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Effect of Scenario Simulation Teaching Method on Fire Prevention Ability of First-Year Vocational Students

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Abstract

Background and Aims: Fire prevention education is a core component of campus safety management in vocational colleges, especially in Yunnan Province, where vocational colleges are concentrated, and campus fire accidents involving vocational students have been reported in recent years. Vocational freshmen face higher fire risks due to insufficient safety education and unfamiliarity with campus environments. Traditional one-way indoctrination fails to equip students with practical fire prevention skills. This study explores the effectiveness of scenario simulation teaching in enhancing fire prevention ability among vocational freshmen to support campus fire prevention goals.

Methodology: This study adopts a quasi-experimental design of pre-test and post-test. Using the cluster random sampling method, 30 first-year students were selected from Yunnan Transportation Vocational College as samples. The intervention measures include 12 hours of scenario simulation teaching, covering six modules. Collect data through fire theory knowledge testing and fire practice skills testing, and analyzed using the dependency t-test and the single-sample t-test.

Results: After using scenario simulation teaching intervention, the average score of students' fire prevention ability (M=82.00, SD=3.54) significantly increased by 29.3 points compared to before intervention (M=52.70, SD=4.60), and the difference was highly statistically significant (t=28.36, p=.001<0.01)The score after intervention was significantly higher than the predetermined qualified standard of 70% (t=18.55, p=. 001<0.01).

Conclusion: The scenario simulation teaching method has effectively improved the fire prevention ability of first-year vocational college students and achieved high acceptance among participants. This indicates that integrating scenario simulation teaching into the systematic development of campus fire safety courses can help enhance students' fire prevention abilities.

Keywords: Scenario Simulation Teaching Method; First-Year Vocational Students; Fire Prevention Ability

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Introduction

Fire continues to pose a significant threat to campus safety, particularly among freshmen in vocational institutions, who often demonstrate insufficient fire prevention awareness and limited practical response skills (Ahmad et al., 2022). Yunnan Province, a major vocational education hub in southwest China with over 100 vocational colleges, faces a severe campus fire safety situation. Fire safety statistics from Yunnan's education system (2022–2024) show that 65% of campus fire accidents involve vocational students, and 78% of the responsible parties are freshmen with inadequate fire prevention skills. This highlights the urgency of enhancing fire prevention competence among vocational college freshmen in the region. China's 14th Five-Year Plan for National Fire Protection (2022) mandates strengthening experiential fire safety education for young people and integrating it into vocational education curricula. However, traditional vocational fire prevention education relies on one-way indoctrination, leading to low knowledge retention and poor skill transfer (Geng et al., 2023). Students often lack proficiency in fire hazard identification, equipment operation, and evacuation route familiarity, resulting in a "knowledge-practice gap" (Liu et al., 2024)

As a potential solution to this dilemma, the scenario simulation teaching method has garnered increasing attention. Grounded in constructivist learning theory (Piaget, 1972), experiential learning theory (Kolb, 1984), and situated cognitive theory (Lave & Wenger, 1991), it constructs realistic fire scenarios to enable students to gain immersive experience through role-playing and task-driven learning. It transforms abstract theoretical knowledge into practical operational skills, thereby enhancing learners' emergency response capabilities through experiential engagement and active application (Kolb, 1984). Previous studies have shown that scenario simulation teaching can enhance students' practical skills and learning initiative across a range of educational contexts (Li et al., 2024), yet systematic empirical research on its application in vocational college fire safety education remains scarce.

To address this research gap, this study aims to investigate the impact of the scenario simulation teaching method on the fire prevention ability of first-year vocational college students. This research seeks to determine whether a structured scenario simulation teaching plan can bridge the "knowledge-practice gap" in fire safety education and ultimately improve students' emergency response capabilities.

Objectives

1. To compare students' fire prevention ability before and after learning through the scenario simulation teaching method.

2. To compare fire prevention ability with the determined criterion of 70%

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Literature Review

Definition and teaching steps of the scenario simulation teaching method

Scenario simulation teaching method refers to constructing realistic scenarios for students to engage in role-playing and decision-making exercises, with real-time feedback to promote knowledge internalization and ability improvement (Kolb, 1984). Its core characteristics include a high level of simulation, learner-centered participation, competency orientation, and multidimensional interaction, which are consistent with the principles of experiential learning and practice-based instruction (Kolb, 1984). Theoretically grounded in multiple learning theories—such as constructivist learning theory, which emphasizes active knowledge construction through situational interaction (Piaget, 1972); experiential learning theory, which highlights the cycle of "experience-reflection-application" (Kolb, 1984); and situated cognitive theory, which emphasizes knowledge acquisition in specific contextual practices (Lave & Wenger, 1991)—this method is validated as a rational and effective approach to bridging the gap between theory and practice. The teaching process in this study follows a structured instructional sequence consisting of scenario construction and goal setting, role allocation and clarification of standards, simulation practice and process monitoring, immediate feedback and corrective guidance, and finally summary, reflection, consolidation, and improvement, which aligns with the experiential learning cycle proposed by Kolb (1984).

