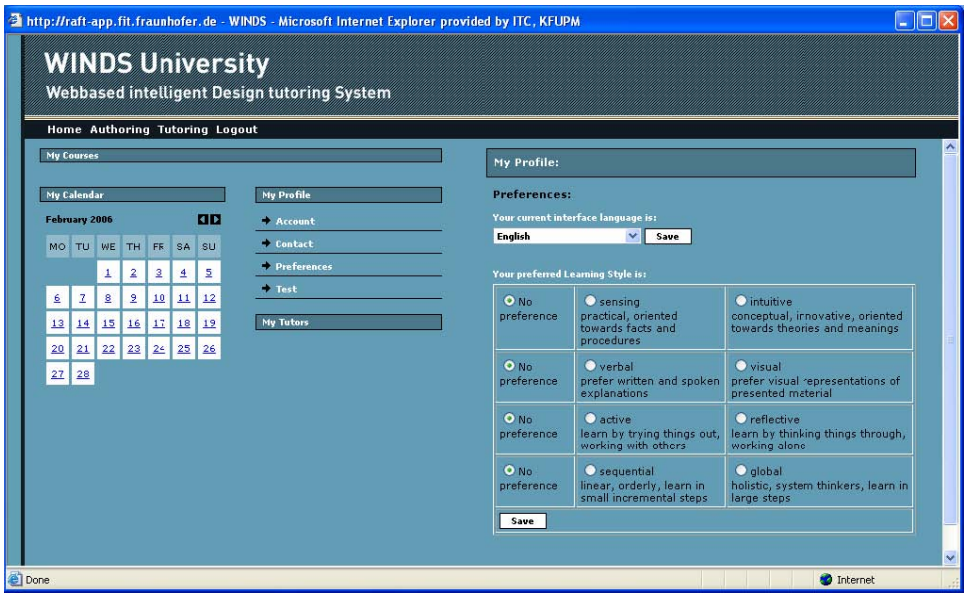


**Figure 4** Accommodating various students' learning styles in WINDS online learning.


**Figure 5** An example of WINDS capacity to support associate relationships of concepts, e.g. digital architecture, in a graphical presentation.

One of the main issues in development of advanced technology learning environments is a gap between pedagogues and technicians. WINDS project has attempted to overcome this gap. Kravcik et al (2004) presented promising qualitative and quantitative evaluation of WINDS as an authoring tool. Teachers of design and architecture specified their pedagogical requirements to be considered by software developers in the implementation of a quite unique adaptive learning environment. The WINDS authors have created 21 courses in the area of design and architecture. As the result authors without programming skills could create adaptive educational hypermedia courses. The performed evaluation has proved usability of the WINDS authoring system.

## Discussion

There are two main restraints with adopting e-learning in general and specifically in design and architectural education. First is in the lack of regular personal exhortations from the instructor; students must be responsible for meeting all deadlines, planning preliminary tasks required to reach the deadline, initiating courses of action and individually pursuing them to completion and, on a practical level, students must possess the skills to use the online system itself as well as associated software tools. This requires that students must either possess these attributes from prior study (secondary or postsecondary) or must be equipped with these skills before embarking on e-learning (Kearsley, 2001). Second, faculty members (instructors and teachers) are not adequately prepared for online teaching (Barker, 2002) which necessitates that new models of teaching and learning are needed if e-learning strategies are to be effectively deployed for an efficient transfer of skills and knowledge. Furthermore, a fundamental premise that forms the basis of online learning communities is that knowledge and understanding are promoted through dialogue, discussion and debate. This is in accordance with Engagement Theory (Kearsley & Schniedermann, 1998), which was constructed with computer-based learning as its focus, and which recognised that the learning experiences should be collaborative, project-based and have a real-world or authentic focus. Fortunately, the collaborative aspect is easily facilitated by email, discussion groups and bulletin boards which are used extensively by both on- and off-campus students. However, the skill set required to successfully manage such learning communities go well beyond those normally associated with being a traditional tertiary educator (Coldwell & Newlands, 2003).

On the other hand, latest developments of e-learning in design and architectural education such as multi-user 3D virtual collaborative learning environments and web-based intelligent design tutoring system (WINDS) has helped in improving the access and use of university teaching resources through the application of information technology and artificial intelligence. This involves both the creation of a remote e-learning environment and the implementation of a large amount of learning contents within a distributed learning environment on a real world university educational scenario. These developments present a shift from e-learning tools that are primarily data-base technology into artificial

intelligence for design education. For instance, WINDS Intelligent Design Tutoring (ITS) consists of a number of strategies that are intended to coach the student according to predefined expert scenarios. Strategies are defined so that they control a number of cognitive and pedagogical aspects like the minimisation of the changes between visual and conceptual reasoning, information overload, and learning path control.

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