

To improve teaching of *Computer Graphics* by using concept mapping

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Abstract

A continuously increasing human population and the knowledge explosion has stimulated tertiary educational systems all over the world to help students become lifelong learners, as well as delivering academic knowledge to students. This requirement only can be attained when teaching pedagogy is dramatically changed. In this paper concept mapping is introduced as an example to demonstrate the improved outcomes of teaching of computer graphics by providing more opportunities for students to practice and enhance their skills on communication, management of time and knowledge, and complex ideas construction. A useful tool for drawing concept map (*SmartDraw*) is also introduced.

Introduction

The current knowledge explosion is changing the world dramatically on a daily basis. One of the most essential activities for a normal life is the development of the skills of lifelong learning. Tertiary educational systems should inevitably be responsible for the training of new generations and their development of lifelong learning skills. Several groups of Chinese scholars from selected universities of China, supported by Chinese Scholarship Council (CSC), were sent to The University of Sydney to observe and learn what has been done to promote lifelong learning skills. According to the agreement between CSC and The University of Sydney, a series of lectures were given on theories of modern education, followed by seminars presented by specialists from different disciplines at The University of Sydney. These Chinese scholars also attended some other courses available for undergraduate and graduate students, including lectures, tutorials, experiments, etc. Some of them had an opportunity to see how the teaching activities are arranged or managed within a department.

In those lectures, the theories of behaviourism, developmentalism and constructivism were introduced, along with many teaching strategies and many useful techniques such as 'concept mapping', 'problem based learning', and 'peer evaluation'. In the seminars, we heard how the speakers had developed their teaching strategies, how the courses are delivered, and included teaching plans, status of the current implementation, comments from lecturers and feedback from students.

In this paper, the teaching of *Computer Graphics* (CG) using concept mapping as a teaching tool is considered. The paper is organised as following: concept mapping is first described; problems in CG teaching are presented; relevant solutions are then discussed; and finally a conclusion is given.

Concept mapping

The concept mapping technique was developed by Joseph D. Novak at Cornell University in the 1980s. From then the benefits of this powerful technique have been identified, and the success of using this technique have been reported many times. The First International Conference of Concept Mapping was held on September 14-17, 2004 in Spain, and the second CMC has been scheduled in Costa Rica for 2006.

Definition of concept mapping

According to Novak (1990), concept mapping is defined as a technique for representing knowledge in diagrams called 'knowledge graphs', which are networks of concepts with relationships between them represented respectively by nodes and links. Concepts and sometimes links are labeled and links can be non-, uni- or bi-directional.

Features of concept mapping

Comparing concept mapping with Mind Mapping® invented (and copyrighted) by Tony Buzan in the UK, a concept map may have several main concepts rather than only one in mind mapping. This means that concept maps need network representations. These networks visualise concepts and their relations and therefore facilitate teaching and learning activities by the following main features:

- aiding learning by explicitly integrating new and old knowledge;
- assessing understanding or diagnosing misunderstanding;
- communicating complex ideas;
- designing a complex structure; and
- generating new ideas.

A tool for concept mapping

Correspondingly there are also many tools to draw concept maps and one of the most powerful tools is *SmartDraw*. Being used as part of *Microsoft Office* and other programs that support Object Linking and Embedding (OLE), *SmartDraw* is an easy-to-use tool for drawing professional-looking charts and diagrams. Compared with other tools, the built-in symbol libraries of *SmartDraw*, which can be installed online and continuously extended, make *SmartDraw* very powerful.

Another characteristic of *SmartDraw* is the Multiple Document Interface (MDI) application supporting up to 32 document windows which can be opened at the same time, sorted as different layers and easily switched to an active layer by clicking the menu bar. Unfortunately, *SmartDraw* is not freeware and can only be used for limited time without purchasing it.

Novak concluded, 'meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures', and concept mapping provides a facility for learners to construct their own schema and for teachers to organise materials for teaching.

Concept mapping for *Computer Graphics*

Computer Graphics is an elective course for undergraduate students in the departments of Computer Science in most of universities of China. It has been offered for more than ten years at Beijing University of Technology.

For the lecturers teaching the course the first common challenging problem is the students' disappointment with the content of computer graphics, which is caused by the imbalance between the students' expectation of colourful visual topics and the reality of strict or even boring mathematical calculations. Therefore, it is essential for students to understand what the *Computer Graphics* course is all about at the very beginning of the course. This means it is important that a two-way understanding, which includes teachers knowing students' expectation of computer graphics and also students knowing exactly what the content will be, is reached.

The above issue can be resolved using one of the main features of concept mapping, assessing understanding and/or diagnosing misunderstanding. This consists of several simple steps. Firstly students are asked to create their own individual concept map of the course. Then students are divided into small groups (less than ten in each) to discuss and revise their concept maps. In this small group discussion, students can learn from each other and this may change their views. After that a new concept map illustrating the general understanding of students can be generated.

