

# Building Interactive Teaching and Learning Environment For High Education in 3D Virtual Worlds

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**Abstract:** How to make the learning process interesting and engaging gets more and more concerns from the educators and researchers. In conventional software engineering courses, students are required to develop a window or console application, and the communications among the teachers and students are limited to the classrooms. Nowadays, games, web applications and virtual world applications become more popular due to their rich contents and “openness” for communication. They have been introduced into the teaching and learning in the recent years. We propose to build interactive teaching and learning environment for high education in 3D virtual worlds, to teach software engineering courses. It promotes the students’ software engineering skills with increased complexities and commercial product requirements. Moreover, the 3D virtual environments become an open platform that teachers and students communicate and share with each other anytime and anywhere. Through our observations in three semesters’ course projects, the students enjoy the software engineering learning and master the software engineering techniques more efficient.

## Introduction

Educators and researchers keep on trying to find the ways to make the teaching and learning process enjoyable. Old technology and methodology, like classroom teaching, limits the evolution of teaching. Nowadays, new media and technology are created and widespread, for example, wiki, facebook, game, virtual worlds. They bring the new ways of communication and collaboration, which provides an opportunity to promote the teaching and learning process.

Software engineering course is a core subject for computer engineering students to build software development skills. Conventionally, students are required to develop a window or console application in their lab work. The application often follows a same pattern without many variations. Different groups of students solve nearly the same application, which reduces their interests at learning and prevents the students from the unknown software development problems. Moreover, in traditional teaching and learning, the communications are limited to the classrooms; thus, the teachers are not able to interact with the students in real-time, at requirements analysis stage, at design stage, at implementation stage, at testing stage and so on.

In this paper, we would like to present the interactive teaching and learning methodology to teach the software engineering courses, so that the teaching and learning are not separate, but interactively integrated, through the wiki, facebook and 3D virtual world. Students learn the software engineering techniques at developing the social network applications, which integrates the 2D web programming and 3D virtual world application. Moreover, they can benefit at collaboration and cooperation from the social network. Activeworlds and Second life are used as the platforms to develop the 3D virtual worlds. MeidaWiki is used for students to document the software engineering process. Facebook is used by the students and teachers to communicate with each other. The course has been conducted for three semesters, and according to the students’ feedbacks, they enjoy the software engineering learning and are able to master the software engineering skills fast and efficient.

The paper is organized as follows. Section 2 shows the related works on promoting the teaching and learning experience. Section 3 illustrates our approach to build the interactive teaching and learning environment for high education in the virtual environment, and how it helps students learn software engineering techniques and promotes the communications and collaborations between teachers and students. The learning methodologies adopted in our

approach are explained in Section 4. Some sample projects developed by students are demoed in Section 5 and their feedbacks are shown in Section 6. Lastly we draw our conclusions and future works.

## Related Works

How to present the learning content in an interesting way is a big challenge to improve the teaching and learning. How to make the communication channel efficient and effective is another major challenge. Nowadays, there has been a lot of research works to foster the learning interests of students. New web technology and virtual world technology grows up prosperously, it makes communications and information sharing much easier. Web 2.0 becomes one hot area to be used as the teaching tool, which enables students to be actively involved in the web communication (Alexander, 2006), e.g. Wiki (Parker & Chao, 2007), Facebook (Ellison *et. al*, 2007). Virtual world or cyber world provides a new presence than the real world, which leads to a new perspective to teaching and learning. Games (Claypool & Claypool, 2005) and virtual environments (Ketelhut, 2007) are used in the teaching to promote the students' interests, and have shown some promising results.

The teaching and learning methodologies are also studied a lot to make the learning more efficient in recent years, e.g. learning by teaching, learning by doing etc. Among them, interactive teaching and learning allows the teaching process and learning process to be integrated rather than separated, which involves the students from passive knowledge receiver to active participants. It is studied that can be helpful to improve the learning process (Bos & Anders, 1992).

## Approach

Interactive teaching and learning is concerned more and more in recent years, as it combines the two processes together to increase the learning efficiency. How can it be adopted in the software engineering education? In our proposed approach, the students develop the social network applications in the 3D virtual worlds, through which they collaborate with each other and communicate with teachers effectively. Web 2.0 is a revolution of the web technology, and it has been used as teaching tools from many educators. By combining the powerful capabilities of web 2.0 into the 3D virtual world development, the learning of the students are expected to be more efficient.

