International Journal of Scientific Engineering and Science
Volume 8, Issue 8, pp. 74-78, 2024.
ISSN (Online): 2456-7361

Effective Methods of Knowledge and Skills Transfer in Aviation Training

Eigil Orgersen
Type Rating Instructor and Airline Captain, Wideroe A/S, Bodo, Norway

***Abstract*— *This study aims to develop and validate an innovative methodology for knowledge and skills transfer in aviation training, focusing on preparing pilots for extreme areas with difficult climatic and geographical conditions. The "Bridging the Gap" method integrates theoretical knowledge and practical skills, addressing the limitations of traditional approaches. The research employs a comprehensive methodology, including literature analysis, empirical studies, statistical analysis, and expert evaluations. The integrated approach enhances pilots' mental models of flight situations, improves rapid application of theoretical knowledge in practical scenarios, and develops metacognitive skills. The study concludes that implementing the "Bridging the Gap" methodology can significantly enhance pilot training effectiveness and, consequently, flight safety in complex operational environments. This research contributes to the field by offering an adaptive, integrated training approach specifically tailored for extreme conditions.*

***Keywords*— *Aviation training, knowledge transfer, skill acquisition, arctic operations, pilot competency, integrated learning, simulation training, decision-making, safety management, cognitive load.*

I. Introduction

In the contemporary aviation industry, the efficiency of knowledge and skills transfer plays a crucial role in ensuring flight safety and optimizing operational processes. The dynamic development of aviation technologies, the complexity of aircraft control systems, and the constantly growing requirements for the qualification of flight personnel necessitate the improvement of training methodologies in the aviation sector.

The relevance of this study is due to several factors. Firstly, there is a clear dissonance between traditional training methods and modern competency requirements for pilots, especially in the context of operating new-generation aircraft. Secondly, aviation accident statistics indicate that the human factor remains one of the key causes of incidents, highlighting the need to improve flight crew training processes. Thirdly, the specific operational conditions characteristic of certain regions and airlines require the development of adaptive training methods that take into account local features [1-4].

The aim of this study is to develop and validate an innovative methodology for the transfer of knowledge and skills in aviation training, based on the principle of integrating theoretical knowledge and practical skills. A particular attention is paid to preparing pilots to deal with complex climatic and geographical conditions.

To achieve this aim, the following objectives were formulated:

- To analyze existing training methods in aviation and identify their limitations in the context of modern requirements.
- To develop a conceptual model of integrated training based on the "Bridging the Gap" method.
- Implement the developed model into the pilot training process.

Within this study, a critical analysis of existing training methods in aviation was conducted, including traditional approaches based on the separation of theoretical and practical training, as well as modern methodologies such as Competency-Based Training and Assessment (CBTA) and Evidence-Based Training (EBT).

The scientific novelty of the research lies in the development of an integrated training model specifically adapted for preparing pilots to work in extreme conditions of the Arctic region. The proposed "Bridging the Gap" methodology represents an innovative approach to synthesizing theoretical knowledge and practical skills, significantly enhancing training efficiency and consequently improving flight safety.

The practical significance of this work is determined by the possibility of directly applying the developed methodology in pilot training programs, especially in the context of operations in challenging climatic and geographical conditions. The results of the study can be used by airlines, training centers, and regulatory bodies to optimize training processes and raise aviation safety standards.

In the subsequent sections of this work, the theoretical foundations of the proposed methodology will be discussed in detail, its practical implementation described, and conclusions and recommendations for its further application and development formulated.

II. Theoretical Foundations

Effective knowledge and skills transfer in the aviation sector is grounded in fundamental principles of cognitive psychology, andragogy, and learning theory. In the context of aviation training, concepts related to the formation of professional competencies under high-risk and high-responsibility conditions are particularly significant.

Pilot training has undergone significant changes since the inception of aviation, thanks to the implementation of new technologies and improved training methods [5]. Concepts that were once theoretical are now fully integrated into all stages of training.

