Advances in Human Factors of Transportation, Vol. 186, 2025, 1–8
https://doi.org/10.54941/ahfe1006488

Investigating Relationships Between First Solo Hours and Overall Flight Training Performance for Part 141 Flight Students

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ABSTRACT

Advancing to a professional pilot career involves successfully completing key flight training milestones, specifically obtaining the Private Pilot License, Instrument Rating, and Commercial Pilot License. This study investigated how the number of flight hours needed to achieve the first solo flight correlates with overall flight training performance indicators, such as the total flight hours required to complete each licensing course and practical test outcomes, including whether students passed on the first attempt. Data from a Part 141 flight school in Florida was analyzed using Pearson and point-biserial correlations. Results showed significant linear correlations between first solo flight hours and the total flight hours needed across all three training courses, as well as a notable correlation with PPL practical test performance. The practical implication was discussed and future research recommendations were provided, including increasing the sample size and incorporating data from other flight schools, such as Part 61 institutions, to enhance the generalizability and accuracy of these findings.

Keywords: Flight training, Solo, Education, Learning progression, Human factors, Transportation

INTRODUCTION

The process in becoming a professional pilot involves obtaining a Private Pilot License (PPL), Instrument Rating (IR), and Commercial Pilot License (CPL) in this particular order using both single- and multi-engine airplanes. A critical milestone in this journey is the first solo flight, which marks the first time a student pilots an aircraft independently. Before attempting the solo flight, students must demonstrate to their instructor sufficient aeronautical knowledge and proficiency in required maneuvers during the pre-solo training phase to receive an endorsement authorizing the solo flight (14 CFR Part 61, 2024).

This study investigated the relationship between the flight training hours required to complete the first solo flight and subsequent flight training performance metrics, such as total hours to complete the training and practical test outcomes (i.e., grades and first attempt pass rates) for the PPL, IR, and CPL courses in single-engine airplanes. The cost and time

commitment required for flight training makes efficiency and performance critical for students aiming to minimize training expenses and duration. Existing studies have examined factors influencing student flight training performance and decision-making for solo flight endorsements, including correlations between academic performance and flight outcomes (Jones, 2013) and frameworks for assessing solo readiness (Thomas & Richards, 2015). However, there is limited research exploring how the timing of the first solo flight in relation to a student's PPL training course progress relates to overall flight training performance throughout their primary flight training career.

This study aimed to address this gap by analyzing whether the timing of the first solo flight can predict students' required total training hours and practical test outcomes. The findings of this study may inform flight instructors and students through emphasizing the importance of early preparation and effective instruction for solo flights. Additionally, flight training institutions can use these insights to optimize flight training curriculums, enhancing student training outcomes while reducing costs and accelerating training durations. This research also highlights the need of efficient training pathways for aspiring pilots, ensuring they achieve required competencies while managing the financial and personal demands of flight training.

In this research, the following hypotheses were tested.

H_1: There is a significant correlation between the flight hours taken for the first solo and the total flight hours to complete the PPL course.

H_2: There is a significant correlation between the flight hours taken for the first solo and the grade of check-ride in the flight portion, whether passed on the first attempt or not for the PPL course.

H_3: There is a significant correlation between the flight hours taken for the first solo and the total flight training hours to complete the IR course.

H_4: There is a significant correlation between the flight hours taken for the first solo and the grade of check-ride in the flight portion, whether passed on the first attempt or not for the IR course.

H_5: There is a significant correlation between the flight hours taken for the first solo and the total flight training hours to complete the CPL course in a single-engine airplane.

H_6: There is a significant correlation between the flight hours taken for the first solo and the grade of check-ride in the flight portion, whether passed on the first attempt or not for the CPL course in a single-engine airplane.

REVIEW OF THE RELEVANT LITERATURE

This section examines key learning processes, including cognitive and psychomotor frameworks, scenario-based training, and motivational factors, alongside the academic, personal, and instructional variables influencing student flight training success. Additionally, it highlights the evaluation metrics critical for assessing training efficiency and identifies gaps in understanding the impact of early flight training milestones, such as first solo completion, on overall performance outcomes.

