Heliyon 9 (2023) e17159

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Chinese virtual simulation golden course: A case report

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ARTICLE INFO

Keywords:
Virtual simulation
Golden course
Green logistics
Case report

ABSTRACT

Chinese Golden Courses was proposed by the Ministry of Education of China in 2018. It consists of five types. Virtual Simulation Golden Course is one of them. The college students are often faced with the problems of few opportunities, higher cost, higher risk and poorer effect during the internship in logistics courses. Virtual simulation experiment course is an important means to solve this kind of practical teaching problem. Green Logistics Virtual Simulation Experiment (GLVSE), a course built according to Virtual Simulation Golden Course, as a case was reported. The development process of GLVSE such as designing reasonable talent training architecture, reflecting Two Properties and One Degree, cooperating between schools and enterprises, and reforming the teaching mode with the way of "mixed online and offline" were introduced in detail. Six successful experiences and a model of building virtual simulation golden course are summed up. The report provides important references for developing high-quality virtual simulation courses not only for Chinese universities but also for other universities in the world.

1. Introduction

Chinese Golden Courses was written into the document of the Ministry of Education of China in 2018. The standard of Chinese Golden Courses is Two Properties and One Degree (TPOD), that is, higher-order properties, innovation properties and challenge degree. The "higher-order properties" is the organic integration of knowledge, ability and quality, which is to cultivate students' comprehensive ability and advanced thinking to solve complex problems. The "innovation properties" means that the curriculum content can reflect the frontier and the times, the teaching form is advanced and interactive, and the learning results are exploratory and personalized. The "challenge degree" means that the course should have a certain degree of difficulty, which requires students to jump to get it, and has higher requirements for teachers to prepare lessons and students to study after class. At present, TPOD has become an important evaluation index for the construction of Golden Courses in higher education in China. Chinese Golden Courses includes Offline Golden Course, Online Golden Course, Online and Offline Mixed Golden Course, Virtual Simulation Golden Course and Social Practice Golden Course.

Green Logistics Virtual Simulation Experiment (GLVSE) course reported in the paper is the kind of Virtual Simulation Golden Course. Logistics pollution is an important source of environmental pollution [1,2]. In the context of global environmental governance,

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https://doi.org/10.1016/j.heliyon.2023.e17159
Received 28 January 2023; Received in revised form 23 April 2023; Accepted 8 June 2023
Available online 9 June 2023

green logistics has become a global focus [3–5]. Training green logistics management personnel has become the demand of the times [6–8]. However, the current modern green logistics enterprises are still few [9], unable to meet the practical teaching needs of a large number of students (internship enterprises are lack); in a few enterprises that have implemented green logistics, they can rarely cover all the logistics pollution problems (internship environment is lack); and in the process of internship, due to the complex human-machine operation environment of logistics [10,11], it is often accompanied by a high degree of pollution safety risk (internship risk is obvious). Therefore, students' practice is obviously limited by "time and space and conditions", which leads to "less opportunities, high cost, high risk and poor effect" of students' practice. Simulation based lab is suitable if the experiment needs the students to gain more on theoretical knowledge and conceptual understanding of a particular experiment [12]. Based on the above considerations, it is necessary to conduct specific case research on the GLVSE course to provide reference for the construction of virtual simulation golden course in colleges and universities by answer the following questions: (1) How was GLVSE course developed? (2) What are the successful experiences of GLVSE course? and (3) Whether a theoretical model can be built to guide the development of relevant virtual simulation courses according to GLVSE course?

2. Case presentation

2.1. Course overview

GLVSE is the first virtual simulation experiment course in the field of green logistics all over the world. It uses 3D modeling, human-computer interaction, information visualization and other technologies to carry out green analysis and transformation training for traditional polluting logistics enterprises. The course adapts to the development needs of global circular economy, adheres to the cultivation concept of "student-centered, problem oriented, production and education integration, innovative practice", and follows

Fig. 1. Scenes before replacement (left column) and after replacement (right column).

the principle of "combining deficiency with reality and using deficiency to make up for reality". It combines with the global standards and the Chinese standards, such as the *publication guide of Greenhouse Gas Protocol* and *GB/T 37099-2018 Green logistics indicators and accounting methods*. It is developed by using Unity3D, 3D Studio Max, Maya, Visual Studio, Photoshop and other development tools, using 3D simulation, HTML5, WebGL and other technologies.

