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Exploring Perceptions of Pilot Licensing and Training Standards: A Survey of Canadian Student and Licensed Pilots

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ABSTRACT

This study investigates the perspectives of Canadian student and licensed pilots on general aviation pilot training and licensing practices. Employing a mixed-methods approach, this research critiques the reliance on flight hours as the sole competence metric and examines the alignment of existing practices with modern aviation's complexities. Findings reveal a divergence in opinions between novice and experienced pilots on flight hours' importance, with a consensus towards a competency-based evaluation model. The study identifies critical shortcomings in existing training practices, such as the challenge of integrating technology, fostering advanced skills, and efficiently utilizing instructional resources. It suggests recommendations for regulatory enhancements, aiming to ensure training practices evolve in line with the changing requirements of aviation safety and technology. The conclusion calls for urgent reform, underlining the imperative for training adaptations that can prepare pilots to proficiently manage the complexities of contemporary airspace, thus safeguarding their proficiency and safety.

Practitioner Summary: A survey conducted among Canadian student and licensed pilots to examine perspectives on general aviation pilot training and licensing practices uncovered critical shortcomings. The findings advocate for a strong preference for competency-based evaluations, urging reforms and regulatory improvements to ensure alignment with the evolving landscape of aviation safety and technological advancements.

Keywords: Pilot perspectives; pilot training and licensing; technology integration; regulatory enhancements; training adaptations.

1.0 INTRODUCTION

In the realm of civil aviation, safety stands as the foremost priority, with human factors acknowledged as essential elements in its preservation. Research indicates that human factors are implicated in approximately 75% of civil aviation accidents, encompassing issues like loss of situational awareness, poor decision making, deviations from standard procedures, incapacitation, and communication failures (Helmreich, 2000; Idowu, 2022; Kelly & Efthymiou, 2019; Kharoufah et al., 2018; Mathavara et al., 2022; Muecklich et al., 2023).

An analysis of data from the Transportation Safety Board of Canada reveals that between 2013 and 2023, Canadian-registered aircraft were involved in 2,093 accidents, defined as severe occurrences with significant harm. Of these, 1,455 were related to general aviation, averaging 132 accidents annually (Transportation Safety Board of Canada, 2024). These statistics underscore the ongoing risks and highlight the need for continual improvements in general aviation safety practices. For clarification, general aviation encompasses all private and non-commercial aviation activities, excluding regular airline flights and fee-based cargo transport services (MacKinnon, 2004). This includes recreational flying, pilot training, agricultural aviation, law enforcement operations, medical air transport, land surveying, and various unscheduled commercial activities. This classification highlights a broader segment of aviation that extends beyond commercial airlines and cargo transport, capturing the essence of private and non-commercial aviation endeavors.

Pilot training in Canada is governed by strict practices and standards to ensure safety, all under the oversight of Transport Canada (Transport Canada, 2023). Despite these rigorous standards, the industry faces challenges, including meeting the increasing demand for pilots and adapting to rapid technological advancements. The COVID-19 pandemic intensified Canada's existing pilot shortage, leading to early retirements amid industry challenges (Pinto, 2023). In 2018, the Canadian Council for Aviation and Aerospace (CCAA) projected a need for an additional 7,300 commercial pilots by 2025 to meet growing demand, specifically emphasizing the requirement for those holding a Commercial Pilot License (CPL) (Canadian Council for Aviation and Aerospace (CCAA), 2018). This projection underscores the increasing necessity for pilots with advanced credentials, including the Airline Transport Pilot License (ATPL). Within the civil aviation sector in Canada, CPL holders frequently seek to advance to ATPL certification, further amplifying the demand for these higher-level qualifications. The current shortage of qualified pilots has enabled recent flight school graduates to secure positions with major carriers earlier in their careers, emphasizing the urgency to elevate pilot training and licensing standards to improve the quality of new pilots and address future industry needs (Hon. A. Sgro, 2019). Meanwhile, advancements in computer and information technologies, including simulators, virtual reality (VR), and artificial intelligence (AI), have significantly evolved (Alahi et al., 2023; Bourechak et al., 2023; Dattel et al., 2023; Garg et al., 2023; Nair & Tyagi, 2023; Tanwar et al., 2023). Despite these technological leaps, their integration into pilot training across Canada remains limited, maintaining traditional practices for decades (Transport Canada, 2004b). Recognizing such issues, the forty-first assembly of the International Civil Aviation Organization (ICAO) emphasized the need for agility and innovation in pilot training (International Civil Aviation Organization, 2022). It highlighted the importance of optimizing training programs to improve safety and operational efficiency, reflecting a global consensus on the need to modernize pilot training and licensing not just for commercial air transport sub-sector, but also for general

aviation. This includes adapting to technological advancements and evolving industry needs to ensure pilots are prepared for the demands of modern aviation.

Pilot licensing in Canada is a staged process, with the most common training pathway starting with the Private Pilot License (PPL) and subsequently progressing to more advanced certifications. The PPL allows individuals to fly single-engine aircraft for personal use. For those aiming to pursue a career in civil aviation, the next step is the CPL, which permits employment as a pilot, including flying single-pilot aircraft and co-piloting multi-crew aircraft with additional ratings. After acquiring a CPL and meeting the extensive training requirements for the ATPL, individuals can take the ATPL exams and flight test. The ATPL, the highest civilian pilot license, qualifies pilots to serve as captains or pilots-in-command of multi-crew aircraft for both regulated and private airlines. However, possessing an ATPL alone is often insufficient for airline employment, as additional qualifications and employer-specific requirements may apply. Regardless of the type of license, the pilot licensing and training process in Canada relies on a series of conventional training requirements, with long-established hours-based training practices being a key component (Transport Canada, 2021). To obtain a pilot license, student pilots must complete ground instruction and accumulate the necessary flight training hours, with advanced level licenses demanding broader training. However, reliance on flight hours as the primary competency measure has its limitations, as pilot proficiency can significantly vary among individuals with identical hours logged (Hon. A. Sgro, 2019). This discrepancy underscores the need for a more nuanced competency evaluation beyond mere flight hours. Internationally, this issue has also been recognized for several years, prompting certain civil aviation authorities (CAA) to adopt competency and evidence-based flight training methodologies. For example, the European Aviation Safety Agency (EASA) has implemented Competency-Based Training and Assessment (CBTA) and Evidence-based Training (EBT) across its member states (European Union Aviation Safety Agency, 2021a, 2022). Similarly, the Civil Aviation Administration of China (CAAC) has also embraced a hybrid approach of CBTA and EBT, leading many Chinese airlines to follow suit (Civil Aviation Administration of China, 2023; Schuurman, 2022). However, the adoption of these methods has been primarily within the commercial air transport sector, with limited application in general aviation pilot training. Moreover, in some instances, the focus of their implementation has been quite narrow, concentrating solely on the development and assessment of specific pilot competencies. To aid CBTA and EBT adoption, detailed guidance materials (International Air Transport Association, 2023, 2024; International Civil Aviation Organization, 2013) have also been made available to CAAs, Operators (AOC), and Approved Training Organizations (ATO) by international aviation agencies such as ICAO and International Air Transport Association (IATA), facilitating a standardized approach across civil aviation industry.

Furthermore, the flight test assessment process in Canada, irrespective of the license type being pursued, combines objective metrics with subjective judgments by examiners, introducing variability in the evaluation (Transport Canada, 2010). Adding to these challenges, the integration of flight simulation training devices (FSTDs) in typical ab initio training programs across flight schools in Canada presents regulatory, technological, and pedagogical hurdles, impacting the effectiveness of training outcomes (Hon. A. Sgro, 2019; Mavin et al., 2017; Pole, 2019).

Considering the reported air transportation accidents involving Canadian-registered aircraft, the noticeable lag in adopting modern technologies, the guidance provided by ICAO, and the evident inadequacies in pilot training and licensing standards, there is an imperative need to explore the

limitations of the prevailing regulatory and educational framework. Driven by this necessity, this study seeks to investigate the perspectives of student and licensed pilots, on the existing practices of airplane pilot licensing and training, aiming to pinpoint opportunities for enhancement. However, within the scope of pilot licensing and training, this study specifically focuses on general aviation pilot training within the civil aviation sector. Through this analysis, the goal is to uncover actionable insights that can address the current shortcomings and align general aviation pilot training and licensing more closely with the evolving demands of aviation safety and technological progress. Accordingly, our objective is to explore the limitations of Canada's existing general aviation pilot training and licensing practices and to uncover new opportunities that can enhance pilot training, offering valuable insights and actionable recommendations. Specifically, the two research questions we will explore are as follows:

1. Do student and licensed pilots regard accumulated flying hours as a reliable indicator of pilot competence?

2. Do student and licensed pilots perceive current pilot training practices and standards as adequately addressing pilots' educational and practical needs, ensuring key instructional and assessment elements are met?

It is important to emphasize that including student pilots in this study was a deliberate decision to capture the perspectives of individuals actively engaged in training. Their feedback can be vital for assessing the relevance of current practices and understanding how effectively these could prepare them for real-world scenarios, directly supporting our study's objective of investigating the perspectives on the existing practices from multiple viewpoints.

2.0 LITERATURE REVIEW

2.1 Literature Review Method

2.1.1 Scoping Review Process and Methodology:

This scoping review adheres to the PRISMA-ScR framework (Tricco et al., 2018), ensuring transparency and rigorous methodology to thoroughly explore research questions and minimize bias. We followed a six-step protocol: 1) conducted a comprehensive literature search across various academic databases aligned with our research objectives; 2) screened titles and abstracts for eligibility; 3) reviewed full texts to finalize inclusions based on specific criteria; 4) extracted relevant data from the selected studies; 5) summarized the findings. Subsequent sections will detail our research sources, approach, screening criteria, and the process used to review and select studies for inclusion.

2.1.2 Research Sources:

The search for relevant literature was conducted across four key databases: Google Scholar, BASE, CORE, and WorldCat. Google Scholar provided extensive access to freely available academic papers, including interdisciplinary studies. BASE contributed a significant volume of specialized articles, enriching the content diversity. CORE, which compiled open-access research from multiple repositories, served as a valuable resource for accessing diverse and comprehensive academic works. WorldCat, a global catalog of library collections, offered a wide array of sources, ranging from academic journals to contemporary discussions, enabling access to content from libraries worldwide. Collectively, these

databases facilitated a comprehensive and focused review of literature across various disciplines, directly relevant to our study's objectives.

2.1.3 Research Approach:

The literature search was conducted using a set of well-defined search keywords and a broad array of corresponding synonyms to ensure a thorough retrieval of relevant publications. The primary keywords were "pilot training standards," "perceptions of pilot training by student or licensed Pilots," "challenges in civil aviation education and training," "pilot training limitations," "shortcomings in pilot licensing," and "regulatory shortfalls in pilot training." To expand the search, synonyms such as "aviation training guidelines," "opinions on flight training from student or licensed Pilots," "obstacles in pilot training," "limitations in flight training programs," "deficiencies in pilot certification," and "regulation gaps in aviation training" were utilized. This comprehensive approach ensured a detailed exploration of literature across various aspects of pilot training and licensing.

