Construction and application of virtual simulation teaching resources in vocational education

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ABSTRACT: Studies on the construction and application of virtual simulation teaching resources are crucial for the advancement of vocational education. Guided by theories of educational technology, the characteristics and status of virtual simulation teaching resources in vocational education were analysed. The following suggestions are proposed to improve the virtual simulation teaching resources in vocational education: choose a suitable resource building project; develop an efficient resource building model; and have a reward system for participants. Modernisation of education has been greatly emphasised recently; the building and the application of virtual simulation teaching resources is a necessary requirement for the informatisation and modernisation of vocational education.

INTRODUCTION

Virtual simulation technology is the third-generation of important new technology in education, after multimedia and network technology. Virtual simulation technology is popular, especially in vocational education. Building and applying the technology to virtual simulation teaching resources are being vigorously pursued.

VIRTUAL SIMULATION TECHNOLOGY FOR TEACHING

Characteristics of Virtual Simulation Teaching

Virtual simulation technology has two components: simulation and virtual reality. Simulation technology refers to the simulation of true working procedures and true working environment. This can be used in scientific research, industrial design and simulated production, using instrument, equipment, site layout and environment models [1]. Virtual reality refers to an environment formed by the computer. People can put themselves into this environment by using various special devices. They can operate and control this environment to realise specific purposes [2].

Teaching software using virtual simulation technology has the characteristics of immersion, interaction and imagination. The learning environment established seems to have a physical, environmental and behavioural reality. Learners experience is as if they were in a similar, true situation. This type of learning environment allows learners to find rules and results by learning in the virtual environment. This can promote inductive learning, and reach the level of *practice makes perfect* through repetition and practice [3].

Application of Virtual Simulation Teaching

Vocational education involves developing front line, practical, high quality, skilled professional talent. The best method for vocational students to master the necessary skills is to study and practice in a real working environment [4-6]. Therefore, colleges need to build training bases for the corresponding skills required by different posts related to the majors. Students can, then, come into contact with, and operate, the tools and equipment of the putative post. Students should become familiar with the required processes and procedures before graduation. Every effort should be made to contact enterprises and arrange for students to gain experience in the actual environment of the enterprise.

The realistic position is that, due to the restriction of capital, technology, suitable enterprises and other factors, colleges cannot provide the students with the appropriate study environment for all majors, and this is a predicament for practical teaching in vocational education. To expand on these points:

- There is not enough capital to equip facilities to keep in step with enterprise technology. There is no capacity to provide students with full operating opportunities. This leads to the phenomenon of studies not keeping up with developments and that the *educational opportunity is not fair* [7].

- Some devices are expensive and complex. Some involve precise processes that are hidden and which you *cannot touch, are inaccessible and fathomless*, e.g. the principle and operation study of SMT (surface mount technology) equipment, and five-axis simultaneously controlled matching centre [8].

- There is exposure to pollution and danger for some majors, and practical training is not suitable, e.g. sewage treatment of the applied chemical specialty [9].

- For some majors, the practical training involves large amounts of consumables and is capital-intensive, e.g. part-manufacturing of the numerical control specialty or the welding specialty [10].

- Some practical training is limited by time and space, and is difficult to realise, e.g. road paving of the highway and bridge major [11].

These factors can influence the quality, effectiveness and benefits of practical teaching. Such problems can be addressed by using appropriate virtual simulation resources to create a virtual but seemingly true study environment.

Virtual simulation teaching methods and functions are as follows.

- Roaming access:

  Teaching content included in roaming access consists of the site environment, site facilities and equipment, as well as basic requirements for production and safety. Roaming access produces a deeply realistic image on the site environment and a preliminary acquaintance with site facilities and equipment. It allows cognisance of practice on the site. For example, an operator can visit any part of a workshop and the equipment and accessories, for instance, for a chip mounter, in the workshop using arrow keys. Meanwhile, through links, other equipment can be reached.

- Presentation function:

  Teaching content of the presentation function includes operating procedures presentation, operation methods, accident events and miss-operations. Taking the miss-operation presentation as an example, this simulation can produce a strong effect that will be deeply remembered by students.