Researchers M. N. Skatkin and I. I. Lerner, studying the processes of material assimilation by students, developed a pedagogical methodology presented in Table 1.

http://ijses.com/
All rights reserved

International Journal of Scientific Engineering and Science
Volume 8, Issue 8, pp. 74-78, 2024. ISSN (Online): 2456-7361

TABLE 1. Teaching methods

Training Method	General Characteristics of the Method
Explanatory-Illustrative Methods	These methods involve full understanding and assimilation of material by students. Examples include storytelling, lectures, explanations, demonstrations of artworks, films, and other visual materials.
Reproductive Methods	These methods focus on applying theoretical knowledge and skills in real conditions, which helps in developing practical abilities.
Partial Search Method	Students independently solve part of the problems, which stimulates their active participation and development of independent thinking.
Research Method	Students independently solve cognitive tasks with the support of the instructor, which fosters the development of critical thinking and independent research skills.

For an effective selection of a teaching method, instructors must consider several conditions affecting the efficacy of each method. The main parameters include:
- Educational objectives for the subject matter
- Specific lesson goals
- Nature of the subject being taught
- Characteristics of the learning material
- Organizational structure of the classes
- Nuances of didactic aids and teaching tools
- Emotional, psychological, and physiological characteristics of students
- Personal characteristics of the instructor

The instructor independently chooses the teaching method or their combination. The selection of the most effective methods and the degree of their application depend on the instructor's qualifications and experience.

The careful selection of teaching aids significantly impacts the effectiveness of the learning process, as they engage different channels of information perception. Teaching aids are categorized as follows:
- Verbal Aids: Designed for self-study by students, enhancing the learning process's efficiency. These include the instructor’s oral speech, educational literature, and scientific manuals, perceived through the auditory channel.
- Visual Aids: Used for the visual representation of educational information. Examples include blackboard notes, tables, charts, models, diagrams, photographs, and graphs, perceived through the visual channel.
- Technical Aids: Necessary for presenting educational material and monitoring its assimilation. Examples include personal computers, magnetic whiteboards, projectors, and tape recorders that use the kinesthetic channel.

For maximum effectiveness, it is essential to combine teaching aids, engaging all sensory perception channels: vision, hearing, and the kinesthetic channel [6-9].

It is also worth noting that traditionally, aviation training was dominated by a behaviorist approach, based on forming stable skills through repetition and reinforcement. However, modern research in neuroscience and cognitive psychology demonstrates the limitations of this method, especially in preparing for non-standard situations.

The cognitive approach, focusing on thinking processes and decision-making, appears more adequate for developing contemporary pilot competencies. Main aspect here is the concept of mental models proposed by Johnson-Laird (1983). According to this theory, a pilot's effectiveness in complex situations depends on the accuracy and completeness of their mental model of the flight situation.

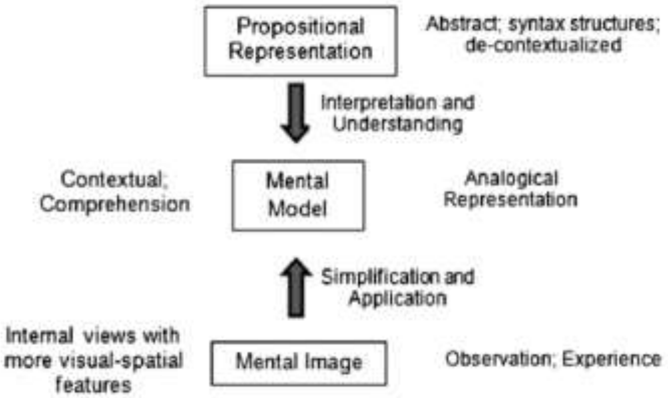

Figure 1: Concept of Mental Models proposed by Johnson-Laird

The Cognitive Load Theory (Sweller, 1988) also plays a crucial role in developing effective pilot training methodologies. According to this theory, optimal learning occurs when there is a balance between the task's complexity and the learner's cognitive resources. In the context of aviation training, this means carefully structuring the learning material and gradually increasing task complexity.