2.1.4 Screening Criteria:

This scoping review primarily concentrated on the current literature on pilot training standards and practices, perspectives of student or licensed pilots on pilot licensing and training practices, and regulatory challenges within pilot training education and training, aiming to provide a comprehensive overview of these critical areas. To ensure a focused and relevant selection of publications for this review, specific inclusion and exclusion criteria were established. The inclusion criteria required that only peer-reviewed journal articles or published conference papers from pertinent academic disciplines such as Aviation and Aerospace Studies, Education and Training, Safety Science, Human Factors and Ergonomics, and Management and Organizational Studies be considered. These publications must specifically cater to ‘airplane’ pilot training and licensing, be published within the last 12 years (2011-2023), and are written in English to ensure that the data is both current and accessible. The publications needed to employ empirical research methodologies involving primary data from student or licensed pilots. Accepted research methodologies encompassed structured or semi-structured surveys, in-depth individual interviews, or moderated focus group discussions or reviews, ensuring a thorough data collection. Moreover, these publications needed to perform a comprehensive analysis of the collected data, clearly report findings with appropriate statistical or thematic analysis methods, and discuss study limitations. The selection process for participants had to be explicitly defined, and data collection needed to utilize reliable and validated tools. If new tools were developed, their validation processes were required to be thoroughly documented. Ethical standards were pivotal; studies had to have obtained necessary approvals, ensuring informed consent, confidentiality, and participant safety. While the geographical focus area was on Canada, the geographical scope was expanded internationally, including countries and regions like the U.S and Europe, due to similarities in pilot training and licensing practices. In addition to peer-reviewed journal articles and published conference papers, relevant reports and guidance materials from international aviation agencies (e.g., ICAO, IATA) were also included to enrich the context and applicability of the review findings. Conversely, the exclusion criteria ruled out non-peer-reviewed materials such as book chapters, online articles, magazines, and studies not written in English. Articles primarily based on literature reviews were typically excluded unless they served as critical supporting information through seminal works or comprehensive reviews that delivered unique theoretical insights or a thorough contextual understanding. This strategy ensured that these reviews

augmented the narrative without becoming the empirical foundation of our research conclusions. Studies conducted in experimental laboratories were excluded to favor research in natural, operational settings that more accurately reflected real-world pilot training environments. In addition to the Inclusion & Exclusion criteria screening, an applicability review ensured that only publications closely related to the core research questions concerning views of student or licensed pilots on the reliability of accumulated flying hours as an indicator of pilot competence or the adequacy of current training practices were included, ensuring the findings were relevant and focused.

2.1.5 Screening Process:

Screening Process: The screening process was conducted using Covidence as the primary tool to enhance efficiency. Initially, all search results (n = 1273) from various databases were uploaded to Covidence, leading to the automated removal of duplicates (n = 297). The subsequent phase involved title and abstract reviews where a significant number of publications (n = 762) were excluded for not aligning with the established research focus. A more detailed full-text screening of the remaining 214 publications resulted in the exclusion of an additional 167 publications that failed to meet the predefined eligibility criteria. The rigorous selection criteria narrowed to 47 potentially relevant publications. Each of these was further scrutinized for its direct relevance to the core research questions. This in-depth evaluation, conducted by two independent researchers, led to the final inclusion of 13 publications deemed most pertinent.

The excluded publications were organized into distinctive groups, each providing valuable insights yet not addressing the core research questions regarding the reliability of accumulated flying hours as indicators of pilot competence or the adequacy of current training practices. We've included a few examples for context: In the "Technological Innovations and Tools" group, (Hight et al., 2022) explored how virtual reality simulations can enhance learning efficiency for ab initio pilot training, and (Guthridge & Clinton-Lisell, 2023) assessed the role of VR training devices by comparing them with PC-based simulators, noting their effectiveness in improving pilot performance, however neither directly addressed our core questions regarding the perceptions of student or licensed pilots on flying hours being competency measure or adequacy of current training practices. In the "Training Effectiveness and Methods" group, (Mendonca et al., 2019) focused on fatigue management strategies in pilot training, emphasizing pilot health over training standards, (Novacek, 2017) evaluated assessment tools for improving knowledge retention and decision-making, and (Khalid et al., 2018) provided insights into various teaching methods, but all these publications lacked direct evaluations of the adequacy of current training effectiveness. The "Regulatory Impact and Compliance" group featured (Depperschmidt, 2013) and (Freiwald et al., 2013), who analyzed regulatory and economic impacts of changes on training costs and investigated how safety culture across flight training organizations influences training outcomes, but neither study assessed training adequacy or pilot competence directly. Finally, the "Educational Strategies and Perspectives" group included (Wilson & Daku, 2016), who surveyed flight instructors on effective teaching methods, highlighting instructional discrepancies but not connecting these to views of student or licensed pilots on pilot competence or training practices. (Marintseva et al., 2022) discussed the low female representation in pilot training, and (Schaffernak et al., 2020) explored educational frameworks in aviation training. Both provided valuable insights but did not directly evaluate their impact on training effectiveness or address core research questions about training practices or standards.

Figure 1 presents a PRISMA-ScR flowchart, detailing the systematic procedure for identifying, screening, and reviewing publications for inclusion in this scoping review. The findings and characteristics of the included publications were synthesized and are presented in the next section.

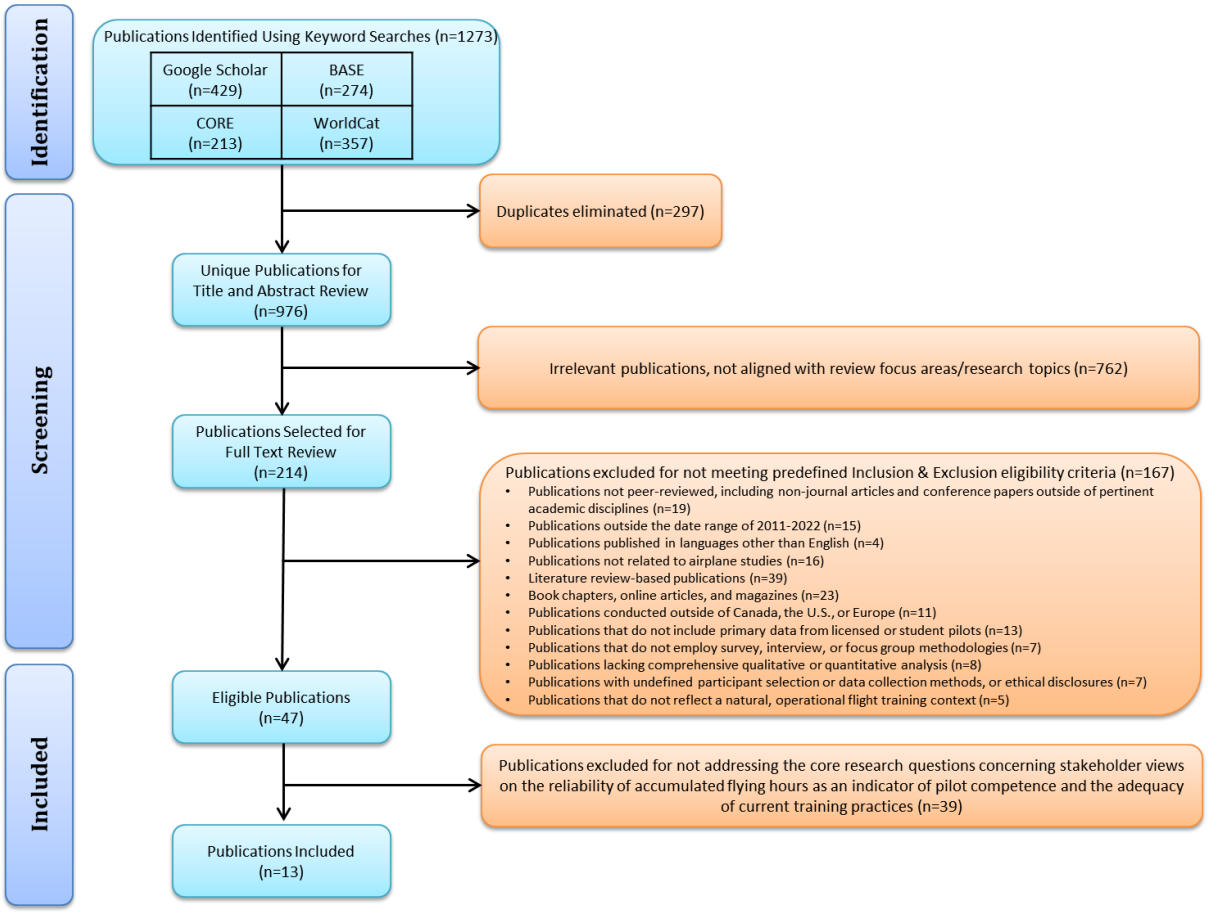


Figure 1: Selection of studies using PRISMA flowchart

2.2 Literature Review Results

Building on the systematic identification and selection process detailed earlier, this section delves into a detailed synthesis of the findings and characteristics of the thirteen publications that met our criteria for inclusion.

Davis's study, involving interviews and flight simulator evaluations with 10 seasoned non-professional pilots in Canada, found that the country's educational and regulatory standards fall short in ensuring operational proficiency (Davis, 2018). The study suggested adopting improved training standards, stricter rules, and fostering a culture of ongoing skill enhancement. A key issue identified was Transport Canada's relaxed approach to enforcing rules, creating an environment where pilots might ignore regulations without consequences. The study also noted differences in training rigor between professional and non-professional pilots, particularly PPL holders, suggesting their recurrent training might not adequately maintain proficiency. The flight simulator evaluations revealed a gap between pilots' training and their ability to handle emergency situations. However, the study's focus on a specific group of PPL holders

from British Columbia, its small sample size, and age skew (average participant age: 54), along with participants' infrequent flying practices, limit its broader applicability and indicate that its findings should be interpreted with caution.

Kearns and Sutton explored the belief that all flying hours on similar aircraft are equally valuable by focusing on non-technical skill development through real-world flying experiences (Kearns & Sutton, 2012). Their study utilized a self-report survey to gather narrative descriptions and involved narratives from 130 Canadian general aviation pilots about their experiences, including challenges and the use of non-technical skills. The findings indicated that flight hours alone might not fully assess non-technical skill progression due to variations in pilots' operational backgrounds. However, the study's limitations include participants reporting only one significant event, which might not capture their complete skill development, and a broad categorization of errors and skills, missing nuanced differences in operations. The research suggests the need for future studies to more objectively evaluate pilot experience across diverse flight operations to better understand skill development.

Fursenko's study analyzed Canada's pilot training system, focusing on regulatory requirements and training methods to identify modernization opportunities (Fursenko, 2020). It pointed out the need for modernization, emphasizing the use of outdated equipment and resources in flight schools. It recommended updating training materials, adopting advanced technologies such as flight simulators, and shifting towards competency-based training for greater efficiency and lower costs. However, the study was limited to secondary sources and lacked direct pilot feedback and quantitative outcome assessments, indicating that future research should include interviews or surveys for a comprehensive evaluation.

Efthymiou et al.'s study investigated why over half of the CPL applicants in Europe fail airline assessments despite training at European Aviation Safety Agency (EASA)-accredited flight schools (Efthymiou et al., 2020). Conducting interviews with 12 industry professionals, including students and instructors, the research pinpointed deficiencies in technical knowledge, preparation, communication, and leadership as significant factors. However, the study had limitations due to its small and specific participant sample of only two students, one instructor, and one examiner, which might not fully capture a comprehensive understanding of training effectiveness.

Majumdar and Marais surveyed 128 U.S. pilots, uncovering training deficiencies in handling in-flight loss of control (LOC) incidents, particularly in spins and spirals (Majumdar & Marais, 2022). It suggested the need to improve training with specific focus on LOC recognition and recovery techniques, aiming to better equip pilots for such emergencies. Though providing valuable insights into LOC recovery, the study's specialized scope limits its relevance to other inflight emergencies.

Casner's study in the U.S. assessed the effectiveness of ATPL training in preparing pilots for unusual in-flight situations (S. M. Casner et al., 2013). With 18 experienced U.S. airline pilots and using a simulator for three unique flight scenarios, the study found that traditional training methods, reliant on memorization, fell short in unexpected scenarios. Pilots were adept at handling familiar situations but struggled with novel and abnormal events, underscoring a critical gap in training that does not fully prepare them for real-world flying's unpredictability. The recommendation is for enhancing training to focus on recognizing and managing unusual flight scenarios. However, the study's findings, focused on ATPL training, may not apply universally across different pilot licenses, potentially affecting the study's broader relevance.

