An Evaluation of an Online Collaborative Course

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Abstract

This paper aims to evaluate the utilization of online collaboration environments in design education in order to conduct an efficient and effective virtual design studio course. Evaluation is based on an international course with the involvement of undergraduate design students of Middle East Technical University (Turkey) and Delft University of Technology (the Netherlands). The course was conducted in 2003-2004 Fall Semester and its duration was twelve weeks. Apart from the last three weeks, nine weeks of the course were conducted with the participation of both Universities.
The well-established conventions of traditional design education; the concept generation phase of design process; peer learning in design studio and design juries are evaluated and compared with their application in Collaborative Virtual Design Environment, called InfoBase.

1 Introduction

In the recent years, the integration of information and communication technologies (ICT) to design education was enabled distant participants to attend to the same design studio courses, and with the utilization of ICT for distant design teaching, the well-established conventions of traditional industrial design education started to be transformed. The transformation from traditional tools to ICT created new opportunities as well as new problems in design education.
The complexity of design tasks and processes in contemporary design education and profession is the key motivation of collaborative virtual design environments (CVDEs). With the help of CVDEs, despite the fact that designers are geographically distributed, they are able to collaborate and interact seamlessly with each other as if they are in the same room. In addition, consultation to experts of other disciplines during design process can be achieved in a feasible way by utilizing information technologies.
In professional life, the pressure on the designer to design the whole life cycle of the product, from concept to end user testing, is increased with the arrival of new technologies in designing, presenting and testing phases. The designer is now asked to be able to cope with the technology as well as the design. Moreover, with the communication and collaboration technologies, designers are able to reach expertise on a specific subject within a matter of seconds. It is obvious that to satisfy the increasing requirements of design profession, design education has to conform to the new developments. The main motivation to initiate CVDEs is to provide the design student with the necessary tools, techniques and skills for professional life. Other motivations of CVDEs might be listed as follows:

- Providing a medium for collaboration with distant international partners. It is relatively easy to establish an international studio with CVDE. Students are able to interact in a foreign environment and gain different design perspectives.
- Exposing students to different cultures and schools of design. Many students enroll in exchange programs to learn about different cultures and enrich their educational experience. With CVDEs that is, to some extent, more cost effective and easy to establish (Dave & Danahy 2000, Laiserin 2002).
- Preparing design students for a demanding profession by teaching both computer aided design (CAD) and information and communication technologies (ICT) (Cheng, 2000).
- Improving students' design skills as well as collaboration skills (Cheng 2000, Laiserin 2002, Zimring, Khan, Craig, Haq & Guzdial 2001 and Dave & Danahy 2000).

A number of empirical studies (e.g. Dave & Danahy 2000, Vera, Kvan, West & Lai. 1998, Briggs 1996, Kvan, Yip & Vera 1999, Zimrig et.al 2001) have been carried out to test various aspects of collaborative virtual design environments in different settings, and the main problems have been identified by different authors. These are:

