# Global Teamwork: A Study of Design Learning in Collaborative Virtual Environments

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A Study of Design Learning in Collaborative Virtual Environments

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## Abstract

With the recent developments in communication and information technologies, using Collaborative Virtual Environments (CVEs) in design activity has experienced a remarkable increase. In this paper we present a collaborative learning activity between the University of Sydney (USYD), and the Istanbul Technical University (ITU). This paper shares our teaching experience and discusses the principles of collaborative design learning in virtual environments. Followed by a study on students' perception on the courses and collaborative learning in both universities, this paper also suggests future refinements on the course structure and the main areas of collaborative design learning.

### Keywords

Collaborative Design; Collaborative Virtual Environments; Design Teaching And Learning

With the recent developments in communication and information technologies, using Collaborative Virtual Environments (CVEs) in design activity has experienced a remarkable increase. Collaboration in geographically distant locations using information technologies has become the new way in which architecture firms and other related parties practise and communicate (Gül & Maher, 2006; Maher, Bilda, & Gül, 2006). As a result, the design curricula have been changing to accommodate this new trend. In design education, web-based tools (Craig & Zimring, 2000; Tokman, Tong, Yamaçlı, & Çağdaş, 2006; Tong et al., 2006), virtual design studios (Çağdaş, Kavakli, Özsoy, Altaş, & Tong, 2000; Kvan, Schmitt, Maher, & Cheng, 2000; Maher, 1999) and 3D virtual worlds (Gu, Gül, & Maher, 2007; Gül, Gu, & Maher, 2007) have been widely used, especially in the form of online design studios. In this content, students have been sharing the collaborative learning environment which offers the shared understanding of a design situation, participation and shared knowledge. In addition, another key element of collaborative learning is the

consensus through cooperation by group members, in contrast to competition (Karakaya & Senyapılı, 2006).

In this paper, we present a collaborative learning activity between the University of Sydney (USYD), and the Istanbul Technical University (ITU). The intentions to set up the collaboration between the two Universities are to:

1. Encourage employing the emerging technologies in design learning, and
2. Understand and apply the principles of designing of collaborative virtual environments, which facilitates collaborative design, information sharing, communication, management and participation.

This paper is motivated by the challenge of new emerging educational paradigms of using CVEs into design education and explores its pedagogical implications on design learning. This paper shares our teaching experience and discusses the principles of collaborative design learning in virtual environments. Followed by a study on students' perception on the courses and collaborative learning in both Universities, this paper also points out some issues that need to be considered in design teaching in CVEs.

## Design teaching in collaborative environments

Collaborative Virtual Environments used for educational purposes are often called Learning Virtual Environments (LVEs) or Educational Virtual Environments (EVEs). CVEs clearly have the potentials to enable innovative and effective education, involving debate, simulation, role play, discussion groups, brainstorming, and project-based group work, etc. The emphasis can be placed on the human-to-human interactions as common understandings are negotiated and developed across differences of knowledge, skills and attitudes. The increased sense of social presence (in relation to that created by traditional design education tools) means that student absence or non-participation is less likely to go unnoticed. A number of experimental CVEs supporting collaborative/constructivist education in children are described in Kirner et al. (2001).

CVEs for education have been discussed in various disciplines. While advanced multi-user educational CVEs are still mostly speculation (e.g. Loeffler, 1993), simpler CVEs based on standard technologies have been in existence for some time such as (Eisenstadt, Brayshaw, Hasemar, & et Issroff, 1995; Hiltz, 1993; Scardamalia et al., 1992). Many CVE researchers stress the importance of collaboration and communication and experiment with currently available communication and information technology. Different applications of virtual environments for educational purposes are being researched by different institutions. For instance, CVEVM (Kirner et al. 2001) was developed as part of the Virtual Museum Project and focused on learning in a constructivist way. The philosophy behind is that in collaboratively creating the world users will learn about the different objects, which form the world. The DeskTOP CVE (Portugal, Guerrero, & Fuller, 2000) was developed to support and promote collaborative learning in universities. It aims at creating new possibilities for communication between users and increasing the awareness that users have of each other. The DigitalEE (Okada, Yamada, Tarumi, Yoshida, & Moriya, 2003) project aims at using a CVE in environmental

education. The system is meant to support discussions and information exchange between different users, create a space were knowledge can be recorded as well as make experiences of certain natural environments and processes possible through Virtual Reality, and add to the experience of real nature by making use of augmented reality.