The aviation sector is characterized by several unique features that must be considered when developing educational methodologies:
1. High Cost of Error: Any mistake in aviation can have catastrophic consequences, necessitating a special safety culture and attention to detail.
2. Dynamic and Uncertain Environment: Pilots must be ready to make quick decisions in conditions of incomplete information and changing environments.
3. Technological Complexity: Modern aircraft are complex technical systems requiring a deep understanding of their operation.
4. Cross-Cultural Interaction: The global nature of aviation requires the development of effective communication skills in a multicultural environment.

These features necessitate an integrated approach to training, combining deep theoretical knowledge with practical skills and the development of non-cognitive competencies such as situational awareness and crew resource management (CRM).

The integration of theoretical knowledge and practical skills is a key aspect of effective aviation training. This approach is based on Kolb's Experiential Learning Theory (1984), which postulates the cyclical nature of the learning process, involving concrete experience, reflective observation, abstract conceptualization, and active experimentation.

The integrated approach allows for a more holistic understanding of aviation systems and processes, which is crucial for effective performance in complex and non-standard situations. Additionally, this approach fosters the development

All rights reserved

International Journal of Scientific Engineering and Science
Volume 8, Issue 8, pp. 74-78, 2024. ISSN (Online): 2456-7361

of metacognitive skills, including self-assessment and self-regulation, which are vital for the continuous professional development of pilots.

TABLE 2: Comparison of Traditional and Integrated Approaches to Aviation Training

Aspect of Training	Traditional Approach	Integrated Approach
Course Structure	Sequential study of theory followed by practice	Alternation of theory and practice
Role of Instructor	Knowledge transmission	Facilitation of the learning process
Focus of Training	Execution of standard procedures	Development of analytical thinking
Competency Assessment	Separate assessment of knowledge and skills	Comprehensive assessment in realistic scenarios
Adaptability	Fixed program	Flexible adaptation to learner's needs

An important aspect of bridging theory and practice is the concept of "educational transfer" (Baldwin and Ford, 1988), which describes the process of transferring knowledge and skills from an educational environment to actual professional practice. Effective transfer of training requires creating authentic training situations that closely mimic the actual working conditions of pilots.

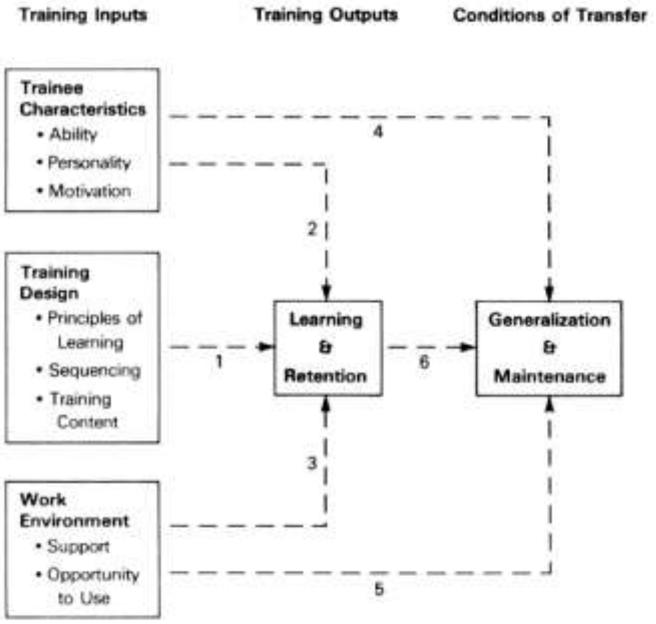

Figure 2: Model of Transfer of Training

In the context of preparing pilots for operations in the extreme conditions of the Arctic region, the integration of theory and practice is particularly significant. The complexity and uniqueness of the operational environment require not only a deep understanding of the theoretical foundations of aerodynamics, meteorology, and aircraft operation but also the ability to quickly apply this knowledge in non-standard situations.

