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Analysis of How Large Models Empower the Reform of Education and Training for Aviation Maintenance Positions

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Abstract

Large models, as cutting-edge technologies, are reshaping the military education landscape. In view of the "strong job orientation, high practical requirements, and rapid knowledge update" characteristics of aviation maintenance job education, this paper systematically explores the mechanism by which large models empower training reform, and reveals its advantages in promoting the leap of the "integration of combat and training" concept, reconstructing dynamic teaching content, optimizing the "unity of knowledge and action" method, expanding organizational models, and forging "on-the-spot decision-making" thinking. At the same time, dialectically examine the weakening of instructors' status, the crisis of trainees' integrity, the risk of knowledge "illusion", and the security and confidentiality risks. Based on this, we propose the construction of a "combined combat and training" knowledge hub, a "precise drip irrigation" training model, a data-driven evaluation system, a virtual-real fusion training scenario, and a human-machine collaborative training strategy to provide theoretical support and practical paths for the intelligent transformation of aviation maintenance training.

Subject Areas

Pedagogy

Keywords

Large Model, Aviation Maintenance, On-the-Job Education, Training Reform, Human-Machine Collaboration, Intelligent Training

1. Introduction

The report of the 20th National Congress of the Communist Party of China clearly states: "Promote the digitalization of education and build a learning society and a learning nation for all." Generative artificial intelligence, represented by large language models, with its powerful capabilities of knowledge integration, logical reasoning and multimodal generation, has become the core driving force for educational transformation [1] [2]. The core mission of aviation maintenance service education is to efficiently train pre-selected and advanced non-commissioned officers for frontline positions in combat forces. Its fundamental attributes are "task-driven, competency-based, position-oriented", with the aim of forging qualified combatants who can independently and precisely complete the maintenance and support tasks of aviation equipment in complex battlefield environments [3]. At present, the field is facing practical bottlenecks such as lagging knowledge updates, limited training resources, rigid teaching models, and capability assessment divorced from actual combat [4]. Large model technology provides a fresh approach to solving these problems. Exploring how it can be deeply integrated into the aircraft maintenance job education system and scientifically responding to its opportunities and challenges is an issue of The Times for improving the quality and efficiency of talent cultivation.

2. The Integration Mechanism of Large Models and Aviation Maintenance Job Training

The essence of aviation maintenance education is to efficiently transform soldiers with basic military qualities into maintenance and support personnel for specific aircraft types and specific specialties within a limited period. This process is highly dependent on structured knowledge transfer, repeated skill training and the development of decision-making ability in complex situations [5]. Large models, with their core capabilities, can be deeply coupled with the training process to reconstruct the entire process of "teaching, learning, practicing, and evaluating".

2.1. Drive the Renewal of the "Integration of Combat and Training" Educational Concept

Large models strongly drive educational concepts to leap from "knowledge transmission" to "ability generation" and from "classroom-centered" to "battlefield-centered". By accessing dynamic data such as exercises and training, battlefield damage, large models can generate hypothetical cases that are close to the future form of warfare, transforming the role of instructors into "battlefield situation" architects. At the same time, as an "intelligent teaching assistant", it forces instructors to focus on guiding deep thinking, establishing a new type of teacher-student relationship of equality, interaction and co-creation, and achieving the organic integration of ideological and political education [6]. This shift in thinking has brought training closer to the demands of actual combat, effectively bridging the gap between traditional education and the demands of the battlefield, and at the same time cultivating the professional qualities of keeping calm and making scientific judgments under high pressure, laying the foundation for the formation of the mindset that "peacetime is wartime and training is actual combat".

2.2. Reconstructing the Teaching Content System of "Job Competence"

Large models can intelligently integrate complex and dynamic aircraft maintenance knowledge to form a living "competency knowledge graph". On the one hand, it can access authoritative sources such as manufacturer service announcements and maintenance notifications in real time, automatically update the knowledge base, ensure that the teaching content is in sync with the current status of the equipment, and achieve "dynamic preservation"; On the other hand, it can push personalized learning paths based on the job attributes and skill levels of trainees, achieving "precise customization". In addition, the large model can break down cross-disciplinary barriers. When a trainee queries a system failure, it can simultaneously present its chain effect on other systems, fostering systems engineering thinking, which is crucial for solving complex and difficult faults. This dynamic, precise and systematic content system fundamentally solves the problem of lagging updates and rigid content in traditional textbooks, keeping the teaching content highly consistent with the demands of the battlefield.