In design education, web-based tools have been widely used (Craig & Zimring, 2000; Rummel, Spada, Hermann, Caspar, & Schornstein, 2005; Tokman et al., 2006; Tong et al., 2006) in particular in the form of online design studios. Broadfoot and Bennet (2003) define online design studio as a web-based studio, which is a `networked studio, distributed across space and time'; such that the participants of an online design studio maybe in different locations handling design communications via computer. Recently, virtual design studios (Çağdaş et al., 2000; Kvan, 2001; Maher, 1999; Schnabel, Kvan, Kruijff, & Donath, 2001) have been set up by architecture and design schools around the globe aiming to provide a shared "place" where distant design collaboration especially synchronised communications and design activities can take place. The forms of virtual design studios vary from the early approach of digital design data sharing to the more recent 3D virtual world approach where the designs as well as the designers and learners are simulated and represented in the virtual worlds allowing the so called "design and learning within the design". This new phenomenon has caught the attention of many design academics. Kvan (2001) argues that while design education has traditionally focused on the product, virtual design studios allow students to learn more about the design process. Dickey (2005) suggests 3D virtual environments can provide "experiential" and "situated" learning. Clark and Maher (2005) examine the role of place in 3D virtual learning environments that encourage "collaboration and constructivism". Wyeld et al. (2006) focus on the cultural aspect in virtual learning environments where students from different cultural backgrounds design and learn collaboratively. The effects of CVEs on the learning process, on the creativity and on the quality of the design solutions and design process are hot debates in academia.

## Global teamwork between the University of Sydney and the Istanbul Technical University

Within this framework, the collaboration attempt in two graduate courses was established between the University of Sydney (USYD) and the Istanbul Technical University (ITU) in 2007. In this collaboration study (Global Teamwork), a total of 52 students, geographically separated, collaborated on a joint-design project over several CVEs and designed 2D and 3D places.

Both universities currently administer design curricula that are reinforced by the emerging field of CVEs in design education. The structure of the Global Teamwork is shown in Fig 1. The USYD course DECO 2010 Collaborative Virtual Environments course had 33 design students, and the ITU course MIM 344 Information Technologies in Architecture course had 19 students who participated in this study. 52 Students formed into eleven groups which had three design students from the USYD and two or one architecture students from the ITU. In order to communicate over the CVEs, the students are provided several tutorial sessions which taught variety of communication

technologies. Then for the group projects, the students had given flexibility to choose a suitable medium for design collaboration. Students in the USYD are asked to develop a web-based management system (WBMS) which was the project 2, as shown in Figure 1. They were also asked to utilise this system for the project 3 with collaboration of the ITU students. The collaboration between the two universities took 5 weeks. Following the completion of the project 3, the students in the USYD analysed their group's collaboration process using protocol analysis method and submitted a reflective report. Moreover the students in ITU were given the questionnaires to reflect their opinion about the course. In this paper, we discussed some of the findings from the reflective reports, the questionnaires and our observations during the Global Teamwork.