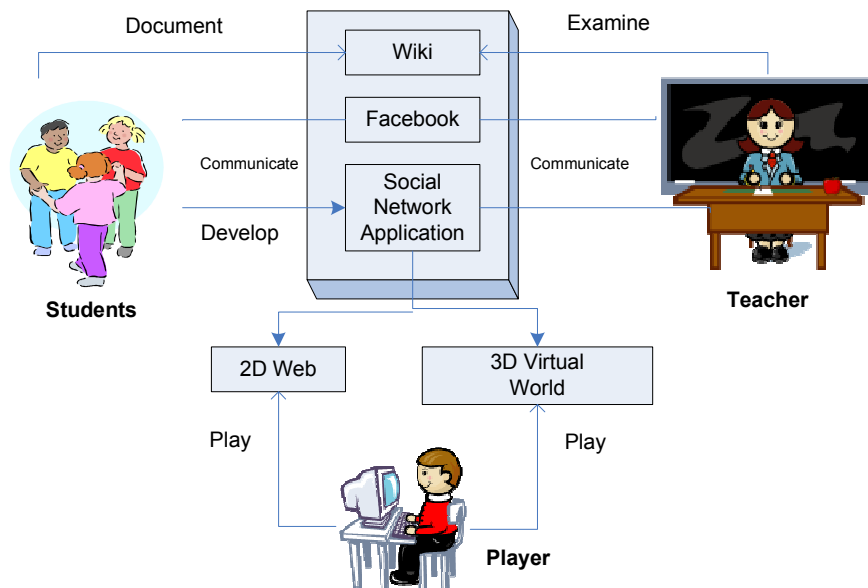


Figure 1 Interactive Teaching and Learning Process

Figure 1 shows our interactive teaching and learning process. The students, teacher and the player can collaborate together in the 3D virtual world in real-time.

## **Wiki**

Wiki is a Web 2.0 application that encourages the collaborative work. It turns the web users to active participants. It has been proven that it is useful at web cooperation and collaboration (Parker & Chao, 2007). In our course, it is used by students as a tool to document the whole software engineering cycle, from the requirement analysis to the final testing. As a collaborative place, the teachers and students can write down their comments interactively.

## **Facebook**

Facebook is one of the most popular social networking systems in the world. Numerous users record, share and comment their experience on this network. It is helpful for the team members to organize the activities of software development.

## **Learning Methodologies**

In our approach, the following learning methodologies are used to promote the teaching and learning.

### **Learning by Doing**

The students learn the software engineering skills by building an interactive teaching and learning environment in the 3D virtual world. The students are encouraged to build the world in order to compete with other teams in the terms of creativity, interestingness and immersion.

### **Learning by Sharing**

The students learn the skills in a deeper manner when they can learn together with sharing. In our proposed work, the students are able to learn the skills at sharing and communicating with other team members and teachers in real time. The sharing in the traditional teaching and learning is limited to place and time. However, the 3D virtual environment as well as web 2.0 applications (wiki, facebook) breaks such a barrier, so that the sharing can be achieved anytime and anywhere. This prolongs the sharing time and enables fast sharing and broad sharing, e.g. panel discussion.

### **Learning by Competition**

Competition is another great force to enhance the learning of students besides the motivation. The students are separated to teams, with 5 to 6 students in a team. Each team creates a 3D virtual world with useful applications. The final 3D worlds will demo to 3 reviewers, and the reviewers mark each team based on the impressiveness of the virtual world, intelligent characters and gameplay experience. The top 3 teams will be rewarded.

As an iterative developing process of software engineering, the teams will try to observe the good points of other teams, learn from them, and make better ideas into their own product developments.

### **Learning by Immersed into the Virtual Environment**

The students build the virtual environment with their own expectations and experiences in real life, e.g. virtual campus, virtual park. Studies of Chris Dede shows that, the immersive virtual environment can enhance the education in three ways: by allowing multiple perspectives, situated learning and knowledge transfer (Dede 2009). The social network application development in the virtual worlds enables the students to have

- Multiple perspectives: the students learn the software engineering skills through virtual world building, non-player characters creating, network functionalities developing, etc.
- Situated learning: the students are immersed into the virtual world that they have created. Through the real-time play in the virtual worlds, they learn the flaws in their developments and improve them.
- Knowledge transfer: the students transfer their knowledge in real-life into virtual world implementation, and an interesting 3D social network application at last.