2.3. Optimize the Teaching Methods and Means of "Unity of Knowledge and Action"

Large models give rise to a completely new "unity of knowledge and action" teaching method [7]. Teachers can use it to quickly generate high-quality lesson plans and materials, making the classroom more dynamic and in-depth; Students can view it as an intelligent mentor, seeking key points of operation, troubleshooting ideas and review comments in real time before and after practice to stimulate self-motivated learning. More importantly, the large model can serve as an innovation partner for the trainees, jointly designing solutions in training such as field repair, exercising their ability to comprehensively apply knowledge, make engineering decisions and manage risks, achieving a shift from passive acceptance to active creation. This comprehensive innovation in teaching, learning and training methods not only enhances training efficiency, but also nurtures trainees' innovative ability to solve unknown problems, enabling them to have strong adaptability in the face of the challenges of rapid iteration of equipment technology.

2.4. Expand the "Integration of Virtual and Real" Teaching Organization

By integrating VR/AR and digital twin technology, large models can break through physical limitations and create flexible virtual-real integration training fields. Instructors can instruct large models to dynamically generate virtual scenarios ranging from standard hangars to field airports, where trainees can practice in an immersive way, and their operation data is recorded throughout the process, and assessment reports are automatically generated after training. This model realizes the synergy of the "teacher-studer-airport" trinity, breaks the temporal and spatial boundaries of the traditional classroom, makes training no longer restricted by the number of equipment, site conditions and safety risks, and truly achieves the ideal state of "learning anytime, practicing everywhere" [8]. This organizational change offers unlimited possibilities for practical training, allowing trainees to receive full training under all kinds of extreme conditions and significantly enhancing their battlefield adaptability and responsiveness.

2.5. Forging the Higher-Order Thinking Ability of Making Decisions on the Spot

In the face of sudden and complex malfunctions, maintenance personnel need to have the ability to analyze calmly and make accurate judgments [9]. The large model can act as the "red square", throwing out atypical faults without standard answers to temper the critical and creative thinking of trainees. It can also serve as a "thinking add-on," guiding students to sort through confusing information and build a tree of troubleshooting logic through Socratic questioning, rather than giving answers directly. This guided, heuristic interaction can effectively cultivate students' ability to think independently and solve unknown problems, ensuring that they can rely on their strong thinking ability to turn danger into safety on the real battlefield in the future. The forging of this higher-order thinking ability is beyond the reach of traditional training models and is a key ability to deal with asymmetric threats in future intelligent warfare.

3. Risk Analysis of Applying Large Models to Aviation Maintenance Training

If applied blindly, large models can also pose serious risks and must be prepared in advance.

3.1. Weakened Teacher Status and Lack of "Warmth"

Excessive reliance on large models can reduce teachers to technical operators, weakening their educational functions such as teaching by word and deed and emotional encouragement. The maintenance style cannot be passed down without the instructor's hands-on teaching demonstration and spiritual encouragement at critical moments. Cold algorithms cannot replace this kind of "warm" teaching interaction, which may cause trainees to lose their sense of awe and belonging to the profession, and ultimately produce a group of skilled but soulless "operators" rather than flesh-and-blood, brave and resourceful fighters. This risk not only affects the quality of talent cultivation, but also weakens the cohesion and combat effectiveness of the aircraft maintenance team. It is necessary to clarify the role positioning and core value of instructors in the intelligent age to ensure that their position as the main body of education is not eroded.

3.2. The Crisis of Student Integrity and the "False Prosperity" of Competence

Students may use large models to write reports and draft plans on behalf of others, resulting in distorted learning outcomes and undermining training fairness. This creates an illusion of a false boom in ability—trainees appear all-powerful but are actually just the mouthpiece of the large model, helpless once out of technical support, seriously eroding their independent judgment and hands-on ability, which is fatal on the battlefield. The long-term reliance on technology will fundamentally undermine the core competitiveness of the aircraft crew. To address this issue, it is necessary to establish a scientific integrity education system and assessment mechanism that, while using technology to enhance efficiency, always maintain an accurate grasp of the true capabilities of trainees and ensure the reliability and authenticity of talent cultivation.