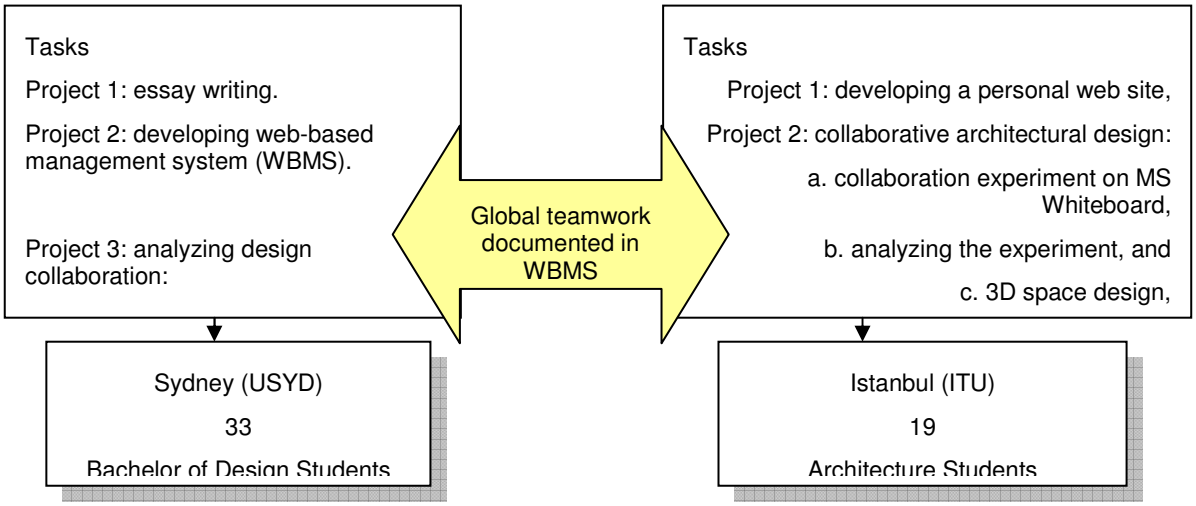


Fig 1. Formulation of design collaboration project between the USYD and ITU

## *The 'designing collaborative virtual environments' course*

"Collaborative virtual environments" was offered as a full-semester (13 weeks) unit in USYD. The weekly format includes a 1-hour lecture and a 2-hour design studio. This course attracted 33 undergraduate students from the discipline of design computing, to explore designing in and of CVEs and the cutting-edge technology.

**Course objectives and structure:** The objectives of this course were:

1. to introduce concepts and techniques for synchronous and asynchronous communication,
2. to develop an understanding of communication and representation of design models in a computer-mediated collaborative design project, and
3. to develop skills in using collaborative technologies.

The course content was structured so that the students could gain an understanding of the basic principles of designing CVEs, communication issues and the skills for the implementation of the CVEs. In order to develop the understanding of CVEs, firstly relevant literature, issues and problems in collaborative design and design examples were introduced and discussed

through lectures. Secondly, the students were instructed to use a wide variety of collaboration tools and applications, and they reported in an essay to reflect their learning outcomes. In order to gain adequate design knowledge and technical implementation skills, three design projects were scheduled as the major submissions for the course, as shown in Figure 1.

**Design projects:** With structured design supervision and technical tutorials, the three projects were assigned, as shown in Figure 1. The first project was an essay writing task which aims:

1. to develop an insight into the technical issues involved in constructing a mixed reality-based CVE for collaborative design,
2. to develop an understanding of the state-of-the-art of mixed reality and CVE, and
3. to think about the future potentials in the CVEs.

In this first project, the students as groups were given three choices of the essay's structure:

1. conceptual specification/design of a CVE based on mixed reality (augmented reality, augmented virtuality or both),
2. a literature review project on a topic mixed reality research, and
3. an evaluation/critiques of the effectiveness of using a particular existing mixed reality based CVE system or method in the area of design.

The second project included developing a web-based project management system (WBMS) which was utilised during the collaboration project with the ITU students (project 3, as shown in Figure 1). The WBMS included the collaboration tools (blog/forum, calendar, schedules, task allocations, meetings, document links, etc.), the member's personal web-space links and the documentation of the design and design process. The students in the USYD and ITU used this space for the collaboration for the project 3.

Third design project included designing two virtual places (a home page and a 3D place in Active Worlds) using 2D and 3D based CVE design tools (shared white-board and Active Worlds) with the collaboration of the ITU students in Istanbul. The final project provided opportunities for students:

1. to develop an understanding of the asynchronous and synchronous collaboration,
2. to develop an understanding of design collaboration processes and activities involved, and
3. to identify issues/problems in collaboration (conflict resolution, time management, task monitoring, project management etc.).

The project two and three also includes developing of the design-related skills (place design, web page design, and interaction design), digital design skills (modelling, image editing, scripting, and html) and generic design skills (decision-making and problem-solving). For assessment, the multi-criteria that cover different design and technical aspects were applied.

