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Evaluating the Impact of Nonconcurrent Flight Laboratory and Ground Course Progress on the Academic Outcomes of Collegiate Aviation Students

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Flight training is often conducted as a two-part model, where a student completes an academic ground course to learn the knowledge and also enrolls in a flight laboratory course to apply the knowledge and skills required to earn a new certificate or rating. Often, these two parts are offered as separate courses to provide flexibility to students in the training environment. The intent is that the ground course and flight laboratory are conducted concurrently so the students apply knowledge from the ground course during their flight training. However, external factors may delay the flight training progress in the laboratory environment, causing the student to disconnect their flight training and ground course into a nonconcurrent status. This study aims to assess the impact of concurrent versus nonconcurrent flight lab enrollment on the academic outcomes of collegiate aviation students in the classroom. The study will determine whether a student conducting flight training in their current course of study (concurrent training) performs significantly better academically than a student conducting training in a previous flight lab in their current course of study (nonconcurrent training). Quantitative data was collected in the form of academic scores on classroom block exams to evaluate the impact of students in concurrent versus nonconcurrent training environments. A series of independent sample t-tests were used to find consistent evidence that students in a concurrent flight laboratory perform better on block exams in their academic ground course than students enrolled in a nonconcurrent flight laboratory. The results of this research will be used to inform educational practices within flight training departments and will assist in providing clarity to external parties interested in evaluating the impact of students completing a lab course that is nonconcurrent to their current ground course of study.

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Decades of research have been published concerning improving student performance, learning, and attitudes toward college-level introductory science courses (Matz et al., 2012). However, little study has been done on the impact of nonconcurrent flight lab training in the aviation industry. Aviation, much like any academic discipline, benefits from the use of technology to assist an instructor in delivering content. Similar to a class in the laboratory sciences, Aviation provides a two-part model of instruction. Students must commonly attend a ground school class to learn the knowledge-based topics while also conducting a laboratory course that teaches them the skill-based maneuvers that are required to earn their certificate or rating. Additionally, after a student completes their initial training, many professional pilots must continuously attend training to maintain their proficiency, which is often referred to as “recurrent training.” These training modes employ a variety of training methodologies, including in-person instruction (both in the classroom and in the airplane), video-based instruction, and simulator-based instruction.

This two-part model has been recognized industry-wide as a method to help improve the knowledge and skills of pilots while reducing the risk of accidents and incidents in an increasingly complex airspace system. In an attempt to lead efforts in training quality, the International Air Transport Association (IATA) “led the development of a new training methodology based on evidence collected in operations and training: Evidence-Based Training (EBT)” (IATA, 2013). As defined by IATA, an EBT program focuses on the development and assessment of key pilot competencies to better prepare pilots to manage potentially dangerous situations in flight operations. This program focuses on developing a competency framework to provide a minimum standard of knowledge for pilots, along with the standardization of instructors in the effective training and assessment of pilots. Ultimately, the EBT program methodology was endorsed by the International Civil Aviation Organization (ICAO) in 2013, along with the publication of an “Evidence-Based Training Implementation Guide” to assist operators with the implementation of EBT in their organizations.

The role of the academic ground course as part of an EBT program is to provide the required knowledge for a given course of study. Through FAA and ICAO guidance, collegiate flight schools have prescriptive knowledge requirements for each level of training, as well as a minimum standard of exam performance within the ground courses. For example, Part 61 of the Code of Federal Regulations (14 CFR 61.105) describes the aeronautical knowledge requirements to obtain a Private Pilot Certificate. A ground course curriculum that complies with FAA regulations would include each of these subject areas, and students must pass each block of learning with at least 76% proficiency. These subject areas include:

(1) Applicable Federal Aviation Regulations of this chapter that relate to private pilot privileges, limitations, and flight operations;
(2) Accident reporting requirements of the National Transportation Safety Board;