Hale and Breaux's study explored the instructional challenges flight instructors face, noting that safety concerns can delay in-flight teaching and slow error correction (Hale & Breaux, 2011). It highlighted how students' focus on flying limits in-flight instruction opportunities. To improve training, the study recommends low-fidelity, scenario-based training and detailed performance measures. However, the study's conclusions are based more on theoretical analysis than on empirical data or direct instructor feedback.

Kolmos's study critiques the prevailing 'one size fits all' approach in pilot training, emphasizing its challenges for older pilots who learn differently from younger peers, especially when adapting to advanced cockpit technologies (Kolmos, 2019). It advocates for age-specific training methods to ensure a smooth transition to modern cockpits. However, the study's reliance on literature and theoretical frameworks might not accurately represent the practical experiences of pilots undergoing this transition.

Guidance materials from ICAO and IATA provide valuable frameworks for enhancing pilot training and assessment, although their applicability to general aviation is limited. The ICAO's “Manual of Evidence-based Training (EBT)” offers detailed guidelines to civil aviation authorities, operators, and training organizations for the ongoing assessment and training of pilots utilizing FSTDs (International Civil Aviation Organization, 2013) . The manual promotes a shift from traditional, scenario-based training to a competency-based approach, focusing on assessing and developing essential competencies for modern aviation safety. This EBT framework leverages data from accident and incident reports, flight data analysis, and safety studies to ensure training is relevant to actual threats and errors in flight operations. Despite its comprehensive guidance on developing training programs and evaluating flight crew performance, the manual primarily caters to commercial air transport. The manual’s implementation in general aviation could be hindered by the complexity of necessary data collection and analysis, which may be impractical on a smaller scale due to limited resources. Over the past decade, IATA has worked to consolidate data from various sources such as flight data analysis, safety reports, and pilot surveys to identify improvement areas (International Air Transport Association, 2014). This collaboration led to the creation of the "Evidence-based Training Implementation Guide" by IATA (International Air Transport Association, 2024). This guide integrated the latest regulatory and industry best practices, providing revised guidelines on how to implement the provisions of ICAO's “Manual of Evidence-Based Training” (International Civil Aviation Organization, 2013) and the applicable sections from ICAO's “Procedures for Air Navigation Services – Training” (International Civil Aviation Organization, 2020). It provides a structured approach for implementing EBT programs to enhance pilot competencies through a data-driven process. It emphasizes continuous data refinement to address significant operational risks. However, the extensive data requirements and advanced analytical tools needed for EBT are often out of reach for general aviation operators, who typically have fewer resources and a less formalized training structure. Additionally, IATA's "Competency Assessment and Evaluation for Pilots, Instructors, and Evaluators" offers a thorough framework for competency-based training and assessment (CBTA) (International Air Transport Association, 2023). This manual details assessment processes and methods aligned with industry best practices, aiming to comprehensively evaluate pilot performance and instructor effectiveness. Yet, its effectiveness in general aviation is limited due to the sector's diverse and decentralized nature. The rigorous data requirements and structured assessment processes, ideal for larger commercial settings, pose a challenge for general aviation entities, which might struggle with these demands due to their smaller scale and less structured environments. As well, the manual’s focus on commercial aviation scenarios limits its relevance to the varied nature of general aviation operations.

Our literature review indicates that pilot training and licensing research in Canada, particularly in the general aviation sub-sector, is significantly under-researched. While some publications identify gaps in current practices and methodologies, many critical areas remain unexplored. International research also highlights additional gaps, presenting opportunities for future investigations. Previous publications also had small sample sizes, focused on specific training aspects, or relied on theoretical discussions without direct data collection from the student pilots or pilot workforce. Publications from international agencies provided detailed frameworks and practical guidelines, such as CBTA and EBT methodologies, that can enable implementation of effective pilot training and assessment programs. However, these are merely guidelines, not enforceable regulations. In practice, general aviation in Canada predominantly adheres to traditional and hour-based methods, and the level of assessment currently in place is not detailed enough to satisfy the criteria set forth by these CBTA and EBT methodologies (Transport Canada, 1997, 2004a, 2004b, 2004c, 2021), highlighting a significant gap. Furthermore, it also remains uncertain whether student pilots at the ab initio or grassroots level will adopt these methodologies. Assessments at the end-user level are necessary to determine the acceptance and feasibility of these approaches among new pilots. While CBTA and EBT methodologies outlined in these publications could be effective, these methodologies primarily focus on commercial civil aviation, suggesting that adaptations are necessary when applying these guidelines to general aviation. This will ensure that the unique challenges and requirements of general aviation are adequately addressed.

To address these research gaps, our study will ensure diverse representation across age, experience levels, and operational backgrounds by engaging directly with student pilots, and licensed pilots from both general and commercial aviation sub-sectors. Although our focus is on general aviation, including pilots from the commercial sub-sector provides a comprehensive range of perspectives and experiences, offering valuable insights into best practices and common challenges across different aviation contexts. Additionally, the interplay between general and commercial aviation practices can reveal areas where general aviation training could benefit from commercial sector innovations and best practices. This approach will enable us to comprehensively assess current pilot training practices, highlight underexplored areas, and develop well-informed, evidence-based recommendations for general aviation pilot training and licensing standards in Canada. The insights derived will aim to enhance the safety, efficiency, and technological integration of pilot training programs, aligning them with the practical and evolving demands of the civil aviation industry.

3.0 METHOD

3.1 Research Instrument

3.1.1 Survey Design and Scope Overview

An internet-based survey was developed to collect self-reported perceptions from both student and licensed pilots, aimed at assessing the current general aviation pilot training standards and practices, and to solicit feedback on existing limitations and potential areas for improvement. It comprised 10 carefully curated questions, balanced between quantitative and qualitative inquiries. Five questions used a 5-level Likert scale, grounded in self-perceived reporting of established training practices to gain a broader understanding of training experiences. The remaining five questions were open-ended, designed to elicit comprehensive insights into the limitations of the training and assessment practices along with their potential opportunities for improvement. These open-ended questions were included to allow for a richer, more detailed exploration of the subject, which standardized scales may not fully capture. This mixed-methods approach was adopted to enable a holistic assessment, combining structured data from Likert

questions with in-depth qualitative feedback from open-ended questions. Demographic data, including age, gender, education, pilot licenses, training locations, flying experience, ratings, and medical categories, were also collected for each participant. It is important to note that this survey did not aim to evaluate training outcomes or validate current methods. Moreover, it did not collect any objective data, such as behavioral, physiological, and other subjective constructs like situational awareness or mental workload, nor did it involve gathering data from experiments conducted in controlled settings. Instead, it focused on gathering pilots' subjective opinions about their training experiences. By assessing their perspectives and satisfaction, this survey sought to capture insights into the perceived effectiveness and value of current training practices without attempting to validate their efficacy. Therefore, this study represents a perception-based assessment rather than a validation of training efficacy.

Additionally, the survey was strategically crafted to capture broad insights into general aviation training practices without categorizing inquiries by different license certifications or ratings. This approach was intended to provide an overarching understanding of the training landscape, highlighting themes and commonalities across all areas of general aviation pilot training. By eschewing segmentation by license type or rating, the design aimed to prompt survey participants to consider their entire training journey, thus allowing for a broader collection of experiences and perceptions. This approach was also designed to circumvent issues related to variability from specialized certifications and to mitigate bias that might arise if participants felt their experiences were narrowly defined by specific certification milestones. Consequently, the survey was specifically designed to enable a thorough exploration of training and assessment practices within general aviation, aligning with the study's objective to assess the overall effectiveness and satisfaction with these practices.

The 10 survey questions are shown in the Appendix.

3.1.2 Survey Design Logic

The theoretical basis for utilizing the survey as a research instrument, along with the design of the survey questions including demographic data collection elements, was rooted in previously published literature (Bourgeois-Bougrine et al., 2003; Boyd et al., 2021; S. Casner, 2008; Hunter, 2003; Ison, 2011; Kearns & Sutton, 2012; Latorella, 2002; Majumdar & Marais, 2022; McClumpha et al., 1991; Mitchell et al., 2009; Naidoo, 2010; Rice et al., 2020; Shappell et al., 2010; van Weelden et al., 2022) with validated frameworks tailored to civil aviation research. These questions were developed following a thorough review of existing literature and well-established theories, thereby confirming the appropriateness of the survey instrument and its design for the intended research. Given the exploratory nature and qualitative focus of half the survey questions, and considering that the remaining questions are single-item and do not measure any specific construct, traditional statistical reliability testing was deemed inapplicable (DeVellis & Thorpe, 2021; Madill et al., 2000; Maxwell, 2013; Nunnally & Bernstein, 1994). Instead, the survey underwent expert review and pre-testing conducted by pilot training experts (Certified Flight Instructors) and a mix of student and licensed pilots. This rigorous process enhanced the questions' clarity, relevance, and neutrality, ensuring they remained unbiased and well-aligned with the research objectives.

3.1.3 Statistical Credibility of Five-Question Likert Scale Data

This survey includes five Likert scale questions, which may lead some to question the statistical credibility of using only a small number of Likert scale questions. However, numerous studies (Barnard et al., 2022; Galiñanes et al., 2013; Gu et al., 2021; León-Mantero et al., 2020; Odom et al., 2021; Rudari et al., 2016; Siebericchs & Kluge, 2016; Versluijs et al., 2023) published in the literature have demonstrated the feasibility of conducting credible research with a small number of Likert scale questions. These studies, across various research contexts and disciplines, including aviation-based research, confirm that

robust statistical analyses can be effectively conducted with limited Likert scale data, provided that the analytical methods are carefully selected to suit the specific context of the study and that the data undergoes necessary validation processes. This supports the viability of our approach, ensuring that the survey results are both statistically credible and methodologically sound.

3.2 Procedure

The survey, developed on the Qualtrics platform, was available online for about four months. It was advertised to student, and licensed pilots in general and commercial aviation across Canada, through flight schools, aviation organizations, and social media. The survey, ensuring confidentiality, required participants to consent before proceeding, was voluntary and anonymous. Utilizing snowball sampling, participants were encouraged to share the survey, broadening the participant base. This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board.

After excluding missing or incomplete entries, the survey collected 206 valid responses. The numerical data underwent a cleaning process for statistical analysis, which involved fixing typographical errors and standardizing text variables into numerical values to ensure data integrity and reliability. For open-ended questions, irrelevant content was removed, response formats and language were standardized, and duplicates were eliminated. Data was analyzed using IBM SPSS® 29.

4.0 RESULTS

4.1 Demographic Insights

The survey garnered responses from 206 participants, consisting of both student and licensed pilots. Figure 2 depicts the percentage distribution between these groups, as well as the variety of license types held by the licensed pilots, including Private Pilot License (PPL), Commercial Pilot License (CPL), Integrated Airline Transport Pilot License (IATPL), and Airline Transport Pilot License (ATPL). Additionally, Figure 3 presents the gender distribution and educational levels of the participants. Age analysis of participants showed an average age of 29.53 years, a median of 24 years, and a standard deviation of 12.30, indicating a wide age range from 17 to 71 years.

Flying experience analysis spanned from beginners with zero flight hours to veterans with over 40 years and up to 30,000 hours in aviation, averaging 1,890 hours but with a high variability (standard deviation of 3,867 hours). This range highlighted the varied proficiency levels, from modest to well-established aviation careers. Additionally, pilots' training backgrounds were diverse, with majority trained in Canada, but some also received education or ratings from countries like Vietnam, France, the USA, and the UK. Regarding medical fitness, the majority (192) of participants met the high standard of Category 1, whereas a smaller group (14) qualified for Category 3.

The survey data revealed varied ratings associations with pilot license holders. PPL holders predominantly had Night Ratings, with 25 pilots accredited; however, 30 lacked additional ratings. In contrast, CPL holders displayed a wider array of qualifications beyond Night Ratings, with the majority also possessing Multi-Engine and Instrument Ratings, alongside Instructor, Seaplane, and specific Type Ratings for aircraft such as Boeing 737-800 and Airbus A32F. IATPL holders mainly had Multi-Engine, Instrument, and Night Ratings, with a few also holding Seaplane and specialized Type Ratings. ATPL holders exhibited a comprehensive skill set, universally holding Multi-Engine and Instrument Ratings, and many also had Seaplane, Night, Instructor, and Type Ratings for various aircraft, including Boeing, Bombardier, and specialized models like the DC3T.