## *The 'information technologies in architecture' course*

The "information technologies in architecture" course was programmed as a full-semester (14 weeks) class for undergraduate architecture students in ITU, as illustrated in Figure 1. It aimed to introduce the students to the cutting-edge technologies on the Internet for architecture in relation to collaborative design environments and communication techniques. The format of the course included lectures and design studio. In the spring semester of 2007, 19 students from the ITU Department of Architecture were signed to take this course.

**Course objectives and structure:** The objectives of the course were:

1. to introduce students to the alternative design environments,
2. to present web page development concepts and techniques for effective communication,
3. to develop skills for managing a computer-mediated collaborative design project, and
4. to gain an understanding of the changes in the architectural practice through the use of information technologies.

The content of the course was structured around small tasks that allow the students to exercise on every topic that was discussed in the lectures. The students were first introduced to concepts and methods and then asked to complete an assignment in order to gain hands on experience about the subject. Since the students taking this class had no computational background. The exercises were particularly selected from those that require no programming and technical implementation skills. Students were expected to use their architectural design skills in computer mediated environments. In order to gain a better understanding collaborative design methods, the students were also asked to collect and present other examples of collaborative architectural design.

**Design projects:** In order to reach the course objectives, students were required to complete three different design projects through the semester, as shown in Figure 1. The first project focused on the basic Internet technologies. Then the students developed their own web sites for introducing themselves to their partners in the USYD. The aim of the first project was allowing students to explore various methods for publishing and communicating on the CVEs and to gain some familiarity with the CVEs. The students were expected to experiment on different web design and navigation schemes to best represent their content. This project was completed individually.

The second project was about discovering several modes of collaborative design. In this project students worked in groups of two. Their first task was designing a small housing unit for 15 students using only MSN Chat and Whiteboard. This task was completed in three hours. Then, the students submitted a report on how this remote design experience was different from conventional design methods and tools. After this task, students were asked to collect examples of virtual collaborative design examples and present them in the class comparing the utilized methods and procedures. This project was concluded by designing a 3D place in Active Worlds using both asynchronous and synchronous collaboration techniques. The students were expected to gain an understanding of the issues and activities involved in collaborative

design and identify the strategies to properly manage a collaborative design project.

The third design project is completed in collaboration with the USYD students. In this project, the students were asked to design a memorial article for representing the collaborative study between USYD and ITU. The designed projects were varied from a web site logo to urban furniture. This project aimed to carry the students' experience on collaborative design to a new level and allow them to test their collaborative skills with a partner coming from a different culture and using a second language.

The design projects were programmed in a way that students could compare different modes of collaborative design and the role of using CVEs in collaborative design. The first project required individual work while the second and third projects provided an opportunity to work on groups.

## Design principles for collaborative virtual environments

Over the past decade, there have been numerous tools investigated to support collaborative design activities. Even though the "shared spaces" for collaborative practice are different for these projects, they all have certain characteristics and design principles. Gross and Do (2007) have come up with the BE-FAT –Buoyancy, Efficacy, Fluency, Advocacy and Transparency principles which are important principles for designing collaborative tools including the CVEs. Below we briefly recapitulate these principles in light of the projects outlined above:

1. *Buoyancy* is the flexibility and ease of use,
2. *Efficacy* can be seen in the process of using the tools. Effects are produced by operations. A tool that supports easy operations would achieve its efficacy,
3. *Fluency* - Many of the sketching systems we describe exhibit the quality or state of flowing or being fluent by simply allowing people to draw what they want. Recognizing a familiar interaction pattern can also be considered as fluency in action,
4. *Advocacy* is the position about how a collaborative tool would facilitate people to perform intended actions;, and
5. *Transparency*- The tool is supposed to facilitate collaboration, and should not get in the way of creative practice of design.

Other related principles might include (Börner et al. 2003):

1. Design for interactivity,
2. Design for effective communication across cultures and age-groups,
3. Design using multiple visualizations from different sources,
4. Use evaluation tools to evaluate and optimize learning spaces built by both students and teachers
5. Apply constructivism, problem-based learning and multiple intelligences theory to the design process in multi-user 3D
6. Support multidisciplinary inquiry

7. Promote productive interactions
8. Make student learning the centrepiece of design activities
9. Focus discussions
10. Design for peer critique, and
11. Design collaborations among heterogeneous groups.

