

Research on Virtual Simulation Experimental Teaching of Audit Decision-Making Based on Multi-Party Dynamic Games

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Abstract

To address the challenges of traditional audit experimental teaching, including limited access to real-world scenarios, high trial-and-error costs, long experimental cycles, and difficulties in presenting multi-party dynamic games, this study constructs a virtual simulation experiment course for audit decision-making based on multi-party dynamic games. The course takes a virtual enterprise operation environment as the carrier, integrates game theory in economics, process design incorporating industrial chain thinking, and experimental economics perspectives, and develops a virtual simulation experiment system covering the entire process of audit decision-making, comprehensive evaluation, and experimental report writing. By embedding artificial intelligence technologies such as DeepSeek, the course achieves deep integration between audit decision-making and intelligent assistance. The course adopts a blended online and offline teaching mode, supporting multi-role collaboration, simulation of multi-party dynamic games, human-computer interaction, and whole-process evaluation. It effectively enhances students' audit judgment, decision-making, and comprehensive practical capabilities, providing an innovative experimental teaching model for cultivating high-quality talents in finance and economics in the era of digital intelligence.

Keywords

Multi-party dynamic games; Virtual simulation experiment; Audit decision-making; Experimental teaching.

1. Introduction

With the rapid development of new-generation information technologies, including the digital economy, artificial intelligence, and big data, the business environment has become increasingly complex, and audit decision-making has exhibited characteristics of multi-party collaboration, multi-factor coupling, and multi-party dynamic games. These changes have placed higher demands on the comprehensive analytical capabilities, risk judgment capabilities, and decision-making capabilities of high-quality talents in finance and economics. The Outline for Building a Leading Education Country (2024–2035) and the Educational Digitalization Strategic Action explicitly propose deepening the integration of information technology and education, promoting the development of virtual simulation experimental teaching, innovating practical teaching models, and cultivating high-quality talents with innovative spirit and practical capabilities. Against this background, constructing immersive, interactive, and intelligent experimental teaching environments based on virtual simulation technology has become an important direction for promoting practical teaching reform in finance and economics disciplines.

However, traditional audit experimental teaching remains primarily focused on case analysis, software operation, and individual business training, and generally suffers from challenges such as difficulties in reproducing real business scenarios, simulating multi-party dynamic games, high trial-and-error costs, long practice cycles, and insufficient comprehensive decision-making training, making it difficult to meet the requirements for cultivating high-quality talents in finance and economics in the new era [1–2]. In particular, during enterprise operation management and audit decision-making processes, complex stakeholder interest games and dynamic decision-making relationships exist among corporate managers, auditors, and market participants [3]. Traditional experimental teaching cannot fully present the entire processes of enterprise operation management and audit decision-making, resulting in students' lack of authentic decision-making experiences and certain limitations in cultivating their comprehensive practical capabilities and innovative capabilities.

To address these issues, this study develops a virtual simulation experimental teaching approach for audit decision-making based on multi-party dynamic games. The course uses a virtual enterprise operation environment as the carrier, integrates game theory in economics, process design incorporating industrial chain thinking, and experimental economics perspectives, incorporates artificial intelligence technologies such as DeepSeek, and constructs a virtual simulation experimental system covering the entire processes of decision preparation, audit decision-making, comprehensive evaluation, and experimental report writing. This approach enables collaborative training in enterprise operation management and audit decision-making. Through blended online and offline teaching, multi-role collaboration, human-computer interaction, and intelligent-assisted decision-making, the approach effectively overcomes the temporal and spatial limitations of traditional experimental teaching, enhances students' audit judgment, decision-making, and comprehensive practical capabilities, and provides new ideas and practical pathways for practical teaching reform in finance and economics disciplines and the cultivation of high-quality application-oriented talents in the era of digital intelligence.

2. Analysis of the Teaching Needs for Virtual Simulation Experiments of Audit Decision-Making

(1) Inaccessibility of real-world audit decision-making scenarios based on multi-party dynamic games.