Moreover, we found that the virtual worlds stimulate the student to produce the creative ideas, which cannot be achieved in the real world. The students create some new functions that are unavailable in the real world, e.g. teleporting to a friend, entering into the plant, wandering on the moon, etc.

## Sample Projects by Students

In this section, we would like to demonstrate two projects done by the students.

### Virtual Park + Facebook

The first team's product is a virtual park created on Activeworlds, in which the Facebook applications are embedded for communications. As a result, the player can invite their friends in the Facebook community to play together in the 3D virtual park.

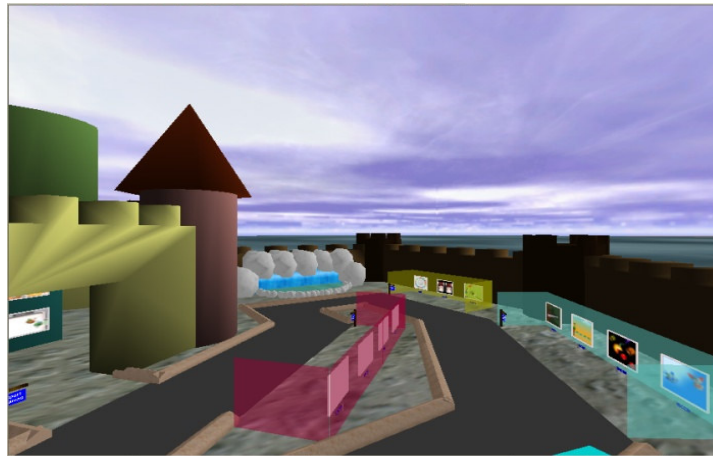


Figure 2: 3D Virtual Park Linking to Facebook Applications

As shown in Figure 2, a theme park is built in the virtual world. Some facebook games are linked on the boards in the park. When a player enters into the park, he/she can play the web games on the walls and play the 3D games, e.g. puzzle, 3D chess and so on.

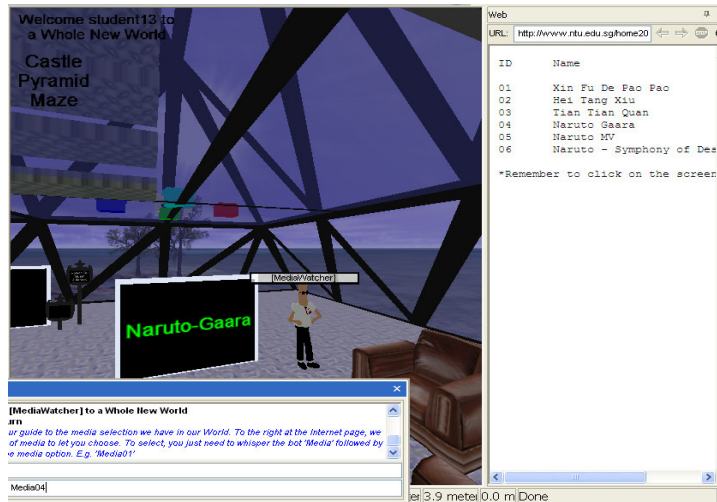


Figure 3: Media Avatar in the Virtual Park Plays Songs for Players

Figure 3 shows a non-player character inhabited in the park which is created by the team. It is a media avatar to play the songs according to player's requirements. By chatting with the avatar, it can help to play the song in real-time.

Starting from the scratch, the students need to figure out all the facilities that their park can provide to the players. This will encourage them to study the software engineering skills well to create the satisfied product.

### Virtual Campus

The second product is a virtual campus of Nanyang Technological University (NTU) based on Second Life, which emerges lots of web-based e-services of school into the virtual world to facilitate the students. This is a joint project by 4 teams of students.



Figure 4: Virtual Campus Overview of NTU in Second Life

Figure 4 shows the basic layout of the virtual campus which consists of four major attractions: Virtual Library, Virtual Classroom, Virtual Project & Meeting Room and SCE Info Center. A visitor center has been built to greet the visitors and lead them to all four attractions.