The average duration of survey participants as pilots since obtaining their first license was 8.2 years, with a standard deviation of 10.8 years. Given that the Flight Training Manual (TP 1102E), Flight Instructor Guide - Aeroplane (TP 975E), Pilot Decision Making (PDM) Manual (TP 13897), and Instrument Procedures Manual (TP 2076E) were last published in 2004 and 1997 respectively (Transport Canada, 1997, 2004a, 2004b, 2004c), it is evident that these resources, which are integral to general aviation training in Canada, have not been updated in two decades. These manuals cover essential aspects such as theoretical knowledge and practical instructions for student pilots, guidelines and best practices for instructors, human factors, decision-making processes critical for safe flight operations, and detailed procedures for instrument flight rule (IFR) operations. Therefore, it was reasonable to conclude that the training perceptions provided by survey participants align with current Canadian civil aviation standards. This alignment confirms that the survey insights accurately reflect ongoing pilot training practices in Canada, despite the manuals' lack of recent updates.

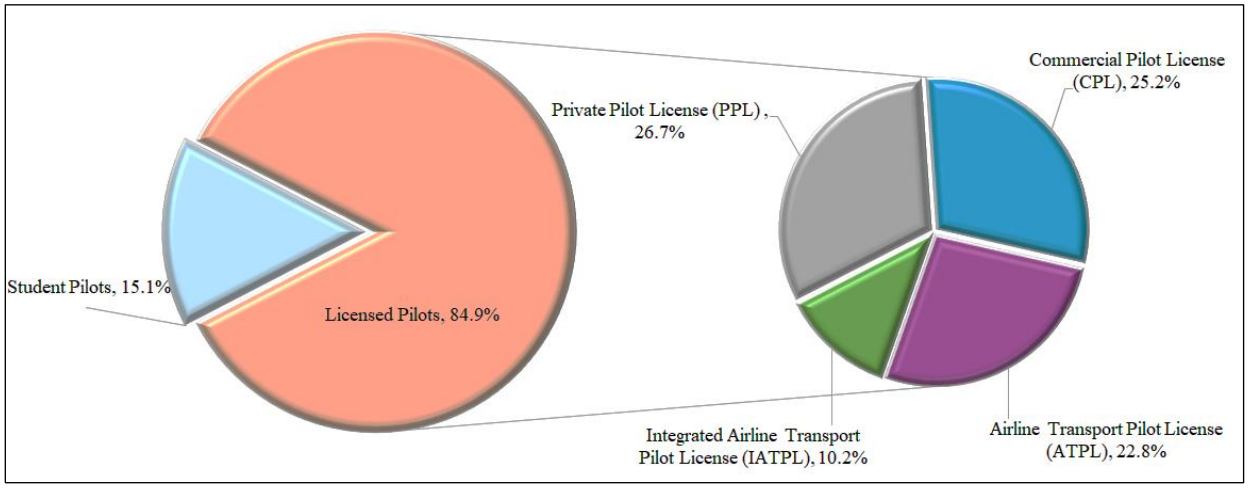


Figure 2: Distribution percentages of student pilots and licensed pilots, along with a detailed breakdown by license types

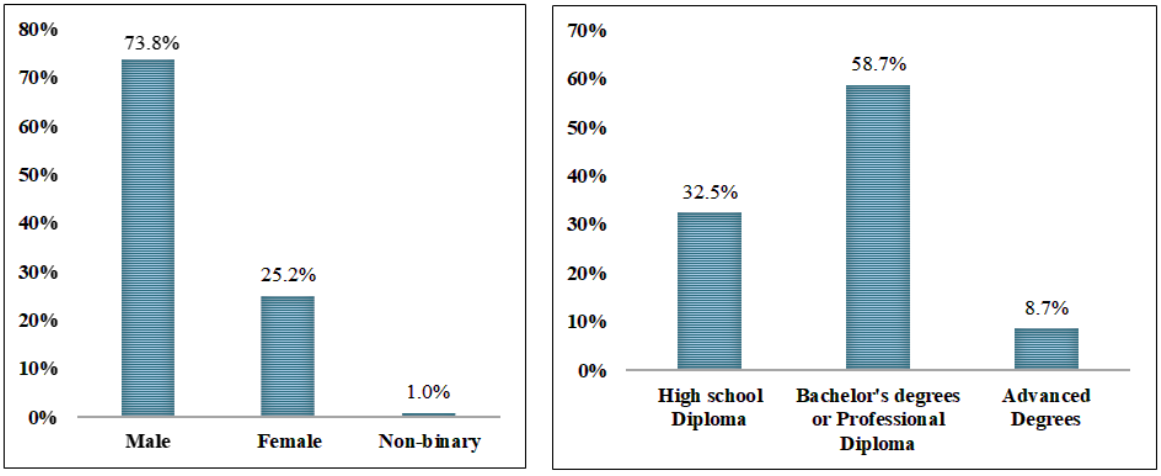


Figure 3: Distribution of gender and educational levels among survey participants

4.2 Quantitative Findings

Statistical techniques, both descriptive and inferential, were utilized to analyze the perceptions of student and licensed pilots based on their responses to Likert scale questions in the survey. Participants rated their level of agreement on a 5-point Likert scale, with the following values: 1 for 'Strongly disagree,' 2 for

'Disagree,' 3 for 'Neither agree nor disagree,' 4 for 'Agree,' and 5 for 'Strongly agree.' The study analyzed data from a diverse participant pool, including student pilots and various licensed (PPL, CPL, IATPL, ATPL) pilots, to identify differences in opinions among these groups. It also explored gender differences within these groups. It should be noted that the primary research questions centered on perceptions among student pilots and licensed pilots with different license types, including PPL, CPL, IATPL, and ATPL, without initially considering demographic variables such as gender. However, as a secondary aspect of the research, the effect of gender on responses to each Likert scale question was explored. This was undertaken to highlight specific barriers faced by underrepresented genders (Allin, 2020, 2023) in the predominantly male civil aviation industry. Unfortunately, the data collected did not include sufficient combinations of participant group and gender to reliably analyze their interaction effects. Therefore, the analysis treated participant group and gender separately to ensure a robust analysis within the constraints of the available data.

Statistical analysis treated participants' level of agreement or disagreement (Likert scale rating) as the dependent variable, reflecting their perceptions. The different participant groups, including student pilots and various licensed pilots (PPL, CPL, IATPL, ATPL), were treated as the independent variable to evaluate how these groups might influence the responses. There were no covariates or control variables.

The Shapiro-Wilk test showed a significant deviation from normal distribution (p-values <0.001) in the response data for each Likert question. Research by (Aksu et al., 2019; Peng et al., 2007) underscores the importance of sample size in accurately conducting transformations to normalize data, recommending a minimum of 1000 samples for reliable parametric estimation in non-normal distributions. Given that our survey's sample size was only 206, the expected transformation effects were likely not sufficiently pronounced; thus, data transformation was not pursued.

Given the non-normal distribution of the data, (Kandane-Rathnayake et al., 2013; Nahm, 2016; Sanjerehei & Rundel, 2019) recommend employing nonparametric methods for statistical analysis. Accordingly, we implemented nonparametric techniques that do not assume normal distribution. We used the independent sample Kruskal-Wallis test to analyze responses to each Likert scale question. For more detailed group-specific comparisons and gender-based analysis within the groups, post-hoc analyses using Dunn's multiple comparisons test or the Mann-Whitney U test were conducted.

4.2.1 Pilot Perspectives on Flight Time as a Competence Measure

Regarding the use of flight time or total flight experience as a criterion for assessing pilot competence, the overall mean score was 2.70, hinting at a slight disagreement but mostly neutral stance, with a standard deviation of 1.21 indicating diverse views. A closer look at the responses by participant groups showed a discernible trend. Pilots with advanced certifications (ATPL: mean 2.17, SD 1.19; IATPL: mean 2.19, SD 0.98; CPL: mean 2.63, SD 0.97) generally leaned more towards disagreement, expressing skepticism about a direct link between flight time and competence. In contrast, less experienced pilots, particularly PPL holders (mean: 2.96, SD: 1.23), had views almost aligning with neutrality, albeit slightly skewed towards disagreement. Conversely, student pilots (mean: 3.48, SD: 1.23) appeared to regard flight time as an essential factor in developing competence, as their average score veered more towards agreement.

An Independent-Samples Kruskal-Wallis Test ($H(4) = 28.12$, $p < .001$) confirmed statistically significant differences in perceptions among the participant groups. A post hoc analysis, which included pairwise comparisons and applied the Bonferroni correction, is shown in Figure 4. In general, the findings suggest that seasoned pilots typically do not consider flight hours as a determinant of overall competence, whereas those in the early stages of their careers tend to place greater emphasis on the quantity of their flight hours.

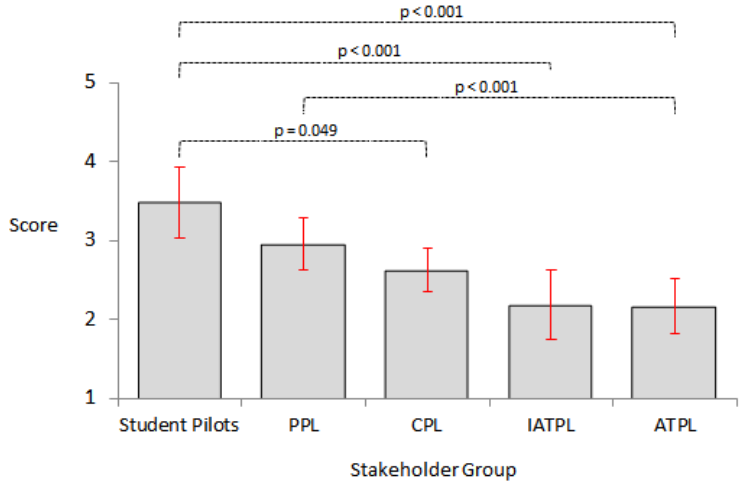


Figure 4: Comparative Analysis: Perceptions on Flight Time's Role in Pilot Competence Assessment
(Error bars represent 95% confidence interval)

Gender-based analysis within participant groups highlighted differences among student pilots. The Mann-Whitney U test (U = 62.00, Z = -2.378, p = .023) revealed female student pilots (N=14, Mean Rank = 20.07) were more likely to see flight time as a reasonable measure of competence than males (N=17, Mean Rank = 12.65). No significant gender differences were found in other groups (p-values >=0.153). Overall, gender has little impact on pilots' perception of flight time as a measure of competence. However, among student pilots, gender influences these perceptions more distinctly.

4.2.2 High-Quality vs. Hour-Count Emphasis in Flight Training: Impact on Skill Acquisition

The survey revealed a broad agreement on the importance of high-quality flight training over mere flight hours, with a mean score of 4.19 and a standard deviation of 0.76. CPL holders strongly concurred (mean: 4.40, SD: 0.09), showing the highest uniformity in opinions. ATPL holders showed a slightly lower consensus (mean: 4.06, SD: 0.14). IATPL holders (mean: 4.19, SD: 0.15), PPL holders (mean: 4.13, SD: 0.09), and student pilots (mean: 4.13, SD: 0.14) also aligned with this consensus.

The Independent-Samples Kruskal-Wallis H test revealed no significant differences in perceptions among the participant groups (H(4) = 7.02, p = .135). Additionally, the Independent-Samples Kruskal-Wallis Test on 206 participants revealed no significant gender-based differences in the perception of high-quality flight training's effectiveness, with H(2) = .70, p = .705.