## *Student designs*

During the course, the students in the USYD submitted 11 group designs of CVEs in Active Worlds and 11 web-based management systems and home-page designs. The students worked on the projects synchronously and asynchronously during the course. Synchronous collaborative working means that all members of a team are working on the same product at the same time simultaneously to search for new innovative design solutions or routine design solutions (Scherer, 2004). Asynchronous collaborative working means that each team members can provide and contribute a part, which is necessary for solving the problems without direct and immediate communication in a formalised way by exchanging the ideas and suggestions (Scherer, 2004). Based on the two distinguished ways of distributed teamwork, we summarise the following observations:

**Asynchronous collaboration:** The teamwork between the students in the USYD and ITU occurred asynchronously most of the time. The main reason for this was the time difference, that is, Istanbul is seven hours behind Sydney. Thus the students utilised the computer-based communication tools such as email, offline MSN Messenger, blog and lifejournal to manage the collaborative design process. The students reported the importance of the task allocations and being aware of each others responsibilities during the project. To maintain and monitor the progress of the collaborative design, they were encouraged to use their groups' web-based management system (WBMS) in which each member can upload information and documents. The students also reported that the distributed team collaboration requires a structured design progress, monitoring tasks and thorough documentation of the development of the design product for keeping track of the process which were also offered by the WBMS. Figure 2b shows one of the WBMS layout design with the logo on top of the screen which is designed by the ITU students (Figure2a). The WBMS has the following features: navigation bar, collaboration tool (including applets for meetings, documents, calendar, transcriptions of previous meetings, file upload, download, etc.) and member links.


(a) (b)

Fig 2. (a) 3D object design as logo by ITU, and (b) WBMS layout design by USYD

**Synchronous collaboration***:* The students reported that they worked synchronously on designing a 3D place in Active Worlds most of the time. Most of the design concepts discussions took place in the tutorial sessions where the students were located in the design studio. Thus being in the same environment encouraged the students working on synchronously. They also reported that they had some face-to-face discussions at the early phase of designing in which they found more effective for having the brain-storming session. The students modelled the 3D places that represent different identity for each group and occupy different functions. Figure 3 illustrates a garden design in Active Worlds which has many features such as waterfall, flower pots and clouds etc.

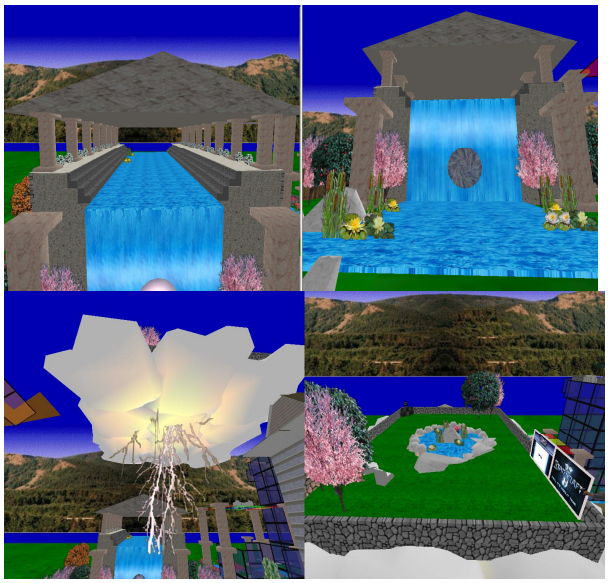

Fig 3. 3D place design in Active Worlds, students designed a garden

## Perceptions of students and observations

Following the completion of the project 3, the students in USYD submitted a report that includes two parts: the protocol analysis and the reflective report. The latter one is the focus of this paper. The reflective reports had four parts:

1. evaluating the effectiveness of the tools for communication and design (on a five-point Likert scale statements),
2. identifying likes and dislikes on the collaboration process (on open-ended questions),
3. evaluating the collaborative design and learning process (on a five-point Likert scale statements), and
4. providing background information of the students.