Learning Processes in Flight Training

Effective flight training combines established educational theories with practical application to ensure students develop the aeronautical knowledge and skills required to obtain pilot licenses. Cognitive theory underpins modern instructional approaches, emphasizing critical thinking, problem-solving, and decision-making (Federal Aviation Administration [FAA], 2020). Bloom's taxonomy of the cognitive domain, which categorizes learning into six levels—knowledge, comprehension, application, analysis, synthesis, and evaluation—provides a structured framework for progressive learning (Bloom et al., 1956). Similarly, Simpson's taxonomy of the psychomotor domain outlines seven levels of skill acquisition, guiding students from basic perception to complex motor skills required for piloting an aircraft (Simpson, 1972).

Scenario-Based Training (SBT) further enhances this learning process by immersing students in real-world scenarios that simulate the challenges of actual flight operations. This approach sharpens decision-making and situational awareness, essential traits for aviation safety (FAA, 2020). Motivation, a critical factor in learning, directly impacts performance; research shows that students with clear goals and intrinsic motivation achieve higher levels of proficiency and training efficiency (Alfano et al., 2015). Together, these theories and strategies provide a foundation for robust flight training programs that emphasize both theoretical and applied competencies.

Factors Influencing Flight Training Success and Evaluation Metrics

Flight training success is influenced by numerous academic, personal, and instructional factors. Academic performance, such as Grade Point Averages (GPA), is a strong predictor of success, with higher GPAs correlating with shorter training durations and higher practical test pass rates (Jones, 2013). Personal factors, including financial stability, English language proficiency, and intrinsic motivation, may also be significant influential. Students with stronger language skills and intrinsic motivation often demonstrate superior performance and faster progression through training (Du & Zhu, 2020; Osman et al., 2022). Evaluation metrics such as first solo completion time, total training hours, and practical test outcomes are critical for assessing both student performance and training program effectiveness. First solo completion time, measured in total flight hours, reflects a student's readiness to operate an aircraft independently, demonstrating foundational skills. Total training hours indicate the efficiency of the training process, while practical test outcomes, including first-attempt pass rates and examiner feedback, provide insight into a student's proficiency and preparedness. Retention and progression rates through the program and cost efficiency, including minimizing additional hours beyond the minimum requirements, further highlight the program's effectiveness. Research underscores the need for aligning instructional strategies with these metrics to enhance training outcomes, reduce costs, and improve overall program efficiency (Bryan, 1996; Carroll, 1989; FAA, 2023). However, gaps remain in understanding how early milestones, such as the timing of the first solo flight, predict

broader training performance metrics. Addressing these gaps, this study aims to provide actionable insights for refining flight training curricula and enhancing both student success and institutional efficiency.

METHODOLOGY

This study utilized a quantitative, non-experimental correlational design to examine the relationship between flight hours required for the first solo flight and overall flight training performance, including total hours to complete training courses and practical test outcomes. Data was sourced from the Flight Data and Certification records of a Part 141 flight school in Florida, organized and anonymized before analysis. The sample included 322 participants who completed three flight courses: PPL, IR, and CPL in a single-engine airplane, within a specified timeframe. The data collected included flight hours for the first solo, total hours to complete each course, and the outcome of the practical test, whether passed on the first attempt or not. Pearson's correlations were used to evaluate the relationship between continuous variables (flight hours for the first solo and total training hours), while point-biserial correlation were conducted to analyze the association between continuous variables and practical test outcomes.

Data was processed using Microsoft Excel for initial organization and IBM Statistical Package for the Social Sciences (SPSS) for descriptive and correlational analyses. Descriptive statistics, including means and standard deviations, were calculated for flight training hours, and graphical distributions summarized practical test outcomes. This approach provided insights into the impact of early training milestones, such as the first solo flight, on overall performance, enabling a detailed evaluation of training efficiency and success rates.