Numerous studies have demonstrated the positive impact of scenario simulation teaching on knowledge application and practical competence across diverse disciplines. Domestically, Du and Gao (2016) reported that fire safety knowledge serves as a significant positive predictor of escape ability, establishing a fundamental link between cognitive awareness and physical response. Furthermore, scenario simulation has been shown to effectively enhance students' practical skills and learning enthusiasm in fields such as management and nursing (Li et al., 2024). Internationally, Kolb (1984) emphasized that experiential and scenario-based learning fosters critical thinking and facilitates knowledge transfer; however, a persistent gap often remains between theoretical fire safety knowledge and actual safety behavior in practice (Al-Rashdi, 2021; Ahmad et al., 2022). In addition, international studies have explored the integration of scenario simulation with emerging technologies such as VR and gamification in safety education. For instance, Smith et al. (2023) applied VR fire simulation in college safety education and found that it enhanced students' immersive experience, though the high cost restricted its application in vocational colleges. Jones et al. (2024) designed gamified fire simulation courses with high student participation, but their effect on improving practical skills was weaker than that of traditional scenario simulation.

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The definition, importance, and constituent elements of students' fire prevention ability

Students' fire prevention ability is a comprehensive competency structured around the logical framework of "prevention in advance, disposal during the event, and escape after the event." Specifically, it refers to students' capacity to apply fire-related knowledge and skills to prevent fires, respond to emergencies, and protect their own and others' safety when facing fire risks (Lin et al., 2021; Australian Disaster Resilience Knowledge Hub, 2023).

Fire prevention ability constitutes a fundamental component of the overall safety assurance system, serving as the first line of defense in preventing fire incidents and as a critical support in fire response and rescue. Given that many fire accidents are closely associated with human factors and negligence, strengthening college students' fire safety awareness and practical prevention skills can help mitigate risks at the source and reduce the overall incidence of fire events (Ahmad et al., 2022). In densely populated campus environments, such capabilities enable individuals to effectively identify and avoid potential risks, contributing to a coordinated "individual–group" safety protection mechanism and ultimately enhancing the overall level of campus safety (Ahmad et al., 2022). Furthermore, strengthening fire prevention ability is essential for improving emergency response efficiency. Adequate knowledge and practical skills facilitate timely alarm activation, correct use of firefighting equipment, and orderly evacuation, thereby increasing survival time and enhancing both self-rescue and mutual rescue capabilities. Conversely, insufficient preparedness may result in panic, misjudgment, and missed optimal response opportunities (Du & Gao, 2016).

College students' fire prevention ability encompasses two core dimensions—systematic theoretical knowledge and practical operational skills—and its development generally follows a progression from cognitive understanding to practical application, consistent with experiential learning theory (Kolb, 1984). Theoretical knowledge serves as the foundation for rapid and accurate responses, encompassing fire hazards and causes, firefighting equipment and their application scope, fire spread laws, safety regulations, and the "alarm-firefighting-coordination" emergency process (Guo, 2023). Practical skills, conversely, are the guarantee for effective response, mainly divided into two areas: first, fire handling ability, which involves identifying and stopping illegal behaviors, cutting off sources, alarming in a timely, and proficiently operating equipment; second, comprehensive evacuation ability, including orderly evacuation to safe areas, formulating or implementing collective plans in complex scenarios, and exercising independent judgment (Qin, 2024; Guo, 2023).

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Conceptual Framework

This study constructs a core path where teaching methods influence learning motivation, which in turn affects fire prevention ability. It takes scenario simulation teaching method as the independent variable and vocational college students' fire prevention ability (theoretical knowledge and practical skills) as the dependent variable. The teaching implementation adopts a five-step process that proceeds from scenario construction to role allocation, simulation exercise, review and consolidation, and finally summary and refinement. It stimulates learning motivation through value recognition, learning interest, and process perception, and promotes students' active, deep learning. The ability assessment uses a dual-dimensional model integrating theory and practice to transform theory into practical tasks around four core indicators, practices, and Kolb's experiential learning theory, which achieves efficient transformation from theoretical knowledge to practical skills, and enhances students' comprehensive fire prevention abilities.