  The presentation function can have the following teaching effects, viz. helping operators to become familiar with operational procedures; making operators understand the logical relationship between operational procedures; making operators pay great attention to safety issues in operation and production; and making operators aware of the serious consequences of errors in operation. For example, through three-dimensional animation, the disassembling procedures of a chip mounter can be clearly displayed.

- Interaction function:

  Virtual simulation practical training that uses the interaction function is one of the most important and most applied simulations. The purpose is to make the trainees learn and master operating skills according to operating specifications as part of a work process. Teaching content of the interaction function includes taking advantage of multi-media means to produce vivid teaching content; with mouse, keyboard or other physical equipment, implementing autonomous operations on a simulated object. Computer simulation provides guidance and training prior to actual operation and must be in accord with actual operation. Teaching effects of the interaction function include improving students' understanding of the classroom teaching by vividly reproducing the teaching content; and improving guidance and training by presenting various practical points. For example, students can complete operations for dismounting a three-phase asynchronous motor step-by-step through simulation software.

- Assessment function:

  Assessment of simulated practical training can verify the learning by students, including of core skill points. The assessment can be direct, fair and enjoyable. Features of the simulated practical training assessment system include whether the question selection is random; the size of the question bank; whether the assessment is of individual core skills; whether the assessment is reasonable; and whether the assessment is significant.

- Comprehensive function:

  Actually, for large-scale simulation practical training, the functions are usually limited to one kind; but some simulations use combinations of these functions. For example, the simulation system for a maintenance electrician

is composed of two systems, viz. simulation practical training and simulation assessment. The simulation assessment system uses a client-server model (C/S), to achieve a three-dimensional interactive paperless assessment. Each assessment item includes the following tasks for assessment, viz. device selection, device inspection, device layout, electrical connection, line inspection, power-on operation and troubleshooting. Teachers can select questions from a database. The system has login, timekeeping, submission, automatic grading, grade statistics and other functions.

Simulation practical training is the companion of the assessment system. It can operate through a browser using the Internet. Each item includes the following tasks for practical training; training device, typical circuit, working principles, circuit connection, line inspection, simulated operation and troubleshooting. The system can guide the operator to complete all the simulated training under three-dimensional conditions. Simulation practical training can be undertaken by students on the LAN first, with assessment through the assessment system, after training.

CURRENT STATUS AND PROBLEMS OF VIRTUAL SIMULATION IN VOCATIONAL EDUCATION

The advantage of virtual simulation teaching arouses strong interest in the educational field. Authorities are acting to promote application of the new technology in teaching, especially for vocational education.

Chinese Government Policy and Support for Virtual Simulation Resource Building

In the document, Several Opinions About the All-Round Improvement of Higher Vocational Education Teaching Quality No. 16 (2006), the Chinese Ministry of Education proposes to …*fully take advantage of modern information technology; develop the virtual factory, virtual workshop, virtual process and virtual experiment* [12]. Further, it proposed in the Ten Years' Development Plan of Educational Informatisation (2011-2020) to …*select and develop 1,500 sets of virtual simulation practical training experimental systems* and to …*create application models of simulated practical training resources, improve the benefits of the application* [13].

At the national level, there are construction projects, e.g. the national shared teaching resource bank, developed by the Ministry of Education, and incentive capital for virtual simulation resource building. Thus, it can be seen that building virtual simulation teaching resources is seen to carry a heavy responsibility toward realising the informatisation and modernisation of Chinese vocational education.

Enterprises and the Development of Virtual Simulation Software

Information technology enterprises engaged in educational software development are very actively researching and developing virtual simulation teaching software for vocational education. They directly build the teaching resources, but also participate in the national resource bank or college simulation training bases and other projects. On the one hand, the participation of enterprises provides abundant virtual simulation teaching resources with high technical content, and this is important. On the other hand, the developers are in competition and there could be conflicts of interest.

Technology involved in virtual simulation teaching software and the software design is highly complex. This requires an IT company with the scale, technology and organisation to develop advanced high-level products. However, the reality is that while there certainly are IT companies with these qualities, their quantity is not great. The majority of IT companies are small, and lack the strong research and development and organisational capacity required to produce virtual simulation teaching software. The virtual simulation software made by them is still at the level of animation demonstrations and simple teaching games, which is far from meeting the requirements of professional teaching to promote vocational skills.

