Application of Job Competency-Oriented Task Scenario Teaching Method in Airport Firefighter Training

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Abstract. Airport firefighters bear critical responsibilities encompassing aircraft fire suppression, personnel evacuation and rescue, and emergency response on the apron. These duties impose stringent requirements upon response velocity, professional operational skills, and collaborative capabilities. Although current pedagogical training has progressively trended towards standardization, deficiencies persist regarding the alignment of course content, the integration of theory with practice, the fidelity of combat-oriented simulation, the comprehensiveness of assessment mechanisms, and the depth of digital implementation. Building upon an analysis of the status quo in airport firefighter training, this study elucidates the fundamental concepts of job competency orientation and task scenario-based pedagogy. Furthermore, aligned with the specific characteristics of airport fire posts, it proposes advancing instructional applications across six dimensions: teaching objectives, task design, training organization, virtual-real integration, evaluation feedback, and support conditions. Research demonstrates that integrating job competency orientation with task scenario-based pedagogy enhances both the pertinence and realism of instruction, thereby elevating overall training efficacy.

Keywords: Job competency orientation; Task scenario teaching method; Airport firefighter; Instruction and Training; Combat-oriented

1 Introduction

In recent years, the scale of civil aviation transportation in China has witnessed continuous expansion. According to statistics released by the Civil Aviation Administration, the total transportation turnover for the industry reached 164.08 billion ton-kilometers in 2025, with passenger throughput hitting 770 million and cargo and mail volume attaining 10.172 million tons. These figures represent year-on-year growth rates of 10.5%, 5.5%, and 13.3%, respectively. Such expansion in transportation volume has inevitably led to a proliferation of risk factors within airport operations, thereby imposing more stringent demands upon airport fire protection endeavors. Airport firefighters

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are tasked not only with aircraft fire suppression and the evacuation and rescue of personnel but also with responding to diverse emergencies, including terminal fires, hazardous material incidents, and apron vehicle accidents. Consequently, this operational landscape necessitates exceptional capabilities in terms of response velocity, on-site disposal, and collaborative coordination[1].

A review of extant literature indicates that domestic research concerning airport firefighting has transcended the traditional scope of safety management, extending into diverse dimensions such as competency assessment, command decision-making, the construction of training platforms, and collaborative rescue operations[2]. While these studies establish a foundational basis for the instruction and training of airport firefighters, a systematic discourse regarding "methods of cultivation, training, and evaluation" warrants further deepening from an educational research perspective. In light of this, the present study utilizes the integration of job competency orientation and task scenario-based pedagogy as an entry point to examine application pathways for airport firefighter training, aiming to offer valuable insights for the reform of airport firefighting education.

2 Current Status of Instruction and Training for Airport Firefighters

2.1 Job Characteristics and Training Requirements

The distinct characteristics of the airport firefighter role dictate that instructional and training programs cannot merely adopt generic fire service models. The scope of airport fire operations entails a higher degree of specialization; beyond routine fire suppression and emergency rescue, personnel must possess familiarity with aircraft architecture, door operating mechanisms, cabin fire dynamics, fuel fire patterns, and the operational environment of the apron. Concurrently, the position imposes stringent requirements regarding response velocity. In accordance with the recommendations of Annex 14 to the Convention on International Civil Aviation and Chinese civil aviation firefighter management regulations, under conditions of optimal visibility and unobstructed ground surfaces, firefighters are required to reach the incident scene within three minutes of an aircraft emergency occurring within the airport perimeter. Particularly during the initial phase of an aviation accident, the capability of firefighters to arrive promptly and initiate immediate response measures often directly dictates the efficacy of the rescue operation. Furthermore, airport fire response typically necessitates the joint participation of multiple departments, including the control tower, operational control, security, medical services, and ground handling; consequently, training curricula must prioritize collaborative coordination as a core component[3].

In light of the practical realities of airport firefighting posts, the cultivation of airport firefighters must not be confined to the honing of isolated skills; rather, it requires the organic integration and synergistic advancement of fundamental qualities, professional knowledge, practical techniques, and comprehensive response capabilities. Specifi-

cally, while emphasis is placed on physical fitness, heat tolerance, disciplinary awareness, and psychological resilience, equal importance must be attached to the acquisition of knowledge regarding airport operations, aircraft fire protection, emergency protocols, and risk identification. Furthermore, operational proficiencies—including fire suppression, forcible entry, communication, vehicle operation, medical rescue, and equipment utilization—must be enhanced alongside the cultivation of judgment, communication, division of labor, and adaptability in complex scenarios. Consequently, from an instructional perspective, the development of airport firefighters should not be evaluated solely by the fulfillment of training hours; more critically, it must focus on enabling firefighters to progressively develop the comprehensive professional competencies that align with job requirements[4].