(3) Use of the applicable portions of the "Aeronautical Information Manual" and FAA advisory circulars;
(4) Use of aeronautical charts for VFR navigation using pilotage, dead reckoning, and navigation systems;
(5) Radio communication procedures;
(6) Recognition of critical weather situations from the ground and in flight, windshear avoidance, and the procurement and use of aeronautical weather reports and forecasts;
(7) Safe and efficient operation of aircraft, including collision avoidance and recognition and avoidance of wake turbulence;
(8) Effects of density altitude on takeoff and climb performance;
(9) Weight and balance computations;
(10) Principles of aerodynamics, powerplants, and aircraft systems;
(11) Stall awareness, spin entry, spins, and spin recovery techniques for the airplane and glider category ratings;
(12) Aeronautical decision-making and judgment; and
(13) Preflight action that includes -
    (i) How to obtain information on runway lengths at airports of intended use, data on takeoff and landing distances, weather reports and forecasts, and fuel requirements; and
    (ii) How to plan for alternatives if the planned flight cannot be completed or delays are encountered. (14 CFR 61.105)

At the collegiate level, flight laboratories and the corresponding classroom ground courses are offered as separate components to provide flexibility in the training environment. In some schools, students are required to enroll concurrently in the flight lab and the corresponding classroom course. However, in other schools, students are allowed to progress more rapidly through the classroom courses and may lag behind in the flight labs. This is due to multiple external factors that can delay the flight training progress in the laboratory environment. These factors can include adverse weather, flight instructor availability, or aircraft availability, to name a few.

There are a number of ways to improve student success in the flight training environment. The Airline Owners and Pilots Association (AOPA) published an article in 2015 that highlights nine habits of successful students. Many of the habits are controlled completely by the student, such as coming ready to fly, setting goals, and communication. However, there are uncontrollable factors that the AOPA study highlights, such as the ability to fly often (Deener, 2015). At the time of this publication, flight instructors are being hired for airline jobs at record rates. This leaves a shortage of qualified instructors at flight schools available to teach an increasing number of student pilots. Because of this dynamic, student progress is often dictated by their flight instructor's availability. If their availability decreases, students must find a way to become more efficient during their lessons just to remain on a reasonable timeline. Otherwise, their flight progress slows down, their flight laboratory becomes delayed, and they find themselves finishing the academic ground course without being finished with the flight laboratory course.

In 2017, advancing research in the field attempted to predict factors that attributed to student pilot success in Part 141 collegiate flight training environment (McFarland, 2017). This research assessed the academic, cognitive, and performance attributes of 242 student pilots in a collegiate flight training program to determine which factors predicted training success. A logistic regression method was employed, which found that it was possible to predict student completion of the multi-engine flight course 73.2% of the time. The study also found a number of significant correlations among performance variables, which indicated that academic performance is a driver of flight training success. One aspect this research assumes is that flight training and academic performance are linked in the same general timeframe. A challenge with this assumption is that many flight training schools will disconnect flight training from the academic ground course in order to continue the student's academic progress. While the organization tracks academic progress as a key indicator of success, the student's flight training progress suffers, as they can only progress at the rate by which the flight instructor and external environment can support.