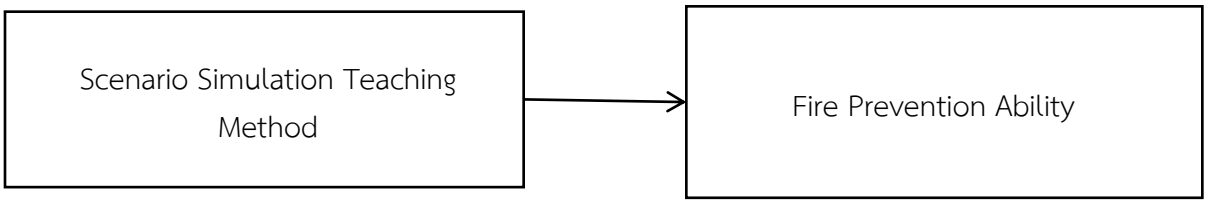


Figure 1 Conceptual Framework

Participants

Population and Sample

The participants were 120 first-year students from Yunnan Vocational College of Transportation, aged 17–19, with no prior systematic fire safety education, ensuring homogeneity. Cluster random sampling was used to select 30 students as the sample, based on quasi-experimental research requirements and the college's teaching schedule. Sampling Method

Data Collection Tools and Quality Evaluation

Data were collected using two main tools: a fire prevention competence test (theoretical knowledge and practical skills) and a student satisfaction questionnaire. Key quality metrics are

1. Theoretical knowledge test: KR-20 reliability = 0.82 (>0.7), item difficulty 0.20–0.80, item discrimination >0.20, indicating high internal consistency and content validity.

2. Practical skills test: Pearson inter-rater reliability = 0.75 (>0.6), showing high expert scoring consistency.

Research Design

A one-group pretest-posttest design was adopted in this study. The independent variable was the scenario simulation teaching intervention, and the dependent variables were students'

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fire prevention competence and learning satisfaction. The intervention consisted of 12 class hours of scenario simulation teaching (6 lesson plans, 2 class hours per lesson plan) implemented from November 2025 to March 2026

Research Instruments

1. Lesson Plans: Five experts evaluated the applicability of each component of the course plans using a 5-point Likert scale (1 = "very low" to 5 = "very high"). Descriptive statistics, including the mean (M) and standard deviation (SD), were then calculated to analyze the overall appropriateness of the course plans.

2. Fire Prevention Ability Test: This test comprises two dimensions. For the theoretical knowledge dimension, a preliminary experiment was conducted on 30 non-research-sample students. The reliability coefficient, calculated via Kuder-Richardson Formula 20 (KR-20), was 0.82 (exceeding the 0.7 target), indicating high internal consistency; its content validity was ensured by verifying item difficulty (0.20–0.80) and discrimination (>0.20). For the practical skills dimension, two experts independently evaluated 30 students' test scores. Using the Pearson correlation coefficient to calculate inter-rater reliability, the resulting coefficient was 0.75 (surpassing the 0.6 target), demonstrating high consistency in scoring. The research procedure and processes were as follows

Step1. Pre-test: Before the implementation of the teaching intervention, a fire prevention competence test was administered to all participants to assess their baseline level of fire prevention knowledge and skills.

Step2. Intervention implementation: The scenario simulation teaching was strictly delivered in accordance with the pre-designed lesson plan, consisting of five sequential stages: scenario construction, role assignment and role-playing, simulation drills, guided feedback and correction, and debriefing with reflective summarization.

Step3. Post-test: Immediately following the completion of the entire teaching intervention, the identical fire prevention competence test was re-administered to measure changes in students' fire prevention knowledge and practical skills.

Step4. Data Analysis

(1) A paired-samples t-test was used to compare the differences in fire prevention competence scores between the pretest and posttest to verify the effectiveness of the scenario simulation teaching.

(2) A one-sample t-test was used to examine whether the posttest scores of fire prevention competence reached the preset 70% mastery.

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Results

This study's findings stem from a comparative analysis of pre- and post-intervention scores on the fire prevention competence test, a composite measure combining a 40% theoretical knowledge component and a 60% practical skills component, conducted as part of the scenario simulation teaching intervention. In addition to the statistical significance test, the effect size of the teaching intervention was calculated to reflect the practical significance of the research results.