Opportunities for entity-based experiments are limited, and restricted physical spaces make first-hand experience difficult to achieve. In real enterprises, core business decisions are rarely assigned to students, and traditional experimental teaching cannot fully create the environment of multi-party dynamic games among enterprises, auditors, and other market participants [4–5]. Through virtual simulation technology, this experimental teaching integrates real cases with real data into the classroom, enabling students to conduct virtual training activities anytime and anywhere through personal computers and other terminal devices. This approach addresses the problems of limited practical opportunities and the inability to effectively develop professional capabilities.

(2) High trial-and-error costs of entity-based experiments.

The outcomes of audit decision-making based on multi-party dynamic games are irreversible, and decision-making failures may lead to serious consequences. Real-world enterprises vary significantly in their operating conditions, and experiments may encounter issues such as limited managerial capabilities, incomplete financial management systems, weak risk resistance capabilities, high operational risks, and insufficient capital resources, making non-professionals' decisions highly likely to generate trial-and-error costs [6–7]. This may cause substantial losses to both the state and enterprises. However, this experimental teaching

incorporates a well-developed fault-tolerance mechanism, allowing students to repeatedly conduct experiments in a virtual simulation environment, identify and summarize errors. Through accumulating experience in virtual simulation experiments, students can substantially improve their business decision-making capabilities in future practical work, thereby reducing trial-and-error costs.

(3) Long experimental cycles of entity-based experiments.

Financial activities, audit engagements, and the manifestation of decision-making effects require long periods, which may take several months or even more than one year. The gap between short-term and long-term decision-making effects is substantial, making it difficult to form an overall evaluation of decision-making effectiveness within a short period [8]. Therefore, students find it difficult to conduct full-process and systematic learning practices. This experimental teaching uses human-computer interaction-based virtual reality technology to condense the experimental process and greatly improve learning efficiency, thereby effectively addressing the problem of long experimental cycles in entity-based experiments.

(4) Complex influencing factors of multi-party dynamic games.

Due to the complexity of socio-economic environments and dynamic games, traditional teaching experiments have difficulty covering the various factors involved [9]. This experimental teaching can visualize abstract and difficult-to-understand procedures, create concrete decision-making scenarios, effectively address the "pain points" in professional teaching, stimulate students' initiative and enthusiasm for decision-making exploration, and improve the quality of talent cultivation.

By utilizing information technology, enterprise operation environment simulation addresses students' "unknowable" problems, process simulation addresses students' "undoable" problems, and decision-making game simulation addresses students' "unreachable" problems. By integrating multidisciplinary knowledge and skills from economics and management into virtual simulation teaching, students' practical and innovative capabilities are enhanced. Therefore, the development of virtual simulation experiments for audit decision-making based on multi-party dynamic games is highly necessary.

3. Implementation Path of Virtual Simulation Experimental Teaching for Audit Decision-Making Based on Multi-Party Dynamic Games

The experimental teaching is based on the market environment of virtual enterprise operations and uses virtual simulation to simulate enterprise management decisions and audit decision-making. By embedding artificial intelligence functions (such as DeepSeek), it enhances students' comprehensive practical capabilities.

(1) Game simulation incorporating game theory in economics.

Students are divided into several enterprise-operated entities and assume different roles within enterprises, including general managers, marketing managers, financial managers, and auditors. Students engage in games under different market environments and receive comprehensive evaluations of annual performance. Due to rapidly changing market demands, competitors have greater space for analysis, consideration, and decision-making.

(2) Process design incorporating industrial chain thinking.

In the virtual simulation experimental teaching of audit decision-making based on multi-party dynamic games, upstream and downstream organizations are designed with reference to the business processes of leading domestic enterprises. Multiple key tasks and daily work tasks extracted from various positions are designed to approximate real organizational operations, thereby realizing process simulation.

(3) Enterprise operation environment incorporating experimental economics theory.