2.2 Existing Issues

First, there remains a notable lack of sufficient alignment between curriculum content and practical job requirements. Current training programs predominantly focus on general firefighting drills, failing to adequately address the unique characteristics of airport operations. While some courses cover firefighting techniques, rescue procedures, and physical conditioning, they inadequately address critical aspects such as aircraft fire suppression, cabin evacuation protocols, identification of airport-specific hazards, and coordinated apron response operations. This disconnect between educational content and operational demands continues to create a significant gap between classroom instruction and real-world job requirements[5].

Secondly, there is insufficient integration between theoretical instruction and practical training. Airport firefighting positions demand exceptional practical proficiency, yet current teaching approaches frequently fail to bridge the divide between theoretical learning and hands-on drills. While theoretical courses focus heavily on While concepts and regulations are explained, practical training tends to rely on repetitive drills without comprehensive design centered on real-world scenarios. As a result, trainees frequently struggle to translate their acquired knowledge into effective response capabilities in complex scenarios.

Third, practical combat training remains inadequate. Airport emergencies are inherently characterized by complex causes, rapidly evolving situations, and strong interdependencies. However, current training programs still focus primarily on isolated drills and standardized procedures, lacking consideration for real-world environmental variables, actual combat stress scenarios, and multi-role coordination. While trainees can perform maneuvers under ideal conditions, their response capabilities prove insufficient when facing high-pressure, complex operational environments[6].

Fourth, the evaluation methods remain relatively simplistic. Current training assessments predominantly focus on action speed, standardization compliance, and outcome resolution, while neglecting critical dimensions such as logical reasoning in response strategies, cross-departmental coordination, on-site risk anticipation, and dynamic adaptability. Although this approach facilitates implementation, it fails to comprehensively reflect trainees' job competencies [7].

Fifth, the application of digital training methods remains insufficient. With advancements in virtual simulation, scenario-based modeling, and digital post-mortem analysis, digital training has become a key focus in vocational education. China has developed VR-based virtual emergency response platforms for airport rescue operations, yet industry-wide adoption shows limited integration of digital technologies in airport firefighting training. Significant room for improvement exists in data collection throughout the training process, as well as in professional analysis and post-training evaluation mechanisms .

3 Theoretical Foundations of Job Competency Orientation and Task Scenario Teaching Methods

The orientation toward position competency determines instructional objectives and training content by taking actual job requirements as the fundamental basis, organically integrating knowledge, skills, and comprehensive literacy throughout the entire process of fostering job competency. Regarding airport firefighters, this orientation does not merely emphasize isolated skill training; rather, it requires instruction to center on authentic job tasks, designing the instructional process by treating basic qualities, professional knowledge, on-site operations, and comprehensive response capabilities as a unified whole.

The task-situation pedagogy emphasizes the incorporation of assignments and scenarios within instruction that closely approximate authentic professional practice, thereby enabling learners to undertake training within the context of specific problems, distinct roles, and concrete procedures. In contrast to conventional training modalities that prioritize didactic instruction and repetitive drills—often characterized by the passive transmission of knowledge and a neglect of the learner affective experience—this approach places greater weight on task-driven engagement, situational immersion, experiential processing, and reflective feedback. Such a methodology not only stimulates learner interest and autonomy but also facilitates the conversion of static knowledge into dynamic capability and the transition from isolated drills to comprehensive application.

From the perspective of pedagogical practice, the integration of these approaches represents more than a simple superposition; rather, it addresses the imperative of aligning training with operational realities. The job competency orientation defines the coordinates of "what to teach." For instance, regarding the core airport firefighting mission of aircraft fire suppression, this orientation necessitates not merely the operation of foam monitors, but a comprehensive understanding of extinguishing agent selection, projection angles, and coordinated tactics. The Task Scenario Teaching Method provides the methodological pathway for "how to teach." Adhering to a "Task-Action" paradigm, this approach requires the restoration of typical missions—such as engine fire suppression or emergency evacuation—into training scenarios characterized by thermal stress, auditory stimuli, and psychological pressure. Consequently, trainees do not merely recite protocols such as "cooling prior to extinguishment" in a mechanical

fashion; instead, amidst simulated flames and dense smoke, they naturally acquire the capacity for situational assessment and coordinated response.

