Exploration and Practical Teaching Improvement of "Game Simulation & Modeling" Course

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Abstract: Due to long-term lack of comprehensive practice platform in simulation courses, students suffer from the challenges of engineering ability and systemic thinking training restrictions, "teaching" and "learning" separation, etc. To solve those problems, our teaching group created a simulation competition platform independently for theoretical and practical teaching of "Game Simulation & Modeling" course. The introduction of competition platform has played a good role in stimulating students' learning motivation, training systemic simulation knowledge points and engineering ability, promoting theoretical and practical teaching, and enriching teaching materials through students' feedback and practice accumulation.

Keywords: Game Simulation & Modeling; Simulation competition; Teaching improvement

1. Introduction

Traditional simulation courses include "Discrete Event Simulation," "Continuous Event Simulation," "Object-Oriented Simulation," "Simulation Modeling," and "Comprehensive Design of Simulation System." Those courses are divided into different stages and focuses on learning of modeling theory, modeling methods, and simulation system design capabilities [1]. In this series of courses, "Game Simulation Modeling" is an application-oriented and comprehensive course. However, due to the lack of a comprehensive experimental platform, it is impossible to integrate different course knowledge points in a unified practical environment during teaching. Therefore, it is difficult to form a teaching model that links knowledge points in teaching and carries out practice evaluation orderly and systematically. There are following adverse effects:

(1) It is unable to training students' engineering ability and system thinking for lacking effective practice. The senior simulation majors have learned enough basic simulation knowledge and need to carry out more engineering practice. However, in the current curriculum, there are limited, separated and small practical topics for unit knowledge points evaluation. Those topics are relatively simple and difficult to effectively cultivate students' engineering abilities. At the same time, due to lack of typical cases, the practical contents are rugged and monotonous in realization, and seem to be separated from the game background.

(2) There are limited interaction between teachers and students with traditional teaching methods, resulting in difficult in accessing students' mastery. The current simulation teaching mainly adopts the form of courseware teaching, for example explaining the knowledge points by means of concept elaboration, formula derivation, two and three-dimensional static/dynamic example diagram display. Due to lack of convenient and effective auxiliary teaching tools and environment, there are little

effective means for students' active participation, division of labor and cooperation, and teacher-student interaction, resulting in the separation of "teaching" and "learning."

In order to solve above problems, our teaching group has created a simulation competition platform independently for "Game Simulation Modeling" course teaching. At first, we stimulate students' learning and interaction motivation through introducing competitions in course teaching. Secondly, students train engineering ability and systemic simulation knowledge points effectively based on competition platform with rich cases and excellent model. Finally, we enrich teaching cases and improve teaching content through students' practice accumulation and feedback. Through exploration and practice, we achieved the goal of enhancing students' learning enthusiasm and consolidating systemic simulation knowledge taught in the course through practice competition. Moreover, we can improve our theoretical and practical teaching method parallel.

2. Course targets

Simulation engineering is an engineering major to provide guarantee of training and equipment simulation talents for the army [2]. Students in the major should master basic theoretical knowledge of simulation, computer technology and other basic skills.

"Game Simulation Modeling" is a compulsory course for undergraduate students majoring in simulation engineering and related majors. The main content of the course includes the basic concepts of simulation modeling, quantitative description of environment, maneuver calculation of agent, target discovery, analytical calculation method of loss, index method to determine effectiveness, description of operations support, etc [3]. The course aims at cultivating students' overall simulation design ability, problem extraction ability, demand refining ability, and simulation engineering practice ability [4].

3. Competition platform integrated into the curriculum

In order to solve the problems of traditional teaching mode in "Game Simulation Modeling" course, the teaching group designed and developed a competition platform independently to meet the demand and course goals. Taking the platform as the starting point, we provide a practical environment to improve the quality of the courses.

3.1. Competition background and rules
3.1.1. Competition background

The Simulation Challenge Competition is sponsored by the Department of Modeling and Simulation of the College of Systems Engineering, National University of Defense Technology. The competition cuts edge of different advanced technologies such as cloud computing and intelligent human-computer interaction. Through competition, research on key issues can be carried out such as agent planning and decision-making, situational awareness, knowledge reasoning, confrontation games, and collaborative cooperation, which provide a solid foundation for research and engineering practice for students [5].

3.1.2. Competition rules

The competition is divided into two stages: preliminary and final stage. The preliminary round adopts a single round-robin system, and the final adopts a group round-robin system. Single round-robin competition system is designed as following: a model submitted by the contestant competes with all other participating models once, and the final ranking is ranked according to the winning rate and points of each team in all competitions. Group round-robin system is designed as following: participants entering the finals are divided into two stages. At first, a single round-robin match will be held within the group, and the ranking will be based on winning percentage and points. Secondly, the teams will compete against each other in the

order of ranking to determine the final ranking of each team.