- **Accessibility of computer tools; hardware, software and network**; when course participants do not have or lack accessibility to these tools and technologies, the communication and collaboration among the participants might fail in many aspects (e.g building trust relations and division of tasks).
- **High degree of computer literacy required to design with computer media;** the solution of design problems generally requires the use of many software packages and hardware tools; as a result of which, students must obtain the ability to choose the right tools at the right time for the right job and the skills to transfer the information from one tool to another. Consequently, students have to be familiar with the software and hardware utilized in the studio in that they have to be able to use a wide variety of software packages and hardware tools.
- **Poor exploration of problem space and early refinement of design alternatives;** Various authors (Lawson & Loke 1997, Kvan, Vera & Yip 1999, Won 2001, Kalawsky 2000, Schweikardt & Gross 2000) stated that the main drawback of computer tools lies in their deficiency in supporting the ambiguous, uncertain and ill-defined nature of the concept generation stages of design process. The problems arise due to the fact that computers can produce an immediate and precise visual feedback and the designer might easily be influenced by the finished look of computer graphics to get fixed in some imaging in mind, which plays an inhibiting role when the designer uses computer to generate concepts (Won, 2001).
- **Peer learning and commenting on each other's works;** Working with peers is a problematic issue in CVDEs. Vaitkus (1991) drew attention to the fact that effective groups are not likely to be formed if "anonymity" is present. He acclaimed that trust relationships are essential to be built if groups are to be established and it is needed that group members know each other if they are to shape a group. Another problematic issue of peer learning in CVDE is commenting on each others' work. Latch & Zimring (2000) and Zimring *et al.* (2001) stated that, although students are encouraged to post comments on each other's work, no one appears to post a comment on the other student's project.
- **Evaluation of design projects (design juries) and assessment of student performance**; In a CVDE, feedback can be supplied either through design reviews or comments on the contributions. Considering the need for privacy, some participants may want some of the comments they have received, not to be seen by everyone and instead they may want them to be kept in secret (Engeli & Mueller, 1999). In a CVDE instructors can not keep track of students by having a look on their sketchbooks or file of works during the project. Students might be asked to keep a history of their digital files to track their progress but the computer software today is not likely to convey clear messages about the development stages of design to someone who's been outside the creative process in that digital medium (Bharat & Danahy, 2000).

2 Case Study

Virtual Design Studio (ID 319), which is the focus of the case study, was an elective course offered in the undergraduate curriculum of Department of Industrial Design (METU). The course aimed to carry out a design project in collaboration with geographically distant partners by utilizing synchronous and asynchronous communication channels and digital media. The course was scheduled as once a week for 3 hours and distant partners got familiar with each other by using IT tools.

In 2003-2004 Fall semester the course was carried out with Delft University of Technology (TUD). The exchange and broadcast of the contributions were achieved through a web-based virtual environment, called InfoBase (see Figures 1 and 2). Participants were able to log-in to the environment and they were allowed to browse, upload, download, comment and rate the contributions. Also they were able to see the history of a contribution, its parent and child, through a java applet.

2.1 Participants and the Course

Participants of the case study were the students who had enrolled in the ID 319 - Virtual Design Studio (METU) and BKMVK05 – Mediated Discourse (TUD). 11 students registered for ID 319, and 5 students enrolled to BKMVK05, the course started with 16 students in total from two universities. None of the students were native speakers of English and both universities were English-medium institutions.
Students were asked to design a game played by either 2 or 3 balls for children aged between 4 and 12. The balls had to move with gravity; and gravity should be considered as a design element while creating concepts. Another constraint was the volume of the game; according to the design brief; the dimensions couldn't exceed 20x20x25 cm. The design brief was announced in the first week of the course, and students were expected to create and upload their initial concept-drawings to InfoBase before the second week.
Due to the difference in the number of students in the Netherlands and Turkey, students in Turkey formed groups of two. In the first four weeks Turkish groups and Dutch students created concepts individually. After 4th week they formed international groups (one Dutch, two Turkish students in 4 groups and one Dutch, three Turkish students in one group) and collaborated on the refinement and presentation of the design idea they have selected from the previously developed concepts.
The first 4 weeks of the studio were reserved for concept generation, every group or student had to generate a new concept for the first week and upload it to the InfoBase. In the following week students or groups had to select a concept from the concepts submitted to InfoBase and generate a new concept from it. This iteration repeated for three times. After selecting concept intentions, groups worked for three weeks to refine the concept and the last 2 weeks were reserved for the preparation of presentations. The final presentation and jury was held in the 9th week. For the final presentations students were required to create a simulation of the game by utilizing Alias MAYA 5.0 dynamics feature, as well as renderings of the product and its packaging.