RESULTS

This section presents the comprehensive outcomes of the statistical analysis, including the correlational analyses conducted, based on the data collected as a part of this research study.

First Solo and Total Flight Hours to Complete the Flight Course

First Solo and the PPL Course. Pearson correlation with a two-tailed test at a significance level of .05 was conducted to test the null hypothesis, $H_0 1$, that there is no significant correlation between the flight hours taken to complete the first solo and the total flight hours taken to complete the PPL course. The result showed a strong and positive linear correlation between the flight hours for the first solo and the total flight hours for the PPL course, $r(320) = .805$, $p < .001$. Based on the result of the Pearson correlation, the null hypothesis, $H_0 1$, was rejected.

First Solo and the IR Course. Pearson correlation with a two-tailed test at a significance level of .05 was conducted to test the null hypothesis, $H_0 3$, that there is no significant correlation between the flight hours taken to complete the first solo and the total flight hours taken to complete the IR

course. The result showed a weak and positive linear correlation between the flight hours taken to complete the first solo and the total flight hours taken to finish the IR course, $r(320) = .194$, $p < .001$. Based on the result of the Pearson correlation, the null hypothesis, $H_0 3$, was rejected.

First Solo and the CPL Course. Pearson correlation with a two-tailed test at a significance level of .05 was conducted to test the null hypothesis, $H_0 5$, that there is no significant correlation between the flight hours taken to complete the first solo and the total flight hours taken to complete the CPL course in a single-engine airplane. The result showed a moderate and positive linear correlation between the flight hours taken to complete the first solo and the total flight hours taken to finish the CPL course in a single-engine airplane, $r(320) = .300$, $p < .001$. Based on the result of the Pearson correlation, the null hypothesis, $H_0 5$, was rejected.

First Solo and the Grade of the Checkride Practical Test

First Solo and the PPL Course. Point-biserial correlation with a two-tailed test at a significance level of .05 was conducted to test the null hypothesis, $H_0 2$, that there is no significant correlation between the flight hours taken to complete the first solo and the grade of the practical test for the PPL course, whether passed on the first attempt or not. The result showed a weak and positive correlation between the flight hours for the first solo and the grade of the PPL check-ride, whether passed on the first attempt or not, $r_{pb}(320) = .138$, $p = .013$. Based on the result of the Point-biserial correlation, the null hypothesis, $H_0 2$, was rejected.

First Solo and the IR Course. Point-biserial correlation with a two-tailed test at a significance level of .05 was conducted to test the null hypothesis, $H_0 4$, that there is no significant correlation between the flight hours taken to complete the first solo and the grade of the practical test for the IR course, whether passed on the first attempt or not. The result showed no significant correlation between the flight hours taken to complete the first solo and the grade of the IR check-ride, whether passed on the first attempt or not, $r_{pb}(320) = .090$, $p = .108$. Based on the result of the Point-biserial correlation coefficient, the null hypothesis, $H_0 4$, was retained.

First Solo and the CPL Course. Point-biserial correlation with a two-tailed test at a significance level of .05 was conducted to test the null hypothesis, $H_0 6$, that there is no significant correlation between the flight hours taken to complete the first solo and the grade of the check-ride for the CPL course in a single-engine airplane, whether passed on the first attempt or not. The result showed that there is no significant correlation between the flight hours for the first solo and the check-ride grade for the CPL course in a single-engine airplane, whether passed on the first attempt or not, $r_{pb}(320) = .029$, $p = .610$. Based on the result of the Point-biserial correlation, the null hypothesis, $H_0 6$, was retained.

DISCUSSION

First Solo and Total Flight Hours to Complete Flight Courses

The strong positive correlation between first solo flight hours and total training hours for the PPL course indicates that early solo completion is an important predictor of overall training efficiency. Students who complete their solo flight earlier demonstrate strong foundational skills and rapid progression, likely due to effective initial instruction and higher learning aptitude. This finding suggests that early solo completion reflects not only proficiency in the required knowledge and skills but also adaptability and confidence in piloting, which positively impact subsequent training phases. The absence of outliers reinforces the robustness of this result, making it a reliable indicator for identifying high-performing students early in their training.

