

# Constructive Theory Foundation and Three Dimension Virtual Study Mode Application

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**Abstract**—Paper introduced the concepts and effecting factors of constructive theory. The four factors take essential and important effects in constructive theory. They are circumstances, coordination, dialog and meaning construction. Then gave out a detailed virtual study mode description and stressed the methods of 3D virtual study environment establishment. Paper mainly discussed the research and application of a virtual three dimensional study technology, including user interface and interactive technology, database access technology and virtual avatar technology. Relatively it presented application systems that we developed for corroborative evidence.

**Index Terms**—constructive theory, virtual study, three dimension technology, avatar

## I. INTRODUCTION

### A. About Constructive Theory

Constructive theory was first proposed by Swiss scholar J. Piaget. He thought that wisdom is a kind of environment adaptation in essence. The wisdom adaptation is also the utilization of a man's conscious dynamic role. A main body will be evoked strong repercussions only when certain extent stimulation is assimilated by people in one's recognition architecture. Constructive theory considers study as a process to construct a person's inherent psychology expression. Based upon one's original experience, the student masters, or acquires new knowledge by the means of interaction with external world. Learning is a process of continuously constructing new knowledge to his brain, not just simply transfer it from outside world into one's memory. Only through the means of fully excavate student's active construction ability, one can obtain his abundant knowledge in a certain study environment.

### B. About Virtual Study

Virtual technology plays a quite important role in academic remote education area, especially for the creation of 3D study environment and realization of virtual interactive study mode, which should be based on the constructive theory.

It is obvious that there are genuine advantages of this technology. Online remote education offers an

opportunity to improve greatly the efficiency of learning with respect to time and cost. In many cases it provides an entire new learning experience for students, including multimedia features, like digital video and web based simulation. Online education supports learning-on-demand, a service which will become increasingly important in the corporate learning arena. It is clear that with a continuously improving technology-infrastructure, such as increased bandwidth, rising penetration of broadband etc., and people growing more accustomed to the use of the computer and the internet, e-learning will attain greater significance as a potential education platform. Universities will have to take this into consideration in their strategic educational planning [1].

The form of manifestation for teaching and learning of today's higher education has been greatly enriched by the development and application of three dimension virtual study technology. Virtual study technology not only provides a new technology and free space for teaching manners, means and contents revolution, but also enhances the student's knowledge comprehending ability, problem analyzing ability, new knowledge exploring and new knowledge utilizing ability. It is an important motive force for building the 3D study environment and virtual interactive mode based on the constructive theory. Although we are gratified at the enhancement of 3D technology, the virtual education is still bothered by the network scope and transportation efficiency problem. The most obvious manifestations are the low Internet transportation rate and user-end 3D graphic rendering rate, with the result that the lowness of real-time interactive efficiency.

The goal of the 3D virtual study technology applied by this paper is to construct a 3D environment, which theory foundation is based on the constructive study theory. The built 3D virtual study environment is a three dimension atmosphere circumstances teaching environment. It offers necessary knowledge acquiring tools and supports the concepts of exploration study, coordination study and experience study, which is based on the constructive study theory. Its main characteristics are enumerated below. First, the relative relation of body shape and position for every teaching model are expressed with 3D

atmosphere vector. Second, the system supports the function of real time wander, and this provides the sustenance for exploration study and experience study. Third, it supplies real time feedback information, including text aided information which is displayed in two dimension type. Fourth, it's equipped with multimedia aided information, such as audio and animation clips. The system is also equipped with abundant theory knowledge and teaching section, designed through practice teaching material and object. All these supply the students every kinds of knowledge acquiring tool of constructive theory, and finally formulate student the meaning construction [2].

## II. CONSTRUCTIVE THEORY FOUNDATION

Now, an important target of education revolution is the transformation from the tradition behaviorism theory, which is centered with instructor, to the modern cognition theory, which is centered with student. As a main branch of cognition theory, constructive theory considers student, one the principal part of cognition, two the center of education, three the active constructor of knowledge concept. There are four essential factors in constructive theory. They are circumstances of study, coordination and experience exchange in study process, and meaning construction of study. Study is a process of knowledge acquirement, and knowledge acquirement is too a process that the student, with the aid of other's help, having mastered necessary resources, through the way of meaning construction, can master knowledge under a proper circumstances. This idea shows no difference with most of education experts'. They think that the effective methods of knowledge acquirement are exploration study, coordination study and experience study.

