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The Impact Of Training Disruption On Commercial Certificate Attainment In Collegiate Aviation Programs

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THE IMPACT OF TRAINING DISRUPTION ON COMMERCIAL CERTIFICATE ATTAINMENT IN COLLEGIATE AVIATION PROGRAMS

by

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This dissertation, submitted by Jonathan M. Pearson in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved

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This dissertation is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota, and is hereby approved.

Dean of the Graduate School

Date

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Department: Aerospace Sciences

Degree: Doctor of Philosophy

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Jonathan M. Pearson

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ABSTRACT

The aviation industry is currently recovering from the COVID-19 pandemic and is forecast to continue to grow after returning to pre-pandemic levels of activity. As a result of retirements and growth, airlines are experiencing a large demand for qualified pilots. Collegiate aviation programs serve as a major source of training and recruitment, but it is unknown to what degree students in these programs were affected by the cessation of flight training during the pandemic. This study examined the impact of different variables, including training disruption, on commercial pilot certificate attainment and flight training hours in collegiate aviation flight training programs. The variables were grouped based on Astin's input-environment-outcome model (Astin, 1993; Astin & Antonio, 2012).

Multiple regression analysis was utilized to examine the impact input and environmental variables have on Commercial Certificate attainment in collegiate aviation programs. It was determined that GPA in aviation-specific courses influences whether a student completes flight training for the Commercial Pilot certificate. Furthermore, average enrolled credit load per academic term was significant in accounting for the variance in the total aeronautical experience required and credit load, gender, and stage check pass rate, were significant in predicting the amount of flight instruction required by a Commercial Pilot student.

These findings are important for researchers and practitioners in understanding factors which influence a student's success in flight training programs. From a researcher's perspective, the importance of utilizing variables specific to a discipline in higher education may

be more significant. For practitioners, understanding factors which affect students throughout flight training allow for appropriate program changes to increase student success in flight training.

CHAPTER I

INTRODUCTION

Despite large-scale disruption due to COVID-19, the aviation industry is expected to quickly return to pre-pandemic levels and continue to grow. According to the U. S. Bureau of Labor Statistics (2022), the number of airline and commercial pilot jobs are forecast to increase by 13% between 2020 and 2030, representing 14,500 pilots each year, much greater than the 8% average growth rate for all occupations. The Boeing Company (2022) predicts 602,000 new pilots will be required to meet worldwide industry demand between 2022 and 2041. This places a large burden on flight education programs, which were also affected by the pandemic. While the demand for pilots continues to grow, it remains unclear to what degree student progression is impacted by training disruptions.

State of the Aviation Industry

The COVID-19 pandemic had a devastating effect on commercial aviation. By the end of March 2020, 98% of global passenger revenue flights encountered severe restrictions such as quarantining arriving passengers, partial travel bans, and, in some cases, complete border closures (Olaganathan & Amihan, 2021). According to the International Civil Aviation Organization (ICAO, 2022), there was an unprecedented 60% decline in world total passengers in 2020 when compared to 2019; however, the recovery is progressing at a rapid pace, with only 49% fewer passengers in 2021 and an estimated 24% to 27% decrease for 2022. According to the Federal Aviation Administration (FAA, 2022), over the coming years, airlines will be focused on recovering from the COVID-19 pandemic, forecasting a return to pre-pandemic activity levels and normalization of the industry by 2025, followed by continued growth.

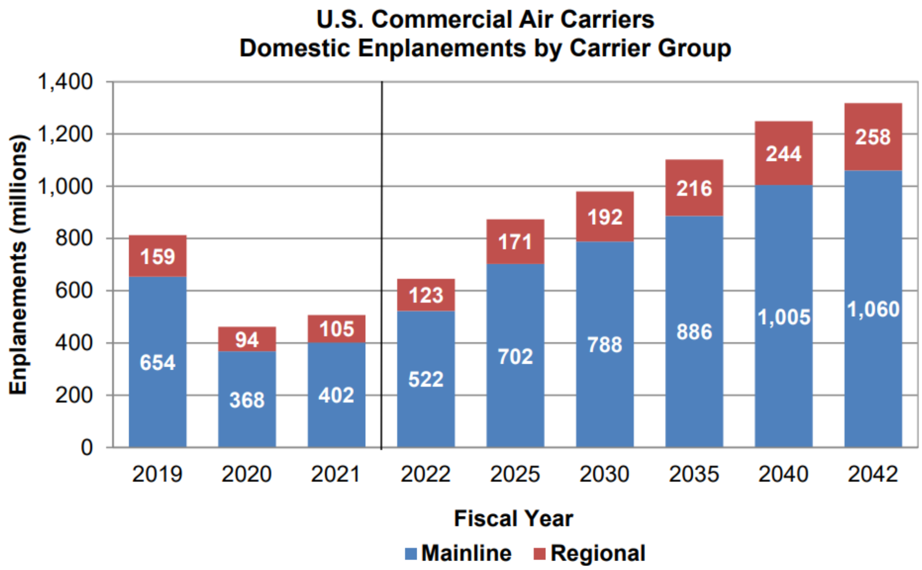

Figure 1. Forecast of Domestic Enplanements by Carrier Group (FAA, 2022).