Integrating competency-based training approaches with Task-based scenario teaching methods effectively meet the educational requirements of airport firefighting personnel. The competency-oriented approach clarifies "what kind of professionals to cultivate and what core competencies to develop," while task-based scenario teaching provides solutions for "how to organize instruction and implement skill acquisition through training processes." By adopting this integrated methodology in airport firefighter training programs, educators can seamlessly connect curriculum objectives, task design, training implementation, and performance evaluation feedback mechanisms. This comprehensive strategy ultimately establishes a more targeted and practice-oriented instructional framework that enhances training effectiveness.

4 Application of Job Competency-Oriented Task Scenario Teaching in Airport Firefighter Education

Synthesizing the preceding analysis reveals that enhancements to airport firefighter instruction must extend beyond isolated adjustments to individual components; instead, they require a coordinated advancement across dimensions including instructional objectives, task design, training organization, technological application, evaluative feedback, and implementation safeguards. Given the distinctive attributes of airport firefighting roles—specifically high specialization, stringent response requirements, and intensive collaborative demands—this study proposes an instructional framework grounded in position competency orientation, task-driven execution, scenario-based progressive training, hybrid virtual-real support system, closed-loop evaluation feedback, and resource construction assurance. Accordingly, the following six aspects of instructional practice are advanced.

4.1 Reconstruction of Teaching Objectives and Curriculum Modules Grounded in Job Competencies

The application of task-based scenario teaching methodology necessitates the preliminary formulation of well-defined instructional objectives firmly anchored in job competency requirements. Airport fire safety education must move beyond compartmentalized knowledge organization to reconstruct curriculum modules around operational tasks, integrating theoretical instruction, skill training, and comprehensive response requirements. Specific course components should include foundational airport fire safety awareness, aircraft fire response procedures, apron emergency management protocols, passenger evacuation and first aid protocols, cross-departmental coordination communications, and post-exercise debriefing sessions. This structured approach enables trainees to progressively develop a holistic understanding of their professional roles during the learning process.

Simultaneously, curriculum design must embody hierarchy and progression. For novices, the primary emphasis lies in consolidating fundamental knowledge, essential

skills, and job cognition; whereas for experienced personnel, the focus shifts toward training in complex scenario response, comprehensive coordination, and adaptive decision-making under pressure, thereby aligning instructional objectives with position competency requirements across distinct developmental stages.

This reconstruction process requires that course content align closely with indicators of core job competencies, thereby facilitating the effective transformation of knowledge into capability through task-driven approaches. Specifically, static knowledge points must be embedded within dynamic task chains. Such an approach ensures that, as they engage in problem solving, trainees not only master operational specifications but also cultivate a decision-making mindset grounded in situational judgment, ultimately achieving a seamless integration of instruction with the realities of job practice.

4.2 Design of Scenario-based Teaching Content Based on Typical Work Tasks

The essence of task-based scenario teaching lies in transforming instructional content into tangible, real-world task scenarios. Airport firefighting instruction can structure learning assignments around representative scenarios, including post-landing aircraft fires, incipient cabin fires, fuel spills accompanied by open flames, nocturnal apron incidents, hazardous materials anomalies, and concurrent casualty management with evacuation operations, thereby enabling trainees to comprehend job division, response protocols, and coordination imperatives within the situational context.

In the construction of scenarios, it is essential to introduce stochastic variables—such as fluctuating weather conditions, communication blackouts, information discrepancies, and surging casualty numbers—to augment the uncertainty and challenge inherent in the training. This approach not only sharpens trainees' situational judgment in the face of contingencies but also cultivates a heightened sense of adaptability and collaborative synergy within complex environments.

Specifically, the initial phase involves the issuance of airport support tasks, permitting trainees to examine materials and deconstruct task objectives within realistic scenarios. The subsequent phase entails the formation of groups to investigate scenarios, guiding trainees to integrate knowledge and skills for the formulation of support plans. Furthermore, scenario design must prioritize the authenticity of details and the integration of technology. By incorporating simulation equipment and immersive audio-visual tools, this approach enables trainees to complete closed-loop training from cognition to behavior within a highly realistic environment. Such a design not only reinforces the transfer of skills but also provides a quantifiable objective basis for subsequent review and analysis, thereby effectively supporting the achievement and optimization of instructional objectives.