Table 1 Comparison of Fire Prevention Ability Scores Before and After Intervention

Group1	Fullscores	n	Pretest scores		Post-test scores		t	p
			M	SD	M	SD		
Experimental group	100	30	52.70	4.60	82.00	3.54	28.36**	.001

** The significance level: $p < 0.01$.

The mean score of students' fire prevention ability before the intervention was 52.70 (SD = 4.60), while the mean score following the intervention was 82.00 (SD = 3.54), representing an increase of 29.30 points. A paired-samples t-test revealed a statistically significant difference between pre- and post-intervention scores (t = 28.36, p =.001), indicating that the scenario simulation teaching method significantly enhances students' fire prevention competence.

Table 2 Comparison of students' fire prevention ability with the 70% preset standard

Group	n	Full score	criterion score	M	SD	t	p
Experimental group	30	100	70	82.00	3.54	18.55**	.001

**The significance level: $p < 0.01$

After the intervention, the mean score of students' fire prevention ability was 82.00 (SD = 3.54), which was significantly higher than the preset passing score of 70 points. A one-sample t-test revealed a statistically significant difference (t = 18.55, p =.001), indicating that the students' fire prevention competence successfully met and surpassed the predetermined qualification criterion.

Discussion

The research results indicate that the scenario simulation teaching method can significantly improve the fire prevention ability of new students in vocational colleges. After the intervention, the average score of students' fire prevention ability increased from 52.70 points to 82.00 points, an increase of 29.30 points, and this score is far higher than the passing standard of 70 points.

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The effect size test shows a large effect, which indicates that the research result has both statistical significance and practical educational significance. This finding is consistent with the research conclusions of Kolb (1984) and Li et al. (2024), both of which emphasize the effectiveness of the scenario simulation teaching method in enhancing fire prevention capabilities.

The fundamental reason why scenario simulation teaching can significantly enhance fire prevention ability is that it activates the deep learning cycle of "experience-reflection-integration-practice" (Kolb, 1984). By concretizing fire scenarios through highly simulated settings, this teaching mode transforms abstract fire prevention theories into tangible, practical situations, which not only strengthens students' cognitive understanding and retention of fire prevention knowledge but also provides immersive opportunities for repeated practice of fire disposal and evacuation skills. Within this simulated framework, students can then proficiently master key operational steps and response logic, thus promoting the transformation of theoretical knowledge into practical fire prevention abilities. Meanwhile, this learning process is regulated by a closed-loop mechanism of "theoretical verification-practical feedback-strategy optimization", which further enhances students' risk identification, rapid decision-making, and team collaboration capabilities in emergency scenarios (Kolb, 1984).

The research results further confirm that immersive teaching is a core effective method for safety education, especially suitable for fire prevention ability training tasks (Gao et al., 2023; Wurdinger & Carlson, 2010). Efficient fire emergency response requires comprehensive capabilities, including knowledge reserves, practical skills, psychological resilience, and team collaboration, all of which can be significantly strengthened through scenario simulation training.

In summary, the results of this study are consistent with the theoretical framework of scenario simulation learning, whose core viewpoint is that "practical participation is the foundation for improving safety capabilities". However, future research still needs to further explore the situational variables affecting teaching effectiveness and in-depth compare the effectiveness differences between scenario simulation and other teaching strategies.

Recommendation

Recommendations for Practice

Based on the finding that scenario simulation teaching has a significant effect on improving students' fire prevention competence, to optimize scenario simulation-based instruction in campus fire safety education, prioritize its systematic integration into the formal curriculum, covering diverse fire emergency scenarios and response procedures. Provide targeted professional development for educators to enhance skills in scenario design, teaching organization, and outcome assessment. Invest in specialized fire simulation facilities to boost scenario realism and

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practical learning value. Adopt a multi-dimensional assessment mechanism to comprehensively reflect students' fire safety competencies and emergency response capabilities.

Recommendations for Future Research

Based on the limitation of a small sample size and a single research object in this study, future research should expand the sample scope and representativeness, increase sample size, and include multi-disciplinary vocational college students across regions to enhance the generalizability. Conduct longitudinal follow-up studies to examine long-term effects on students' fire prevention awareness and behaviors. Explore integrating emerging technologies into simulation models to build immersive learning environments and refine teaching methodologies. Investigate discipline-specific applications in vocational fields to develop tailored training programs addressing unique risks and improve education pertinence and effectiveness.

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