The sample size is reasonable, 30 out of a class of 33 students responded. We summarise the students' reports indicating their preferences and perceptions as follow:

1. 71% of the students thought as not effective/not very effective of the whiteboard as a tool to draw collaboratively with the group members, and 86% of the students thought as effective/very effective of the chat channel in net meeting/messenger as a tool to communicate and share ideas.
2. 40% of the students thought as effective/ very effective of Active Worlds as a tool to design collaboratively with the group members (32% nature),
3. Students were divided about how effective Active World was for communication. 41% of the students rated as effective/very effective of the chat channel in the Active Worlds as a tool to communicate and share ideas whilst %46 of the students rated not effective/not very effective.
4. 72% of the students were satisfied / very satisfied with their design decision and solution in homepage design task, and 68% of the students were satisfied / very satisfied with their design decision and solution in 3D place design task.
5. 60% of the students rated superb / efficient of asynchronous collaboration and 89% of the students rated superb / efficient of synchronous collaboration.
6. Some students found it difficult to work together because they were not able to meet face-to-face. %47 of the students agreed / strongly agreed with that statement, and %32 of the students disagreed /strongly disagreed.
7. %46 of the students found managing team activities difficult in remote designing.
8. %61 of the students agreed / strongly agreed that teamwork tasks encouraged collaborative learning.

Students also commented on the 2D and 3D place design, collaboration mode (synchronous and asynchronous). Some comments include:

> I believe (synchronous and asynchronous collaboration) they both have an important part to play in collaboration (...) it would be increasingly difficult to do any project without a mix. Synchronous collaboration allows fast and clear communication (…). Asynchronous

> allows flexibility above boundaries and solidification of ideas (…) It was a good way to communicate and organise events and dates in advance (…) sometimes took too long for people to respond (talking about asynchronous collaboration).
>
> I disliked the long delay of receiving feedback in emails. I did like the way that the blog allowed us to write our ideas formally and in great detail.
>
> The chat windows were the most effective for understanding across cultures and easiest to use.
>
> I liked making buildings and objects and talking to people in digital environment. I disliked the building inspector which blocked our construction and the fact that you could not manipulate other objects made by people (…) in Active World, The virtual world gave a feeling like you were communicating with people in person.

Similarly, in order to get feedback from the students and understand how they perceived the collaborative virtual design process, two evaluations were collected from the students at the ITU. The first evaluation is gathered as a report right after the students completed the collaborative experiment on MS Whiteboard. In this report, the students' compared the collaborative design activity with the individual design process practiced in the previous web site design task. The students responded to this experiment as an interesting experience. However the limited capabilities of Whiteboard as a design tool prevented them to express their ideas properly. The students enjoyed from collaboration and used the Whiteboard for brain storming of the conceptual development in the early phases of design.

The second evaluation of the ITU was gathered from the students as a questionnaire at the end of the class. In the questionnaire, the students were given 37 multiple-choice questions for assessing how much the course objectives were reached. In general students had a positive attitude for collaborative virtual design and found it productive. The resulting designs were creative and matured in a relatively short time. On the other hand, the students found Active Worlds environment very limited for architectural design and time consuming for finding the right building element or material. Half of the students said that they had a frustrating experience with Active Worlds. Technical problems such as, Internet connections, system errors and licence problems, as well as usability problems such as, ineffectiveness of mouse and keyboard, inability to develop conceptual schemas and diagrams, were the reasons of the frustration.

Based on our observations and the discussion with the students during the design studio, we summarise some of the benefits and limitations of the Global Teamwork. The students pointed out that the collaboration with the ITU students gave them the opportunity to learn about a different culture, and hand-on experience of using communication and design tools. They had to develop skills to manage the collaborative design process and develop a shared understanding of design. However, the students also said that leaving in different parts of the world and language became problematic in some situations where the USYD students used the slang and the abbreviation to express their feelings during the social conversations. Establishing a team

sharing the same goals and establishing the trust took more time. The big time difference was another limitation of the Global Teamwork which caused the delay in the response most of the time.

## Issues in teaching designing in and of collaborative virtual environments

As the most common pedagogical approach, problem-oriented learning and design-studio teaching are combined to provide a platform where students were exposed to and explored a variety of CVE design issues which included developing digital communication skills and learning about the cutting-edge design and communication tools such as 3D virtual worlds, tangible design systems, augmented reality and mix-reality. The students are also given chance to design collaboratively with a group of students in Istanbul. Based on the purpose of the subject, our teaching experience and the course outcomes, we highlighted the following issues that need to be considered when teaching designing the collaborative virtual environments.