The experimental teaching includes all links of the complete enterprise operation supply chain, as well as various simulated organizations involving related service industries and administrative management institutions. It constructs operating environments consisting of virtual enterprises, tax administration departments, market regulation departments, consulting institutions, banks, and other entities. Students are required to virtually implement policy analysis, market forecasting, product production, sales, after-sales services, and internal enterprise management. Key functional departments and major job positions within enterprises are extracted and simulated, thereby achieving the construction of a complete virtual environment.

4. Experimental Procedures of Virtual Simulation for Audit Decision-Making Based on Multi-Party Dynamic Games

Following the principle of using real cases as the foundation, virtual simulation to reproduce reality, and practical authenticity as the basis, this experimental teaching adopts real enterprise cases that are freely selectable by experiment participants. Through the experimental teaching platform, it integrates online human-computer interaction and offline team discussions. During the experiment, participants make autonomous decisions throughout the entire process and independently complete experimental tasks under system-assisted guidance, a task-driven approach, and artificial intelligence embedding. The experimental process is shown in Figure 1.

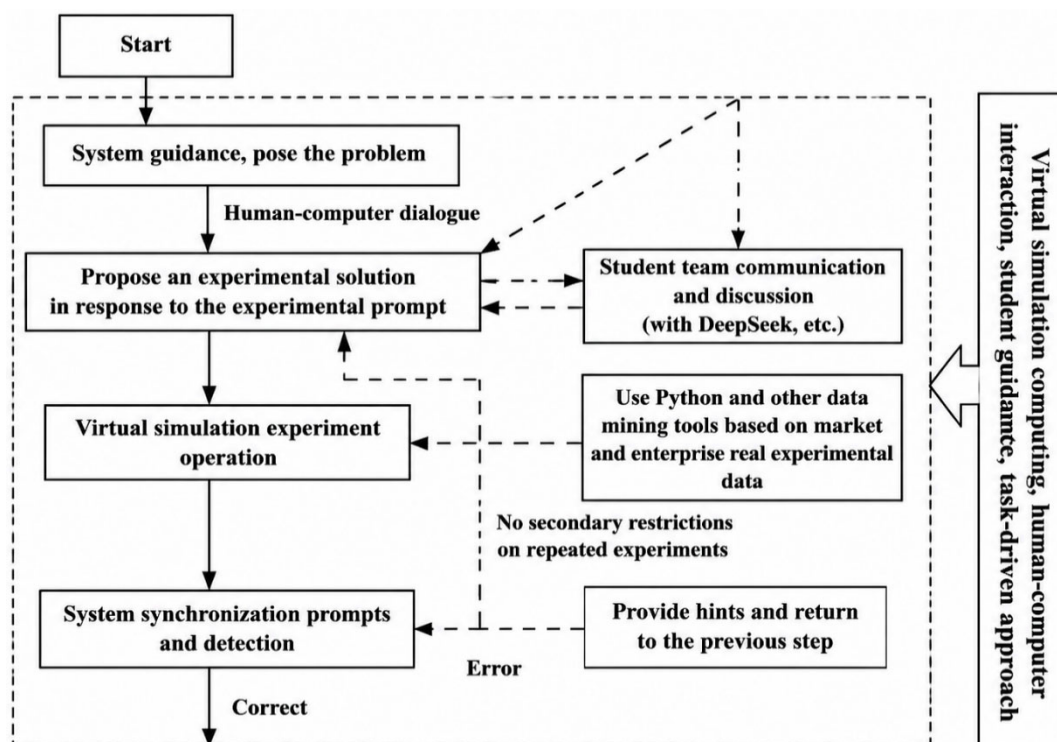


Figure 1. Experimental Operation Flowchart

For students from the grades and majors offering the experimental course, instructors assign virtual simulation experiment learning tasks and specific requirements. Students can conduct experiments using their own computers or by making reservations to access the college's virtual laboratory. The experimental content mainly includes the decision preparation phase, enterprise operation management phase, comprehensive evaluation phase, audit decision-making phase, and experimental report phase, with each phase building upon and connecting with the subsequent phase.