Thus, the theoretical foundations of effective knowledge and skills transfer in aviation training are based on integrating cognitive, andragogical, and industry-specific approaches. The development of the "Bridging the Gap" methodology aims at the practical implementation of these theoretical concepts, considering the specific requirements of the aviation industry and the peculiarities of aircraft operations in extreme conditions.

III. Practical Implementation: Innovative Training Methodology

The "Bridging the Gap" method represents an innovative approach to pilot training, aimed at overcoming the traditional divide between theoretical knowledge and practical skills. In the aviation industry, where safety directly depends on a deep understanding of theory and the ability to apply it in practice, this method is particularly significant [10-12].

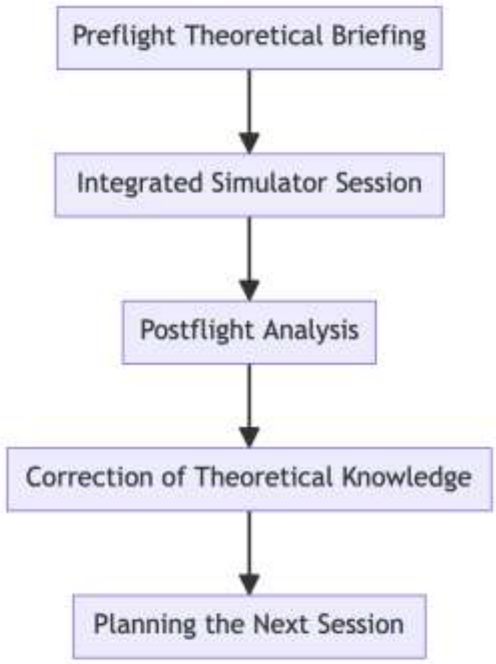

Figure 3: The "Bridging the Gap" Learning Cycle

A key element of this methodology is the intensive pre-flight theoretical briefing. This stage, lasting from 60 to 90 minutes, serves not just as a review of material but as active preparation for the practical part of the training. The instructor uses interactive presentations and 3D models to visualize complex aerodynamic processes, significantly improving comprehension and retention of the material.

Special emphasis is placed on analyzing real aviation incidents where theoretical knowledge (or the lack thereof) played a decisive role. This helps trainees realize the critical importance of theory for flight safety. Discussing potential scenarios stimulates active application of knowledge and develops critical thinking skills.

The integrated simulator session following the briefing is not just about practicing skills but a holistic process where theory and practice are inseparably linked. Over 3-4 hours,

http://ijses.com/
All rights reserved

International Journal of Scientific Engineering and Science
Volume 8, Issue 8, pp. 74-78, 2024. ISSN (Online): 2456-7361

trainees not only perform flight tasks but continually analyze their actions from a theoretical perspective.

When errors occur, the simulation is paused, and the instructor initiates a detailed review of the situation. The trainee must explain the physical processes leading to the error, significantly deepening their understanding of theoretical concepts. This approach helps pilots not only correct mistakes but also prevent them in the future based on a deep understanding of flight theory.

An important aspect of the simulator session is practicing non-standard situations requiring quick decision-making. After each such scenario, a brief analysis is conducted where the trainee explains their actions based on knowledge from various fields of aviation science. This develops the ability to quickly apply theoretical knowledge in critical situations.

The final stage of training is the post-flight analysis, lasting 60-90 minutes. This stage is crucial for consolidating the acquired experience and forming strong links between theory and practice. The instructor uses simulator recordings to review key moments of the flight step by step, constantly linking the pilot's actions to theoretical concepts.

A particularly valuable part of this stage is discussing alternative scenarios. Trainees consider various "what if" situations, theoretically justifying possible alternative actions. This develops flexible thinking and the ability to adapt to unforeseen circumstances.