3.3. The Illusion of Knowledge and the Misbelief in Technical Authority

Large models are at risk of generating false information. In the field of aircraft maintenance, where fault tolerance is extremely low, a single wrong parameter can lead to disaster. Junior students, lacking the ability to distinguish, tend to take it as a technical authority and accept it all, weakening the scientific attitude of being rigorous and realistic, and even ignoring the most basic checking and verification procedures, which poses a huge safety hazard. This blind trust in technology runs counter to the core concept of "extreme responsibility and meticulous maintenance" in aircraft maintenance work. To address this risk, it is necessary to establish a multi-level knowledge verification mechanism and a critical thinking training system, so that trainees can take full advantage of the convenience of technology while always maintaining the professional habit of independent thinking and careful verification.

3.4. Weakened Teamwork Spirit

If trainees are accustomed to seeking help from large models alone, they will reduce communication, discussion and collaboration with their peers. Aircraft maintenance work is a highly coordinated collective action, from receiving the aircraft, dividing tasks and troubleshooting to the final signing and release, every link requires seamless connection and efficient communication. If this continues for a long time, the team spirit, communication skills and coordination ability under pressure will not be exercised, and it will be difficult to adapt to the demands of future joint operations and distributed support, and the overall combat effectiveness will be greatly reduced. To address this issue, it is necessary to strengthen the elements of teamwork in the training design to ensure that the application of technology not only enhances individual capabilities but also improves the overall effectiveness of the team and cultivates the sense of synergy and collective responsibility of the trainees.

3.5. Loss of Control over Confidentiality, Security and Data Sovereignty

The technical parameters and fault data of aviation equipment are highly sensitive military secrets. The use of large public cloud models implies the risk of data leakage. Even in private deployments, the sources of data, model robustness, and the flow of data in the interaction process form a complex security chain, and any oversight in any link could lead to catastrophic consequences. Security and confidentiality are red lines that cannot be crossed, and the highest level of protection must be taken to ensure that data sovereignty is firmly in one's own hands. We must adhere to the principle of "no data out of the network, self-control of models, and supervision of applications" and build a comprehensive and multi-level security protection system to ensure the absolute security of military training data.

4. Major Strategies for Deepening the Reform of Education and Training for Aviation Maintenance Positions with Large Models

In the face of opportunities and challenges, systematic strategies must be adopted to ensure that technology truly serves combat capability generation.

4.1. Build an Intelligent Knowledge Hub That Integrates Combat and Training

This is a fundamental project. It is necessary to build a large model dedicated to aircraft maintenance that is independently controllable, secure and trustworthy. Based on the military Intranet, deploy domestic private large models to ensure that data does not leave the Intranet; The system collects, cleans and labels multi-source data such as technical manuals, fault cases and expert experience to form an authoritative knowledge base; A group of instructors, backbone members, and experts will manually verify the content generated by the model to suppress hallucinations; Build a dynamically evolving knowledge graph using large models to clearly show the logical connections among knowledge points, skills, and faults, providing underlying support for intelligent teaching. This knowledge hub must adhere to the principle of "safety first, close to the battlefield, dynamic evolution" to ensure the accuracy, timeliness and practicality of the knowledge content, become an intelligent bridge connecting theoretical teaching and practical demands, and truly achieve seamless coupling of knowledge and the battlefield.

4.2. Create a Personalized Training Model of "Precise Drip Irrigation"

Shift from "flooding" to "precision drip irrigation" in response to individual differences. Collect full-dimensional behavioral data of trainees in the theoretical, virtual, and practical stages, and build a dynamic profile that includes multiple dimensions such as knowledge mastery, skill proficiency, and cognitive style; Based on the profiling, the large model intelligently recommends learning content, training items and difficulty levels, automatically identifies weak links and pushes targeted reinforcement training; Deploy terminals in the training area where trainees can ask questions at any time, and the large model will predict and warn of potential errors based on their historical performance to achieve preventive guidance [10]. This personalized training must prevent the tendency of "technology replacing human", always maintaining the instructor's dominance and oversight over the training process, so that personalized training truly serves combat effectiveness generation, rather than simply pursuing the perfection of technical indicators. At the same time, a mechanism for evaluating the effectiveness of personalized training should be established to regularly examine the extent to which training results are transformed into practical combat capabilities.