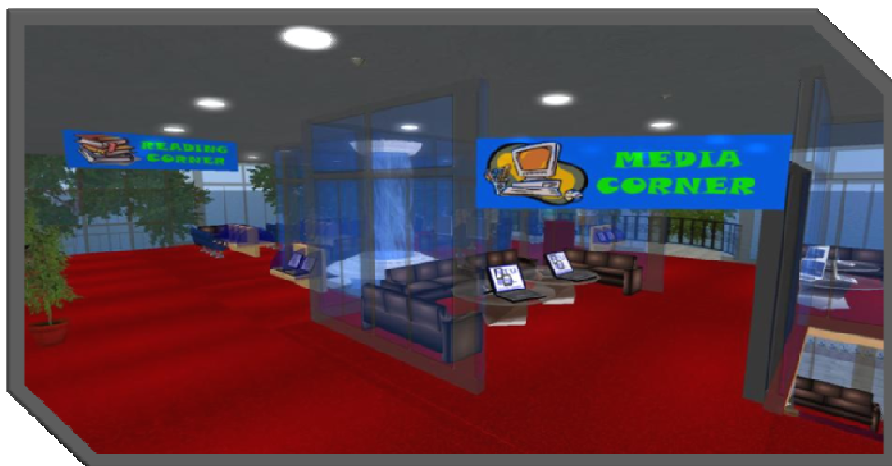


Figure 5: Virtual Library

Figure 5 shows the interior of the virtual library. The players can access the ebooks and media resources of NTU library through interacting with the 3D books and computers in the scene.

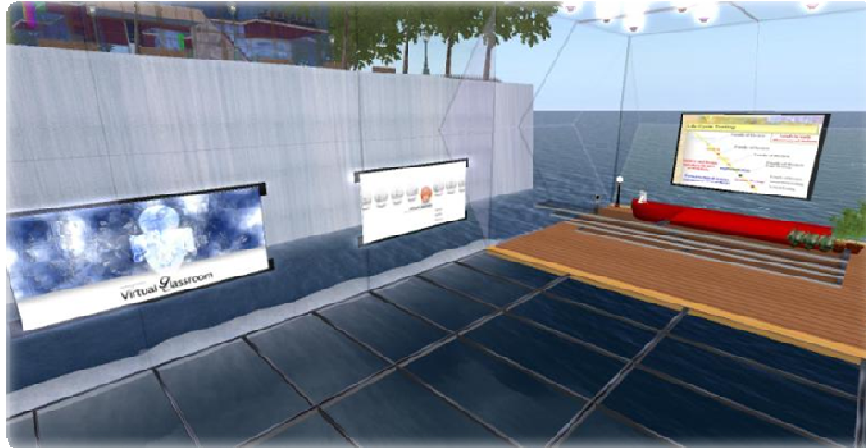


Figure 6: Interior of Lecture Theater with 3D Slides Show

Figure 6 shows the interior of the virtual lecture theater. The players are able to watch the pre-recorded videos of software engineering courses together. Different with viewing from the webs, the perspective view can make the students feel more immersive, especially when a group of players are watching the video together. Moreover, the students and teachers can discuss with each other in a virtual face-to-face manner, which will help students to understand the course much clearer.



Figure 7: AI Avatar Talking to the Player about School Events Shown on the Web

Figure 7 presents an intelligent avatar created in Second Life, which can communicate with player and share the information that the player might be interested.

## Preliminary Results

The course (Software Engineering II) is a third year core subject of school of computer engineering, NTU. The students have had the fundamental software engineering course before it, through which students develop some window/console application using the software engineering techniques. The course was taught for three semesters with the new methodology and the 3D virtual world building, with around 60 students every semester.

Here are some feedbacks from the students:

- “Virtual Worlds are ideal places to mix pleasure with learning.”
- “It is an ideal setting for quality learning.”
- “We wish to create this project to demonstrate the power of virtual worlds and artificial intelligence in imparting education to students.”
- ...

According to our observations, the learning methodologies are applied well in the whole developments. We have got the following achievements:

- Students are encouraged to be creative.
- Students involve the most new techniques and ideas into their developments.
- The productivity of software development is increased.

## Conclusions

In this paper, we presented our work to use the interactive teaching and learning in software engineering education. By developing the social network applications in the 3D virtual world, the students are able to learn the software engineering techniques with a more engaging experience, and to communicate with the teachers more efficiently with their developed applications. Through three semesters' study, we observed that the students show very positive comments on the learning methodology and enjoyable 3D virtual world applications. In the future, we would like to continue the interactive teaching and learning environment building in 3D virtual worlds, and build up an open platform to facilitate teaching of university courses.

## Acknowledgements

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