Compared with other types of media products, virtual simulation software developed by enterprises generally has a high price and is not very effective. At present, there is a lack of a unified and transparent way to assess products and prices. There is good and bad with varying cost performance. In addition, there is repetition, e.g. automobile simulation software has been developed by many IT companies, which makes selection difficult.

Colleges Buying, Building and Applying Virtual Simulation Resources

Under the triple influence of micro-direction, enterprise publicity and the demands of teaching, many college leaders and teachers in the vocational field have taken action by: first, investing money to purchase finished professional simulation teaching software; second, co-operating with enterprises to develop simulation teaching software with teacher participation; third, building a development team at the college to independently develop virtual simulation resources; fourth, encouraging teachers to participate in teaching reform by building and applying the virtual simulation resources.

After several years of vigorous effort, the result leads to both joy and concerns. The joy follows from the fact that, indeed, the high-tech virtual simulation resources provide virtual imitations of skills that cannot be gained by practice in the actual environment; it makes up for the deficiencies of traditional teaching; and it improves the teaching quality and

effectiveness. One concern is the high price of enterprise virtual simulation teaching products, which is a considerable expenditure for a college. In addition, some of the software is not adequate in teaching design, vocational interaction and situational awareness. Such products usually cannot be adopted by teachers or applied to the teachers' teaching. Though high cost, they have little use in teaching; the colleges' relevant staff and the teachers feel that the investment and results are not commensurate.

For teachers to participate in design and development would cost much time and energy without the guarantee of developing an excellent product in teaching design, software design and in accord with the actual requirements of a post. The effort is either abandoned or has superficial results. Thus, the waste is of capital and the human costs to teachers. For teachers, if there is ready-made software, they will use it in teaching. Some software is used just to assist and demonstrate teaching and teachers will develop such systems. Students are not attracted to study if the software has imperfections.

At present, college relevant staff and the teachers, who once had enthusiasm, have moved towards a slower path, which has again verified the situation with educational technology, viz. *…instead of a simple objection or acceptance, the attitude of teachers is varied. New technology with plenty of investment or which brings huge change to the existing teaching system will encounter large obstacles during its promotion and application* [14]. Much time and professional knowledge is needed to apply virtual simulation to teaching; few teachers are willing to take this technology forward.

SUGGESTIONS ON VIRTUAL SIMULATION IN VOCATIONAL EDUCATION

Good designs are needed that promote study and improve learning. Noting research on theory and practice, the following suggestions are made on the building and application of virtual simulation resources.

Choosing Resource Projects Carefully

Given the capital and manpower cost of virtual simulation resources, as well as the complexity of the systems, the selection must be cautious. First, the selection should be positioned on those fields with low traditional teaching benefits or where the teaching cannot be completed properly. Second, have an early comprehensive demonstration to ensure the necessity and suitability of the purchased software or software that is planned to be developed.

Teachers should do the early investigation and survey, and select the software or software development company. The proposal, then, needs to be reviewed. Personnel participating in the review include teachers, experts in the industrial field, software developers and college leaders. They will analyse the need, considering the academic degree and the industry skill requirements. They will review advantages and characteristics of the software, as well as the resources required, from different angles. They, then, make the decision. It is found in practice that some software useful for teachers is deficient for industrial experts. Through discussion, it may be possible to accept some defects or the software may be adopted once perfected by the developer.

Efficient Resource Building Model

Resource building involves the following considerations:

- Three-mode building model:

  The college has three possible acquisition models, i.e. outsourcing, co-operative development and independent development. Outsourcing requires the software to have been widely used by teachers in similar colleges with good effect, especially in teaching. This model acquires the software by spending money. The basis of co-operative development is that there is immature software for which teachers can propose additional requirements and improvements, to make it suitable for teaching. The professional IT company with the technical ability and project organisational capacity can, then, develop this professional-level application software.

  A high-level model is required to cover the co-operation, mutual benefits, the college teacher resources, required skills, and the research and development. For independent development, the technical difficulty and complexity of the software should be lower. The teachers can identify demands and can provide an accurate teaching design. Then, the college has a team of software developers to implement the design.