3.2. Competition scenario and content
3.2.1. Competition scenario
The main background of competition is offensive and defensive battle of tank. Surrounding with typical actions such as advancing, unfolding, and seizing impact targets, tank encounter competition scenario is designed to traction competition activity and agent strategy design.

On a certain day of the month, the tanks of A and B met in a certain place and demanded to end the battle within the specified time. In this scenario, both sides carry a certain number of missiles and can turn on shield defense, and a series of sensors are configured to detect map elements. The tank can communicate within a certain distance.

3.2.2. Competition content
Based on the training simulation system independently developed ourselves, we abstract and simplified construction of a lightweight simulation competition platform. The platform is composed of functional modules such as visualization, simulation engine, componentized model, data collection and playback, and engagement ruling.

For this competition, the platform implements and limits the types of tank executable actions and perceptual input information. Participants finish the design and code of tank behavior logic and tactics rules by using machine learning, behavior trees, behavior scripts and other methods flexibly.

3.3. Integration of competition into curriculum practice
During the course teaching, we make use the competition platform in course system introduction and knowledge points explanation. On one hand, we use the platform to connect knowledge points under case when introducing the course system. On the other hand, we visualize the knowledge point by platform and facilitate students' understanding when explaining basic logic. Moreover, in the students' practice session, students carry out a full practice of modeling and simulation based on the platform for a specific scenario, which is used to evaluate and improve the systemic knowledge application. The detailed approach is as follows:

3.3.1. Visualizing basic knowledge explanation based on the competition platform
In course teaching, we use the competition platform to explain the basic knowledge points of the course. In this way, teachers can explain and derive formulas by implementing operations on the platform and learning knowledge from practice, instead of traditional blackboard writing, static pictures and animation demonstrations. For example, in the target discovery section, we use the competition platform as an example to explain how to calculate the visibility, and lead students to code. The competition platform environment is very good at brought students into the world of the simulation system, which allow students to understand the role and significance of the teaching content set in the course from the perspective of simulation engineering.

3.3.2. Using the competition platform to link knowledge
Although the case is simple, most of course knowledge points are included in the competition platform implementation. For example, the quantitative description of the environment corresponds to the map and various features on the competition platform map. The maneuver calculation of the agent corresponds to the maneuvering of the tank on the map. The target discovery involves the obstacles on the map and the sensor detection. Therefore, we can connect various knowledge points in series through the competition

platform to explain the relationship between those knowledge points. It is entirely different from the loose relationship of knowledge points in traditional teaching, so that students can recognize the entire curriculum as a system. When learning a new knowledge point, students will understand its role and function in the knowledge system they have learned.

3.3.3. Examining students' mastery and application of knowledge through the competition platform

Using the platform in the course teaching, we not only require students to create a tank behavior model that can run and even destroy enemy tanks, also we require students to introduce their design ideas and what knowledge they have used. At the same time, we will also question about the tank behavior model designed to examine students' understanding extent of specific knowledge.

4. Role in teaching

As a long-term teacher of this course, the author finds the urgent problem of low participation and low enthusiasm of students in the traditional teaching methods. Some students report that the content of the course is relatively abstract and the knowledge is boring. Even those students getting good scores in the final exam, also reflect that they do not know the role of the "Game Simulation Modeling" course knowledge and how to apply it. The pure theoretic teaching and separated practice topic does not improve their ability effectively. However, after the introduction of competitions in the curriculum, significant changes have taken place both in terms of student learning attitudes and class atmosphere. The following effects have been presented.

4.1. Competition inspires enthusiasm for learning

After introducing competitions into the curriculum, students' learning enthusiasm has been greatly improved. We analyzed the following reasons.

4.1.1. Forming a competitive atmosphere in the class

Through the guidance of the competition, students will no longer regard this course as just a course that can be completed by traditional lectures and pre-test surprises. Instead, it has become a stage of competition among students of the major. Students with a better foundation are eager to try not to give in to each other and stimulate their enthusiasm for learning in the competition. At the same time, since the competition is set as a team battle, each group must have three members. The students with poor foundation must study hard in order not to hinder the team. A good class learning atmosphere is formed invisibly.

4.1.2. The important role of the competition itself in promoting learning

The simulation challenge competition that this course relies on is currently designated as a school-level competition, and the awards of the competition are bonus points for students' evaluation. Especially for students who have good academic performance and intend to get the admission of postgraduate recommendation without examination, the competition has greatly improved their enthusiasm for learning because of the high factor. In addition, the prizes of this competition are rich and very attractive.