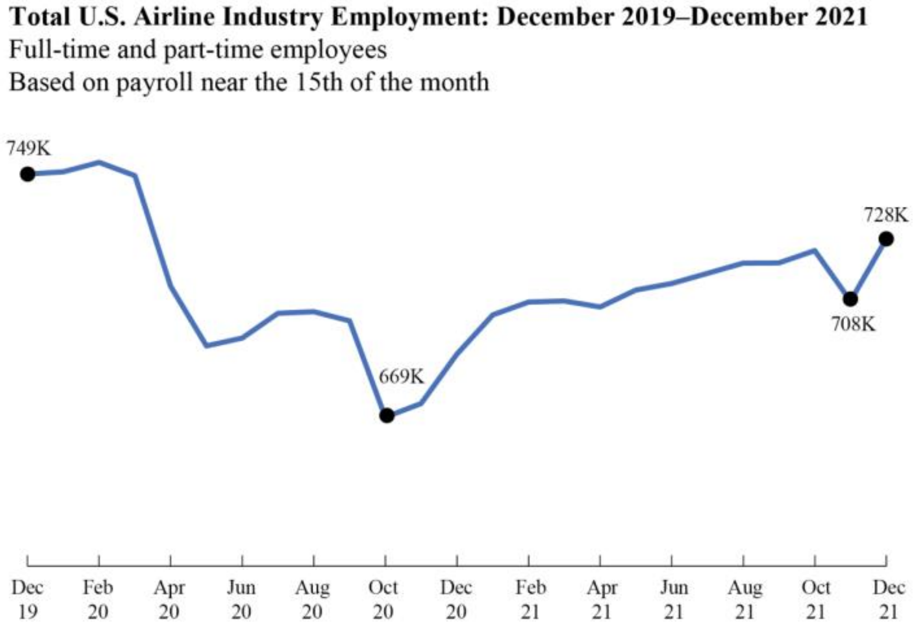
Research that expands upon existing studies in the field of concurrent enrollment in lectures and laboratories comes at an optimum time with unique dynamics in the aviation industry. Current practices encourage the disconnect between laboratory and classroom instruction, such as the increased hiring of flight instructors, causing a reduced ability of student pilots to maintain consistent flight training progression. In a 2016 study conducted by Lutte and Lovelace on the Regional Airline pilot shortage, the authors note that one prominent airline had a hiring target of 50 pilots for the first quarter of the year, but they only hired 28 pilots due to an acute shortage of qualified, appropriate pilots on the market. Additionally, earlier that year, this same airline was forced to cancel a scheduled training class due to a lack of qualified candidates (Lutte and Lovelace, 2016). This highlights the trend in the aviation industry, where the airlines are hiring qualified flight instructors faster than the civilian and military sectors can produce newly-qualified pilots to take their place. These dynamics influence the rate at which students complete their training. Student pilots must work one-on-one with their flight instructor to complete the flight lab lessons, whereas classroom ground courses can train upwards of 30-50 students at a time. Pressure is placed on students to accelerate the rate of their training progress, which results in students electing to continue to the next classroom ground course while they are still completing a previous flight lab course. As student enrollment increases and flight instructor availability decreases, the chasm between flight lab progress and classroom progress increases.

Purpose of Study

The purpose of this study is to assess the impact of flight lab progress on the academic outcomes of collegiate aviation students in the classroom. It provides insight into an integral piece in assessing the impact of students not concurrently enrolled in a flight laboratory and classroom ground course. This research is a valuable addition to current research in the field that evaluates how concurrent enrollment in lectures and laboratory enhances student performance and retention. Additionally, this research helps inform the current educational methodology and training structure to help improve student academic performance in the flight training environment.

When the study was designed in 2019, airline hiring had been at an all-time high (Bureau of Transportation Statistics; BTS, 2022). Due to the COVID-19 pandemic, airline hiring was halted, which resulted in a lack of pilot jobs in the industry. In turn, this resulted in a temporary surplus of flight instructors at flight schools worldwide. While this dynamic helped student pilots progress in flight schools, it is expected that flight instructors will again be rehired at airlines at greater rates than before the COVID-19 pandemic. In fact, the Bureau of Transportation Statistics shows a 2.8% month-over-month increase in airline employee hiring as of June 2022, with total employment approaching pre-pandemic levels of December 2019 (Figure 1) (Bureau of Transportation Statistics, 2022). With this expected increase in airline hiring, student pilot progress will again slow to a point where completion rates suffer in the collegiate flight training environment. Flight schools must be prepared for this effect and rely on research in the field of student success to best prepare for the capacity impact within their organization.

Figure 1.
Total U.S. Airline Industry Employment: December 2019-December 2021 (Bureau of Transportation Statistics, 2022).



At the time of this publication, increased numbers of students enrolled in flight training to fill an industry-wide pilot shortage while facing reduced numbers of certified flight instructors available to perform their training. As student enrollment increases and flight instructor availability decreases, the chasm between flight lab progress and classroom progress is expected to widen. The results of this study will help inform existing research in the field of aviation education and include recommendations for flight training departments that are considering a nonconcurrent training model between flight lab courses and classroom ground courses.