2.2 Physical Environment

Course participants from Turkey and the Netherlands met weekly via synchronous interaction using Video Conferencing. Participants in Turkey used conferencing facilities, where multi media PCs were also available. In the Netherlands, participants used separate rooms for video conferencing sessions and private in-group meetings via desktop video.

2.3 Virtual Environment: InfoBase

In ID-319 virtual design studio, "InfoBase" was used as the collaborative virtual design software. InfoBase has been developed by Delft University of Technology to provide necessary medium for students to share their design thoughts in the form of sketches, computer drawings, CAD files and digital animation. A java applet embedded into InfoBase enables students to link their contributions to another contribution or create a new thread. The graphical representation of the hierarchy of contributions reveals the history of a design idea or concept through parent-child relation (Akar, Oztoprak & Tuncer, 2003).
Students could use "Guides" and "Browse" pages to navigate through the environment. At "Guides" page (See Figure 1), the contributions and authors are listed in three rows according to various criteria. At this page, students could see the *latest*, *best rated*, *most commented* and *most accessed* contributions, as well as *all contributors*. After clicking on the thumbnail of a contribution or the "*browse*" button, the second page, "**Browse**" opens. At this page, students are able to locate the contribution in the process with the graphically represented history of the contributions in the java applet (See Figure 2).
The java applet automatically creates a tree structure according to the contributions' parent. Students were able to associate their contributions to thumbnails and keywords in order to track the threads and organize their contributions. With this tree structure students and instructors have the opportunity to track the design process of a concept from beginning to final stage.

2.4 Data Collection

Methods utilized during the case study were questionnaires, interviews, video recordings and personal observations of the researcher. Before the course, a questionnaire of 14 questions was given to the students to collect data on the accessibility of computer tools and network resources at their own environment. During the course, studio progress

and motivation were analyzed by the help of video recordings and personal observations. After the course, interviews were conducted with students and a questionnaire was delivered on satisfaction of students from the course. Open and close ended questions in the questionnaire and interviews as well as observations provided qualitative and quantitative data. The qualitative data was grouped under common responses and used to reach to conclusions about students' opinions about the course.

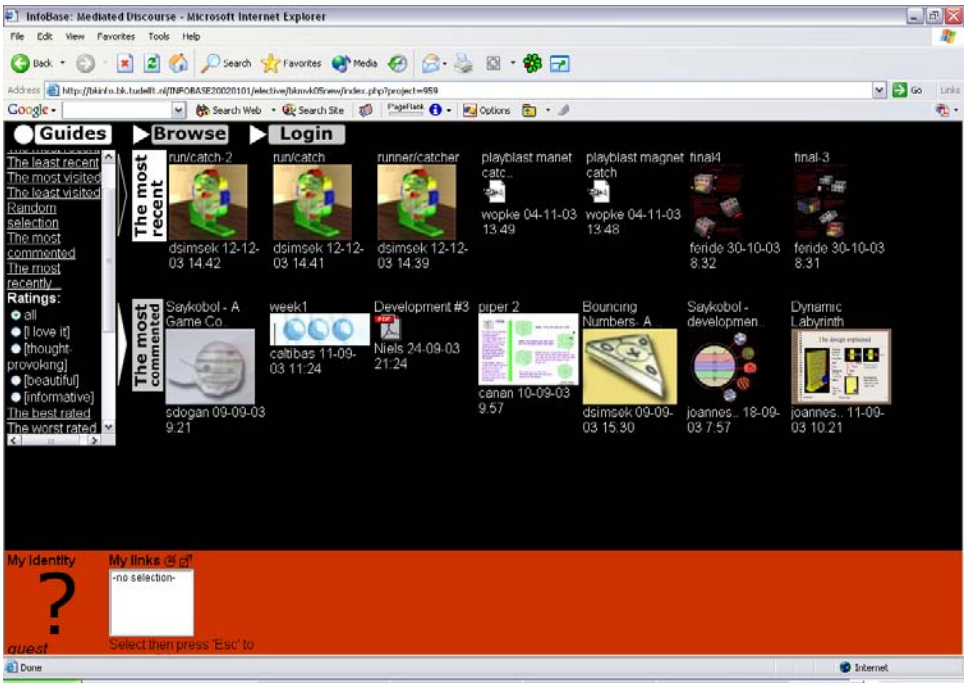

Figure 1 Guides view of InfoBase. Courtesy of Technical Design and Informatics Section, Faculty of Architecture, Delft University of Technology