4.2.3 Assessing Current Flight Training Standards: Uncovering Limitations

The survey results showed a general consensus on the limitations of current flight training standards, including both dual instruction and solo flying, and their impact on training outcomes. The average score of 3.81 suggests a tendency towards agreement, with a standard deviation of 0.70 indicating moderate opinion diversity. IATPL holders agreed the most (mean: 4.00, SD: 0.10), followed by CPL holders (mean: 3.92, SD: 0.09), and ATPL holders (mean: 3.87, SD: 0.12). PPL holders (mean: 3.62, SD: 0.10) and student pilots (mean: 3.74, SD: 0.11) showed milder agreement.

The Independent-Samples Kruskal-Wallis Test showed no significant differences in perceptions of flight training standards among different participant groups (H(4)=8.93, p=0.063). Furthermore, the Independent-Samples Kruskal-Wallis Test (H(2)=0.22, p=0.896) on 206 participants revealed no significant gender-based differences in the perception of flight training limitations.

4.2.4 Current Flight Training Standards: Assessing Technical and Non-Technical Adequacy

The survey results on current flight training standards revealed diverse opinions among participants. The overall average score of 2.86 suggests a mild disagreement with the standards' ability to meet training needs and ensure proficiency. The moderate standard deviation of 1.03 indicates significant opinion variation. Group-specific analysis revealed ATPL (mean: 2.62, SD: 0.17) and IATPL (mean: 2.38, SD: 0.19) holders generally disagreed, with IATPL holders showing stronger disagreement and uniform opinions within each group. CPL holders were neutral (mean: 3.00, SD: 0.15), whereas PPL holders leaned slightly towards agreement (mean: 3.18, SD: 0.12), with both groups showing low response variability. Student pilots (mean: 2.74, SD: 0.17) mildly disagreed, in line with the overall trend and with notable uniformity in their responses.

The Independent-Samples Kruskal-Wallis Test ($H(4) = 14.31$, $p = .006$) highlighted notable differences among participant groups. Pairwise comparisons are shown in Figure 5.

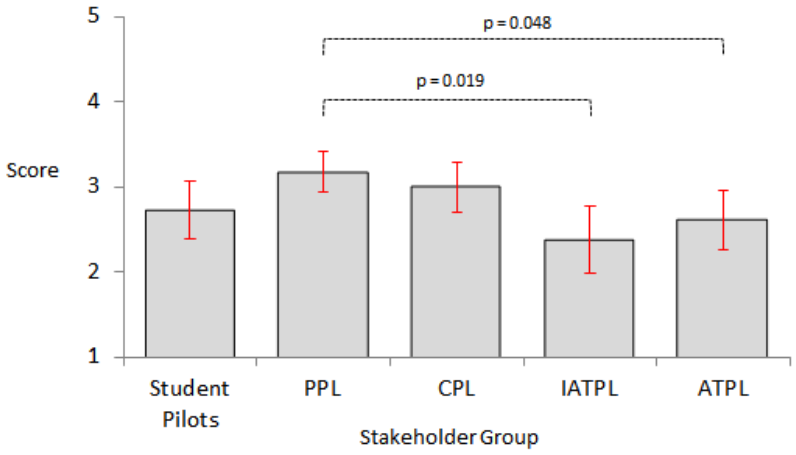


Figure 5: Comparative Analysis: Perceptions on Flight Training Standards' Efficacy and Proficiency
(Error bars represent 95% confidence interval)

Gender-based analysis within participant groups, employing the Independent-Samples Mann-Whitney U Test or Kruskal-Wallis Test, uniformly revealed no significant differences among male, female, and non-binary pilots regarding training adequacy, with p-values >=0.097.

4.2.5 Objectivity in Flight Test Assessments: Evaluating the Presence of Subjectivity in Evaluation Processes

The survey results on the perception of objectivity in flight test assessments showed varied viewpoints across participant groups. The overall average score of 3.10 suggests collective neutrality. Additionally, a moderate standard deviation of 1.01 indicates a variety of perspectives among the participants. ATPL holders (mean: 3.00, SD: 0.16) exhibited neutrality with minimal variation, while IATPL holders (mean: 3.10, SD: 0.24) also showed neutrality but with slightly more variability. CPL pilots (mean: 2.80, SD: 0.14) tended towards a minor disagreement, hinting at perceived subjectivity. PPL pilots (mean: 3.04, SD: 0.13) were neutral with low variability. Remarkably, student pilots (mean: 3.93, SD: 0.09) were more inclined to agree, perceiving higher objectivity with the greatest consistency in their responses.

The Independent-Samples Kruskal-Wallis H test revealed significant differences in perceptions of flight test assessments' objectivity among the participant groups ($H(4) = 27.74$, $p < 0.001$). Bonferroni-adjusted pairwise comparisons are illustrated in Figure 6.

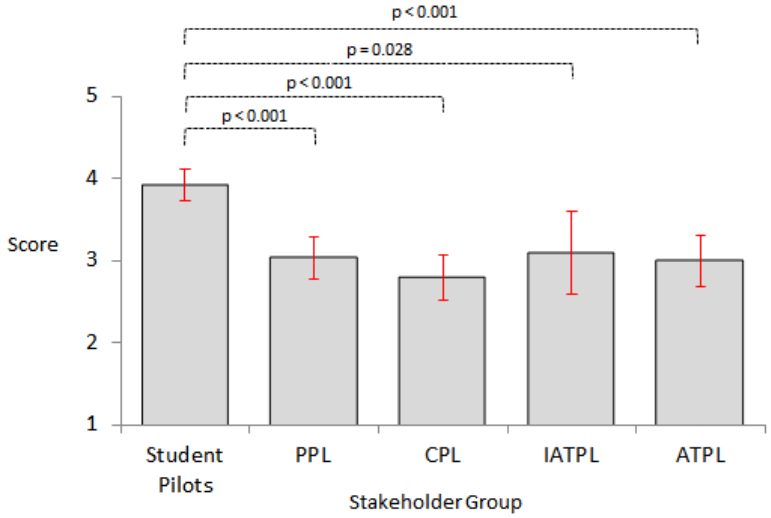


Figure 6: Comparative Analysis: Perceptions on Objectivity in Flight Test Assessments
(Error bars represent 95% confidence interval)

Gender-based analysis within the PPL group revealed a notable difference: male PPL pilots (N=39, Mean Rank=31.23) perceived flight-test evaluations as more objective than their female counterparts (N=16, Mean Rank=20.13), as indicated by the Mann-Whitney U test ($U = 438$, $Z = 2.46$, $p = 0.014$). However, no significant gender disparities were observed in the other pilot groups (p-values ≥ 0.062).

4.3 Qualitative Findings

The qualitative findings provide a comprehensive overview of participant insights gathered from open-ended survey questions regarding current pilot training standards and practices. These questions explored existing limitations and identified potential areas for improvement, focusing on both technical and non-technical flying competencies. Moreover, the survey probed limitations and opportunities for improvement in flight test assessments, eliciting recommendations for future enhancements.

The open-ended survey responses were analyzed using thematic analysis, following the methodology outlined by Braun et al. (2017). Initially, two researchers ensured the data's reliability by verifying its consistency and accuracy, crucial for maintaining the integrity of the research findings. Deductive coding was applied to see if the data aligned with established research categories, including main topics, key aspects of the research questions, or categories derived from literature or theoretical frameworks. Inductive coding was then used to create new categories from observed data patterns. This categorization process helped identify broader themes, which were rigorously validated for consistency and relevance. Subsequently, these themes were clearly defined and their associated data were thoroughly analyzed, yielding detailed insights that enhanced our understanding of the participants' perspectives.

It is important to clarify that the findings presented in this section are derived solely from insights gathered through open-ended survey questions answered by Canadian student pilots and licensed pilots who are currently or have previously been involved in flight training. These insights reflect their direct experiences and recognized best practices within the industry, rather than conjectures made by the authors. This approach ensures that our summary is firmly anchored in the real-world perspectives and expertise of those well-acquainted with the field.

4.3.1 Pilot Training: Analyzing Limitations and Exploring Improvement Opportunities

Qualitative insights from the survey on pilot training were organized into three distinct themes: Training and Assessment Methods, Instructor and Resource Challenges, and Regulatory and Curriculum Development. These themes aim to enhance the effectiveness, accessibility, and relevance of pilot training, ensuring that pilots are well-equipped with the necessary skills for modern aviation.

The Training and Assessment Methods theme focuses on enhancing the quality and effectiveness of pilot training by moving beyond traditional quantitative measures like flight hours. It promotes the use of advanced simulations for complex scenarios, structured assessments, and dynamic training strategies that enhance critical thinking and decision-making skills. Meanwhile, the Instructor and Resource Challenges theme emphasizes the sustainability and quality of instruction, advocating for the professionalization of flight instructing, expansion of instructional resources, and equitable access to training facilities to improve outcomes and reduce barriers. The Regulatory and Curriculum Development theme advocates for the modernization of regulatory frameworks and curricula to reflect current aviation technologies and practices. It encourages the integration of contemporary navigational tools and team-based training formats, tailored to meet the diverse objectives of pilots pursuing different career paths in aviation. Together, these themes address specific limitations and offer improvement opportunities, as summarized in Table 1, with subsequent sections providing a detailed description of these themes.

Table 1: Pilot Training: Current Limitations and Suggested Improvements

Theme	Pilot Training Limitations	Suggested Opportunities for Improvement
Training and Assessment Methods	Flight training prioritizes flight hour quantity over quality, often neglecting the qualitative aspects of pilot experience, resulting in inadequate assessments of pilot competence.	Implement a competency-based assessment system with detailed performance metrics, including documentation of training records at all training stages.
	FSTDs are underutilized for complex, emergency and non-normal scenario training, with an overemphasis on basic maneuvers.	Enhance FSTD use for nuanced scenarios while maintaining a balance with actual flight experiences.
	Solo flight training lacks a formal performance assessment, relying on subjective self-reports that may miss incorrect techniques.	Implement technology for objective data collection and formalize debrief process.
	Current flight training focuses on rote learning (procedural), overlooking the cultivation of essential decision-making skills for varied contexts.	Adopt an interactive training approach; incorporate digital resources and scenario-based exercises to bolster pilots' decision-making skills and versatility.
	High costs deter small flight schools from integrating FSTDs, favoring actual flight hours despite FSTDs' benefits.	Subsidies or financial aid for FSTDs could make them accessible to all schools.
	Current training lacks formal evaluation of student pilot's performance progression, leading to unclear skill assessments and potential training inefficiencies.	Implement a standardized system to record and accurately assess pilot proficiency development over time.

	Due to flight training guidelines treating FSTD sessions as optional, there's a tendency to underutilize FSTDs, favoring actual flight hours instead.	Make FSTD training mandatory to provide a more rounded education, covering both standard and complex flight scenarios.
Instructor and Resource Challenges	Flight instructing is seen as a temporary step (transitional phase), not a viable long-term career path, resulting in high turnover and inexperienced instructors.	Elevate instructing as a career with better pay, incentives, and clear career pathways.
	Resource shortages at flight schools result in overbooked schedules, extended training times, and a bias against local Canadian pilots in favor of foreign students and specific program enrollees.	Expand school capacities and resources, ensuring equitable access. Explore accelerated programs.
	High training costs and strict mandates at flight schools hinder skill development for student pilots needing additional training time.	Implementing financial support, scholarships, and streamlined training requirements could render pilot training more accessible and adaptable.
	Weather disruptions extend training timelines and financially impact instructors.	Implement advanced forecasting, flexible scheduling, and revised compensation. Utilize indoor training methods temporarily to stay current with flying practices during weather-related training delays.
Regulatory and Curriculum Development	Outdated regulatory standards prolong PPL and CPL training, increasing costs and delaying proficiency milestones.	Update regulations to reflect modern aviation practices.
	Flight training focuses on outdated navigation techniques, neglecting modern systems like FMS and GPS.	Update curriculum and leverage with aviation technology manufacturers to enhance training programs with current technology.
	Commercial pilot training lacks compulsory multi-crew training, inadequately preparing pilots for airline operations.	Integrate multi-crew training into the CPL curriculum to align with airline industry standards and improve pilot readiness.
	Training and standards do not distinguish between private and commercial pilot goals, leading to training inefficiencies.	Incorporate options to customize training programs to align with specific goals of student pilots, making them efficient, relevant, and safer.