Methods

The primary outcome of this research is to assess the academic impact of nonconcurrent flight lab courses on the academic outcomes of classroom training. A quantitative approach was used to assess the student's academic outcomes in classroom ground courses based on their progress in the associated flight laboratory course. This scientific approach was chosen due to the standardization of the block exams and the consistency of academic outcome expectations in the ground courses. As described below, a series of t-tests were used to evaluate the mean difference in block exam scores between the concurrent and nonconcurrent groups.

Participants and Group Membership

The participants in this study were selected from students enrolled in an introductory instrument course and a flight instructor course at a midwestern university in the United States. Students were selected from these two courses to collect a dataset that was broadly representative of the total student population, as the courses are spaced at median points across the curriculum. To collect a sample from the population, data were collected from five total classes during the Fall 2020 academic semester. Within the introductory instrument course population, seven total classes were offered, which enrolled a total of 217 students. Three classes were selected from this offering, which equaled a sample size of 78 of the total 217 students enrolled during the semester. Within the flight instructor course population, four total classes were offered, which enrolled a total of 135 students. Two classes were selected from this offering, which equaled a sample size of 66 of the total 135 students enrolled during the semester.

All participants in this study successfully completed their classroom ground courses, with varying levels of progress in their flight laboratory course. Demographics of the participants can be found in Table 1, which represents the combined sample population, along with the sample populations for each of the concurrent and nonconcurrent groups at the beginning of the academic semester.

At the beginning of the semester, students were assigned to groups based on their flight laboratory course enrollment. Students who were in the same flight laboratory as their ground course of training were assigned to the concurrent group, whereas students who were competing in a previous flight laboratory course were assigned to the nonconcurrent group. During the semester, students were expected to continue their training in the flight laboratory course, regardless if they were completing the concurrent laboratory or the nonconcurrent laboratory. Because some students would finish the nonconcurrent laboratory between the academic block exams, their group membership would change from nonconcurrent to concurrent. Because of this factor, each block exam was analyzed independently due to the differences in group numbers at each exam. Additionally, the study accounted for block exams one through four due to the University’s established last day to drop, after which many of the students in nonconcurrent laboratories dropped the academic ground course due to their delayed progress.

Quantitative Study

The purpose of the quantitative study was to determine the degree to which nonconcurrent flight lab training impacts the academic outcomes of students in the classroom ground course. Academic performance data was collected in the form of block exam scores. The structure of the academic ground courses was to provide block exams that are comprehensive to a building block of learning in that course. The block exams were spaced at approximately one-month intervals during the Fall 2020 academic semester. Because of this, each of the two courses was evaluated separately during the data analysis phase due to the difference in evaluation content and criteria for each of the respective block exams. The block exam scores were aggregated into populations based on concurrent and nonconcurrent flight lab enrollment at the time the participant took the Block Exam.

Table 1
Demographic Characteristics

	Combined Dataset	Concurrent	Nonconcurrent
	n = 144	n = 69	n = 75
Gender			
Male, *n (%)*	125 (86.8)	62 (89.9)	63 (84.0)
Female, *n(%)*	19 (13.2)	7 (10.1)	12 (16.0)
Academic Year			
Senior, *n (%)*	51 (35.4)	21 (30.4)	30 (40.0)
Junior, *n (%)*	49 (34.0)	24 (34.8)	25 (33.3)
Sophomore, *n (%)*	41 (28.5)	22 (31.9)	19 (25.3)
Freshman, *n (%)*	3 (2.1)	2 (2.9)	1 (1.4)
Program of Study			
Commercial Aviation, *n (%)*	121 (84.0)	60 (87.0)	61 (81.3)
Commercial Aviation & UAS Operations, *n (%)*	11 (7.6)	4 (5.8)	7 (9.3)
UAS Operations, *n (%)*	9 (6.3)	4 (5.8)	5 (6.7)
Commercial Aviation & Management, *n (%)*	3 (2.1)	1 (1.4)	2 (2.7)

*Note. D*emographics were collected at the beginning of the academic semester.