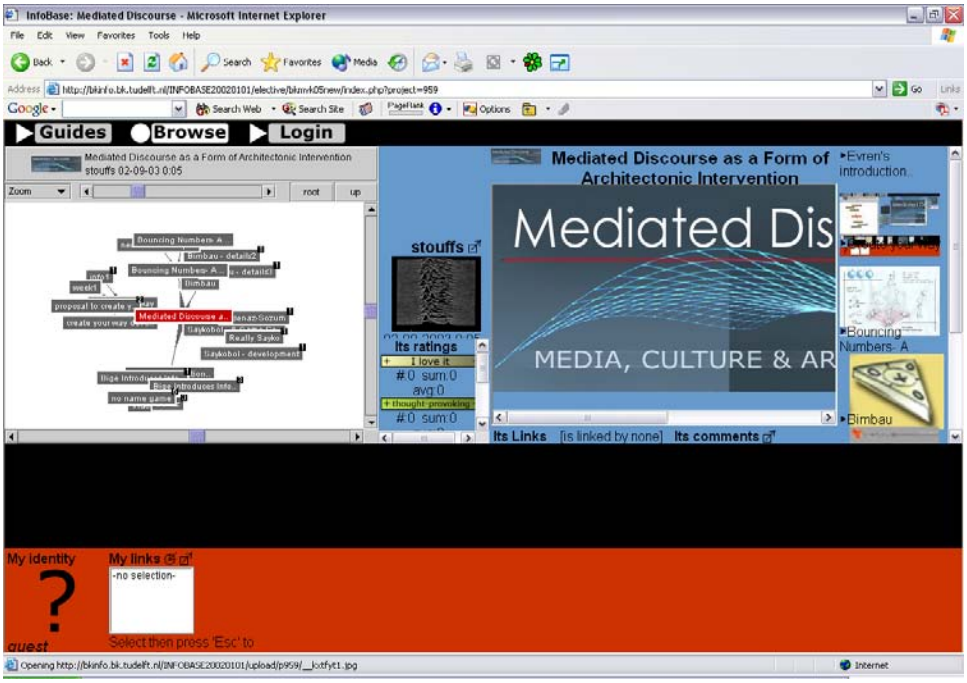

Figure 2 Browse view of InfoBase. Courtesy of Technical Design and Informatics Section, Faculty of Architecture, Delft University of Technology

3 Results & Discussion

Descriptive statistics were utilized to evaluate the raw data. The means and standard deviations of quantitative data were calculated and statistically significant results flagged for evaluation. After the evaluation of data, research results concerning the virtual design studio are presented under 2 main titles; (1) Utilization of Information Technologies in industrial design education and (2) Usability of collaborative virtual environment; InfoBase.

3.1 Utilization of Information Technologies in Industrial Design Education

It was observed that groups who had an accessible permanent network connection at home, collaborated efficiently, on the other hand; groups, who lacked the internet access experienced problems and never had a synchronous interaction; moreover their asynchronous interactions were at minimum level. 4 out of 5 groups collaborated on their design tasks by utilizing asynchronous and synchronous communication tools. They reported that they used e-mail to decide on a synchronous meeting time and to send smaller files. However, one group reported that they never met synchronously, other than the weekly meeting hours. They had problems due to the late responses from each other. Both the Turkish and the Dutch student complained about the lack of interest at the other side. The students in this group did not have access to a network connection at home and replied to each other with a delay and that might be the main reason behind the problems. Groups with permanent connection reported that they had synchronous meetings for 3 to 4 hours when they saw each other online and discussed their design tasks. As a result, it can be concluded that the availability of network connection is an essential factor to sustain collaboration, communication and trust.