In this experiment, a large traditional polluting logistics enterprise is simulated in 3D. From the perspective of logistics manager and referring to the relevant standards of green logistics, students diagnose the pollution problems of logistics business (transportation, packaging, noise, green space, water system, waste, energy, etc.). In addition, the green replacement decision is made for the polluting equipment and business, and the human-computer interaction calculation is carried out for the key issues (air pollution emission, greenhouse gas emission, path optimization, etc.). The students can complete the experiment under two kinds of 3D simulation landscape: in the training mode they will experience the environment-friendly logistics enterprise, and in the assessment mode they will teste the green effect of the logistics enterprise under their own decision. Some scenes before replacement and after replacement are shown in Fig. 1. The teaching objectives of the course are as follows: (1) Cultivating students' comprehensive understanding of green logistics in one-stop, (2) Cultivating students' ability to solve key problems of green logistics, (3) Cultivating students' sense of social responsibility and sense of responsibility, and (4) Training green logistics management professionals urgently.

2.2. Development process of GLVSE

2.2.1. Designing reasonable talent training architecture

Draw lessons from some related studies such as [13–17], the curriculum builders made full use of scientific research and teaching resources at all levels, and set up a talent training framework as shown in Fig. 2, with theoretical support, technical support and practical application as pillars, outstanding pollution problems in the field of green logistics as the core of teaching, and training professional green logistics management talents as the training goal. This architecture design not only attaches importance to the existing foundation, but also emphasizes the pillar of development, and focuses more on the training of future talents, reflecting the construction height of undergraduate courses. Compared with the few previous research on the talent training framework in the logistics field [13,14], this is not only the first systematic framework of green logistics personnel training, but also the first one to train green logistics talents through green logistics virtual simulation experiments. The talent training framework of GLVSE course has filled the gap in this research field.

2.2.2. Reflecting "Two Properties and One Degree (TPOD)"

Curriculum builders highlight the "high-level properties" in the education of knowledge, ability and quality. They set up a more comprehensive knowledge about green logistics in the experiment such as transportation, warehousing, packaging, distribution, loading and unloading, and so on., Some modules are designed to cultivate students' ability of communication, criticism and innovation such as air pollutant emission calculation, greenhouse gas emission calculation and transportation path optimization calculation. The introduction of green logistics cases at home and abroad are set to cultivate students' quality. The integrated education of "knowledge-ability-quality" has well cultivated students' comprehensive ability and advanced thinking to solve complex problems.

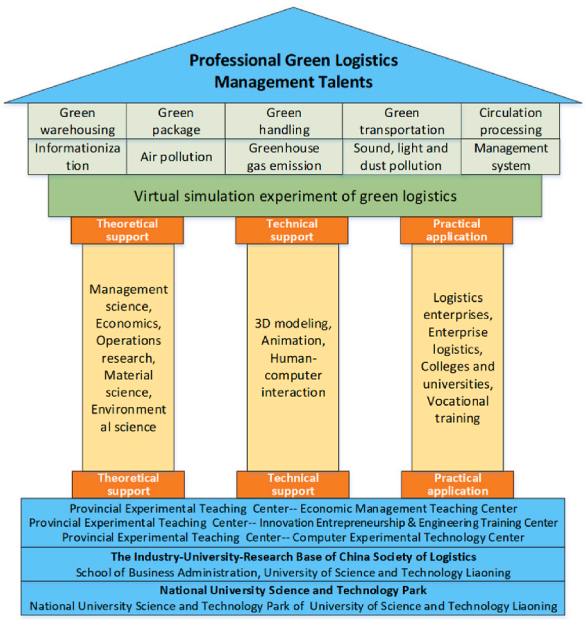

Fig. 2. Talent training framework.