A series of independent samples *t*-tests were conducted to evaluate the mean difference between students enrolled in a concurrent flight laboratory and a nonconcurrent flight laboratory. Eight *t*-tests were conducted in total, which compared each of the four block exams for two separate academic ground courses during the Fall 2020 semester.

Results

The Introductory Instrument Course

The introductory instrument course is offered immediately after the student finishes their Private Pilot training. In this course, a total of 217 students enrolled during the Fall 2020 semester. This study sampled three classes of the total population of the introductory instrument course, which equaled 78 students (35.9%) of the total population. In this sample, 41 students (52.6%) began the flight laboratory concurrently with the academic ground course. The remaining 37 students (47.4%) were still finishing the Private Pilot flight laboratory and were considered to be in a nonconcurrent laboratory.

Students in this academic course spend Block One reviewing content related to the Private Pilot course, which typically garners higher results during the Block One exam since the students have recently trained on this content to proficiency prior to enrolling in the introductory instrument course. Subsequently, the course proceeds to cover topics of flight instrument systems, methods of basic attitude instrument flying, and navigation systems. Blocks Two through Four offer a more in-depth study of topic areas and may be considered "new content" for the purposes of learning the material. Because of this, the results of Block Exams Two through Four could be related to a traditional academic course that offers new content for all blocks of learning.

In this study, there was no significant effect for Block One exam scores, $t(76) = 1.191$, $p = .237$, despite students in a concurrent lab ($M = 88.41$, $SD = 8.11$) scoring higher than students in a nonconcurrent lab ($M = 86.22$, $SD = 8.17$). For Block Two exam scores, students in a concurrent lab ($M = 88.94$, $SD = 9.15$) scored significantly better than students in a nonconcurrent lab ($M = 80.07$, $SD = 9.59$), $t(76) = 4.065$, $p = .001$. For Block Three, students in a concurrent lab ($M = 89.38$, $SD = 7.56$) scored significantly better than students in a nonconcurrent lab ($M = 78.44$, $SD = 20.01$), $t(76) = 3.517$, $p = .001$. Finally, for Block Four exam scores, students in a concurrent lab ($M = 80.76$, $SD = 10.11$) scored significantly better than students in a nonconcurrent lab ($M = 75.25$, $SD = 11.66$), $t(76) = 2.020$, $p = .047$.

In the results above, the Block One exam presumably did not show significance due to the nature of the content of the Block One exam. Content on this exam is a review of material that was recently completed by the students in the course immediately preceding this course. For the remainder of the Block Exams, significance was found between the concurrent and nonconcurrent groups. Figure 2 and Table 2 show the results of each block exam score for the introductory instrument course.