Theme: Training and Assessment Methods

The "Training and Assessment Methods" theme criticizes the reliance on flight hours to gauge pilot competency, pointing out its failure to account for the diverse learning outcomes from varied flying conditions. This method does not fully capture the range of pilot skills, leading to inconsistencies. The theme calls for a shift towards competency-based assessments, advocating for regulatory updates and collaborations with aviation bodies to establish comprehensive evaluation standards, including performance metrics at specific training stages. It suggests implementing a system for tracking competency at set training intervals and effectively managing detailed training records to provide a more accurate assessment of a pilot's abilities. Additionally, it recommends developing secure methods for

documenting and sharing training records to support hiring decisions based on genuine skills instead of just flight hours.

Underscoring the underutilization of FSTDs for emergency and advanced scenario training, this theme advocates for their increased use alongside real aircraft to develop core flying skills. It also points out the lack of a standardized system for assessing solo flight training performance, noting that current post-flight debriefs rely heavily on subjective student self-reporting. This subjectivity, especially during solo cross-country flights, hinders accurate progress assessment. The theme recommends adopting objective evaluation methods for solo flights, such as using technological tools or flight data recorders to gather precise data, enabling instructors to offer targeted feedback. Additionally, it proposes a formalized debrief process, like a standardized questionnaire or checklist, to improve discussion of flying experiences and challenges, thereby enhancing training effectiveness and skill development.

Addressing the shortcomings of current flight training's procedural focus, this theme highlights its insufficiency in cultivating critical decision-making skills and thorough aviation knowledge. It advocates for the integration of digital flight preparation tools, such as simulation software, interactive platforms, and digital resources, to effectively connect theoretical learning with practical application. Furthermore, it underscores the importance of varied training environments to enrich learning outcomes. Concentrating on Pilot Decision Making (PDM) and applying scenario-based training that merges in-flight and FSTD experiences, the proposed strategy seeks to enhance pilots' adaptability and decision making across diverse situations.

Identifying the high costs of quality FSTDs as a significant obstacle in flight training, this theme advocates for subsidies or financial aid from regulatory bodies to enhance FSTD accessibility. It argues for an integrated training model that combines actual flying and simulations for a cost-effective approach. Additionally, it highlights the lack of a formal system to track a pilot's skill development during training. Current logbooks, which record flight hours and exercises, fail to measure proficiency accurately, leading to potential inefficiencies in training. The absence of standardized evaluation for maneuvers complicates skill assessment, often resulting in prolonged, expensive training. The theme suggests adopting a standardized evaluation system with clear proficiency benchmarks to identify areas for improvement and objectively determine flight test readiness, improving training transparency and effectiveness in developing skilled pilots.

Finally, the theme stresses the necessity of making FSTD training mandatory to address instructors' bias towards real flight hours for logbook and billing purposes, which often sidelines FSTDs' critical role in complex scenario training. Implementing compulsory FSTD sessions will guarantee a more rounded training experience, boosting safety and proficiency. It also highlights the importance of educating both students and instructors on FSTD benefits, aiming to shift the training focus towards a balanced approach that prepares pilots for diverse flying conditions.

Theme: Instructor and Resource Challenges

The "Instructor and Resource Challenges" theme underscores the issue of high turnover rates among flight instructors, often viewed as a stepping stone to airline jobs rather than a long-term profession. This leads to a reliance on less experienced pilots for foundational training, a problem compounded by low pay and variable demand for pilots. Additionally, this cycle frequently results in a scarcity of seasoned instructors available for training new flight instructor candidates or those seeking advanced instructor certifications. To address this, the theme proposes enhancing the instructor role through improved compensation, incentives for long-term commitment, and career advancement opportunities within flight schools. These measures aim to position instructing as a viable long-term career option, helping to retain experienced instructors and ensure high-quality training.

Resource constraints within flight schools, including limited aircraft availability and infrastructure, contribute to overbooked schedules and prolonged training periods where license delays can span years due to limited flying opportunities. This situation is worsened by some schools' preference for foreign students or those enrolled in specific academic programs, disadvantaging local pilots. The theme advocates for flight school resources expansion, equitable scheduling systems, and accelerated programs to expedite the licensing pathway. Funding from regulatory bodies or government grants could support the necessary expansions, ensuring access to quality training. Fair access for all students and faster training options aim to reduce the time to obtain licenses, facilitating quicker transitions to airline careers and minimizing potential income losses for student pilots.

Financial challenges in flight training, especially for those requiring additional practice, result in higher costs and can limit training frequency, negatively impacting skill development. Strict training protocols at some flight schools further contribute to students achieving only minimal passing criteria, hindering skill acquisition. To overcome these financial hurdles, the theme underscores the introduction of supportive measures such as airline and government subsidies, increased financial aid, scholarships, and specialized loan programs for aspiring pilots. Additionally, re-evaluating and possibly simplifying training requirements may reduce financial pressure, allowing for more tailored training that suits individual learning speeds without sacrificing educational quality.

Lastly, the theme points out that weather-related challenges often delay flight training, as students face frequent cancellations, affecting both their progress and instructors' financial stability due to lack of compensation for canceled sessions. Recommendations include using advanced weather forecasting, implementing flexible scheduling, improving instructor compensation for cancellations, and investing in indoor training facilities with FSTDs. These measures aim to ensure consistent training progress despite adverse weather conditions.

Theme: Regulatory and Curriculum Development

The "Regulatory and Curriculum Development" theme emphasizes the need to update flight training regulations and curricula to reflect modern aviation practices. Current minimum training requirements PPL and CPL are outdated, often leading student pilots to exceed the regulatory minimums, such as requiring 60-80 hours for PPL proficiency against the mandated 45 hours. This discrepancy prolongs training and increases costs for student pilots. The theme calls for a thorough revision of these standards to include contemporary aviation technologies and methods, aiming to make training more efficient and cost-effective.

Addressing the gap in navigation training, this theme critiques outdated navigation training (VOR and NDB) for not preparing pilots for modern technologies like FMS and GPS. While foundational knowledge of traditional navigation aids remains valuable, especially in technology failure scenarios like GPS outages, it should not be the sole focus. The theme recommends updating curricula to cover these advanced systems also, using FSTDs that reflect today's aircraft cockpits. To keep training current, it suggests forming partnerships with technology manufacturers for the latest in FSTD technology.

On the topic of multi-crew training, this theme pinpoints a significant shortfall in Canada’s commercial pilot training, which omits essential preparation for collaborative operations in commercial airlines. It suggests adding multi-crew training to the CPL curriculum to provide realistic training experiences, covering crew resource management (CRM) and standard procedures, and allowing student pilots to practice roles of both pilot and first officer. Establishing partnerships between flight schools and airlines could customize training for multi-crew operations and specific airline procedures, ensuring training relevance and smoothing the path to airline careers.

Finally, this theme reflects on the evolving needs of pilot training, noting the diminished relevance of traditional exercises like diversion and precautionary landings in commercial aviation dominated by IFR and well-equipped runways. It advocates for a training model more attuned to the operational realities and roles pilots will face, emphasizing GPS over outdated paper maps for planning. Tailoring training to equip pilots with relevant skills promises enhanced proficiency and safety in the cockpit, preparing them for the demands of contemporary aviation.

4.3.2 Flight Test Assessment: Analyzing Limitations and Exploring Improvement Opportunities

Qualitative insights on flight test assessment were organized into five distinct themes: Standardization and Fairness in Flight Testing, Relevance and Modernization of Training and Assessment, Addressing Biases and Ensuring Objectivity in Assessments, Comprehensive and Adaptive Pilot Training, and Regional Variability and National Skill Harmonization. These themes aim to enhance the fairness, relevance, effectiveness, and adaptability of flight test assessments, ensuring that pilots are thoroughly evaluated with the skills necessary for modern aviation.

The Standardization and Fairness in Flight Testing theme focuses on eliminating the variability in testing procedures and examiner approaches that can affect the difficulty and fairness of flight tests. The Relevance and Modernization of Training and Assessment theme emphasizes updating training and assessment methods to align with contemporary aviation practices. The Addressing Biases and Ensuring Objectivity in Assessments theme seeks to mitigate biases introduced by examiners' prior knowledge of student pilots, economic incentives, and regional disparities. The Comprehensive and Adaptive Pilot Training theme addresses the need for training that prepares pilots for real-world challenges beyond standardized tests. The Regional Variability and National Skill Harmonization theme tackles the challenges posed by regional differences in Canada that affect flight test outcomes and pilot skill development. Together, these themes address specific limitations and offer improvement opportunities, as summarized in Table 2, with subsequent sections providing a detailed description of these themes.

Table 2: Flight Test Assessment: Current Limitations and Suggested Improvements

Theme	Flight Test Assessment Limitations	Suggested Opportunities for Improvement
Standardization and Fairness in Flight Testing	Non-standardized pre-flight assessments lead to inconsistent pre-flight briefings amongst examiners	Adopt a standardized pre-flight assessment framework with set durations and uniform topics.
	Ambiguous definitions of deviations in flight test guide allow for subjective interpretations by examiners, leading to inconsistent evaluations.	Introduce precise, objective criteria for deviations. Conduct periodic examiner training to standardize these evaluation criteria.
	Variability in examiner approaches and external conditions affects test difficulty.	Establish standardized guidelines for each exercise, with a focus on consistent scenario and environment selection.
	Grading system for each exercise focuses on the lowest-performing criterion, overshadowing a pilot's overall proficiency and strengths.	Adopt a balanced grading approach that evaluates each criterion individually within an exercise.

Relevance and Modernization of Training and Assessment	Night and seaplane ratings lack formal testing, potentially overlooking critical flying challenges.	Introduce standardized, comprehensive testing for both ratings, including scenario-based assessment.
	Flight tests rely on outdated navigation aids, misaligning with current GPS-focused practices.	Update test procedures to emphasize GPS and modern navigation methods.
	Certain aspects of pilot written exams focus on outdated theories, missing practical skills relevant to modern aviation.	Revamp exams to cover practical knowledge, including decision making and modern navigational tools.
Addressing Biases and Ensuring Objectivity in Assessments	Bias from economic incentives and performance metrics leads to uneven testing rigor and compromises assessment integrity.	Implement a transparent system with random examiner assignments along with periodic ethical training.
	Examiners' knowledge of students' past performances tends to introduce bias, affecting the fairness of flight test evaluations.	Rotate examiners and enforce objectivity and bias awareness with periodic training.
	In-house examiners and their geographic limits lead to institutional bias, affecting the impartiality of evaluations.	Diversify the examiner pool by appointing independent, external examiners. Revise examiner performance metrics; focus on broader criteria beyond pass-fail rates.
Comprehensive and Adaptive Pilot Training	"Teaching to the test" limits real-world preparedness, leading to inadequate skill development.	Shift to versatile, scenario-based training, with varied emergencies. Periodic ethical training to emphasize training practices focused on skill development as opposed to just test passing.
	Instructors' resistance to new methods and technology can make their training less relevant to modern aviation.	Update instructors' recurrent training to include new techniques, safety protocols, and modern technology. Introduce periodic instructor evaluations.
Regional Variability and National Skill Harmonization	Regional differences in Canada affect flight test outcomes and skill development due to varied geographical conditions.	Expand curriculum to include all relevant geographical conditions and scenarios.