Demand for pilots is also increasing in the recovery. During the pandemic, mainline carriers offered early retirement to flight crews to reduce costs; however, as activity levels increased following the relaxing of travel restrictions, they replenished their ranks by drawing pilots from the regional carriers, exacerbating pre-pandemic pilot shortages (FAA, 2022). According to Boeing's Pilot and Technician Outlook for the 2022-2041 period (2022), in addition to those who received voluntary early retirements during the pandemic, many junior pilots who lost their jobs will not return, having left the aviation industry. 602,000 new pilots are required to meet worldwide demand between 2022 and 2031, with 128,000 required to meet North American demand, alone (Boeing, 2022). As a result of pilot shortages prior to the pandemic, many airlines instituted cadet pilot programs. These programs create partnerships with universities and colleges to develop clear pathways for students and allow airlines to secure access to potential employees earlier in training (Lutte & Mills, 2019). While many of these programs were paused or canceled during the pandemic, they have resumed, given the current shortfall. However, these pathway programs will take years to produce results, with airlines experiencing a lack of experienced pilots in the interim (Boeing, 2022). Compounding this current shortage is the number of airline pilots reaching the mandatory retirement age. The Regional Airline Association (2022) predicts 45.9% of eligible airline transport pilots (ATP) will reach the mandatory retirement age within 15 years, with 13.2% reaching retirement age within 5 years. According to the U.S. Government Accountability Office (2018), collegiate aviation schools continue to be viewed as a key source of new commercial pilots by aviation stakeholders as these programs are designed to produce professional pilots.

Collegiate Aviation Programs

There are several different environments of pilot training that can lead to employment as a professional pilot. The Government Accountability Office (2011) identified flight programs in universities as a key source for training commercial pilots, partially due to the preference for a four-year college degree for most United States airlines. Another reason these institutions are attractive to students and airlines is the ability to qualify for a Restricted Airline Transport Pilot (R-ATP) certificate. FAA regulations require all pilots operating for air carriers under Title 14 of the Code of Federal Regulations Part 121 to possess an Airline Transport Pilot certificate (Operating Requirements: Domestic, Flag, and Supplemental Operations, 2022). This certificate requires 1,500 hours of flight time; however, with approval, graduates of those programs offering a bachelor’s degree with an aviation major qualify for an R-ATP certificate with only 1,000 hours of flight experience (Certification: Pilots, Flight Instructors, and Ground Instructors, 2021). There are 101 such collegiate aviation pilot schools in the United States certificated by the

FAA under 14 CFR Part 141 (Pilot Schools, 2021; U. S. Government Accountability Office, 2018). Only these certificated schools may apply to the FAA for R-ATP authorization.

Several requirements must be met for a pilot school to qualify for a Letter of Authorization (LOA) from the FAA which grants institutional authority to certify program graduates for an R-ATP certificate with 1,000 hours of flight experience. The institution of higher education must be accredited, award students with a bachelor's degree in an aviation major, possess a curriculum consisting of at least 60 credit hours of aviation and aviation-related coursework designed to improve and enhance professional pilot skills, and possess a Part 141 pilot school certificate (Certification: Pilots, Flight Instructors, and Ground Instructors, 2021). The training curriculum must include courses covering the subject areas necessary for pilot certificates and ratings, aerodynamics and aircraft performance, aircraft systems, aviation human factors, Air Traffic Control (ATC) and airspace, aviation law and regulations, aviation weather, and aviation safety (Federal Aviation Administration, 2013a). Pilot schools with institutional authority validate students' completion of the requisite coursework by providing a certifying statement through an official transcript or other authorized means to the graduate.