Under the prerequisite of a complete set of computer and network hardware resources, it's quite important and significant to build education software resources. But now, most of the digital software resources are displayed in a manner of two dimensions, and most of the education resources are the simple refurbished version of original textbook and study materials. Under this old classroom teaching refurbished circumstances, the student's knowledge acquiring channels are still limited to mechanical study and spoonfeedable teaching.

In this paper, we put forward a new 3D virtual study pattern in e-Learning [3] [4]. Its target is to construct a three dimension study environment, and its theory foundation is based on the constructive study cognition theory. The built 3D virtual study environment is a three dimension atmosphere circumstances teaching environment. It offers necessary knowledge acquiring tools and supports the concepts of exploration study, coordination study and experience study, which is based on the constructive study theory. Its main characteristics are enumerated below. First, the relative relation of body shape and position for every teaching model are expressed with 3D atmosphere vector. Second, the system supports the function of real time wander, and this provides the sustenance for exploration study and experience study. Third, it supplies real time feedback

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During the whole process of student's knowledge acquiring activities, the following four factors take essential effect in constructive theory. They are circumstances, coordination, dialog and meaning construction [5].

### A. Circumstance

The circumstances in study environment must be favorable to the meaning construction of learning content for students. It proposes new demand on teaching design. Under the condition of constructive study, teaching design should emphasize not only on teaching target analysis, but also on circumstances creation, which is beneficial for student's constructive significance. In practice, we should take circumstances creation as the most important content of teaching design.

### B. Coordination

Coordination among students runs through the study process from beginning to end. It takes an important part for collect and analysis of learning material, proposal and verification of scientific hypothesis, evaluation and appraisal of study achievement, and even final construction of meaning level.

### C. Dialog

Dialog is an indispensable section in coordination process. Through dialog, students can discuss questions among each other, such as how to fulfill the stipulation study target. In addition, coordination study process is also a dialog process. In this process, every student's thought achievements (also called wisdom) can be shared by whole study group. So we think dialog as a major measure to achieve meaning construction.

### D. Meaning Construction

Meaning construction is the ultimate aim of the whole study process. The contents of meaning construction are the character and law of things, as well as the internal relation among things. In order to help students construct meaning, the study process should help them acquire fairly profound understanding to the character and law of things, and the internal relation between these things with other things, all things are about the students' learning knowledge. This fundamental explanation and analysis of construction theory is in keeping with student's learning psychology. It is also approved by many senior education experts. They think that the effective methods of knowledge acquirement are exploration study, coordination study and experience study. Construction

theory provides virtual three dimension study technology with solid theory basis.

### III. 3D VIRTUAL STUDY MODE [6]

We can divide virtual study pattern frame into four parts. They are student(s), instructor(s), three dimension virtual study environment and self adaptive assistance, see reference Fig. 1.

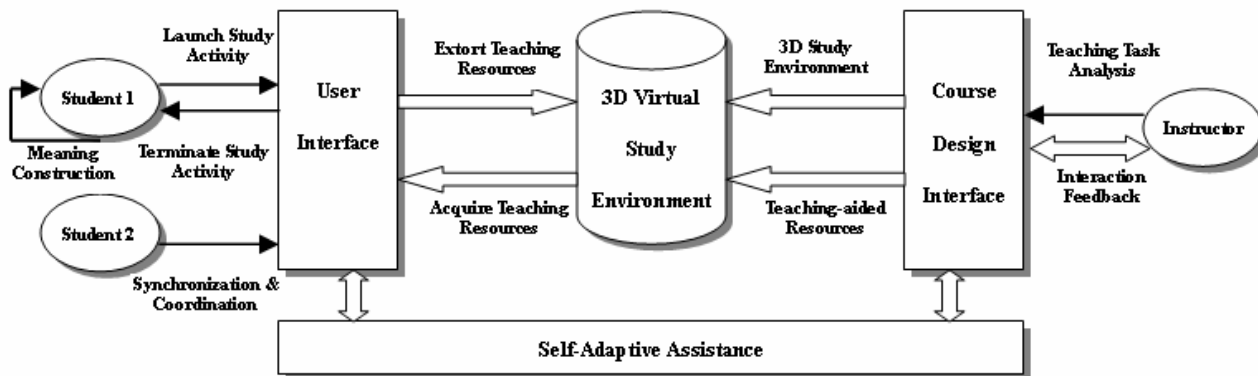


Figure 1. Frame diagram for constructive theory study pattern.

