InfoBase: a multimedia learning environment to support group work

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ABSTRACT: We are developing a multimedia learning environment to support group work and discourse. It aims to offer the student the means and tools to organize his or her learning activities in cooperation with others. The focus is on information and document management, presentation and publication, communication and discourse, and cooperation and group work. The design of this environment is considered in relationship to an educational process in which the student becomes familiar with the use of ICT for supporting communication and cooperation. We believe that such an environment plays a vital role in the application of e-learning to the design context, and that it will facilitate the initiation of networks or working groups that serve as virtual centers of knowledge and experimentation.

1 INTRODUCTION

A curriculum review at the Faculty of Architecture, Delft University of Technology, has provided us with the opportunity to reflect on the role of ICT (Information and Communication Technology) in the curriculum and to redesign the implementation of this role. Two main strengths of ICT have been singled out: as a design support and as a means to support cooperation among students. Each strength has been translated into an educational path that is embedded and integrated into the curriculum.

The first path is developed around the use of ICT to support the, mainly, individual design processes. In a first step, students learn simple modeling techniques, focusing on form, color, and visibility, and apply these to the composition and decomposition of a building with respect to basic notions such as load bearing structure, circulation, functionality, etc. In a second step, the knowledge of modeling techniques is extended with free-form surfaces and solids, material properties, daylight analysis, and the generation of simple spatial structures from repetitive elements. Towards the end of the path, the emphasis is on the advanced modeling of form in relationship to structure, using a variety of software tools and applications in combination and succession, on the expression of design as a machine, in relationship to free-form buildings, and on the use of computational intelligence in order to process increasing amounts of information, data, and knowledge.

The second path considers the use of ICT to support group work and discourse in relationship to the design process. Here too, a number of steps are considered in order to familiarize the students with the potential of web-based design communication and cooperation. In the first step, the emphasis is on presentation and publication to others in the form of a digital portfolio. In the second step, a cooperative database serves the management and presentation of design analysis information and construction component and material information on a collective basis. The third step considers the design and development of a communication process to link individual design activities within a common context or under a common theme.

In order to support the activities and steps within this second path, we are developing a multimedia learning environment that offers the students the means and tools to create and develop structures for information management, presentation, communication, and cooperation during the learning process. This should allow students, at their own initiative or under the guidance of an instructor, to organize their learning activities and to cooperate amongst themselves and with their instructors. Our aim is to initiate networks or working groups, within an integration of education and research, that serve as virtual centers of knowledge and experimentation on specific themes, in order to advance both education and research.

In this paper, we consider the general role e-learning can play in education, concentrate on specific aspects of e-learning in design education, detail the educational path towards ICT use for cooperation and group work, and describe the multimedia

learning environment under construction. Its implementation into the educational curriculum will be illustrated using cases from past, present, and future.

2 BACKGROUND

E-learning promises to play an important role in education. Large IT multinationals are currently leading the e-learning evolution; they are recognizing the need for life-long learning for their employees and are banking on the knowledge and information base that is built up within a company's workforce. They also consider it an important service to their customers, offering them training over the internet concerning their products and related knowledge domains. Online universities are also targeting the active professional as the most profitable profile in this new market. Many offer continuing professional education, possibly customized to corporations' specific workforce needs (Schelin 2001).

While e-learning is growing rapidly and is set to overtake traditional training within a few years (according to a study by IDC and Bouthry et al. (2000)), universities have important assets that can help them assure their place within the e-learning evolution. Universities are outstanding knowledge centers and as such particularly suited to become preferential knowledge partners for companies looking to extend their e-learning offerings content-wise (Van Petegem 2001). Maybe even more importantly, e-learning can only be successful if supported by appropriate pedagogic and didactic models (Govindasamy 2002, Van Petegem 2001). Universities offer excellent environments for researching and developing such models and experimenting with them in an educational setting.