Figure 2.
Introductory Instrument Course Block Exam Scores

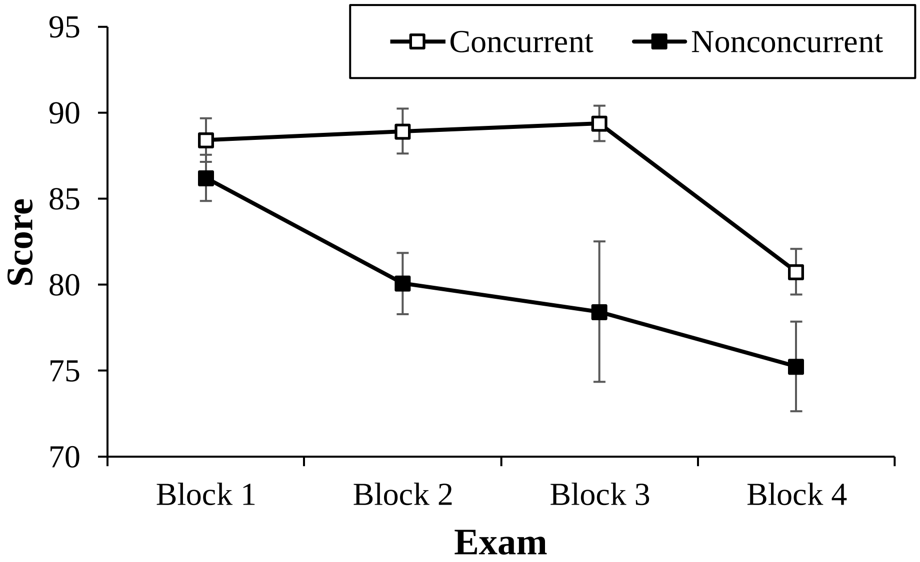


Table 2
Introductory Instrument Course Block Exam Scores

	Concurrent Lab *(n)*	Nonconcurrent Lab *(n)*	*p*
Block One, *score (n)*	88.41 (41)	86.22 (37)	.237
Block Two, *score (n)*	88.94 (49)	80.07 (29)	.001*
Block Three, *score (n)*	89.38 (54)	78.44 (24)	.001*
Block Four, *score (n)*	80.76 (58)	75.25 (20)	.047*

Note. * $p < .05$

The Flight Instructor Course

The flight instructor course is offered immediately after students finish a course in commercial multi-engine flying. Students that enroll in a concurrent flight laboratory learn how to teach fundamentals of aviation instruction in a single-engine aircraft, while students in a nonconcurrent laboratory course learn how to master the pilot-in-command responsibilities of a multi-engine aircraft. These courses are significantly different in structure and content, which likely explains the consistent difference in scores on each block exam.

The initial split of students in nonconcurrent and concurrent flight laboratories was wider in this course, largely due to the complex nature of the preceding multi-engine course. The multi-engine course requires uniquely qualified flight instructors, which slowed down the progress of the population of students planning to enroll in the flight instructor academic ground course. In this course, a total of 135 students enrolled during the Fall 2020 semester. This study sampled two classes of the total population of the flight instructor course, which equaled 66 students (48.9%) of the total population. In this sample, 28 students (42.4%) began the flight laboratory concurrently with the academic ground course. The remaining 38 students (57.6%) were still finishing the multi-engine flight laboratory and were considered to be in a nonconcurrent laboratory.

Students in the academic course will spend time learning the fundamentals of instruction, which includes topics related to lesson planning, content delivery, student evaluation, and assessment. These topics are combined with technical subject areas related to general flight, including aerodynamics, aircraft performance, systems, flight planning, and flight maneuvers. Generally, these topic areas have been previously learned by the students. However, they are now expected to learn and teach these topics at an instructor’s level of knowledge. For the purposes of this course, all blocks of learning could be considered “new content” from the fundamentals of instruction perspective, even though there are a number of content areas that are familiar to students in the form of technical subject areas they have previously learned.

In this study, all Block Exam scores showed significance, with similar raw score differences between the concurrent and nonconcurrent groups on each Block Exam. For Block One exam scores, students in a concurrent lab (M = 89.46, SD = 5.75) scored significantly better than students in a nonconcurrent lab (*M* = 85.17, *SD* = 8.06), *t*(64) = 2.402, *p* = .019. For Block Two exam scores, students in a concurrent lab (*M* = 90.65, *SD* = 5.39) scored significantly better than students in a nonconcurrent lab (*M* = 86.86, *SD* = 7.90), *t*(64) = 2.244, *p* = .028. For Block Three exam scores, students in a concurrent lab (*M* = 89.87, *SD* = 4.53) scored significantly better than students in a nonconcurrent lab (*M* = 84.36, *SD* = 6.12), *t*(64) = 4.208, *p* = .001. Finally, for Block Four exam scores, students in a concurrent lab (*M* = 87.37, *SD* = 5.99) scored significantly better than students in a nonconcurrent lab (*M* = 84.36, *SD* = 5.61), *t*(64) = 2.023, *p* = .047. Figure 3 and Table 3 show the results of each block exam score for the flight instructor course.