In the first phase, decision preparation, students independently study relevant materials, fully experience the management scenarios, and lay the foundation for conducting enterprise operation management and audit decision-making. In the second phase, enterprise operation management, students complete procedures including establishing enterprises, making strategic decisions, managing procurement, production, and sales, and generating operating results (balance sheets, income statements, and operating performance rankings). In the third phase, audit decision-making, students conduct risk assessment, materiality level estimation, audit procedures, and audit decision-making. In the fourth phase, comprehensive evaluation, students participate in one-on-one question-answer competitions or human-computer competitions based on a preset question bank. In the fifth phase, students write experimental reports.

(1) During the decision preparation phase, multiple learning resources are embedded into the system. Students first enter this phase to study experimental-related content and understand the decision-making background information. Based on this preparation, a one-class-hour offline session is arranged, in which instructors provide centralized explanations of decision-making rules, guide students in the preliminary construction of the experimental project and the first enterprise operation task, and enable students to independently become familiar with enterprise operation rules.

(2) During the enterprise operation management phase, students complete the decision-making game process according to operational guidelines. After students input decision variables, the system automatically calculates order allocations and presents sales revenue and operating results. After the game results are generated, the system displays and evaluates the outcomes of the first enterprise operation decision-making round. The remaining operations are student-centered, with students conducting independent training according to the guidance provided by the basic experimental procedures within the specified completion period. During the process, online and offline teacher-student interaction and question answering are available.

(3) During the audit decision-making phase, an audit module is constructed based on big data tools such as Python. Through risk assessment, materiality level estimation, audit procedures, and audit decision-making, students' audit practical capabilities and decision-making abilities are enhanced.

(4) During the comprehensive evaluation phase, students select either the online one-on-one competition mode (randomly matched opponents) or the individual online answering mode to complete randomly selected questions. After confirmation and submission, the system provides immediate performance feedback. Students may answer multiple times, and the highest score obtained is taken as the final score for this phase.

(5) During the experimental report phase, students independently review the gains and losses during the decision-making process throughout the experiment, reflect on methods for optimizing decisions, and improve their disciplinary thinking abilities through systematic summarization.

5. Conclusion

This study addresses the challenges in traditional audit experimental teaching, including difficulties in obtaining real-world scenarios, high trial-and-error costs, long experimental cycles, and the inability to fully present the processes of multi-party dynamic games, by constructing a virtual simulation experimental teaching system for audit decision-making based on multi-party dynamic games. The system relies on a virtual enterprise operation environment, integrates game theory in economics, industrial chain thinking, and experimental economics theory into course design, and incorporates artificial intelligence tools such as

DeepSeek to establish a whole-process teaching model integrating decision preparation, enterprise operation management, audit decision-making, comprehensive evaluation, and experimental report writing. Through multi-role division, dynamic competition, human-computer interaction, online and offline collaboration, and task-driven approaches, students can complete enterprise operation and audit decision-making training in a low-risk and repeatable environment. This experimental teaching model not only overcomes the limitations of traditional entity-based experiments in terms of time, space, cost, and scenarios, but also strengthens students' understanding of the intrinsic relationships among financial activities, enterprise operation management processes, and audit engagements. It contributes to enhancing students' capabilities in financial analysis, risk judgment, audit decision-making, teamwork, and comprehensive practical application. This experimental teaching model provides a feasible pathway for the deep integration of digital intelligence technologies and finance and economics education, while offering practical references for cultivating high-quality talents in finance and economics with innovative awareness and complex decision-making capabilities.

Acknowledgments

This work was supported by Jiangxi Provincial Social Science Fund (Grant No. 25GL22); Jiangsu Provincial Science and Technology Plan Project (Grant No. BR2023020-3); Yangzhou Social Science Research Project (Special Topic for Audit) (Grant No. 2026YSJ-001); Teaching Reform Research Project of Yangzhou University (Grant No. YZUJX2022-C18); and Teaching Reform Research Project of Yangzhou University (Undergraduate Discipline Competition Special) (Grant No. xkjs2025052).

Data availability

Data can be obtained from the corresponding author on request.

Declaration of Interest Statement

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.

Conflicts of Interest

The authors declare no conflicts of interest.

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