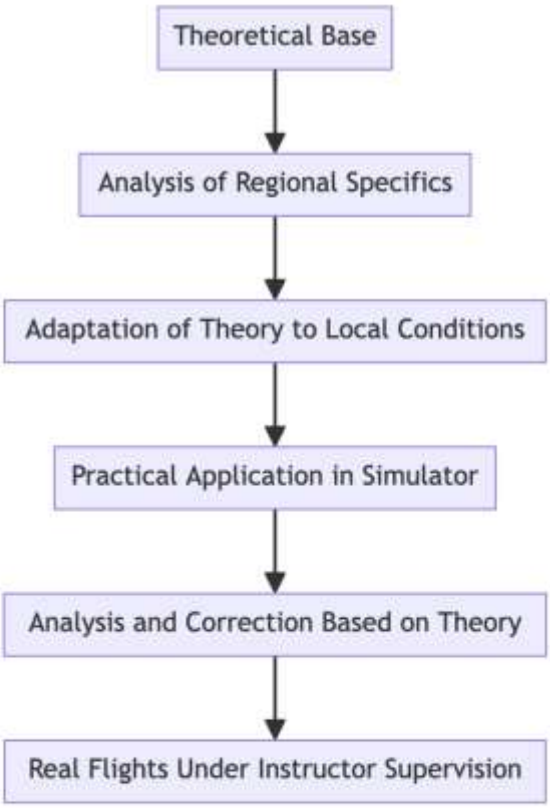

Figure 4: Integration of Theory and Practice

Based on the strengths and weaknesses identified during the session, an individual further training plan is formed. This plan includes both theoretical aspects that require deeper understanding and practical skills that need improvement.

The specifics of arctic operations require a unique approach to pilot training, considering the challenging conditions inherent in areas with complex climatic and geographic conditions. The training covers four key aspects: Arctic climate, challenging weather conditions, mountainous terrain, and short runways.

Preparation for flights in the Arctic climate includes comprehensive study of the impact of extremely low temperatures on aircraft systems. Trainees go through specially designed scenarios simulating temperatures as low as -50°C, allowing them to familiarize themselves with the peculiarities of hydraulics, avionics, and engines under such conditions.

Special attention is given to de-icing and anti-icing techniques. Pilots study the physics of ice formation on aircraft surfaces and practice procedures for activating and monitoring anti-icing systems. Practical exercises in visually identifying ice types help develop skills in quickly assessing the situation and choosing appropriate countermeasures.

Training for flights in challenging weather conditions includes intensive preparation for operating in low visibility, strong winds, and snowstorms. Pilots undergo an advanced meteorology course specific to the Arctic region, allowing them to better understand and predict weather phenomena.

Simulator training includes approaches and landings in near-minimum visibility conditions and techniques for flying in strong crosswinds. Special emphasis is placed on training for "white-out" conditions, where pilots learn to rely entirely on instrument readings.

Preparation for flights in mountainous terrain requires special attention to navigation and understanding aerodynamics. Pilots study the region's topography and its impact on airflows, practice visual navigation using ground landmarks, and focus on the technique of steep approaches typical for mountain airfields.

A separate training module is dedicated to operations on short runways. Pilots study the flight operations manual and performance charts in depth, learning to quickly and accurately calculate takeoff and landing distances considering multiple variables. Simulator training includes techniques for precise landing and takeoff with maximum efficiency. This comprehensive training program, combining deep theoretical knowledge with intensive practical preparation, equips pilots to safely and effectively conduct flights in the unique and challenging conditions of the areas with challenging climatic and geographical conditions.

IV. Conclusion

The research conducted on the development and application of the "Bridging the Gap" methodology in the context of aviation training yields several important conclusions and recommendations for the further advancement of educational practices in the aviation industry.

Key Findings of the Study:

1. Based on the above described, it is possible to assume that the Bridging Gap method contributes to the formation of a more complete mental model of the flight situation in pilots, which is

http://ijses.com/
All rights reserved

extremely important for the effective performance of flights in complex and non-standard conditions.
2. The integrated approach to training significantly same pilots' ability to quickly and effectively apply theoretical knowledge in practical situations.
3. The adaptability of the methodology allows for the consideration of individual learning differences and the specific operational environment of a particular airline.
4. The application of the "Bridging the Gap" methodology same the development of pilots' metacognitive skills, which are essential for their continuous professional development.