#### A. Student and Instructor

In the above diagram, a single student can launch or terminate study activity as one pleases, then extort and acquire education resources from 3D virtual study environment, and finally master knowledge in a higher level of meaning construction. Multiple students not only possess a single student’s knowledge extorting and acquiring channels, but also are able to exchange ideas and methods with other students. Here, we can adopt synchronization or coordination pattern to control information interchange process among students. The user interface provides students with any kind of activity control technique support.

The instructor is the supplier of teaching resources; he is also the organizer of course design. The instructor’s task is to design the teaching objective and content by analyzing education task. Under the basis of education object analysis, teacher also needs to design reasonable course evaluation standards. The course design interface can assist instructor to design three dimension study environment in a manner of visualization. It also interacts in real time with instructor to modify and consummate 3D study environment design.

The students and instructors constitute two major direct user colony of constructive theory study pattern.

#### B. 3D Virtual Study Environment

The built three dimension virtual study environment is a complicated knowledge base rich in education resources. The base embodies course ideology of teacher or teaching materials. Every part in the environment is a three dimension circumstance study atmosphere. The relative relation of body shape and position for every

teaching model are expressed with 3D atmosphere vector. It supports the function of real time wander and supplies information feedback in real time, including multimedia aided information. This environment provides abundant knowledge theory study, designing all study models through practice teaching material and object. Some principal factors included in the three dimension study environment are analogue entity, abstract entity, motion entity, artistic entity and information entity. The details

are described below.

Analogue entity is the teaching model built by 3D modeling software, with reference to practical material object, such as nature scene in reality life or chemical material in chemistry laboratory.

Abstract entity is the object that doesn’t exist ever or can’t be observed in reality life, such as planet running in universe, or atom and molecule existing in microcosm. The abstract entity 3D model can supply student with audio-visual object concept, so student is easy to constructive concept module.

The system’s motion entity realizes reappearance of object moving process based on the technique of 3D motion emulation. Some examples are the ball moving games in physical textbook, the motion of energy conservation in physics, and some dangerous demolition and exploration movement of daily life. Modeling for motion entity contributes to the expression of abundant teaching thought, and the reflection of multi level teaching knowledge. Under the help of motion entity, the student will be more substantial in the following period of meaning construction.

On the basis of analogue and abstract entity, artistic entity possesses the advantage of expression entity in a more embellish mode, for example the mathematics model in CyberMath, all of them are artistic processing entity.

Information entity includes entity illustration, factor analysis of assessment system, and operation guiding instructions.

#### C. Self Adaptive Assistance

The self adaptive assistance part provides interfaces with assistant tools, such as text information prompt in two dimensions, FAQ inquiring mechanism, JAVA real time monitor mechanism, and intelligence proxy. The application of above mentioned tools can make students acquire abundant knowledge and fulfill study activities in an easy, correct and efficient mode.

#### IV. 3D VIRTUAL STUDY ENVIRONMENT

Virtual technology has a vast reservoir of application probability, and holds infinite vitality in higher education area. It can set up a more natural and more realistic virtual study environment, and break through early WWW remote teaching pattern. Student will be able to derive rich knowledge from virtual 3D study environment, in a manner of net browsing and initiative exploring. Examples are listed below. For example, to study astronomy knowledge by entering virtual firmament, to study geographical knowledge by making use of a virtual globe, to exchange ideas with historical figures by crossing virtual time and space, to fall into a molecule world by touring virtual chemical hall. Through these applications we can conclude that virtual study pattern, under some situation, can greatly reduce the operation difficulties and dangerous in reality space. It will be more important to cut down the training cost, and to endow subject teaching with vividness and interest, immersion and interaction [7] [8].