4.3. Establish a "Data-Driven" All-Dimensional Evaluation and Feedback System

Shift to formative evaluation throughout the entire process and in all aspects. Use sensors, cameras, etc. to collect data on operation sequences, action norms, line of sight focal points, etc., to fully characterize behavioral traits; The large model analyzes the data not only to judge whether the results are right or wrong, but also to gain insights into their thinking logic, decision-making basis, risk awareness and stress resistance; The evaluation results provide immediate feedback and generate actionable suggestions for improvement, providing a scientific basis for teaching optimization and forming a virtuous loop of "training - evaluation - feedback - improvement". This evaluation system must break away from the traditional single-dimensional assessment model and establish a comprehensive evaluation index that includes multiple dimensions such as knowledge, skills, thinking, style, and psychology, so that the evaluation results truly reflect the practical ability of the trainees. At the same time, the evaluation data should be used for the continuous optimization of teaching content and methods, forming a virtuous cycle of promoting teaching and learning through evaluation, and constantly improving the quality and efficiency of training.

4.4. Create Immersive Training Scenarios That Integrate Virtual and Real Elements

Integrate large models with XR technology to create future training grounds. Build digital twins that are exactly the same as real equipment for each main fighter type, ensuring precise mapping of physical attributes and logical relationships; Large models act as "super dispatchers", dynamically and randomly injecting various single and compound faults, and simultaneously simulating the battlefield environment to test comprehensive handling capabilities; Build a "maintenance metaverse" space that supports multi-person online collaboration to train remote collaboration, command coordination, and system support capabilities. These immersive scenarios must adhere to the principle of "close to real combat, above real combat", creating a more demanding training environment in a virtual setting than actual conditions, allowing trainees to experience various extreme situations under safe conditions. At the same time, a mapping verification mechanism between virtual training and actual combat capabilities should be established to ensure that the effect of virtual training can be effectively transformed into actual support capabilities and avoid the disconnection of "virtual is wonderful, actual combat is helpless".

4.5. Promote the New Training Model of "Human-Machine Collaboration"

Clarify the boundaries of human-machine responsibilities and build a complementary relationship of advantages. Instructors focus on training system architects, higher-order thinkers, and aircraft spirit inheritors to strengthen the educational function; Establish "Machines do repetition, people do creation; Machines manage processes, people manage decisions; The fundamental principle of "machines provide information, people take responsibility", each with its own strengths; Regularly organize "back-to-back" combat tests that are completely detached from the support of large models to test true capabilities, prevent technological dependence, and build a solid foundation of combat effectiveness. The core of this training paradigm is to clarify the subjectivity of human beings and the auxiliary function of machines, ensuring that the application of technology always serves the all-round development of human beings. It is necessary to establish a system for evaluating the effectiveness of human-machine collaboration, regularly examine the effect of human-machine cooperation, and dynamically adjust the human-machine division of labor mode based on the evaluation results, so that the application of technology is always in the best state. At the same time, it is necessary to enhance the intelligent literacy training of instructors so that they can skillfully handle intelligent tools and give full play to the leading role of people in the training process.

5. Conclusion

The wave of large model technology is unstoppable. Aviation maintenance job education must be self-centered and for combat use, viewing large models as a "multiplier" for improving training quality and efficiency, rather than a "terminator" replacing humans. By building a secure and controllable intelligent knowledge hub, implementing precise and efficient personalized training, establishing a scientific and comprehensive all-dimensional evaluation, creating realistic and immersive virtual-real fusion scenarios, and establishing a complementary human-machine collaboration paradigm, we will forge a new era aviation maintenance force that is ideally strong, technically proficient, and has a fine style. In the intelligent military transformation, only by making forward-looking plans, systematic planning and steady advancement can we gain the initiative in the future battlefield and contribute solid strength to safeguarding national airspace security. Technology is the means, talent is the foundation, and combat effectiveness is the standard. This fundamental principle must run through the entire process of intelligent transformation.

Conflicts of Interest

The author declares no conflicts of interest.

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