- Research and development team:

  Development of the virtual simulation teaching software should be a result of co-operation between teaching experts, industry experts and software building experts. The teaching experts develop the teaching design and prepare and formulate scripts in accordance with the technical guidance of the industry experts. The software experts' task is to build innovative software. Hence, virtual simulation teaching software can be researched and developed combining theory with reality. What must be stressed is the importance of the industry experts. They play a significant role in ensuring that learners using the system acquire the key skills of the industrial field.

At an early stage of the software development, the industry experts provide suggestions for content. In the later development process, the teaching design personnel provide the teaching aims, media materials and proposed assessments to the industry experts for their feedback, based on their professional and practical experience.

- Identifying major responsibilities

A well-developed resource building team will include unified planning and organisation for superior operation; building with care by a professional company; a capital contribution by the college; a good teaching application; and student support for independent study and improvement. Teachers should not spend time and energy researching and producing virtual simulation resources beyond their capability. In consideration of the significance of virtual simulation teaching to teaching, as well as the difficulty and cost of developing these types of programme.

It is suggested that the model for state-compiled textbooks be imitated, i.e. lead by a senior business department (e.g. Ministry of Education, Education Department, Advisory Committee of Education, professional teaching associations and other authorities or organisations); organise professional teaching experts, industrial experts and teaching technical experts to conduct question selection; teaching design and building design for the virtual simulation resources; choose a professional manufacturer with strong technology through bidding or other form; invest adequate capital to build high-quality virtual teaching software; then, promote to the colleges.

Due to wide application, although the manufacturing cost is high, the market price can be reduced because of the volume of purchases. A college will introduce the resource for applying the teaching, and the benefit of the students. A Web edition is likely to promote widespread use; thus, further reducing the cost.

Stimulating Teachers to Use the Virtual Simulation Resources

As mentioned above, most teachers cannot participate in building and applying virtual simulation resources. Therefore, to stimulate teachers into using this advanced technology and improving teaching, colleges should adopt a few necessary measures, as follows:

- Provide support:

College leaders should not only be conscious of innovation but also be willing to invest. The college should be willing to purchase simulation software proposed by teachers which, although expensive, has reasonable cost performance and which is necessary for teaching. Co-operation with an enterprise should be approved where a teacher has the requisite research and development ability. There should be internal technical support by the college. In summary, a *green channel* should be opened up for the teachers.

- Build a platform:

Take as the starting point building a simulation practical training base applying virtual simulation resources. The simulation practical training base is the project started by the Simulation Technical Professional Committee of the Chinese Association for Educational Technology in 2008. This was developed under the guidance of the Simulation Technical Professional Committee, and with the assistance and strong support of IT enterprises.

The aim was, through a three- to-five-year effort, to develop practical training and teaching with virtual simulation technology. The goal was to modernise vocational education using modern educational technology. This would play a leading role for Chinese vocational education, by displaying the results of simulation practical training and teaching. It would also act as a model for colleges [3].

During the construction of the simulation practical training demonstration base, colleges need to optimise the layout of their practical training base. The modern practical training model combines virtuality and reality. It is put forth to tackle the high cost and low efficiency of practical training, large resource consumption, environmental pollution and other problems. It enhances the teaching and advances the informatisation and modernisation of training. Meanwhile, it promotes a new model of co-operation between collages and enterprises. Therefore, building a simulation practical training demonstration base is important in reforming education and teaching content, methods and means for vocational collages. With this platform, teachers can participate in the building and application of virtual simulation resources, with purpose and organisation.

- Rewards:

Teachers effective in building and applying virtual simulation resources, should be rewarded in their performance assessment, as well as in other respects. This will affirm the value of these teachers and promote continuing educational reform, as well as improved talent cultivation.

CONCLUSIONS

At present, modernisation of education has been greatly emphasised. Building and applying virtual simulation teaching resources is a necessary requirement for the informatisation and modernisation of vocational education. Only by insisting on reasonable development of the resources can virtual simulation teaching make a sustainable, positive contribution to vocational training.

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