The virtual study pattern application is realized by simulating the authentic multimedia teaching center of a university. By using virtual three dimension modeling language, the realization synthesizes VRML's Transform, Scale, Inline etc scene nodes and some sensor nodes, such as the ProximitySensor, PlaneSensor and TouchSensor node. The size and the position of the virtual objects in a scene could be determined by manual justifying. Some elementary interaction can be realized by using sensor nodes, in combination with ROUTE sentences, with reference to following programs. An example is the moving of the notebook computers, see reference Fig.2 and pay attention to the mouse shape. For some complicated interaction applications, we use the Script node and embedded it into controlling sentences to input and output necessary events. This kind of application includes the environment curtain movements, the opening and the closing of LCD displayers etc. Further consummation of the scene effect also makes use of the Texture, MovieTexture, and Sound nodes of VRML. By using all these techniques, we can enhance the multimedia characteristics through strengthening the visual and audio effects. All of the realization could be managed by using the interaction 3D technology.

Fig.2 shows the effect of the virtual 3D education pattern built based on construction theory. All of the models, including the multimedia classroom, desks, notepad computers, projector and screen curtain etc, are built by using different kind of VRML nodes. The size of the created scene file is 27KB. If it is compressed by VrmIpad, the size is only 4KB, which is quite ideal for network transmission.

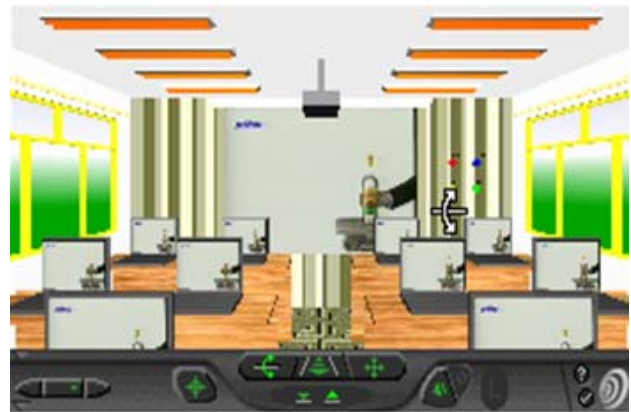


Figure 2. 3D atmosphere circumstances teaching environment.

#### V. VIRTUAL STUDY TECHNOLOGY [9]

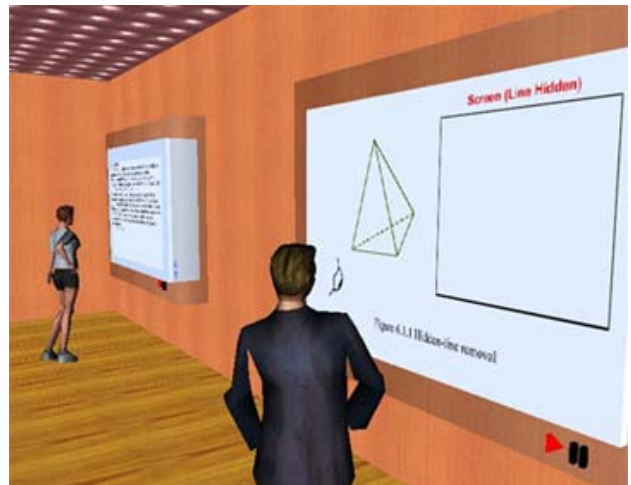


Figure 3. Virtual study environment.

We designed an interactive 3D virtual study environment platform based on Web, with reference to Fig.3. On this platform, a student can read textbook contents in study room; operate interactive experiment in virtual laboratory. Every student is substituted by a target avatar of himself. A student can choose a kind of avatar that he likes, on a voluntary basis. The avatars support action expression. This platform is based on high performance PC virtual system, running on desktop surroundings. Student can enter into a 3D course study environment and experience supplied virtual study by directly visit Internet course servers.

##### A. User Interface / Interactive Technology [10]

There are two kinds of external established program languages supplied by VRML. One is VRML Script; the other is Java/Java Script.

The functions supported by Java are much more than VRML Script's, especially under the Web-based architecture. We can fully manipulate the powerful man-machine interface and support function provided by Java for its users.

VRML's Script node can provide convenient communication support between VRML scene and external application program. It can link an application

program into a specified scene in a manner of executive manner. VRML's Script nodes also can creative new interpolation node and sensor node to drive and control VRML scene.

Java support VRML in a manner of enveloped class. These enveloped classes are sealed in VRML's external author interface (EAI) [11]. Fig.4 explains methods to acquire current explorer variable by using Java.



Figure 4. User interface.