### *Structure of the subject*

In terms of the subject's structure, the lectures in which students would be exposed to several communication and design issues should be used as the ground for integrating collaborative design knowledge. The structured discussion sessions would also contribute to the development of shared understanding of the designing in collaborative virtual worlds and enhance the critical thinking skills. Following the accretion of collaborative design knowledge, the development of various skills is essential. Therefore, a set of tutorials in which students would expand knowledge of and apply in using the tools should be formed. These technical tutorials should provide the basic knowledge about how to operate a particular piece of software. Finally, students should be given opportunities to apply the knowledge and skills that they have developed during the course, so different sets of collaboration scenarios should be given.

### *The nature of the collaborative design task*

The nature and complexity of collaboration tasks to be used as the triggers for learning in CVE design should be carefully considered. The design tasks should be complex enough to grasp students' attention and to be challenging, which requires employing cognitive skills. The collaboration tasks should offer opportunities for students:

1. to develop and apply design principles of CVEs,
2. to master the knowledge and techniques for CVEs implementation, and
3. to employ group collaboration skills.

### *Feedback–reflection mechanism*

A feedback–reflection mechanism is essential in all design-related subjects. This mechanism should be set in each phase to provide the constructive feedbacks for students' work. First one would be formal brief discussions where students would present their initial ideas and get feedbacks from the tutor and

the fellow students. During the project development, students would have a chance to have feedback from the tutor. Finally, students would have the final presentation to the lecturer, tutor and their fellow students and receive feedbacks from them, that is, to give them a chance to improve and refine their design project before the final submission. Students should be given time to reflect the final comments.

### *Required skills*

The collaborative design problem should require the development of a variety of skills that include:

1. communication using variety of communication and information tools (blog, forum, lifejournal, MSN messenger, shared-white board and virtual worlds),
2. digital design skills (web-site designing, modelling, imaging, scripting and programming), and
3. generic design skills (problem-solving, decision making, adaptability, shared situational awareness, performance monitoring and feedback, leadership/team management, interpersonal relations, co-ordination and communication).

### *Degree of the collaboration*

Teamwork and group discussions should lead to developing a participatory environment that is essential to increase a shared understanding of design. The groups would include students with different background and interest. Students should distribute the task according to the interests and skills and gain experience of working in a design team situation. As a group, students should have the same goal which is successfully achieving the given design problem. Based on this shared goal, the key aspect of collaborative learning is the consensus through cooperation by group members.

### *Management of the collaboration*

Management of design collaboration is required for the completion of the tasks. Students are encouraged to design and use a web-based management system which may be used for collaboration management purposes that includes: task management (allocation and monitoring), scheduling and documenting meetings, uploading and downloading design and communication documents, etc. with the use of this tool students would experience and gain the knowledge of the requirements of the collaboration and information sharing in a design situation. This also helps students with learning from their own design process and experience.

### *Using different media*

Designing CVEs would require using 2D-3D based media such as shared white-board applications and 3D modelling applications, etc. these media should be available and students might choose different media to suit their own needs. For examples, we observe that some students preferred to develop conceptual ideas on papers and some had the whole design and implementation process done in the digital media.

### *Learning from experience/ learning by doing*

Students are asked to analyse their collaborative design processes, reflect on their observations and issues raised during the collaboration projects. The analytical and critical views would help students to develop an understanding of the issues which might be raised in design collaboration. In the design studio context, students will be given opportunity of learning by doing and learning from the collaborative design experience.

## Concluding comments

This paper presents our experience in a collaboration project, Global Teamwork, developed by USYD and ITU as a new collaboration attempt between the Universities, and reflections and feedbacks from students on the courses and collaborative learning. Our observations show that the courses give students opportunities for collaboration and communication in remote locations and new experiences of design collaboration with a peer in a geographically distant locations as well as collaboration with their class mates. Thus students experience asynchronous and synchronous collaboration and learn from their own collaboration processes. This initiative will prepare the new generation of architecture and design students to develop an understanding of using CVEs as the new kind of design and communication environments. As for the potential of future integration of this subject with the current teaching curriculum, we believe that design schools should employ emerging technologies into design curricula to create places for experience, communication and design learning.

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