4.1.3. Selecting outstanding students to teach them in accordance with their aptitude to improve their abilities

In addition, through organizing competition training and guidance in class and after class, we have discovered a group of students who are interested in research. We encourage this group of students to maintain close contact with the teaching and research team, and even enter the laboratory in advance to carry out academic research. In this process, we teach students in accordance with their aptitude, so that

outstanding students can learn more knowledge outside the course, get more practical opportunities and teacher guidance, which can prepare for the goal of cultivating future scientific and technological talents for this major.

The author evaluates the students after the lecture. Students generally think that it is helpful to add a competition to the course. Among them, students believe that the most important factor to improve learning is the improvement of the learning atmosphere (41%), and the second most important factor is students who recommend graduate students to interview and prepare for admission (32%).

4.2. Completing theoretical and practical teaching goals effectively

On the one hand, the introduction of the competition has increased the students' enthusiasm for learning and improved the learning effect. On the other hand, the competition itself is also a good theoretical and practical teaching method, which solves the bottleneck problem of traditional teaching methods.

4.2.1. Improving students' understanding of the basic theories and key content of the course

In this course, teachers need to explain a lot of terms related to simulation systems. As a person who has been engaged in teaching and scientific research in this major for a long time, the author is relatively familiar with simulation systems and easy to understand the major terms. However, for students who have not been exposed to simulation systems, these concepts are really difficult to be understood, such as why random numbers can be used to simulate the dynamic process in the Monte Carlo calculation of loss. The competition platform is a typical miniature version of the simulation system, which can bring students into the environment of the simulation system and facilitate them understanding the design idea of the simulation system [6].

At the same time, some key content in the course, such as observation-orientation-decision-action loop (OODA loop), can only be described to students in the traditional method. After introducing the competition platform in the course teaching, students can correspondingly understand the role and meaning of each module in the competition platform.

4.2.2. Strengthen students' practical ability

The introduction of the competition platform provides students with an environment where they can practice what they have learned in the course. To train students' engineering abilities, the platform not only provides C++ language and behavior tree method to control tank behavior, but also provides an interface based on Python language to use machine learning method to control tank behavior. It greatly meets the needs of students of different abilities, and has a good practice platform for students of different abilities. At the same time, relying on the competition, students have teachers to provide timely guidance when they encounter difficulties, and students can safely try to get in touch with the cutting-edge knowledge of simulation, boldly innovate and write more complex and intelligent tank behaviors.

4.3 Accumulation of course teaching materials

This competition platform is an iterative development platform. In the initial competition platform, there is only simple tank behaviors coded by platform designer. After more and more students joined, the tank behavior was gradually written more complex and intelligent.

4.3.1. Accumulating materials by using the competition platform in the course

After several rounds of attempts to integrate the competition into the teaching, there are outstanding works in each class of students. The author will keep the outstanding works of each class and show them to them in the next class. Knowing that if my work can be done well, it can be learned by future students, which

also stimulated their enthusiasm for learning.

These complex tank behavior models have also become a means of accumulating materials for this course. The material compilation of cutting-edge extended content related to machine learning in this course requires a lot of time and energy to build, and it is difficult for the R&D team to achieve perfect implementation cases. The behaviors written by students in the competition greatly enriched the course and competition materials. It also provides learning materials for future students, and can greatly improve the quality of teaching and competition.

4.3.2. Developing platform through external resources

Based on the competition, we established a WeChat exchange group, WeChat official account, and a technical exchange community, effectively establishing a communication channel for the user platform. We develop iteratively through this interaction between teaching and learning. As a developer and platform maintainer, we will continue to improve and expand platform functions to support user needs, and at the same time gradually try to change the competition rules, add other elements, and enrich the platform and teaching content.

5. Conclusion

By incorporating the simulation challenge competition platform into the course, the problem of the separation of "teaching" and "learning" in the long-term simulation course in traditional teaching has been effectively solved. The introduction of competitions in the curriculum shows great potential in stimulating the learning enthusiasm, enriching curriculum materials, and promoting students' understanding of the curriculum key content.

In future teaching and competitions, we will continue to conclude our experience to adjust and improve the competition platform and teaching methods based on the problems reported by students. What's more, we will try to promote the competition platform to other related courses of simulation engineering to improve the cohesion between courses.

Disclosure statement

The authors declare that there is no conflict of interest.

Author contributions

Conceptualization, Q.Z. and K.X.; Formal analysis, L.Q.; Funding acquisition, Q.Y. and K.X.; Investigation, J.Z., and Q.Z.; Project administration, Q.Y.; Validation, J.Z. and Q.Z.; Writing original draft, Q.Z. and K.X.; Writing review & editing, Q.Z. and L.Q.

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