Collegiate aviation pilot schools may differ in academic curricula and may be housed in various colleges within the university, or in their own college (University Aviation Association, 2022). Although not identical, collegiate aviation pilot schools possess features which aid commonality. The schools must meet standards prescribed by the FAA, to include a structured curriculum. Curricula may differ among schools, but all must meet the FAA's pilot training requirements and pilot school requirements (U. S. Government Accountability Office, 2018). Students trained by these pilot schools all must meet the minimum aeronautical experience requirements, pass the same standardized knowledge test, and meet the set airman certification standards on a practical test in order to receive pilot certification (Certification: Pilots, Flight Instructors, and Ground Instructors, 2021). In addition to FAA standards, many collegiate programs have taken the extra step of accreditation through an accrediting body. 42 universities have one or more accredited aviation programs through the Aviation Accreditation Board International (AABI), following common guidelines and standards, increasing commonality (Aviation Accreditation Board International, 2022).

Even before the onset of the COVID-19 pandemic, university-based pilot schools faced difficulties in meeting pilot demand. The Government Accountability Office (2018) reported, as a result of surveys, collegiate aviation schools faced two primary challenges: flight instructor retention, and the high cost of pilot training. 16 of the 18 schools surveyed reported difficulty in recruiting and retaining flight instructors, leading to the inability to accept some students who applied to the programs. Survey respondents attributed high instructor turnover to the increased demand for commercial pilots at the airlines due to the rapid pace of retirements, as most flight instructors seek employment to build the experience necessary to enter airline jobs (U. S. Government Accountability Office, 2018). This difficulty is not expected to decrease in the near future, due to the number of airline pilots who took early retirement offers during the pandemic downturn (Boeing, 2022). The second major challenge faced by collegiate pilot schools is the high cost of flight training, which has continued to rise. In addition to university tuition, which varies considerably but may be as much as $36,000 annually for out-of-state students, total flight lab fees at the majority of programs surveyed cost more than $50,000, with an upper cost of $81,000 (U. S. Government Accountability Office, 2018). These high costs are also not likely to decrease in the recovery from the pandemic as operating costs are forecast to continue to increase, particularly fuel costs as a consequence of increased global demand for oil combined with increasing difficulty of extraction (Federal Aviation Administration, 2022). As a result, in order to make maximum use of flight instructor resources, increase student retention and progression in the program, and maximize the number of students accepted, some university-based pilot schools have transitioned to capped enrollment and selective admissions (Louisiana Tech University, 2022; University of North Dakota, 2022).

At the onset of the COVID-19 pandemic, many institutions turned to remote instruction. As flight training is conducted in-person, some flight schools ceased operation for a prolonged period of time, from March until May 2020 (Murphy, 2021; Nasworthy, 2020). Still, some students may not have resumed flight training at this time due to the end of Spring and start of Summer terms, or due to health concerns related to the ongoing pandemic. Without specific literature regarding this break in training specific to the collegiate aviation context, it remains unclear the degree to which student progress was impacted.

While some research exists into attributes related with student retention and progression through these programs, it is still limited (Bjerke, 2009; Bjerke & Healy, 2010; Hanna, 2014; Leonard, 2018). Furthermore, scant literature exists on how training disruptions affect student progression and success in collegiate aviation programs.

Theoretical Background

Alexander Astin (1993) developed the Input-Environment-Outcome (I-E-O) model as a conceptual guide for researchers studying college student development. The model consists of three elements. First are the inputs, which refer to student characteristics at the time of initial entry or enrollment at the institution. Second are the environmental variables to be studies, which consist of the programs, policies, faculty, peers, and educational experiences to which the student is exposed (Astin, 1993). These may be grouped into two types of environmental variables:

institutional characteristics used for between-institution study, and particular educational experiences at the institution, which are utilized for examining student differences within-institution (Astin & Antonio, 2012). Third are outcomes, or the characteristics of the student after exposure to the environment (Astin, 1993). Importantly, inputs and outcomes refer to the state or characteristics of the student at two different points in time, before and after exposure to the environment (Astin & Antonio, 2012).

The purpose of the I-E-O model is to measure whether environmental conditions affect student growth or change. Astin (2012) suggested the examination of outcome measures, alone, is insufficient to assess educational programs, as these measures do not tell why or how student development occurred. Input and outcome variables, together, represent student development, changes in student knowledge and abilities over time. Examining the particular environmental experiences allows researchers to understand why some students develop differently than others. In implementing the I-E-O model, researchers examine the impact of various input characteristics and adjust, or control, for these differences in order to determine with less bias the effects different environments have on student outcomes (Astin & Antonio, 2012).

The I-E-O model was developed to address methodological problems with non-experimental research within social sciences due to the non-random distribution of students to programs (Astin & Sax, 1998). Because some students within a program may be more or less inclined to participate in or be subjected to certain experiences (environment), outcome measurements do not necessarily measure the impact of those experiences unless input characteristics are controlled (Astin & Sax, 1998).