According to students' responses to the pre-course questionnaire it was observed that students were familiar with office, image editing and 3D modeling applications. Moreover responses given to the post course questionnaire showed that students did not feel incompetent with the computer tools utilized in the course. They also reported that they feel more competent with the tools they learned in the course. Observations during the course showed that students equipped with necessary computer literacy and a proper background would not be frustrated with the utilization of sophisticated computer tools in collaborative virtual design environment.

Students were able to fix some software and hardware problems occurring during the studio. However, due to occasional serious technical problems, students couldn't upload their contributions to InfoBase and video conference sessions couldn't be conducted. These problems showed that technical support is an essential and necessary input for a CVDE.

The first 4 weeks of the course schedule was devoted to concept generation phase. Students created concepts and submitted them for further improvement by other participants. After 4 weeks there were 18 different concepts and 15 different variations of these concepts. The observations and responses given to the questionnaires' showed that the quantity of design concepts and solution alternatives did not change significantly in Collaborative Virtual Environment which is contrary to the literature. However, it was also observed that concepts submitted as photorealistic renderings and finished-look had not been selected by students for further development, which is in-line with the literature.

3.2 Perceived Satisfaction from InfoBase

In order to evaluate the perceived satisfaction from the course and the virtual collaborative environment, students were asked to reply a post-course questionnaire. The questionnaire consisted of 45 close ended questions and a five degree scale was used.

According to the responses, the shared environment was a motivating factor for students to upload contributions. They argued that publishing works on the network and presenting them to an international partner were motivating factors for themselves and they agreed that working with an international partner was an interesting experience. Also the responses to the related items showed that sharing knowledge on the website and seeing each others work was very useful in learning from friends. However, it was observed that due to social and practical reasons some of the works of the students were not uploaded to InfoBase.

Students pointed out that they did not feel the absence of face to face desk reviews with instructors and they agreed that they learned from their peers as well as their instructors during the course. The responses of students to the related questions showed that seeing each others' work was very useful for learning from friends, which was in accordance with the literature.

Because of some social reasons students did not use commenting and rating functions of InfoBase. The interaction was mainly achieved via third party synchronous instant messaging and desktop video sharing applications. Although nobody commented or rated others' work in shared environment, it is observed that students criticized each others work in private communications.
After having completed the course, students agreed that virtual design studio improved their CAD and computer mediated communication skills. They also said that the skills they improved in the course would be useful in their future academic and professional life, which was mentioned in the literature.
To assess students rating for the course they were asked to mark their overall rating from a five degree scale from unsuccessful (1) to successful (5). The means and standard deviations are as follows:

Table 1, Overall rating for the course

	N	Min	Max	Mean	Std Dev
Overall Rating	14	3	5	4,07	0,61

Responses given to the overall rating for the VDS course shows that, students both from Turkey and the Netherlands found the course successful.
The design process in the case study was pre-structured and the durations of the phases of design process were defined by instructors in the form of a schedule. The first 4 weeks were reserved for concept generation, in accordance with the given facts of literature about the problems arising due to the early refinement of design alternatives and poor exploration of design space. According to the observations and responses given to the questionnaires' related parts, the amount of sketching, design concepts and solution alternatives did not show a significant change in the virtual design studio, which is contrary to the literature. However, it was also observed that concepts submitted as photorealistic renderings with a finished-look, were not chosen by students for further development, which is in the same line with the literature.
During the concept refinement and detail-design phases computer tools were used extensively. Students agreed that computer tools were useful in design communication, detail-design and physical simulation of design ideas. They also agreed that using digital media was not a limiting factor for designing. That is also contrary to the literature.
The virtual design jury, which was a simulation of a traditional design jury, was frustrating in terms of many aspects, as put forward by the literature. The physical environment was dimmed out in order to see the projected images, consequently the quality of the images transferred via video conferencing equipment decreased significantly. In addition to the relatively low-resolution images compared to printed media, participants frustrated because of the disparity and echo in audio transfer.