Already, a growing number of online universities result from partnerships between e-learning vendors and academic institutions. "Academic institutions, the major producers of branded educational content, recognize the need to offer and distribute their programs online, but generally do not have the technical or financial capacity" (Urdan & Weggen 2000: 24). Though online education is growing rapidly, it remains a risky business, as a result of fast and continuous technological changes and the fact that few referential cases exist that may offer a lead for further developments and offerings. A comparative study of e-learning platforms conducted by French researchers in 1999-2000 identified a marked difference in products from year to year (Bouthry et al. 2000, Turbé-Suetens 2000). Of the nine platforms presented in 1999, most were no longer in existence in 2000, while others had been extensively updated and adapted to evolving technologies.

Nevertheless, it can be argued that without the adoption of some forms of e-learning, traditional universities will no longer be able to serve the same broad audiences they currently reach out to. Since long, and still now, universities and other institutions of higher education serve to a large extent as public centers of knowledge and research. Even as these institutions attempt to adapt themselves to evolving societal needs and expectations with respect to forms of education and learning, until now, they have shown relatively little flexibility in the way students access their educational programs. The web is by far the most effective technology to facilitate a more personalized approach to customers and clients. To some extent, it already fulfills on this promise through the integration of new technical solutions and educational techniques into the digital culture, enabling one to take one's personal, professional, and economical development better into one's own hands. If universities are intent on sustaining their role as public centers for knowledge and education within an increasingly networked environment, they will need to adopt some of the new ways of knowledge and information transfer made possible by the web.

E-learning efforts can serve universities both to improve their current educational programs and to reach out to alumni or other interested people for extra training or for an actualization of one's knowledge. Especially, in the context of lifelong learning, a university can hardly afford to target only students who are either fresh out of high school or are prepared to study quasi-fulltime within the physical walls of the university. E-learning also enables institutions to reduce the workload of their teaching staff, thereby enabling an improvement in the quality of education as a result of the extra available time. The Dutch Institute for Educational Services (IOWO) claims that currently only 5% of a lecturing hour is effective and that more time must be given to students for information search and retrieval, and analysis and processing tasks. By means of the web, students can prepare themselves independently for a task, such that the instructor can use his or her time more effectively by focusing more on the qualitative guidance of students rather than on transferring various information to them.

At the same time, more attention should be directed towards a critical analysis of current forms of education and learning, and on the continuous adaptation and renewal of the educational model to the most recent standards and expectations. In the Netherlands, an evolution in the approach to learning and education has led to a move in secondary schools to replace the traditional school model in the higher years by a study house approach. In this approach, students are led to work more independently in collecting information and processing this information into reports and papers. The use of computers and of new multimedia educational tools for information gathering and management is an essential part of the application of this study house model. As a result,

universities and other institutes of higher education are necessitated to adapt their own educational model to the new type of students entering their programs, in order to offer them a consistent educational path. The newest developments with respect to e-learning are for this purpose indispensable.

3 DESIGN EDUCATION

E-learning is not simply the result of offering course information and content on the internet. First and foremost, online courses can increase student-instructor communication and interaction, enable supplementary instruction, and provide means to track and report student progress (Schelin 2001). Additionally, e-learning can offer students the means to organize their own learning activities and processes, both individually and in a group. For this purpose, an e-learning environment should offer students, next to content, a variety of tools and instruments to facilitate information management and communication within the learning process. The initiative for adopting selected tools and techniques should come primarily from the student. At the same time, technology is all but the most important aspect in e-learning. Technology only serves to support the learning process. As such, e-learning cannot be considered solely on its own, but must be embedded in a review of the whole learning and educational experience. Particular care must be taken to consider e-learning in the context of design education.