Theme: Standardization and Fairness in Flight Testing

The theme "Standardization and Fairness in Flight Testing" highlights the lack of fairness and uniformity in flight test evaluations due to non-standardized pre-flight assessments and subjective performance deviation (critical, major, and minor) interpretations by examiners. It proposes creating a standardized framework for pre-flight assessments to unify briefing content and lengths and recommends defining clear, objective criteria for evaluating deviations. Additionally, it suggests regular examiner training to promote consistency and fairness in evaluations. The theme also points out the inconsistency in flight test difficulty arising from examiners' subjective assessments, notably in scenarios such as simulated engine failures where the scenario choice affects the test's difficulty level. Variability is further increased by

factors like weather and air traffic conditions on the day of the test, impacting fairness and performance. To address these issues, it suggests establishing standardized guidelines for exercises to ensure consistent scenario and condition selection. It also recommends uniform training and evaluation programs for examiners to guarantee fair assessments. Moreover, the current grading system for flight test exercises focuses on the lowest-performing criterion, which can potentially undermine a pilot's overall proficiency. In simpler terms, if a pilot performs well in several areas but struggles in one, the grading system emphasizes the lowest score. This approach might give the impression that the pilot lacks overall proficiency, even though they may excel in other aspects. Such a method can obscure the pilot's strengths and lead to an imbalanced assessment of their true abilities. This grading practice also does not align with ICAO recommendations, which advocate for a more holistic evaluation. A more effective strategy can be to assess each performance criterion individually within an exercise. This improved approach would offer a more comprehensive and balanced evaluation, effectively highlighting both strengths and weaknesses. Consequently, this can enhance the overall quality of training and assessment by ensuring that while a pilot’s deficiencies are addressed and improved upon, their competencies in other areas are also recognized and appropriately valued.

Theme: Relevance and Modernization of Training and Assessment

The "Relevance and Modernization of Training and Assessment" theme highlights deficiencies in current flight test assessments, particularly for night and seaplane aviation ratings, where pilots receive ratings without formal tests, missing out on challenges like navigating in low light or executing short takeoffs from water. It suggests implementing comprehensive, standardized tests and scenario-based training for these ratings to prepare pilots for various situations. The theme also critiques the use of outdated navigation aids like NDBs and ADFs in assessments, despite the advent of GPS technology, recommending a shift towards GPS and modern navigation training to align with contemporary aviation standards. Additionally, the theme critiques outdated components of pilot certification written exams, emphasizing theoretical knowledge less relevant due to GPS and EFBs like ForeFlight. It recommends updating exams to focus on practical skills, including PDM, CRM, and Human Factors, through scenarios that employ modern tools. This update aims to blend theoretical understanding with essential practical skills for today's aviation, enhancing pilot proficiency and safety in real-world scenarios.

Theme: Addressing Biases and Ensuring Objectivity in Assessments

The theme "Addressing Biases and Ensuring Objectivity in Assessments" identifies bias in flight test evaluations stemming from economic motivations or examiners' interests in maintaining high pass rates, leading to inconsistencies and potentially lenient assessments. It suggests establishing a transparent, standardized system for evaluating and compensating examiners, enhanced by regular audits, performance reviews, and random examiner assignment to students, to uphold fairness and integrity in assessments. The theme also suggests rotating examiners and providing bias awareness training to mitigate bias, especially when an examiner is familiar with a student's history, ensuring evaluations focus on objective criteria for fairness. Furthermore, it addresses institutional bias stemming from in-house examiners and the geographical limitations faced by non-in-house examiners, proposing the adoption of independent, external examiners and the expansion of examiners' operational areas to prevent flight schools from favoring certain training methods. This approach necessitates policy changes by aviation authorities and the updating of performance metrics to assess examiners on criteria beyond mere pass-fail rates, with the goal of enhancing pilot skill evaluation and the fairness of testing.

Theme: Comprehensive and Adaptive Pilot Training

The theme "Comprehensive and Adaptive Pilot Training" addresses the issue of training primarily aimed at passing flight tests, which may overlook preparation for real-world scenarios. It advocates for a broader

training approach that equips pilots with skills for diverse situations, emphasizing emergency simulations and scenario-based training for critical decision-making skills. This method aims to prepare student pilots for exams and flying's unpredictability. It also emphasizes the need for uniform assessment criteria to avoid training tailored to specific examiners and advocates for ethical training practices that emphasize skill development beyond merely passing tests. In addition, the theme points out the reluctance of seasoned flight instructors to adopt new methodologies and technologies, preferring traditional practices over modern techniques and safety protocols. This resistance can render their training outdated for today's aviation standards, potentially overlooking important contemporary skills like situational awareness in favor of classic aircraft control. To address this, it proposes regular updates to instructor training programs, incorporating the latest techniques, safety protocols, and technological advancements to ensure their instruction meets current industry demands.

Theme: Regional Variability and National Skill Harmonization

The "Regional Variability and National Skill Harmonization" theme underscores disparities in flight test skill levels across Canada, attributed to varying geographical and environmental conditions. For instance, emergency landing maneuvers vary significantly with terrain, making such maneuvers in flat regions like the Prairies less challenging than in the mountainous areas of British Columbia, thus leading to regional skill differences. It suggests expanding the training curriculum to cover diverse conditions across Canada's varied airspace, emphasizing the development of adaptable decision-making skills to standardize pilot proficiency nationwide. This approach ensures pilots acquire skills for all flying conditions, aiming to unify training standards across the country and achieve consistent competence among student pilots, regardless of their training location.

5.0 DISCUSSION & CONCLUSION

5.1 Do student and licensed pilots regard accumulated flying hours as a reliable indicator of pilot competence?

Historically, flight hours have served as a key benchmark for evaluating pilot proficiency. However, as the civil aviation sector advances with technological innovations and evolving safety paradigms, the reliability of flight hours as the sole measure of pilot competence is increasingly questioned. This study investigates whether student and licensed pilots view accumulated flying hours as a dependable indicator of pilot skill, examining perceptions across the civil aviation community.

Overall, pilots consider flight hours to be an inadequate metric for quantifying pilot competence, particularly among those with extensive flying experience. Experienced pilots express more skepticism, highlighting that true proficiency extends beyond mere airtime. Conversely, novice pilots tend to regard flight hours as a valuable skill indicator, suggesting that perceptions of competence evolve significantly with accumulated training experience. During the early stages of pilot training (e.g., 0-50 hours), flight training adheres to well-established guidelines and manuals, featuring a clear structure and standardized steps. As a result, student pilots' skill progression is generally consistent as training hours accumulate. However, for experienced pilots (e.g., over 500 hours), the development of their skills is influenced by various situational factors, such as their job type (e.g., flight instructor or bush pilot), exposure to complex flight conditions (e.g., adverse weather, busy airspace), and the level of mentorship received from senior pilots (e.g., flying solo versus with a captain). Consequently, experienced pilots argue that the rich complexity and diversity of their experiences cannot be accurately captured by flight hours alone. The disparities in perspectives on the importance of flight hours among study participant groups,

spanning different experience levels and, to some extent, gender differences among student pilots, highlight the urgent need to critically re-evaluate the traditional hour-based metric for assessing pilot competence. The study advocates for a shift towards a competency-based evaluation framework, moving from a purely quantitative assessment to one that values the quality and diversity of flight experiences. This requires a collaborative effort from aviation regulators, training bodies, and industry stakeholders to redefine pilot competence. By focusing on systematic tracking of pilots' skill development and maintaining detailed performance records throughout the training process, this competency-based framework can offer a comprehensive insight into a pilot's skill set, which could lead to more informed hiring decisions based on a comprehensive skill profile rather than solely on flight hours. It also highlights the necessity for secure, privacy-aware methods for recording and sharing training data, ensuring evaluations meet modern data protection standards. Furthermore, recognizing gender differences in flight hour perceptions emphasizes the need for inclusive assessment criteria and training methods, enhancing pilot evaluation accuracy, safety, and efficiency while adhering to data security and privacy principles.

By promoting a nuanced and comprehensive assessment approach, this study contributes to the ongoing dialogue on improving pilot competence evaluation for general aviation. It calls for collaboration across the aviation industry to achieve excellence in general aviation pilot training ensuring evaluations remain robust, relevant, and aligned with the highest safety and professionalism standards in this rapidly evolving field.

5.2 Do student and licensed pilots perceive current pilot training practices and standards as adequately addressing pilots' educational and practical needs, ensuring key instructional and assessment elements are met?

In the rapidly evolving landscape of civil aviation, the adequacy of pilot training practices and standards in meeting the educational and practical needs of pilots emerges as a critical inquiry. This study, motivated by the question of whether current general aviation pilot training practices and standards adequately address all key instructional and assessment elements, aims to explore the perceptions of both student and licensed pilots on this matter.

The study reveals that, although current pilot training practices and standards are fundamentally strong, they do not fully meet the modern demands of pilot training as recognized by study participants from various experience levels and gender identities. There is a unanimous recognition of the need for improvement, with both quantitative and qualitative findings pinpointing specific areas for development in technical, non-technical, and decision-making competencies within pilot training. Key recommendations include integrating FSTD training for emergency and non-normal scenarios to complement real aircraft experience, adopting objective and standardized assessment methods, especially for solo flight training, and implementing systems to track pilot proficiency development. Modernizing the curriculum to incorporate advanced aviation technologies, critical decision-making skills, and modern navigation tools, including GPS and flight management systems, is emphasized. Additionally, accommodating regional variability to allow for national skill harmonization has been deemed essential. Addressing flight instructor turnover and resource constraints with better compensation, incentives, and career pathways, alongside regulatory support for high-quality FSTD access, is also critical.

The study underscores the diverse perceptions of flight test assessment objectivity among student and licensed pilots surveyed for the study. Student pilots, viewing these evaluations through the lens of their novice status, tend to perceive them as more objective, equating them with fairness and a well-structured learning process. In contrast, licensed pilots, armed with greater experience, approach these assessments with a critical eye, often adopting neutral or slightly skeptical attitudes. This variance underlines how different stages of pilot training influence perceptions of fairness and objectivity in assessments. Furthermore, the research identifies a significant gender disparity among PPL holders, where male pilots are more inclined to view flight test evaluations as objective compared to their female counterparts. This finding signals the importance of developing targeted strategies to ensure that assessments are perceived as equally fair and objective, irrespective of the pilot's gender. Surveyed student and licensed pilots advocate for enhanced standardization and fairness in flight testing, suggesting a framework that incorporates precise, objective criteria for performance evaluation. Such a framework could feature a balanced grading system and regular training for examiners to mitigate biases and guarantee consistency in evaluations. To bolster testing rigor and integrity, the introduction of a transparent system with randomly assigned examiners is recommended. Additionally, addressing institutional bias through the diversification of the examiner pool, including the integration of independent, external examiners, is proposed as a means to further ensure the equity and objectivity of flight test assessments.

These reforms collectively strive to elevate the quality and effectiveness of pilot training, equipping pilots to navigate the complexities of modern aviation. They advocate for a collaborative dialogue among the pertinent stakeholders to harmonize training standards with the educational and practical needs of pilots, aiming towards a future with enhanced flight training standards.

5.3 Comparison of insights from current study with existing regulatory standards and guidelines

Insights from survey participants (student and licensed pilots), gathered through open-ended survey questions, have revealed several limitations and potential improvements in current Canadian pilot training, flight test assessments, and evaluation practices. Given the strong global reputation of EASA as an aviation authority, its strict adherence to ICAO standards, and its efforts to ensure consistent safety measures across member states (European Commission, 2023, 2024; European Union Aviation Safety Agency, 2024; Lapesa Barrera, 2022), EASA practices were chosen for comparison with the improvement opportunities suggested by survey participants. This comparison aims to explore opportunities that have not yet been adopted by EASA, and identify best practices from a global perspective. The comparison is organized into two categories for clarity: pilot training and flight test assessment. Overall, while EASA’s established practices align well with many recommendations from survey participants, there are distinct areas where Canadian insights could further enhance EASA's practices. These suggestions add new dimensions to the training and assessment processes, offering valuable insights for global aviation training enhancements.