In the effect of experimental teaching, they pay attention to "innovation properties". The content of this experimental course focuses on the issue of green logistics, which caters to the development needs of global environmental governance, embodying the overall innovation. In addition, they also pay attention to the inquiry and personalization of learning effect. For example, in the "experimental training" mode, students can widely explore relevant knowledge by choosing different answers to the questions, and can expand their knowledge through "two-dimensional code", so as to achieve reasonable "burden increase" in learning. In the "experimental assessment" mode, for all kinds of problems, students give answers according to independent thinking, and then the traditional polluting equipment or business will be replaced by the answers given by students, reflecting the future green logistics landscape. This design greatly stimulates the students' curiosity, meets the students' sense of achievement, and embodies the personalized design concept of this experiment.

In the difficulty of the experimental content, students must jump to get it, which reflects the "challenge degree". For example, in view of the air pollution, greenhouse gas emissions, transportation route optimization and other problems of traditional forklift, if the students do not grasp the relevant knowledge firmly, they are very difficult to complete. This kind of topic with appropriate difficulty increases the students' learning challenge, but it also cultivates the students' fighting spirit when facing difficulties. It is just the so-called "unlimited scenery in the dangerous peak". After breaking through these problems, students will benefit more.

2.2.3. Cooperating between schools and enterprises

In order to improve the development quality of virtual simulation experiment teaching system, the course group invited more than 10 well-known enterprises such as Jingdong Logistics to realize collaborative development. Jingdong Logistics is a subsidiary of Jingdong group, one of the world's top 500 enterprises. It is the first logistics enterprise in China to commit to establish the Science Based Targets initiative (SBTi)). The advanced experience of Jingdong Logistics in the field of global green logistics and the operation strength of e-commerce played a key role in the development of this project. Many logistics enterprises participated in the development of this project, which made the green logistics problems and design solutions refined in this course more accurate and effective.

In order to select the software development enterprises with rich development experience and strength to cooperate, the specific requirements and evaluation standards of the project were put forward in detail during the bidding, and the bidding enterprises were investigated in advance. Finally, the curriculum builders successfully selected a high-quality technology development partner.

In addition to the top-level cooperation between universities and enterprises, the course group also invited some enterprise experts to guide the project. For example, Xue Liu, a project director of Intelligent Supply Chain Industry Platform Department of Jingdong Logistics, has extremely rich practical experience in the simulation operation of e-commerce logistics.

Since the launch of GLVSE, in addition to more than 150 universities such as University of science and technology Liaoning and Shenyang University of Technology, many logistics enterprises such as Jingdong Logistics and Trawind Shipping Logistics Company have also applied in enterprise staff training. The curriculum builders have received many good feedback from students and enterprise staff. At the same time, this course has also received a lot of improvement opinions and suggestions from schools and enterprises. After continuous iteration, the green logistics virtual simulation experiment teaching system with high quality, stable operation and good effect was finally formed.

2.2.4. Reforming the teaching mode with the way of "mixed online and offline"

Online and offline mixed teaching process. In order to improve the effectiveness of experimental class and the effect of classroom experiment, drawing lessons from related research [18,19], students are arranged to study the standards and basic knowledge about green logistics in advance online. Relevant materials are uploaded in the "Internet platform" and "mobile learning app platform" of this experiment, which realizes the students' seamless self-learning connection between the computer end and the mobile end. In the simulation experiment class, teachers mainly carry out flipped teaching for knowledge points, who answer students' questions and teach key and difficult knowledge. At present, three grades of students have adopted this way of learning, and the overall satisfaction rate of students is as high as 98%.

Online and offline mixed teaching resources. The course group has established online MOOC, realizing the synchronous teaching with

Table 1
A mixed online and offline teaching assessment system based on OBE and TPOD.