One of the main advantages of e-learning is its ability to focus on both just-in-time learning, i.e., independently of time and place, at the moment there is a need for it, and on-demand instruction, that is, customized to the individual (Van der Biest 2001, Van Petegem 2001). Both fit well into design education. The design process is both information and knowledge intensive, concerning a wide variety of subjects, where the application of subjects, both in terms of content and time, is dependent on the specifics of the design and the design process. As such, just-in-time learning and on-demand instruction are particularly suited to support the design process in providing the individual student access to the necessary information and knowledge at the appropriate moment.

In adapting e-learning to design education, however, we must be careful to consider students not only as educational consumers, as in the traditional view, but also as valuable participants in the educational process. Especially in architecture, an established tradition exists of learning from one another through group presentations and critiques. At the same time, design and design analyses processes generate extensive bodies of information that may be of value to other students within, but also outside of, the respective studio or course. For example, students learn from design precedents and the analyses of existing designs. These may be provided by the instructor or the analyses may be performed by the students themselves as part of their design tasks. At the same time, the subjects of the analyses can be selected to support a specific design task or project, or collections of design precedents and analyses may serve a wide variety of design activities. The same applies to new designs and students' design products. Especially in the context of research by design, the organization and management of design information and results for subsequent reuse and analysis is very important. Comparably, large IT companies consider data mining and knowledge management systems as quintessential to support their business activities.

Information technologies can play an important role both in collecting students' design and analysis studies, and in presenting these studies as reference material to other students. In this way, students contribute to the information and knowledge that is present in the educational process and, as such, to each other's learning experience. Thus, students can position themselves both at the receiving end and at the contributing end of the educational economy. An e-learning environment is especially suited to integrate both the capturing and the presenting of such information in support of students' learning activities. For example, a digital environment for the presentation of design precedents may, at the same time, serve students to present their own design analyses, extending on the initial body of information (for example: Akin et al. 1997, Tunçer & Stouffs 2000). Electronic repositories play an important role in managing, indexing, and publicizing this information such that a larger audience, extending far beyond the confines of a specific course, may profit from this work. Most important is that such tools are easily accessible to students such that each student or group may choose its own instruments in facilitating its (electronic) communication and learning.

As with traditional learning, and teaching, communication is key to an effective learning process and the same efforts that are applied to achieving quality education in the physical environment must also be applied to the virtual classroom. As such, not a single technology or methodology can serve every e-learning situation. Instead, a variety of technologies and techniques, each adaptable to a variety of different situations, should be combined in order to create an interesting and stimulating learning environment that motivates students. Means of synchronous and asynchronous electronic communication enable the creation of new lines of communication between participants that may otherwise have little or no contact. For example, educational experiences at ETH Zurich show how students' social circles may expand through initial electronic communications (Engeli & Mueller 1999). Standard e-learning

tools offer little or no support for such processes, focusing rather on student-teacher relationships and on private group work.

4 ICT EDUCATION FOR GROUP WORK

In the context of a curriculum review at the Faculty of Architecture, Delft University of Technology, we are designing and developing an educational path in support of ICT use for cooperation and group work. Within this path, students learn to use ICT means for information management, presentation, communication, and cooperation in support of their educational activities. Three important steps define this path (Fig. 1).

1. The first step is the presentation and publication of design abstractions within a digital portfolio. While the design of a portfolio is an activity of the individual, the student learns to consider the viewpoints of others in the organization and presentation of design information. The construction of a digital portfolio forms an integral part of the student's learning activities in the first year of the B.Sc. program. The students are encouraged to maintain and update their digital portfolio throughout the remainder of their education. For this purpose, the digital portfolio is conceived as a public portion of a student's electronic workspace.

2. The second step is the management and presentation of design analysis information and construction component and material information in a cooperative database. Here, the emphasis is still on the organization and presentation of design or design analysis information, but on a collective instead of an individual basis. That is, students must consider their place and contribution in a larger process of information gathering and presentation. Students will not yet be expected to collectively design the organization of the database. Instead, they will be presented with an initial organizational structure that should assist them in presenting their own information as part of a larger collection of information. The construction of a cooperative database serves the design process in the second year (fourth semester) of the B.Sc. program.