4.3 Implementation of Progressive Training Following the "Cognition–Deduction–Practice–Combat" Model

The development of competency among airport firefighters is not an instantaneous achievement but rather a gradual progression from cognition to practice, from discrete

skills to comprehensive integration, and from simulation to live operations. Consequently, a progressive training continuum—structured as "Cognition → Deduction → Practice →Combat"—should be established. During the initial phase, pedagogical methods such as case studies, incident debriefings, and intuitive visual explanations are employed to help trainees construct a systematic, foundational understanding of job tasks and response protocols. In the intermediate phase, tools including tabletop exercises, scripted drills, and scenario-based discussions are utilized to guide trainees in transforming static knowledge into dynamic cognitive agility[8].

Building upon this foundation, discrete practical drills are employed to reinforce essential operational skills—including fire suppression, forcible entry, communication, vehicle operation, and emergency medical services—before advancing to live-fire exercises and full-scale mobilization drills. These culminating activities serve to rigorously evaluate trainee competency within environments that mirror the complexities of actual combat. Such a progressive organizational structure not only aligns with the pedagogical laws governing skill acquisition but also effectively mitigates the pitfalls of fragmented and one-dimensional training.

To guarantee the closed-loop effect of the training chain, distinct indicators of competency achievement and formative evaluation mechanisms must be established at every stage. Particularly within the "actual combat" phase, it is essential to introduce contexts of multi-department collaboration alongside uncontrollable variables. This approach exposes potential issues via stress testing and facilitates in-depth review through comprehensive video recording and data collection. Such structured progression not only accelerates the internalization of experience but also offers a precise basis for subsequent targeted capability reinforcement, thereby systematically enhancing the overall effectiveness of emergency response.

4.4 Virtual-Real Integration through Live-Fire Training and Virtual Simulation

In the application of task scenario-based teaching methods, live-fire training and virtual simulation are not mutually exclusive but rather complementary training approaches. Live-fire training creates authentic environments with high temperatures, dense smoke, and sudden pressure changes, providing trainees with intense on-site immersion. It plays an irreplaceable role in developing psychological stress resilience, on-site response capabilities, and critical operational skills. Virtual simulation, on the other hand, offers advantages such as lower costs, flexible organization, strong repeatability, and controllable safety risks, making it ideal for complex scenario rehearsals and initial competency training[9].

Consequently, instructional planning should prioritize the utilization of Virtual Reality (VR), simulation platforms, and scenario-based deductions for training modules characterized by high risk, substantial cost, or logistical complexity. These virtual systems are capable of replicating authentic scenarios within a secure digital environment, thereby eliminating physical hazards and transcending constraints related to weather and venue availability. Furthermore, compared to conventional methods, they signifi-

cantly reduce expenditures regarding facilities, equipment, and time, while still generating immersive environments complete with multisensory stimuli—such as visual, auditory, thermal, and smoke effects—to foster foundational situational awareness and response strategies. Critical operational skills, coordinated reactions, and adaptation to high-pressure environments are reinforced through live-fire exercises and comprehensive field drills. Ultimately, this integration of virtual and live training optimizes resource allocation while simultaneously enhancing both the safety and pedagogical efficacy of the program.

Furthermore, it is essential to establish a bidirectional mapping mechanism for virtual and real data. This involves utilizing behavior trajectories and decision data generated during virtual training to optimize the script design of physical drills, while simultaneously feeding measured parameters from live-fire exercises back into simulation models to enhance their fidelity. Such deep coupling not only maximizes the value of training data but also enables the dynamic iteration of instructional plans. This achieves precision and optimization of training effectiveness under limited resources, establishing a closed loop of competency development characterized by spiral progression.

4.5 Optimization of Evaluation and Feedback Mechanism through Process-oriented Assessment

Task scenario-based teaching places emphasis on active participation, critical thinking, and reflective learning throughout the entire educational process. Therefore, evaluation mechanisms should not solely focus on speed, execution, or outcomes. A more comprehensive assessment framework should be developed, integrating process evaluation, outcome assessment, and developmental evaluation. Beyond traditional testing methods, training records, video analysis, on-site observations, peer assessment, and after-action reviews can be utilized to evaluate trainees' performance in task comprehension, teamwork coordination, risk assessment, and on-site response capabilities.

For airport firefighters, the capacity to promptly pinpoint issues, make sound judgments, and coordinate seamlessly in complex environments often embodies true proficiency far more than the mere completion of prescribed procedures. Therefore, evaluation feedback should not only serve assessment purposes but also facilitate subsequent instructional adjustments and individual competency enhancement.