Evaluation stage	Content and score of evaluation		Supporting objectives
Offline preview (Pretest, 10%)	1. Preview assessment: MOOC	5 points	(1)
	2. Flipped Q&A: flipped teaching	5 points	(1) (4)
Online operation (Interim test, 65%)	3. Online attendance	5 points	(4)
	4. Diagnosis and decision making of green logistics (higher-order properties test)	25 points	(2) (4)
	5. Air pollution calculation (challenging degree test)	15 points	(3) (4)
	6. Greenhouse gas emission calculation (challenging degree test)	15 points	(3) (4)
	7. Chapter assessment: MOOC	5 points	(1) (2) (3) (4)
Online interactive Q &A (Interim test, 10%)	8. Online community: participation	5 points	(4)
	9. Online Q & A: accuracy and innovation (innovation properties test)	5 points	(3) (4)
Offline report (Posttest, 15%)	10. Report format: normative	5 points	(4)
	11. Experimental conclusion: adequacy	5 points	(1) (2) (3)
	12. Experimental reflection: innovative (innovative properties testing)	5 points	(1) (3) (4)

the experimental course. The MOOC has five chapters of "experimental cognition, basic knowledge, equipment cognition, experimental training and experimental assessment", which are synchronized with the simulation experiment. Each chapter has three modules of "teaching guidance, chapter assessment and extended learning". In the "teaching guidance", there are the synchronous teaching videos; in the "teaching assessment", the assessment questions for important knowledge points are set; in the "extended learning", some cutting-edge learning materials about green logistics are provided. The establishment of MOOC greatly facilitates students' experimental self-study, and helps experimental teachers to carry out classroom assessment and management.

Online and offline mixed evaluation system. Outcome-based education (OBE) has become the direction of education reform in the United States and other countries. OBE requires schools and teachers to make clear the learning outcomes first, then let students realize their own outcomes with flexible personalized learning requirements and feedback the outcomes back to teachers to improve the original curriculum design [20]. GLVSE systematically integrates "higher-order properties, innovation properties and challenge degree" into the evaluation system, and establishes a mixed online and offline teaching assessment system based on OBE and TPOD as shown in Table 1. In order to effectively support and achieve the curriculum objectives, 12 indicators of 4 categories are used to evaluate students' performance.

3. Discussion

3.1. Successful experiences of GLVSE course

Combined with the construction process of GLVSE course, six successful experiences can be summed up. They will play a fundamental role in building a virtual simulation golden course.

The overall talent training structure should be constructed. Top level design is the strategic layout of experimental teaching project development and construction. Without solid foundation, strong support, advanced content and goal design, the development and construction of a virtual simulation experiment course will face many challenges. To build a Golden Course, we must analyze whether the existing construction foundation is solid or not. These foundations include the number of professional audiences, the number of teachers, the echelon of teachers, the published papers, teaching materials, monographs, project achievements, etc.). In addition, it is necessary to analyze whether there are advanced research, development and application strength at the theoretical, technical or practical level, whether it is reasonable and advanced in content design, and whether it is feasible and forward-looking in the overall goal of talent training.

TPOD should be realized through "three haves". "Higher-order properties, innovation properties and challenge degree", namely TPOD, is an important guide to the construction of Golden Course. However, to achieve it, we need to implement "three haves" – having design, having content and having evaluation. "Having design" refers to the top-level layout about TPOD in the overall structure of the course to achieve OBE teaching effect, rather than random combination of scattered convergence; "Having content" refers to the close combination of teaching content with TPOD, so as to realize the internal integration of knowledge points, rather than superficial significance show; "Having evaluation" means TPOD should be reflected in the performance evaluation system of the course so as to achieve closed-loop teaching, rather than snaking.

Carrying out the teaching reform of "online and offline mixed" actively. Most of the experimental courses in traditional university education depend on the laboratory. However, with the development of information, intelligence, visualization and personalization, the teaching mode of virtual simulation experiment courses also needs to be reformed. The teaching process, teaching resources and performance evaluation system of GLVSE course have been systematically reformed. The flipped teaching has been realized, and the reform attempt has been recognized by students. The results show that online and offline hybrid teaching is feasible and active in virtual simulation experiment teaching. More and more virtual simulation experiment courses can try to carry out teaching reform in related fields.

