Application of Emulation Instruction in Engineering Education

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Abstract: The advantages and disadvantages of emulation instruction in engineering education were analyzed in this paper. Based on constructivism, the basic principles of emulation instruction were presented. Emulation instruction can not completely replace the physical experiments, so the two teaching methods should be closely combined, complementary advantages, and the similarity of simulation scene should be improved for training teaching.

Introduction

Emulation instruction is a teaching method that create all kinds of virtual environment to simulate the real environment with physical or computer, and according to the real environment, validation, design and operation in the virtual environment. At present simulation teaching are widely applied, and the majority of simulation teaching are finished by computer technology. Constructivism learning theory is widely used in modern education, also it promote the rapid development of Emulation instruction. At present, most subjects have developed Emulation instruction software update rapidly, large numbers of intelligent, situational software are emerging. With the rapid development of computer technology and software level and the hardware construction lag of the practice teaching, the Emulation instruction research in education is of great significance to improve the engineering teaching results, promote the teaching and learning each other.

Advantages of Emulation Instruction in Engineering Teaching

Engineering education has strong dependence on the practice teaching facilities. Under the background of continuous enrollment expansion of colleges and Construction lack of teaching facilities, the advantage of emulation instruction in engineering education are mainly reflecting in the following aspects.

Reducing Hardware Construction Pressure of Practice Teaching

Emulation instruction has the advantages of less equipment investment, short construction period, low cost and high equipment utilization rate. Through the establishment of local area network with professional simulation software, a simulation laboratory can satisfy many simulation experiments and practices. Especially in civil, metallurgy and other subjects, some high investment experimental facilities often become the bottleneck of the development of related subjects in local colleges and universities. The aid of simulation software has the practical significance on relief the pressure on practice teaching resources construction in some extent.

Teaching Breaks Through Time and Space Limitations

With network technology, emulation instruction can break through the limitations of time and space, teachers’ teaching demonstration can be flexible laid out, student can do experiments and explorations independently, can facilitate students team cooperation learning, and improve student learning initiative and learning effect. Furthermore, the teaching supervision, achievement evaluation, information query, data files, and related teaching activities can realize network operation. In the scene reappearance, emulation instruction has its incomparable superiority.
Whether in teaching demonstration, or student experiment can break the limitations of time and space, realize the complete scene reappearance. Moreover, emulation instruction is beneficial to the selective control of teaching, can repeat or close-up details, difficulty, key, also can fast-forward or skip certain content.

**Constructing Resource Sharing Platform**

Emulation instruction only need to maintain, update computer and upgrade software, the teaching content can be timely tracking the development frontier of related technology. Many simulation software can provide a wealth of teaching material with internet, search massive material. Many simulation software have function of integrating multiple disciplines. For example, MATLAB is a powerful system analysis and simulation software, which can solve many engineering, scientific computing and mathematics problems. In the early 80's many famous universities of United States had put MATLAB in the course teaching plan in electrical, civil, mechanical engineering, and it has become a compulsory course and the basic skills in experiment environment.

**Improving Safety of Experiments Teaching**

During the courses of engineering teaching, sometimes we need to do destructive experiments or fault simulation experiments, such as limit voltage experiment of electrical engineering specialty, blasting experiment of civil engineering specialty, fire fighting experiment of safety engineering specialty, radiation protection experiment of nuclear specialty and so on. These experiments sometimes will destroy the practice, some have security risks. Do the demonstration experiments and observation with simulation software, we will get great convenience.

**Facilitating Teaching in Accordance with "Materials"**

Emulation instruction has features of immersive, perception, and interactive, achieve a seamless connection between teaching and engineering applications. At the same time, there are many similar and crossover simulation software, you can flexible choose combine to the needs of the teaching or programs. Such as thermal analysis simulation software: thermal analysis of electronic devices can choose the FloTHERM, thermal analysis of aerospace devices can choose SINDA / FLUINT, thermal analysis of building ventilation can choose FloVENT, thermal analysis of fluid can choose Fluent, heat conduction analysis of solid-state can choose ANSYS.

**Disadvantages of Emulation Instruction in Engineering Teaching**

Emulation instruction can not completely replace physical experiments, training, and factory practicing, emulation instruction has its inherent disadvantages.

**Lack of Physical Skill and Experience**

Simulation software used in actual effect is restricted to the actual object and the physical process of perceptual basis. Many teaching software can achieve "high-degree simulation", but the feeling and operation skills of the actual equipment, components and tools must be from practical experience. Many critical states of experimental procedures, process need to rely on the aid of "feeling" to grasp and judge, only rely on the simulation software cannot build this "feeling".

**Effectiveness Restricted by Computer Foundation**

The use of simulation software relies on computers, and the skills of man-machine dialogue directly restricts the effectiveness of simulation software. Many operating instructions of simulation software requires a higher English level, especially the standard of specialized English. The difficulties of reading and understanding to operating instructions are directly restricting the software using effectiveness of Chinese students. For example, widely applicable engineering analysis software ANSYS, FLUENT, require four or higher reading, translation level can barely understand the operating instructions.
Idealistic, Simplified and Modeled Simulation

The situations of practical engineering are usually the result of a variety of mutual restraint engineering factors, and the results are dynamic; But simulation software is often idealized results based on a simplified model. Emulation instruction often idealizes experiment or conditions, and simplify the analysis of data and processes to make the students understand. But idealized results are inevitable difference from the actual process under a variety of factor constraints, simulation software is difficult to show some engineering in particular scenarios.