Figure 3.
Flight Instructor Course Block Exam Scores

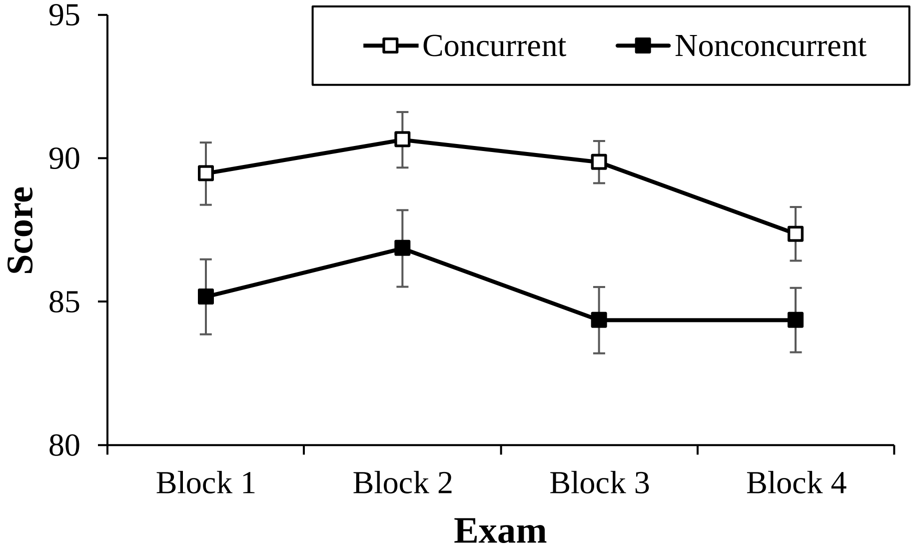


Table 3
Flight Instructor Course Block Exam Scores

	Concurrent Lab *(n)*	Nonconcurrent Lab *(n)*	*p*
Block One, *score (n)*	89.46 (28)	85.17 (38)	.019*
Block Two, *score (n)*	90.65 (31)	86.86 (35)	.028*
Block Three, *score (n)*	89.87 (38)	84.36 (28)	.001*
Block Four, *score (n)*	87.37 (41)	84.36 (25)	.047*

Note. * p < .05

Discussion

The key finding of this study is that concurrent enrollment in aviation ground courses and flight training laboratories positively impacts academic outcomes. As the Aviation industry climbs out of the COVID-19 pandemic and hires airline employees at pre-pandemic rates (Bureau of Transportation Statistics, 2022), these findings provide important guidance to flight training organizations on methods that hinder student pilot academic success. These findings are particularly important when considering methods to alleviate organizational capacity demands when faced with a flight instructor shortage. Additionally, as incoming student enrollments increase, these findings provide guidance to evaluate alternative methods to providing an appropriate training structure that ensures the academic success of students enrolled at the flight school.

One consideration this study addresses is the range of courses and experience offered by a flight training organization. When pursuing a career as a professional pilot, each flight training course provides a different level of intensity due to the wide range of knowledge and skills required across the curriculum. While looking at the programmatic requirements of the flight training curriculum, one might consider the initial private pilot course and the flight instructor course as the most intensive training courses offered. Alternatively, the introductory instrument course might be considered one of the courses with the least training intensity. In any case, the findings of this study highlight the importance of maintaining concurrent enrollment in a flight laboratory that matches the academic ground course.

Nearly all block exams showed statistical significance through the quantitative study, with the one exception being the Block One exam in the introductory instrument course. As stated previously, this exam is a review of material previously learned by students in the course immediately preceding the introductory instrument course. Because of this, it was expected that all students would perform similarly on the Block One exam, regardless of concurrent or nonconcurrent laboratory status.

When considering the raw score differences amongst all block exams in the data set, students in a concurrent flight laboratory consistently scored higher on block exams than students in a nonconcurrent flight laboratory (5.5% higher, on average). Functionally, this is equivalent to a full letter grade change in a student's exam score, which could be the difference between a student successfully passing the academic ground course and a student being required to retake the same course due to a failing grade.