3. The third step is the design and development of a communication and discourse process to support the interaction between different students' (individual) design activities within a common context or under a common theme. In the third year (fifth semester) of the B.Sc. program, the process of communication and information sharing supports the design and renovation of an urban site where the different buildings constitute the design subjects of different students or groups. In this case, the process is guided and shaped by the design in-
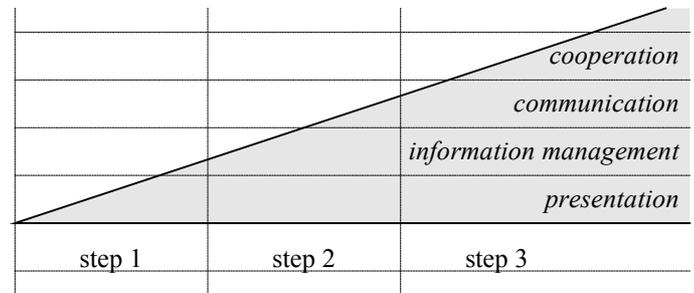

Figure 1. Diagram presenting the role of presentation, information management, communication and cooperation in the three steps of the ICT educational path.

structor. In the project phase (second year) of the M.Sc. program, the process of communication and discourse supports the relating of various design and research projects under a common research theme, in order to advance both education and research. Here, while the process is guided by the responsible instructors, it is shaped by the students' contributions, on both an individual and communal initiative.

Within the learning processes identified in these steps, two important activities can be distinguished. These are searching for information and storing information. Their embedding and interaction evolve in each step, leading to a strongly integrated process in the third step (Fig. 2).

1. In the first step these activities are entirely separate: searching for information supports the design process; this results in various design abstractions that are subsequently stored in a digital portfolio.

2. In the second step, a stronger dependence is created between these activities, even if these still take place distinguished in time. Consider the use of the cooperative database for the development of a library of precedent analyses. Students search this repository for information to serve the analyses of existing buildings. They add the results of these analyses into the same repository. Consecutively, they utilize the information that is collectively gathered in this repository to support their design process.

3. In the third step, both activities form the basic components of a communication and discourse process supported by a cooperative database. Students are expected to present their own project results and information in the environment, while extracting information from others that relate to their own activities from the environment. They can react to the presentation and information of others, either by relating various information entities within the environment or by commenting directly to an information entity presented. The result is a communication process that produces an integrated body of information and data with respect to the context or theme.

searching for information

storing information
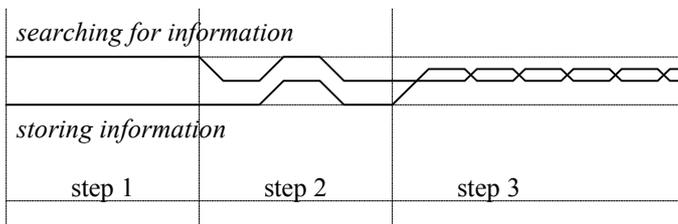
step 1   step 2   step 3

Figure 2. Diagram presenting the interaction between the two activities, searching for information and storing information, in the three steps of the ICT educational path.

The final aim in the development of this educational path is to support the formation of networks or working groups, within an integration of education and research, leading to the prospective establishment of virtual knowledge centers. While strengthening the scientific character of the education, integrating education and research in this way also enables the students' educational activities and the results thereof to contribute to the research. Constructing such virtual knowledge centers requires both an informational and a social, interactive basis. The development of a multimedia learning environment to support group work can assist with respect to both aspects.

5   DEVELOPMENT ACTIVITIES

We distinguish four main activities necessary in order to implement this educational path. These are:
1 the development of a multimedia learning environment to support group work and discourse,
2 the parallel development of learning processes and activities that use the functionalities of this environment,
3 the embedding of these processes and activities in the educational program, and
4 the evaluation of this embedding towards the future development of the educational process.