In order to directly acquire graphic interface on Internet, we use Java Applet to program [8]. Applet is a kind of small application program in net pages. Usually they are stored in Web server. When navigating through HTTP server, Applet will be downloaded into customer-end explorer, along with net pages. It operates working by drawing support from Java virtual machine (JVM) in net explorer.

**B. Database Access Technology**

In order to receive and send out student's relative information live on the platform, we design and utilize database technology in this virtual study environment. The database's remote access technology adopts Java remote methods invoke (RMI) mechanism and Java's JDBC database access mechanism to achieve. RMI is a distributive object system. In comparison with adopting socket method, RMI is simple and easy for the development of distributive application program for the reason of no need to do design protocol work, which is easy to be wrong. In RMI, the invoke method seems to invoke local method from local class file, but actually transmits the actual parameter to a remote target in the practice. After parameter being explained by target side,

the result will be transmitted back to invoke side. Sun Company provides a kind of Java application programming interface (JDBC), through standard SQL accessing database technology. JDBC defines an interface class library (Java.sql package) between Java and database. It is Java's API to execute SQL statement, and composed of a series of classes and interfaces. All these classes and interfaces are written with Java. By using JDBC, a programmer can establish links with platform database, execute SQL sentence and deal with the returned result of SQL sentence in Java.

**C. Avatar Technology**

The management of virtual avatar is a main factor of students being able to undertake study activity in an immersive way. It also is an important factor for applying virtual reality technology in this environment. Now, the virtual avatar technique adopts Blaxxun Company's avatar mechanism. It supports VRML2.0 human animation standard (HANIM). The joint model for every virtual avatar can be simplified to 7 parts. They are head, upper body part, lower body part, arm, hand, leg and foot. Relative joint articulation points are rump bone, hip, knee, ankle bone, upper back part, lower back part, shoulder, elbow, waist, neck and head. Blaxxun avatar station (BAS) is a design software tool for making virtual human modeling. It not only sustains above mentioned HANIM standard, but also supports figure action making. Every action will be completed within animation's 9 frames. Yet in virtual perception field, BAS is unable to provide strong support and expansion.

**VI. CONCLUSION**

Coming to an end, paper explained concept and application of a 3D study environment in academic e-learning area, on the basis of constructive theory. Combining with the available research work, it analyzed the theory foundation, explored three dimension study mode, and described the key technique of building 3D virtual study environment. The existing work has profound theory and practical significance for deeply launching research and application by utilizing 3D virtual study technique.

**REFERENCES**

- [1] Allan Collins, Situated Learning and the Culture of Learning [J], Education Researcher, 1989, 18(1): 32-42.
- [2] Dalgarno, B. J. Developing Constructive Computer Assisted Learning Resources: A Model Drawing on Instructional Design and Software Engineering Principles [R], Work-in-progress paper presented at ASCILITE, 1998.
- [3] Roach M.P. and Stiles M.J., COSE - A Virtual Learning Environment Founded on a Holistic Pedagogic Approach [J], CTI: Software for Engineering Education, 1998, No 14
- [4] Chen Shouman and Jiang Jianguo, Application of Virtual Reality Technology in Teaching [J], Journal of Computer Applications, 2002, 22(4): 111-112.
- [5] Brooks M., Brooks J., In Search of Understanding: the Case for Constructive Classrooms [C], Alexandra, VA: ASCD, 1995.

- [6] Livia Szedmina and Robert Pinter, Interactive Multimedia English Course, 2nd Serbian-Hungarian Joint Symposium on Intelligent Systems SISY 2004, Subotica, October 1-2, 2004.
- [7] Saljo, R., Learning and Understanding: A Study of Differences in Constructing Meaning from a Text, Alta University
- [8] Zhu Jiejie, Hu Weihua, Pan Zhigeng, Design and Realization of Virtual Multimedia Classroom [J], Journal of Computer-Aided Design & Computer Graphics, 2004(1), 1003-9775.
- [9] Bouras C., Philopoulos A., Distributed virtual learning environment: a Web-based approach[C], Proceedings of the 26th Euromicro conference, 2000
- [10] ISO/IEC 14772-1:1997, VRML97 International Standard [EB/OL], The VRML Consortium, <http://www.vrml.org>.
- [11] External Authoring Interface Working Group, The VRML Consortium [EB/OL], 1998, <http://www.vrml.org/WorkingGroups/vrml-eai>.



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