Purpose of the Study

Collegiate aviation pilot schools face difficulties related to the high cost of pilot training and retaining flight instructors necessary to teach students. (U. S. Government Accountability Office, 2018). Given the current pilot shortage and high demand for commercial pilots, exacerbated by the COVID-19 pandemic (Boeing, 2022), it is imperative that collegiate flight programs identify student characteristics and environmental factors which affect student success and progression through the program.

The purpose of this study was to utilize traditional academic measures together with flight training variables to examine the impact on commercial pilot certificate attainment in collegiate aviation programs. While previous studies have examined the impact of such variables on student persistence and retention and degree completion in collegiate aviation, little literature exists examining the impact of factors on pilot certificate attainment in these programs. Given the high cost of pilot training, it is important to examine environmental variables within the program which may lead to increased training times and incur additional costs to the students. Likewise, little has been done to examine the impact of training disruption on student progression in collegiate aviation programs. The COVID-19 pandemic has resulted in a cohort of aviation students who experienced a prolonged break in flight training. This study examined the impact of student input characteristics and environmental attributes on commercial pilot certificate attainment and training time. The results are useful both for students and collegiate aviation flight training programs in increasing student progression and minimizing costs associated with flight training.

To better understand the study, one must understand Astin's I-E-O theoretical framework (Astin, 1993; Astin & Antonio, 2012). Figure 2, below, depicts the framework for the study. It begins with the inputs, which consist of traditional measures used in higher education. The environmental variables consist of both traditional academic measures combined with those specific to aviation. The outcome measures relate to commercial pilot certificate attainment.

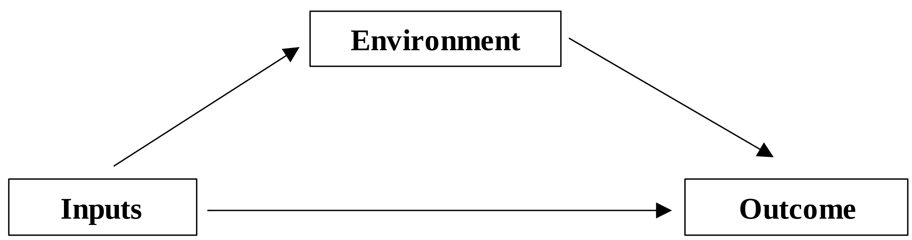

Figure 2. Proposed Framework for Study (Model).

Research Questions

The following research questions were derived from Astin's framework using the Input, Environment, Outcome model (Astin, 1993; Astin & Antonio, 2012), adapted for use in collegiate aviation flight programs. Figure 3 presents the variables used in the study and are further explained in Chapter III.

1. What is the relationship between collegiate aviation student input and outcome variables?
2. What is the relationship between collegiate aviation student environmental and outcome variables?
3. Can you predict collegiate aviation student commercial pilot certificate attainment based on input and environmental variables?