The development of a multimedia learning environment to support group work and discourse will allow the student to organize his or her learning activities and cooperate with other students and instructors. Such cooperation may be guided by the instructor or initiated by the students. This learning environment will be web-based, be strongly interactive and flexible, embed a diverse collection of tools, and include access to other electronic learning tools and environments. A diversity of tools should assist the student in constructing information structures and applying these to information management, presentation, communication, and cooperation during the learning process. Existing electronic information tools and environments such as repositories for course information and digital libraries will enrich the informational environment.

Within the larger context of various electronic tools and environments, we envision the learning environment under development to take on the role of a work and discourse environment for the student within which he or she can store, manage, and present collected and created information, individually or in cooperation with others. The work processes are hereby at least as important as the information results. Integrating these processes into the didactic approach central to the curriculum review will require both the adaptation of existing learning methods and processes as well as the development of new methods and processes. In the B.Sc. program, corresponding, primarily, to steps 1 and 2 of the educational path presented, the learning processes are clearly outlined and are strongly guided and, to a lesser extent, shaped by the responsible instructors. Here, an adaptation of the existing processes to the functionality of the learning environment may be sufficient. On the other hand, in the M.Sc. program, the development of the communication and discourse process goes hand in hand with the construction of virtual laboratories with respect to research themes. In these laboratories, the process is primarily shaped through the contributions of the individual students within the communal context of the laboratory.

In order to prepare for the development of these processes, we intend to develop and execute an educational experiment in the form of an elective course, the subject of which will be the design and execution of the form and content of an architectonic discourse. The aim of this discourse is to reach a broad exchange of ideas, information, and knowledge from various disciplines, using different media. The topic of the discourse will be based in actuality and relate to architecture, the built environment, the arts, and society. The emphasis in this course will be on communication using various media, possibly including text, images, 3D models, video, interactive interfaces, and computer games. The communication will obviously take place primarily through the learning environment.

The objectives of this elective course will be threefold:
– to promote the use of ICT and new media in the education by assigning these an important role in the communication among students and instructors,
– to bridge different disciplines as well as the various M.Sc. programs within the Faculty of Architecture through a common discourse, such that each participant contributes from his or her own viewpoint, while familiarizing oneself with the various viewpoints from other participants, and
– to embed this experiment within a broader societal context through the selection of the topic of discourse, the involvement of persons and organizations from outside of the university (including

artists and policy makers), and the publication of the discourse and its results (on the web and in an exhibition).

The results of this course will be analyzed and used to prepare the embedding of the environment in the project phase of the M.Sc. program.

Finally, the evaluation of the entire project should not only include an assessment of its success, but also an analysis that may shed light on possible future developments. We specifically consider the evolution towards virtual knowledge centers, the extended role of the (digital) portfolio within the curriculum, and the effects of collective authorship on the education and possibly in practice.

6   THE INFOBASE ENVIRONMENT

The InfoBase learning environment aims to support students to electronically manage and organize their communication and cooperation activities. The functionality of this environment primarily concerns:

1 the storage and management of working documents:
   – uploading documents and web links into web-accessible documents
   – a simple folder structure for the organization of documents
   – access rights for the specification of certain parts as public or private
   – management and control of document versions
   – thumbnails for images
2 a powerful and flexible organization of information and documents:
   – semantic maps as organizational structures
   – decomposition of images and texts
   – specification of relationships between documents
   – graphical overviews of (parts of) the information structure
3 the presentation, within the group and also to the public:
   – specification of presentation paths within the information structure
   – image maps linking various documents
   – multimedia web pages composed of existing documents
4 the integration of communication with document management:
   – message forums
   – commenting on and discussing existing documents

The environment should also possess the following characteristics:
– interactive and dynamic
– flexible, such that the student can adopt the environment independently of any instructor or course
– multimedia-oriented, including video, audio, images, text, etc.
– web-based
– inspiring, such that it incites and stimulates the user
– easy maintenance for instructors
– supporting group work and discourse
– simple interface, also visually
– extendable