When the concept maps of students are worked out, the teacher compares them with his own pre-defined concept map and identifies the differences between the expectation of students and the actual content that will be delivered later. This will be helpful for teachers to know how to help students to learn the subject. One simplified concept map of CG is shown in Figure 1.

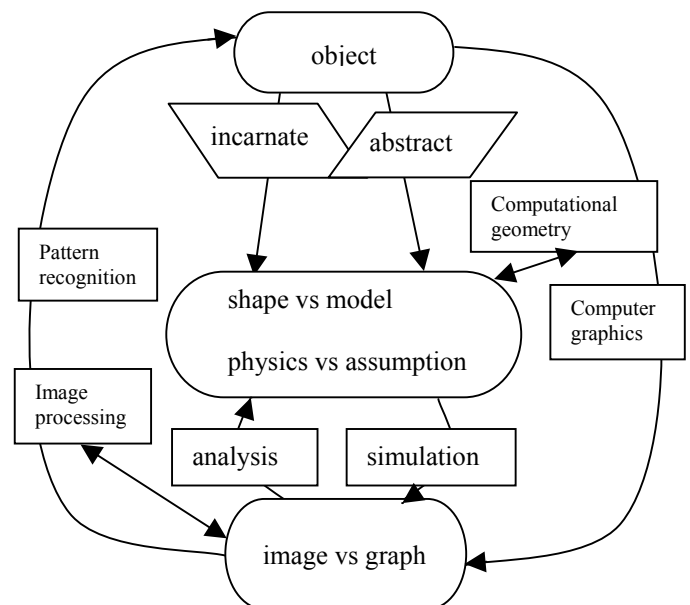


Figure 1. A simplified concept map of computer graphics

Hopefully, using this map, teachers can help change students' original ideas, associated with colours, images, animations, motion pictures, and even *Disneyland*, *Photoshop*, and *3D Max* and others, into a new one, shown in Figure 2, which outlines the issues to be covered in lectures.

The initial concept map of *Computer Graphics* keeps extending dynamically as the course progresses into multi-branches according to the different themes, termed as thematic concept maps, which are developed hierarchically from the nodes of the original concept maps.

Students can also change and enlarge their concept maps as the course progresses and can use them to check what are the most important points and evaluate how much they understand at every stage. Peer evaluation based on the concept mapping can also be carried out to encourage students in their learning.

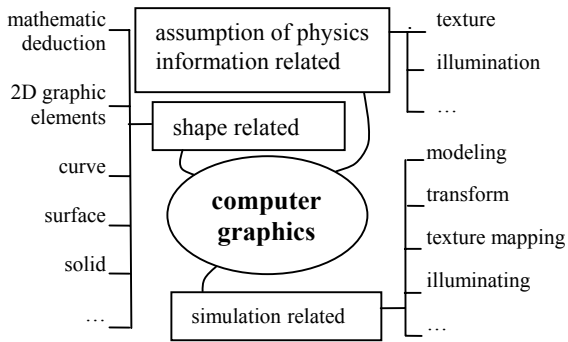


Figure 2. Initial concept map of computer graphics

Concept mapping for understanding rendering of 3D objects in CG

More than half of the students who choose *Computer Graphics* find it difficult to understand the process of rendering of 3D objects. The main reasons are the complexity of the process itself and the incomprehension of the transformations included in the process, which may be due to the poor mathematical background of some students. To tackle the problem of communicating complex ideas, concept mapping can be adopted. The following figure organises the main steps and concepts of this process, including some of the finer details.

In the concept map, every compound stage is dissected into basis concepts and techniques that can be understood easily. Being guided by the map, students can arrange their learning in any order they like and assemble what they learn one-by-one according to the threads given by the map and eventually focus on the individual difficult points that are encountered. Finally when they have worked out the whole concept map based on their personal understanding they will have understood the process very well.