Recommendations for Implementing the Methodology in Aviation Training:
1. Airlines are advised to integrate elements of the "Bridging the Gap" methodology into their pilot training programs, especially for operations in challenging climatic and geographical conditions.
2. Training centers should consider restructuring their curricula to more closely integrate theoretical and practical training.
3. Regulatory bodies are encouraged to take the findings of this study into account when developing standards and recommendations for aviation training.
4. Further research should be conducted to adapt the "Bridging the Gap" methodology for various segments of the aviation industry, including cabin crew and ground staff training.

In conclusion, the proposed "Bridging the Gap" methodology represents a significant advancement in the field of aviation education. Its implementation can substantially improve the effectiveness of pilot training and, consequently, the level of flight safety, particularly in complex and non-standard operational conditions. The further development and adaptation of this methodology have the potential to transform professional training approaches not only in the aviation industry but also in other fields characterized by high complexity and responsibility.

References

1. Organizational factors affecting the effectiveness of the educational process of training air traffic controllers. Electronic resource] Access mode: https://www.cell.com/heliyon/fulltext/S2405-8440 (22)03089-4 (accessed 06/14/2024).
2. Pilot training: Is the outdated task-based method not enough for aviation today? [Electronic resource] Access mode: https://aviationvoice.com/pilot-training-outdated-task-based-method-not-enough-for-aviation-today-201910011644 / (accessed 06/14/2024).
3. Using technology to improve learning. [Electronic resource] Access mode: https://unitingaviation.com/news/capacity-efficiency/using-technology-to-improve-training / (accessed 06/14/2024).
4. Acquisition of aviation training: Mastering aviation training: Best practices and strategies. [Electronic resource] Access mode: https://fastercapital.com/content/Aviation-Training-Acquisition--Mastering-Aviation-Training-Acquisition--Best-Practices-and-Strategies.html (accessed 06/14/2024).
5. Revolutionary Pilot training: How artificial intelligence and virtual reality enhance efficiency and realism. [Electronic resource] Access mode: https://techbullion.com/revolutionizing-pilot-training-how-ai-and-virtual-reality-improve-effectiveness-and-realism / (accessed 06/14/2024).
6. Marishin S.V., Geikina A.A. Methods and means of education in aviation // CHRONOS: animation sciences.2022. Volume 6 No.4(66). pp.19-20.
7. Radjabova, D. A. Modern educational technologies in teaching a foreign language /D. A. Radjabova // Young teacher.. — 2017. — № 13 (147). — Pp. 592-595.
8. Preparation of the training course. [Electronic resource] Access mode: https://flightsafety.org/asw-article/the-path-to-continuous-improvement / (accessed 06/14/2024).
9. Evidence-based training: A modern approach to pilot training. [Electronic resource] Access mode: https://www.airwaysmag.com/legacy-posts/ebt-modern-approach-pilot-training (accessed 06/14/2024).
10. The role of simulators in modern pilot training: Advanced training and flight safety. Electronic resource] Access mode: https://medium.com/@kavya.yugtechnology/the-role-of-simulators-in-modern-pilot-training-elevating-skills-enhancing-safety-8c1db40a5067#:~:text=Simulators%20are%20versatile%20tools%20that,equipped%20to%20handle%20diverse% 20% (accessed 06/14/2024).
11. Why flight simulators are important tools for pilot training. [Electronic resource] Access mode: https://aag.aero/why-flight-simulators-are-important-tools-for-training-pilots / (accessed 06/14/2024).
12. The Flight Academy of Pilots offers a broader program. [Electronic resource] Access mode: https://www.halldale.com/articles/20266-cat-pilot-flight-academy-offers-pilot-pathway-with-wideroe (accessed 06/14/2024).

All rights reserved