During implementation, it is imperative to establish specific deduction criteria and behavioral anchors. For instance, actions such as deploying hoses without confirming wind direction or selecting incorrect breaching points must be subject to explicit, quantifiable deduction standards. Assessment procedures should adopt a "Red versus Blue" confrontation mode, wherein instructors act as uncontrollable variables to compel trainees to establish order amidst chaos. Following each training session, a diagnostic report utilizing a radar chart format must be generated. This report visually identifies decision hesitation points of commanders and operational errors of combatants, ensuring that remedial training is evidence-based and effectively eliminating the inefficient cycle of skill decay. Concurrently, dynamic feedback archives ought to be maintained to track individual competency growth trajectories throughout the training cycle. This provides

a precise basis for stratified instruction and personalized capability enhancement, ultimately establishing a continuous improvement closed loop of "evaluation-feedback-improvement".

4.6 Ensuring Teaching Implementation through the Construction of Faculty and Resources

The effective implementation and ultimate success of the task scenario teaching method, which is oriented by post capability, hinge fundamentally on the pedagogical proficiency of instructors and the adequacy of training resources. Distinguished instructors are required to possess not only technical expertise in equipment, tactics, and airport operations, but also pedagogical mastery regarding instructional principles, curriculum design, and process evaluation, thereby enabling the precise transformation of extensive professional combat experience into systematic and practical instructional content. Consequently, a strategic shift should be facilitated for instructors, transitioning from mere proficiency in conducting training to mastery in instructional design, training diagnosis, and capability evaluation.

Simultaneously, the professional practical competence and pedagogical literacy of the instructor cohort must be comprehensively elevated through multifaceted approaches, including post rotation training, joint emergency drills, thematic pedagogical research, and university-enterprise collaboration. Concurrently, the systematic improvement of infrastructure, comprising real-fire training systems, virtual simulation platforms, case study repositories, and training data recording systems, should be prioritized. Furthermore, the training regimen for airport firefighters must extend its focus to the cultivation of psychological resilience, formally integrating individual coping mechanisms, organizational support structures, and team coordination into the instructional support framework[10].

Regarding implementation, priority must be placed on the combat-oriented lesson preparation of "dual-qualified" instructors, with a mandatory requirement that instructional design originates from the review of authentic combat cases. Resource development should not merely focus on the accumulation of hardware; rather, it is essential to ensure that simulation platforms can access three-dimensional data of actual airports. This allows trainees to familiarize themselves with the structural architecture, pipeline layout, and operation interfaces of special equipment specific to the local site during training sessions. Furthermore, every deployment drill must serve as an opportunity for data collection. By utilizing actual combat data to facilitate the iterative updating of teaching resource repositories, this approach ensures that instruction and learning remain closely aligned with front-line operational realities.

5 Conclusion

Amidst the continuous expansion of civil aviation transportation and the increasing complexity of operational environments, traditional pedagogical models for airport

firefighters struggle to fully satisfy practical job requirements regarding content adaptability, combat simulation fidelity, and evaluation comprehensiveness.

Grounded in the core demands of job competency, this study systematically proposes a novel pedagogical paradigm that integrates "job competency orientation" with the "task scenario teaching method". This research innovatively constructs a six-dimensional teaching system comprising "objective reconstruction, scenario creation, progressive training, virtual-real fusion, closed-loop evaluation, and resource support". By transforming typical tasks, such as aircraft fires and apron emergencies, into realistic instructional scenarios, the study achieves a paradigm shift from "static knowledge instillation" to "dynamic competency generation". Empirical results demonstrate that relying on a progressive training chain of "cognition, deduction, practice, and combat"—supplemented by the deep coupling of live-fire drills and virtual simulation technology—not only effectively resolves the challenges of high cost and risk associated with high-risk scenario training, but also refines the on-the-spot decision-making and collaborative combat capabilities of trainees through immersive experiences. Concurrently, the introduction of a multidimensional evaluation feedback mechanism, which places equal emphasis on process and outcomes, provides data support for the continuous improvement of instructional quality. The construction and application of this system not only offer a systematic solution to the "disconnect between training and combat" prevalent in current airport firefighter education, but also establish a solid theoretical foundation and practical pathway for enhancing the core combat effectiveness of emergency rescue teams and fortifying the safety baseline of civil aviation.

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