The development of this environment will continue from the earlier development of an educational electronic document management system and profit from continuing research into such systems. We currently use this web-based system to manage all digital products, mostly images, submitted by the students in the context of various exercises and design studios. All products are submitted through a web interface and are immediately visible and accessible on the web. This allows the students to compare their own work with others', and possibly learn form one another. An assessment module allows the instructors to evaluate the products and assign a grade to each product and student. Extended functionality allows the active management of digital documents within a hierarchical folder structure. This has been used within a studio course emphasizing group work among various partners and disciplines in the building design process. Upon a first experiment two years ago, last year all groups were required each to adopt the web in order manage an electronic log of their redesign process of an existing building. The same extended functionality is also available on an individual basis to support a basic digital portfolio.

Research into electronic document management systems focuses on the use of semantic maps as organizational structures for positioning and searching documents, and on the specification of documents as compositions of document components or existing documents (Tunçer et al. 2001). Superimposing a semantic map on an organization using categories or keywords facilitates the mental conceptualization of this organization. Various visualizations of this semantic map may further enhance this ability (Fig. 3). An application currently under development enables an image to be decomposed into various components (Fig. 4) where each component can be individually positioned into the information structure while maintaining its link to the original image document. Another application allows for the specification of an image map, by adding hotlinks to an image, that can serve as a content map or index to a collection of related documents. The base image may constitute a plan of a building, markers can then be positioned on the image and related to the appropriate documents: section markers indicate where on a plan a section is taken, and in which direction; view markers define where a picture or an elevation is located in relation to the plan (Fig. 5). When moving the mouse pointer over a marker, a preview image of the related document appears. Clicking the marker brings up the respective document.
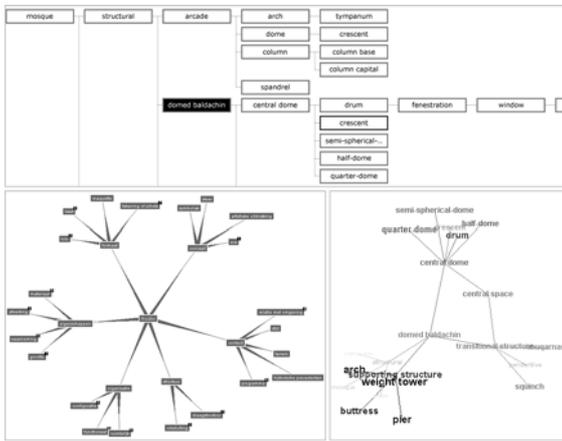
Figure 3. Snapshots from three different visualizations of a semantic map: top, 2D list view; left, 2D dynamic tree view; right, 3D dynamic network view.

Figure 4. An image decomposition: left, snapshot from the image decomposition tool with two rectangular areas marking two image components; right, an image decomposition hierarchy.
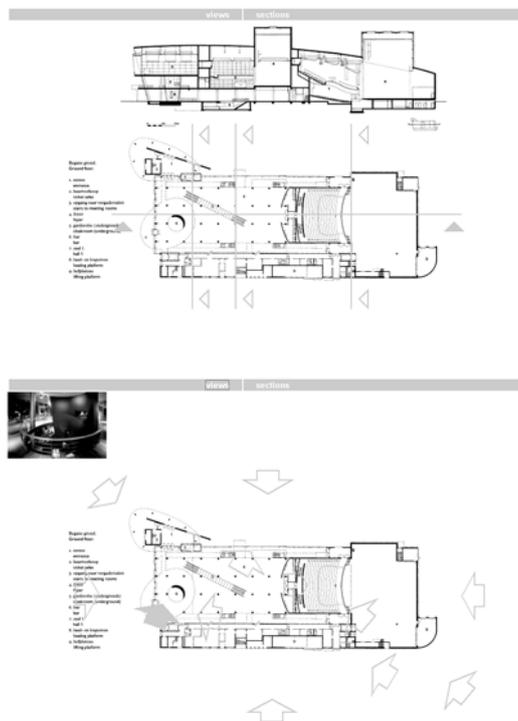

Figure 5. Generated web pages containing image maps that serve as a content map or index to a collection of related documents: left, image map with section markers; right, image map with view markers.