Pilot Training

EASA has implemented CBTA primarily in commercial air transport under its Part-FCL (Flight Crew Licensing) guidelines and regulations (European Union Aviation Safety Agency, 2022). However, its application in other civil aviation sectors, like general aviation and non-commercial operations, remains limited. EASA encourages the adoption of these training methodologies across various sectors, though mandatory regulations focus predominantly on commercial air transport. This makes CBTA more

prevalent in advanced training stages rather than at the ab initio (beginning) level. Survey participants, on the other hand, advocate for the integration of competency-based training from the onset of pilot training to cultivate a competency-focused learning trajectory across all areas of civil aviation, including general aviation and non-commercial sectors. They also recommend employing objective evaluation methods for solo flights, such as technological tools or flight data recorders, to refine training methods and enhance pilot competency assessments. While EASA recognizes the importance of FSTDs in training for both standard and complex scenarios (CAA International, 2021; European Union Aviation Safety Agency, 2020b, 2021b), suggestions from survey participants include mandating FSTD training to ensure comprehensive coverage of all training scenarios. They also highlighted the financial hurdles flight schools encounter, proposing financial aid strategies to facilitate the integration of FSTDs into training programs, an area not explicitly addressed by EASA. Furthermore, although EASA advocates formal evaluations to track student pilot progress (European Union Aviation Safety Agency, 2021a), survey participants propose developing a system to monitor pilot competency at set intervals, manage detailed training records, and establish secure methods for documentation and sharing, aiming to support hiring decisions based on actual skills rather than merely flight hours.

In Canada, flight instructing is often seen as a temporary career step, resulting in high turnover and less experienced instructors. Although EASA offers a variety of training and certification programs to help instructors advance their careers, including initial and recurrent training, standardization programs and specialized courses to improve instructional techniques (Civil Aviation Authority, 2019; European Union Aviation Safety Agency, 2020a, 2021a), survey participants have proposed specific strategies to elevate flight instructing as a long-term career option with better compensation and incentives. They also addressed the challenges of overbooked schedules and prolonged training periods due to resource shortages at flight schools or weather disruptions. While EASA ensures flight schools have the necessary infrastructure and aircraft for quality training (European Union Aviation Safety Agency, 2018), insights from survey participants go further, recommending advanced forecasting, flexible scheduling, and revised instructor compensation strategies to manage these issues effectively. This includes using indoor training methods temporarily during weather disruptions. Additionally, to support student pilots facing high training costs and needing more time to develop skills, survey participants have proposed financial measures such as subsidies, scholarships, and specialized loan programs.

Survey participants identified outdated regulatory standards as a significant challenge that prolongs the duration of PPL and CPL flight training, increases costs, and delays proficiency milestones. In contrast, EASA has proactively updated its regulations and aligned its training programs with contemporary aviation practices and technological advancements, thereby reducing unnecessary training costs and delays (European Union Aviation Safety Agency, 2018, 2020a, 2020b, 2021a, 2022). EASA's curriculum now includes modern navigation training with systems like FMS and GPS, ensuring that pilots are proficient with the latest technologies. Similarly, survey participants have proposed updates to the Canadian training framework. They advocate not only for active curricular updates but also for forming partnerships with aviation technology manufacturers to keep training programs at the forefront of technological trends. Additionally, they emphasize the need to tailor training programs to the specific goals of student pilots, thereby enhancing their efficiency, relevance, and safety. A key recommendation is the integration of multi-crew training into the CPL curriculum to align more closely with airline industry standards and significantly improve pilot readiness. While EASA has integrated multi-crew training into its broader training framework through a separate airline pilot standard multi-crew

coordination (APS MCC) program and advanced stages of the Airline Transport Pilot License (ATPL) training (European Union Aviation Safety Agency, 2022), this is not yet a requirement for the CPL curriculum.

Flight Test Assessment

Survey participants identified several issues with flight test assessments, including non-standardized pre-flight assessments that lead to inconsistent briefings among examiners, and ambiguous definitions of deviations in flight test guides that allow for subjective interpretations. These issues result in inconsistent evaluations and overshadow a pilot's overall proficiency and strengths. In contrast, EASA has made significant strides in standardizing pre-flight assessments, establishing objective criteria for deviations, creating standardized guidelines for conducting flight exercises, and adopting a balanced grading approach, aligning well with improvements also suggested by survey participants (European Union Aviation Safety Agency, 2018, 2021a, 2023).

Additionally, survey participants have noted that night and seaplane ratings often lack formal testing, potentially missing critical flying challenges. While EASA mandates specific training requirements for these ratings, it does not include standardized comprehensive testing (European Union Aviation Safety Agency, 2018, 2019). Therefore, focusing on standardized, scenario-based testing for night and seaplane ratings could enhance EASA's established practices.

Moreover, survey participants point out that certain aspects of pilot written exams are based on outdated theories and lack practical skills relevant to modern aviation. Although EASA has updated its theoretical knowledge requirements to include practical skills and modern navigation tools (European Union Aviation Safety Agency, 2016), there is a call for a comprehensive revamp of written exams to further integrate relevant practical knowledge, such as decision-making and contemporary navigational tools. These changes could align theoretical assessments with current aviation demands.

Survey participants also raised concerns about biases and a lack of objectivity in flight test assessments. Economic incentives and performance metrics for instructors can potentially lead to uneven testing rigor and compromised assessment integrity. While EASA promotes consistent examiner training and standardized evaluation criteria (European Union Aviation Safety Agency, 2023), recommendations from survey participants include implementing measures such as random examiner assignments, periodic ethical training, rotating examiners for retests or when familiar with a student's history, employing independent external examiners to mitigate institutional bias, and expanding examiners' operational areas to prevent favoritism in training methods. These improvements could further enhance the fairness and objectivity in flight test assessments.

Additionally, survey participants have identified "teaching to the test" as a significant limitation to real-world preparedness, leading to inadequate skill development. They also note resistance from instructors to adopting new methods or technologies, which makes the training less relevant and effective. In contrast, EASA has implemented EBT, which focuses on scenario-based training and directly addresses real-world preparedness by incorporating varied emergency scenarios (European Union Aviation Safety Agency, 2021a). However, the adoption of EBT outside of commercial air transport remains limited. To address these issues, survey participants advocate for the expansion of scenario-based training for ab initio (initial) pilot training, including in general aviation and non-commercial sectors, to enhance real-world

preparedness. They also suggest including periodic ethical training for instructors to shift the focus from merely passing tests to actual skill development.

Finally, regional differences in Canada affect flight test outcomes and skill development due to varied geographical conditions. While, EASA's training programs, particularly through EBT, incorporate a variety of scenarios (European Union Aviation Safety Agency, 2021a), survey participants suggest expanding the EBT framework to include all relevant geographical conditions and scenarios to harmonize skills nationwide. This approach would ensure consistent skill development across different training environments, highlighting the need for a more comprehensive training strategy that accommodates regional variability.

5.4 Comparing Past Studies and New Research Outcomes

Previous research broadly identified inadequacies in Canada's pilot training and licensing standards and practices without providing detailed recommendations or identification of specific areas needing enhancement. They highlighted the general need for enhanced protocols that encompass both technical and non-technical skills, as well as the incorporation of advanced technologies and methodologies. Building on this foundation, the current study introduces new insights and offers a thorough examination of the limitations in pilot training and licensing standards and practices. It distinguishes itself by offering a detailed analysis of the perceptions of pilot training from both students and licensed pilots, forward-thinking recommendations for training and assessment reforms, and advocating for a more inclusive and comprehensive approach to pilot training and competency evaluation. These recommendations chart actionable pathways for enhancing training effectiveness, unexplored in previous studies, with the potential to significantly improve the development of more effective and equitable training and assessment protocols. Moreover, the study underscores the importance of collaborative dialogue among aviation regulators, training bodies, and industry stakeholders in harmonizing training standards, highlighting the necessity of a unified approach for systemic reforms. This emphasis on collaboration is vital for addressing the complexities of modern aviation. Uniquely, the study identifies gender disparities in perceptions, suggesting strategies to ensure assessments are perceived as equally fair and objective across genders. This focus on inclusivity and fairness introduces a new dimension to the discourse on pilot training and assessment, enriching the conversation with perspectives on gender equity.

Comparing the findings from previously published studies and the current findings reveals areas of novelty, highlighting the current work's significant contributions to the field of pilot training and competency assessment. The novel insights, fresh perspectives and practical recommendations offered by this study underscore its pivotal role in driving forward the understanding and implementation of more effective, equitable, and inclusive practices in general aviation pilot training and assessment.

5.5 Limitations & Future Research

The gender composition of the 206 participants in the study was uneven, consisting of 73.8% males, 25.2% females, and 0.8% non-binary individuals. Such imbalance restricts in-depth gender-based analysis, possibly missing nuances among different gender groups. Future research could strive for balanced gender representation.

The study broadly examined training and assessment practices across general aviation, without distinguishing between the specific license certifications or ratings that fall within this sub-sector of general aviation. While this approach allowed for an overarching understanding of the training landscape and encouraged participants to reflect on their entire training journey, it may have overlooked specific nuances and challenges unique to different license certifications or ratings within general aviation. Future research could address this limitation by conducting a survey study that categorizes inquiries based on different licensing stages or ratings. This structured approach would enable the collection of specific feedback, offering more granular insights into the unique challenges and effectiveness of each licensing or rating level. Such a targeted study could enhance our understanding of the specific needs and experiences of pilots at various certification or rating levels, thereby facilitating a more nuanced analysis of the training and assessment practices within general aviation.

The online survey method in this study limits follow-up questioning and participant clarification, hindering deeper insight into their perspectives. Future research could be enhanced by incorporating focus group interviews, which can allow for more direct interaction and detailed exploration of participant views. Additionally, employing mixed-method approaches, such as combining quantitative surveys with focus group discussions, could be another method to facilitate a more thorough investigation of responses. These can enable clarification, elaboration, and detailed examination of complex topics.

The study included 31 student pilots (15.1%) and 175 licensed pilots (84.9%), with licenses distributed as follows: 55 PPLs (26.7%), 52 CPLs (25.2%), 21 IATPLs (10.2%), and 47 ATPL (22.8%). Although the licensed pilot group's diversity strengthens the study's conclusions, the underrepresentation of student pilots and IATPL holders suggests room for a broader perspective. Future research could aim to include a more expansive and balanced participant mix, particularly by increasing student pilots and less prevalent license types, to enhance insights into pilot training and evaluation.

The scope of this survey is confined to Canada, focusing solely on student and licensed pilots within general aviation of the Canadian civil aviation sector. This geographical limitation constrains the applicability of the findings to pilot training and assessment practices globally. Future research could broaden the scope by examining these practices in various countries, enabling a comparative analysis to uncover unique challenges and best practices with worldwide applicability.

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DATA AVAILABILITY

The dataset that support the findings of this study is available from the corresponding author on reasonable request.

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APPENDIX

General Aviation Pilot Training Survey (Airplanes)

Where applicable, rate statements using a 5-point Likert scale ranging from 1 ('Strongly Disagree') to 5 ('Strongly Agree'), with 2 indicating 'Disagree,' 3 'Neither Agree nor Disagree,' and 4 'Agree.' Provide descriptive responses for inquiries that do not fit this format.

1. Flight time or total flight experience (accumulated flying hours) is a reasonable method to quantify pilot competence.

2. High-quality flight training could result in improved acquisition of the necessary knowledge, skills, and abilities to fly an aeroplane versus flight training that focuses simply on the number of hours flown.

3. From an instructional and learning context with respect to current flight training standards for both dual instruction training and solo flying, there exist limitations that potentially impact the training outcomes.

4. Briefly outline those limitations (if any).

5. Briefly outline any opportunities for improvement to address the limitations identified previously.

6. Aside from limitations identified previously (if any), current flight training standards adequately serve training needs and ensure satisfactory proficiency in technical and non-technical flying competencies.

7. Briefly outline areas of improvement (if applicable).

8. Flight test assessment and evaluation are conducted objectively, with a minimal degree of subjectivity.

9. Briefly outline any assessment-based limitations across current flight training standards (if any).

10. Briefly outline any opportunities for improvement to address the limitations identified previously.