Inconducive to cultivate the spirit of exploration and tenacity

In physical operation, we may face repeated failure, require teamwork and mutual assistance. But simulation software can often be completed independently by a mouse click, therefore, too much reliance on the simulation software is easy to form some kind of impulsiveness, is not conducive to cultivate the spirit of diligence tough and exploration, the cultivation of safety awareness, the spirit of cooperation. Some software has colorful and successive animation, easily lead us shallow thinking, lack of deep thinking of scientific laws and mechanism.

Principles of Emulation Instruction

Developing simulation software and courseware should follow some principles:

Emphasizing "Leading-Main Body" Teaching Mode

Teachers is the organizer of teaching activities, the founder of learning context and the helper of meaning construction; Students should do exploratory, discovery learning, become the main body of information processing, constructors of knowledge under the teacher's help. For example: FloEFD with CAD is tightly integrated, can automatic mesh generation, as well as wall treatment does not depend on the grid. These prominent advantages of FloEFD makes the temperature field, velocity field, pressure, humidity and other parameters concerned in the HVAC industry calculate easy. In the teaching process, teachers should focus on explaining the basic concepts and methods of the algorithm, modeling, and cultivate students’ perceptual knowledge with classic case. Students should do different types, different depths simulation exercises, from shallow to deep, master basic skills and engineering analysis skills of FloEFD software.

Simulation Promote the Meaning Construction

Through realistic simulation execution and dynamic presentation, simulation learning can help students to establish the link between "new knowledge" and "old knowledge", and the experience of original cognitive structure may assimilate new knowledge, so that students’ leaning motivation may be stimulated, their ability to understanding and participate may be improved, and the meaning construction may be promoted. For example, based on the principle of electrical and thermal analogy, "thermoelectric simulation of temperature field of the two-dimensional heat conduction " can be the created. The computer in experimental system through the A/D interface directly with the electrical experiment table, complete experimental sets of data automatically take, storage, data processing, and according to experiments data printout temperature and temperature graph. In the simulation demonstration, the thermal conductivity of thermoelectric simulation can be completed within a few minutes, the temperature field of two-dimensional thermal conductivity inside the object characteristics can be demonstrated. Students use the electrical engineering knowledge in high school physics course promote the understanding of the principles of thermal conductivity.

Establishing a Collaborative Learning Environment

Collaborative learning focuses on the interaction between learner and environment, students discuss and exchange under the organization and guidance of teachers, so that the group thinking and the wisdom of learner can be shared, the knowledge reconstruction may be completed, and engineering simulation goals can be achieved. For example, in the teaching of construction equipment simulation, teachers set the subject of an intelligent building environment control, after
demonstrating the principles of building environment control system, distribute work through the network system, namely commitment to the design work of security, the heat source, air conditioner, water supply and drainage, lighting, regulation and control, and guide the students with the data sharing of network system, realize the coordination and matching of the various subsystems, form a complete simulation of "an intelligent building environment control system". According to students’ understanding of knowledge, teachers can further set the system operational failure, changes in environmental and design parameters from a different angle through the network to guide students to optimize the design, do system simulation drilling and debugging. Through the drilling of emulation instruction, teachers and students can communicate and judge, also we can train students the concept of engineering systems and teamwork.

Ultimate Goal of Cognitive Reconstruction

Centering on "meaning construction" in emulation instruction design, whether students' independent exploration, collaborative learning, or teacher-assisted learning, the meaning construction of knowledge is the ultimate goal in the whole learning process. For example, the above simulation of "an intelligent building environment control system". On the one hand, through the simulation demonstration of security, heat sources, air conditioner, water supply and drainage, lighting, regulation and control, provide the necessary foundation to construct understanding. On the other hand, leave broad construction space for students. Based on the simulation of an architectural building environmental control systems, select equipment and integrated construction, and debug simulation system under the teachers’ set of a system failure, parameter adjustment, then according to different program choose optimization program. As the selection, use and control of media is decided by students, teachers need to guide students to retrieve, extract, process information resources through a variety of databases and network resources, including literature, standards, and product information. Therefore, in this learning environment, emulation instruction is not only conducive to the situation of students' meaning construction, but also establish a teaching atmosphere of teaching benefiting teachers as well as students under teachers’ guide.

Conclusions

Emulation instruction has a great advantage in improving the density and rhythm of teaching, reducing the cost and increasing the flexibility. However, emulation instruction can not replace the actual experiment, practice teaching completely. The perception via computer is different from the exercise in the real environment, we can not feel the work atmosphere in factory and enterprise. Emulation instruction should be combined with practice teaching. True feelings may be developed by practice teaching on a variety of equipments, components, then combined with emulation instruction, students are guided to finish independently verified experiments, and began to do innovated experiment gradually, thus achieve the engineering system design. Two teaching methods should complement each other's advantages to improve the teaching effectiveness.

Emulation instruction is the practice of constructivist theory in engineering teaching, conversely, this practice further test, develop the constructivist theory. In order to achieve the goal of engineering quality training, the necessary and inevitable efforts of emulation instruction should be focused on improving the similarity of simulation scene of simulation software. establishing a collaborative learning environment, creating a teaching atmosphere of teaching benefiting teachers as well as students.

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References