Currently, the InfoBase environment is built around a client-server architecture, using a MySQL database for persistent storage, the PHP scripting language for the implementation of all server-side functionalities, HTML and JavaScript for basic client-side interfacing, XML and related developments for advanced interfaces and visualizations, and Java for additional client-side applications (such as described above). We intend to redevelop the InfoBase environment following the specification of a detailed functional and technical design, and a market study of systems and components that could play a role in this redevelopment.

7 THE E-LEARNING CONTEXT

In order to accomplish the educational objectives described before, it is important that the InfoBase environment is linked and integrated with other electronic learning tools and environments that are available to the students within their education. In particular, we consider the need to seek links with various information resources, such as the university's electronic library, digital image archives developed within the Faculty of Architecture, and course descriptions and other information available within Blackboard®, the digital educational environment selected by the university as a central educational repository and learning environment.

Blackboard offers students a uniform web environment for accessing all educational material, independent of the faculty or program presenting this material. In relationship to InfoBase, it will serve as a portal, offering access to the InfoBase environment and providing the necessary authentication in order to identify the actors in this environment.

The Image Archive Architectural Intervention (iaai.bk.tudelft.nl) is an initiative within the Faculty of Architecture to link all its digital archives using an independent indexing and search engine. Rather than collecting and copying information from various archives and locations, it offers a single access point to decentralized information sources, even allowing any student to link his or her architectural project work into the archive. All links are checked on a regular basis in order to ensure reliability. Though students have free access to link information into the archive, a tight integration into other e-learning tools is important to ensure an extensive and up to date collection of information. Course-specific interfaces to the archive can assist students in searching and browsing project-specific information within the context of the entire archive. By integrating these interfaces into the InfoBase project environment, the archive's information may serve as an extension to the student's own project information, while the student's design results may be linked back automatically to the archive. The Image Ar-

chive Architectural Intervention is also being used as a source for case information to support the development of decision support systems (e.g.: Tisma 2001).

DelftSpecial (delftspecial.tudelft.nl) is a project of the university library to develop an ICT-based instructional program that, in a close integration with Blackboard, can be adopted by the student both independently and embedded in a course. In the instruction, the entire process of information gathering, storage, and presentation is analyzed. Practical exercises that are directly related to the specific course allow the student to run through the instruction in a step-by-step manner. In this way, students learn the required skills and gain insight into the importance of the information process for their academic development.

8 CONCLUSION

Technological advances enable practitioners and students to make the design process more information-intensive, both in their own activities and in collaboration with others. For this purpose, it is important that students familiarize themselves with such technology, including database access, archiving functionalities, portfolio presentations, and a variety of communication tools, and adopt it in ways that meet their needs and requirements. We envision this technology to become commonplace in educational environments, extending the current set of electronic information and communication tools available to students.

Therefore, we aim to develop a flexible environment that provides students with the tools and means to adapt and apply this technology throughout the curriculum, supported by course specific e-learning offerings. For this purpose, these tools should be designed and developed so as to stimulate the student to explore the respective field of study independently of the instructor and to cooperate with others in achieving solutions to a problem. As such, the objective of the environment is to support educational processes that motivate students to learn from one another and collaborate with each other.

Applications of this functionality are the submission and management of digital products in the context of digital lab sessions, information and document management in the context of a design studio with the purpose of creating a digital log corresponding to the design process, the creation of a digital portfolio by the students, and the presentation of architectural analyses in the context of an extensible digital library on historic precedents related to the theme of a design studio.

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