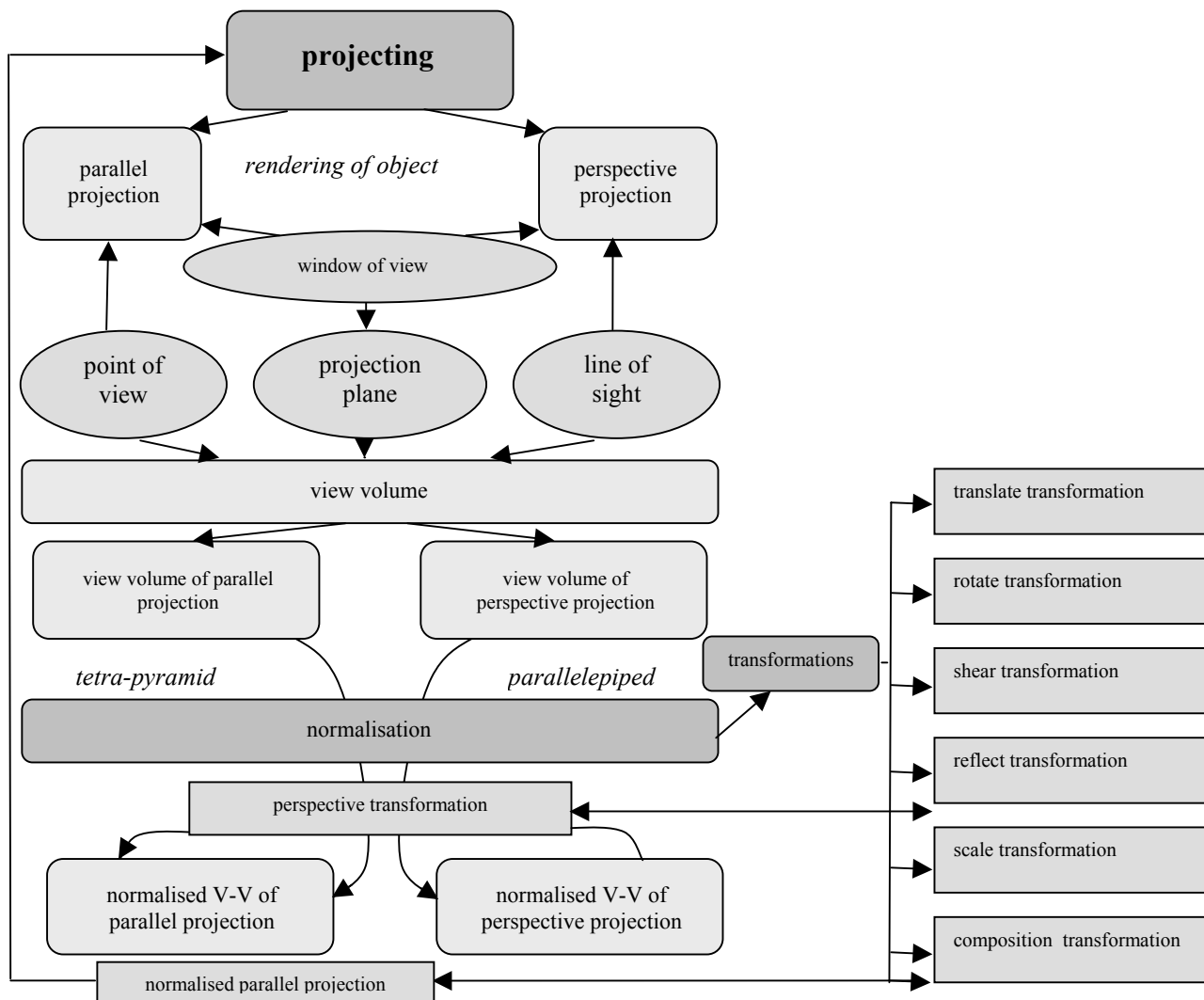


Figure 3. Concept map of the processing of rendering of 3D objects

Discussion and Conclusion

Starting with the first Chinese university, Beiyang School of Western Science, established in 1895, the Chinese tertiary educational system has been developing for more than one hundred years and is continuing to change. Like the rest of the world, the Chinese tertiary educational system is still not perfect. The rapid growth in population has resulted in a huge number of students and a large range of student abilities. In such a situation, teachers need to update their pedagogy of teaching and teaching strategies so that students can develop as lifelong learners.

Two examples are given in the paper on how to implement change in the teaching of *Computer Graphics*. In the first example, students are asked in advance to construct an individual concept map and then participate in team activities to refine their maps. When they communicate with peers by presenting their own ideas and convincing others, they can work out the initial concept map of *Computer Graphics*. From the initial concept map, teachers and students can both keep working on it as the course continues and develop hierarchical multi-branch concept maps that can be used to manage knowledge as well as assess the outcomes. In the second example, students have a chance to practice controlling complex structure and learn to manage time in addition to attending the comprehensive lectures. Again, more attempts, such as case study and problem based learning methods, can be tried in the teaching of *Computer Graphics* to enrich the learning outcomes for students.

Although having thousands of years of educational history, the Chinese tertiary system in some aspects is still behind its western counterparts. A teacher-centred teaching pedagogy is still the dominant strategy in Chinese universities, and there is a needs for urgent reform to fit the culture of lifelong learning.

Confucius, the originator of Chinese education, indicated an elementary belief of education: teaching students in accordance with their aptitude. With respect of modern

education, we should add that the ability to continue to learning after graduation is essential.

To try different methods to teach effectively and adopt approaches to encourage students to develop lifelong learning skills is now a greater expectation of society.

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