Full attention should be paid to "multi dimension" school enterprise cooperation. It is not necessary for any virtual simulation experiment project to invite industry enterprises to participate in the cooperative development. However, if a virtual simulation experiment project is not a pure scientific problem, but is related to practical application, then it is better to invite professional enterprises from related industries to participate. The development of virtual simulation experiment project requires the software to have a good degree of simulation, which not only reflects the reliability and validity of the mathematical model, but also reflects the authenticity of the scene. In the development of GLVSE course, the experience of cooperation with enterprises such as "Jingdong Logistics" tells us that cooperation with industry enterprises is conducive to data sampling and effect verification, especially to the model construction of some 3D experimental scenes such as 3D modeling of logistics center. At the same time, in the course development of virtual simulation experiment, we should cooperate with professional software development enterprises. Such enterprises should not only have solid technical development strength, but also have successful development cases in the field of this project. Therefore, in the project bidding, it is necessary to make the project development indicators as detailed as possible. The establishment of these indicators will play a key role in the final bidding effect of the project.

The guiding role of experts from all walks of life should be given full play. For the practical virtual simulation experiment teaching project, the rich experience of experts from all walks of life is a very valuable intellectual resource. Take GLVSE as an example, the course group invited Haiyun Hou who is the main drafter of Chinese national standard *GB/T 37099-2018 Green logistics indicators and accounting methods*. She has ILT logistics manager qualification, and has rich theoretical and practical experience in green logistics. The participation of these experts has obviously promoted the improvement of project quality.

"Open sharing" should be carried out to realize knowledge dissemination. The evaluation of a good course should be multi-faceted, in which the effect of curriculum implementation is an important index. Through open sharing, GLVSE course has not only been selected

in more than 150 universities, but also applied in many logistics enterprises. In this process, the course has been praised by all parties, and what is more valuable is the harvest of various feedback. These feedback and suggestions promote the course to achieve continuous iterative optimization, so as to obtain the continuous improvement of the course quality.

3.2. Successful model building virtual simulation golden course

By summarizing the construction process of GLVSE and integrating the above six enlightenments, we summarize a model of virtual simulation golden course as shown in Fig. 3. The model takes the virtual simulation experiment platform as the core, takes the talent training framework as the foundation, and combines with other five secondary indicators and 12 tertiary indicators, so as to finally achieve the goal of building Chinese virtual simulation golden course.

In this model, the "talent training framework" is the car framework of the virtual simulation experimental course construction. The strong car body is the forerunner of the Golden Course construction; "Two Properties and One Degree" is the engine of the virtual simulation experimental course construction, and the accurate drive is the driving force of the Golden Course construction; "school-enterprise cooperation" is the booster of virtual simulation experiment curriculum development, it has great potential from demand analysis, development and design to application promotion; Teaching Reform of "mixing online and offline" is the throttle pedal of virtual simulation experiment teaching, which can improve students' learning vitality; in addition, the participation of experts from all walks of life and "open sharing" are also the important parts of the development and construction of virtual simulation experiment courses. If the relevant virtual simulation experiment courses can be built with reference to this model, it will be beneficial to drive into the fast lane of first-class curriculum construction.

This is the first conceptual model to systematically reveal the construction of virtual simulation experiment golden course in China. It reveals the important links and mechanisms of virtual simulation golden course construction as a whole, especially the integration of Chinese Golden Course Standard into the model, which is of reference value for the theoretical research of virtual simulation experiment course construction.

4. Conclusion

As the experiencers taking part in the construction of GLVSE course, we investigated the research status of green logistics virtual simulation experiment related courses, sort out the key actions in the course construction of GLVSE, analyzed the successful experience of GLVSE course, and finally put forward a model of building virtual simulation golden course. We have given the clear answer to the presupposed questions.