The weak positive correlation observed in the IR course suggests a diminishing influence of solo flight hours on later stages of training. While earlier solo completion still provides some benefit, the relatively weaker correlation indicates that other factors, such as the development of instrument-specific skills and operational decision-making, play a larger role in determining efficiency in the IR course.

Similarly, the moderate positive correlation for the CPL course implies that early solo completion retains some predictive value but is less dominant as a performance factor. These results suggest that while foundational skills gained during early training are critical, the complexity and specialization required in advanced courses may dilute the impact of initial milestones. Students who excel early may maintain an advantage, but success in later courses is increasingly dependent on advanced skill development and experience.

First Solo and Practical Test Grades

The weak positive correlation between first solo flight hours and PPL check-ride outcomes suggests that early solo completion may contribute to better performance in the practical test. Students completing their solo flight with fewer hours were more likely to pass the check-ride on their first attempt, indicating that early solo completion reflects a solid foundation in aeronautical knowledge and flight skills. These students may also demonstrate greater confidence and preparedness, translating into improved performance during practical evaluations. However, the substantial overlap between groups passing and failing the check-ride indicates that while early solo completion provides an advantage, other factors, such as preparation for specific check-ride maneuvers or test-day conditions, also significantly influence outcomes.

For the IR and CPL courses, no significant correlation was found between first solo flight hours and practical test grades. This lack of association suggests that the influence of early solo completion diminishes as students' progress to more advanced stages of training, where course-specific challenges and skill requirements take precedence. In these courses, factors such as mastery of instrument procedures, precision in commercial level flight

maneuvers, and cumulative training experience likely overshadow the impact of when the initial solo flight was completed. These findings imply that while early milestones are essential for setting a strong training foundation, success in later stages depends more on targeted skill acquisition and continuous improvement throughout the training program.

The results highlight the importance of early solo flight completion as a critical milestone in flight training. Its strong association with PPL course efficiency and its moderate influence on later courses suggest that foundational skills established early can provide long-term benefits. However, the diminishing correlations in IR and CPL courses reflect the increasing complexity and specificity of training at advanced stages, where cumulative learning and specialized competencies take precedence. These findings suggest that instructors should prioritize effective preparation for the first solo flight as a means of fostering strong foundational skills while recognizing that advanced training success requires ongoing development and adaptation. Programs could benefit from tailored instructional approaches that support students throughout their progression, emphasizing both early achievement and continuous skill refinement in later stages of training.

CONCLUSION

This study investigated the relationship between the flight hours required to complete the first solo flight and overall flight training performance, including total training hours for the PPL, IR, and CPL courses in a single-engine airplane, as well as practical test outcomes. Results revealed significant positive correlations between the hours needed for the first solo and total training hours across all three courses. Specifically, students who completed the first solo in fewer hours also demonstrated greater efficiency in completing subsequent courses, highlighting the pivotal role of the first solo flight in setting the trajectory for overall training performance. However, the correlation between first solo flight hours and practical test grades was significant only for the PPL course. Students who completed their first solo quickly were more likely to pass the PPL check-ride on their first attempt. For the IR and CPL courses, no significant relationships were observed between first solo completion time and check-ride outcomes, suggesting that advanced courses rely more heavily on skill specialization and cumulative experience rather than early training milestones.

These findings emphasize the critical importance of the initial phase of flight training. Students who excel during the first solo phase, benefiting from effective instruction and developing strong foundational skills, are better positioned to progress efficiently through subsequent training stages. Early mastery of aeronautical knowledge and flying skills not only boosts training efficiency but also supports students in maintaining motivation and confidence throughout their flight training journey. This has significant implications for reducing the overall financial burden and time investment associated with obtaining pilot licenses, as efficient progression minimizes additional training hours and associated costs. Consequently, it is recommended that both students and instructors focus on optimizing

performance during the initial solo phase, leveraging structured training approaches and personalized guidance to ensure long-term success in aviation education and certification.

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