The findings of this study show the importance of maintaining concurrency between a student pilot's flight laboratory and the associated academic ground course. Research has shown that students who engage in well-designed laboratory experiences develop problem-solving and critical-thinking skills, as well as gain exposure to reactions, materials, and equipment in a lab setting (ACS, 2022). However, it is important that students apply the knowledge in a timely manner, which is the primary reason why a student enrolled in a nonconcurrent laboratory suffers academically. These students are applying knowledge from a previous academic course in their laboratory while attempting to learn new content in their current academic ground course. This disconnect may be detrimental to a student's academic success, and therefore every effort should be made to avoid nonconcurrent laboratories during their flight training.

Limitations

Limitations of this study center around the dynamics related to group membership and the reasons for switching from a nonconcurrent to a concurrent laboratory status. There are many reasons that a student becomes delayed in their flight training. Natural causes may include weather, flight instructor availability, or aircraft availability, to name a few. Other variables may be more undetectable, including stress, fatigue, financial hardship, or relationship struggles. It is important to note that these potentially confounding variables were outside of the scope of this research and not accounted for in the dataset.

Finally, when a student finds themselves in a nonconcurrent laboratory status, they may take on an alternative approach to their academic success versus students in a concurrent laboratory. For instance, some students in a nonconcurrent laboratory may put more effort into remaining proficient in the knowledge and skills required by the previous academic course in order to ensure their success in the nonconcurrent laboratory lessons. These students may suffer academically in the concurrent course since they are choosing to focus on different content. Alternatively, students in a nonconcurrent laboratory may choose to focus more intensely on the new content of the concurrent course in order to not fall behind and suffer in the classroom. The academic motivation was not collected during this study and was not accounted for during the analysis.

Implication for Practice

The results of this study show that value should be placed on maintaining a concurrent flight laboratory and classroom ground course with all students in the curriculum. Additionally, this research shows that students may suffer academically if they accelerate their classroom ground courses without first completing any previous flight laboratory courses that are required by the curriculum. Risks to an educational model that provides nonconcurrent flight laboratory and classroom ground training are a significant decrease in classroom academic performance.

What an academic ground course is not able to provide is a way to develop a student pilot's flying skills in the aircraft, which is a foundational requirement for both initial and recurrent pilot training. When considering the theories of learning that apply to this two-part model of instruction, it is critical to explore the foundations relating to how skills are learned by student pilots. In the process of conducting this exploration, one must consider the perception of the student pilot and what they will be most successful in transferring to learning. "Initially, all learning comes from perceptions, which are directed to the brain by one or more of the five senses: sight, hearing, touch, smell, and taste. Psychologists have also found that learning occurs most rapidly when information is received through more than one sense" (United States, 2008). Research has explored the use of flight simulators as a practical learning technology and has centered around four main themes, which include how the simulator replicates the specific aircraft configuration, how the simulator replicates the real-world environment, the simulator's visual field of view, and how the simulator replicates the sensations of flight (including motion and tactile feedback). Research consideration should be explored in providing a structured, self-paced pre-training course for student pilots that may help accelerate and increase the proficiency of training in the flight lab courses, thus increasing the probability of maintaining concurrency between the flight lab and classroom ground courses within the flight training curriculum. Finally, future research should be conducted to evaluate the efficacy of low-cost flight simulation technologies that could be used to support a self-paced training curriculum by student pilots, which would not be reliant on flight instructor availability for a successful outcome. Study and research of this topic in the aviation industry are integral to maintaining and bolstering the pilot pipeline while maintaining the proficiency and knowledge standards employed by the industry. Beyond the research presented in this paper, it is suggested to employ these statistical methods on aviation training models outside of the primary flight training environment. These could include recurrent training and initial type rating training. Additionally, researchers may wish to include academic motivation as an additional variable when choosing to replicate this study. For instance, in a recent study by Wilson and Stupnisky (2022), the authors use the Academic Motivation Scale (AMS; Vallerand et al., 1992) to evaluate for differences in motivation between students who enrolled in either a blended course or an online, asynchronous section of a senior-level advanced aircraft systems course. A similar methodology could be employed to evaluate the differences in motivation for students in a nonconcurrent and a concurrent flight laboratory course.

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