In this case study, we have found some core construction tracks of GLVSE course, which promoted GLVSE course developed continuously and had been recognized by all walks of life. These important construction tracks include designing reasonable talent training architecture, reflecting Two Properties and One Degree, cooperating between schools and enterprises, and reforming the teaching mode with the way of "mixed online and offline" were summarized by us first. What needs to be specified here is that compared with the few previous research on the talent training framework in the logistics field [13,14], the talent training framework of GLVSE course has filled the gap in this research field. On the other hand, six successful experiences have also been successfully identified. They are constructing the overall talent training structure, realizing TPOD through "three haves", the teaching reform of "online and offline mixed", "multi dimension" school enterprise cooperation, guidance from experts in various industries, and knowledge dissemination with "Open sharing". Another most important finding is a model of building virtual simulation golden course was built successfully.

In theory, the model of building virtual simulation golden course proposed in this paper is the first conceptual one to systematically reveal how to construct virtual simulation experiment golden course. Compared with previous studies, mainly about the positive role of virtual simulation course construction such as [21,22], the platform construction of virtual simulation experiment course such as [23–25] and the construction of a virtual simulation experiment course such as [26,27], the model we proposed reveals the important

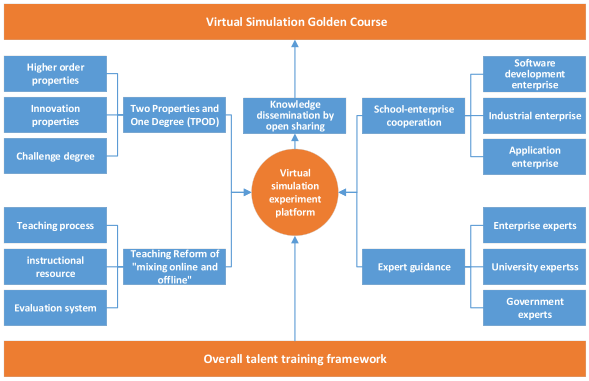

Fig. 3. The model of building virtual simulation golden course.

links and mechanisms of virtual simulation golden course construction as a whole, especially the integrating the standard of Chinese Golden Courses into the model, It has theoretical reference value for the course construction of virtual simulation experiment all over the world. In practice, the successful experiences of GLVSE course summarized in this study is more diversified. Compared with previous related studies such as [27–29], this study makes an in-depth exposition on the multi-dimensional cooperation between universities and enterprises, online and offline mixed teaching and so on. At the same time, in view of the interconnection of course teaching, the successful experiences and model of GLVSE will have many references value not only for Chinese universities but also for other universities in the world. It may make a positive contribution to improving the teaching quality of global virtual simulation course. In the future, we suggest that teachers engaged in virtual simulation teaching can refer to the experience of this case, especially the model of building virtual simulation golden course proposed by us, combined with the characteristics of students in different countries and regions, to develop high-quality virtual simulation golden courses with their own characteristics. GLVSE course has not such as block chain, big data artificial intelligence and so on till now, and the design related to carbon emissions is not very adequate in this course. In the follow-up construction of GLVSE course, to improve students' ability to familiarize themselves with emerging technologies and solve cutting-edge problems, we will continue to explore more successful experiences in this case, integrate emerging technologies and optimize the design on carbon emissions and carbon trading so as to make efforts to enrich the theory and practice in the field of green logistics and virtual simulation experiment teaching.

Author contribution statement

All authors listed have significantly contributed to the investigation, development and writing of this article.

Funding statement

This work was supported by Research Project on Undergraduate Teaching Reform of General higher Education in Liaoning Province in 2022 from the Educational Department of Liaoning Province [Grant number 220], Social Science Foundation of Liaoning Province (CN) [Grant number L22BJY040], Basic Scientific Research Project of the Educational Department of Liaoning Province (CN) [Grant number LJKQR20222553] and Education Project of Industry-University Cooperation of the Ministry of Education [Grant number 220505844255058, 202101057024].

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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