4 Conclusion

The application of traditional design studio elements to VDS; concept generation with sketching, peer learning and a design jury were observed and evaluated during the case study, nevertheless, due to the limitations of the case study, desk reviews couldn't be observed.

The findings regarding the utilization of computer tools in the early phases of design process are very promising. Although the problems about the early fixation of design concepts, early refinement of alternatives and poor exploration of problem space identified in the literature, the findings of the case study showed that the number of concepts created was not less than a similar project in traditional design studio. Identifying the period for concept generation and imposing a minimum number of concepts helped the students to overcome the problems identified in the literature.

The role of intercultural communication in design collaboration was very positive. The shared database utilized in the web-environment enabled students to see each other's work. The responses from the students showed that this feature of the collaborative virtual design environment was a motivating factor and seeing others' work was very useful for learning from their peers. Also students were capable of dealing with the digital design process and sharing outcomes via web environment. Further studies should be carried out to maximize the efficiency of digital design and computer mediated collaborative work in design education. When compared to traditional design studios, CVDEs provide novel opportunities to teach communication and international team work efficiently and effectively.

References

Akar E.,Oztoprak A. Tunçer B. (2003) Evaluation of a Collaborative Virtual Learning Environment in *E-learning International 2003 conference proceedings*. Glasgow – Scotland.

Briggs J.C (1996) The Promise of Virtual Reality. *Futurist* vol. 30 issue 5 pp.13-19

Cheng N.Y.W. (2000) Web-based Teamwork in Design Education in SIGraDI 2000 *conference proceedings*. Rio de Jenairo – Brasil

Dave B. Danahy J. (2000) Virtual Study Abroad and Exchange Studio. *Automation in Construction* Vol 9 pp. 57-71

Engeli M., Mueller A., (1999) Digital Environments for learning and collaboration architecture, communication, creativity in proceedings of *ETH Zurich, Architecture & CAAD*. ETH Zurich, Switzerland.

Kalawsky R.S (2000) JTAP Project 305, Human Factors Aspects of Virtual Design Environments in Education: Project Report available online at http://www.jisc.ac.uk/uploaded_documents/jtap-048.pdf on 07 Aug 2004

Kvan T., Vera A, Yip W. H., (1999) Supporting Design Studio Learning: An Investigation into Design Communication in computer Supported Collaboration in proceedings of *CSCL'99*, Stanford University, Stanford - California.

Laiserin J. (2002) Collaborative shape Conceptualization in virtual design environments *Communications of the ACM* Vol 44 number 12 pp. 141-142

Latch D, Zimring D. (2000) Supporting collaborative design groups as design communities. *Design Studies* Vol 21 No 2 pp. 187-204

Lawson B., Loke S. M. (1997) Computers, Words and Pictures. *Design Studies* Vol 18 pp.171-183

Schweikardt E., Gross M.D, (2000) Digital Clay: Deriving Digital Models From Freehand Sketches. *Automation in Construction*. Vol 9 pp.107-115

Vaitkus S. (1991) How is society Possible? Kluwer Academic Publishing, the Netherlands

Vera, A. H., Kvan T, West R L, Lai S. (1998) Expertise, Collaboration and Bandwidth, Proceedings of *CHI'98*

Won P.H. (2001) The Comparison Between Visual Thinking Using Computer And Conventional Media in the Concept Generation Stages of Design. *Automation in Construction* 10 - pp.319-325

Zimring *C, Khan S, Craig D, Haq S, Guzdial M.* (2001) CoOL Studio: using simple tools to expand the discursive space of the design studio. *Automation in Construction* vol 10 pp.675-685