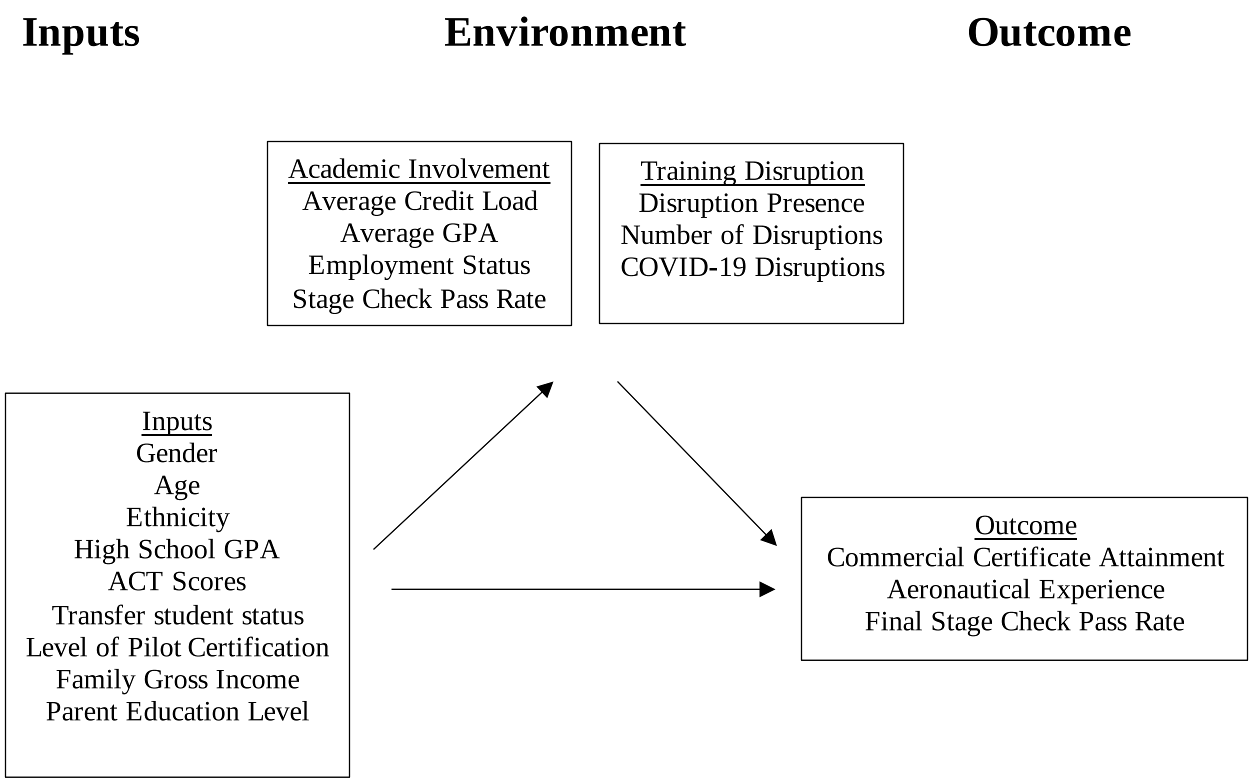

Figure 3. Variables Used in the Study.

Definitions

Educational Terms

ACT: A standardized test used for university admission purposes.

Credit Load: The number course credit hours taken by a student over an academic term.

Course Credit: Recognition for having taken a course at a university, measured in hours; used for determining completion of academic requirements for a degree.

Degree Attainment: Successful completion of academic requirements which results in the issuance of a degree to a student by the institution.

Grade Point Average (GPA): A measure of academic achievement calculated by dividing the number of grade points received by the number of credit hours awarded.

Retention: The ability of an institution to maintain student enrollment until degree completion.

SAT: A standardized test used for university admission purposes.

Standardized Test: A test administered and scored in a consistent manner.

Transfer: A student who departs their initial university of enrollment and enrolls at another university.

STEM: A grouping of academic curricula in the fields of science, technology, engineering, and mathematics.

Aviation Terms

The following terms are derived from Title 14 of the Code of Federal Regulations (Federal Aviation Regulations).

Aeronautical Experience: Pilot time obtained in an aircraft, aviation training device, or flight training device used to meet the requirements of a pilot certificate or rating.

Certificated Flight Instructor (CFI): A pilot authorized and certificated by the Federal Aviation Administration to provide flight instruction to students.

Commercial Pilot: A pilot certificated by the Federal Aviation Administration who may carry passengers or property for compensation or hire.

Part 121: Regulations governing commercial, scheduled, air carriers.

Part 141: Regulations governing pilot schools.

Private Pilot: A pilot authorized and certificated by the Federal Aviation Administration to fly an aircraft for which they are rated, with or without passengers, but not for compensation or hire.

Stage Check: A practical test given to a student pilot by a designated stage check instructor at regular intervals during flight training which tests the student's knowledge and flying ability and must be passed in order for the student to progress to the next stage of flight training.

Delimitations

This study utilized cohorts of students who completed training for the commercial pilot certificate between Fall 2017 and Fall 2022 at a public, four-year, research university in the Southern United States. The aviation program at the university is of moderate size. The university's commercial pilot program is certificated by the FAA and accredited by AABI. The aviation program also possesses institutional authority to certify graduates for an R-ATP.

Limitations

The greatest limitation to this study is the use of sample students from only one institution's aviation degree program. The sample population is limited to students who ceased or completed training for a commercial pilot certificate during the period from Fall 2017 until Fall 2022.

Overview of Chapters

The study is organized into five separate chapters. The first three chapters provide the background information necessary to fully comprehend the scope and purpose of this study. Chapter I serves as the introduction. It described the need for the study, followed by articulating the conceptual framework on which the study is based. The purpose and research questions conclude this chapter. Chapter II provides a review of the extant literature related to variables concerning student progression and achievement in higher education, STEM curricula, and aviation programs. This chapter provides numerous examples of relevant research at various levels in higher education. Chapter III details the methodology used in this study. It is in this chapter the sample and setting are defined. The chapter defines the variables used and describes the method of data collection. The final two chapters include the results and recommendations.

Chapter IV presents the results of the statistical analyses. This chapter presents the findings as responses to each research question. Chapter V, the final chapter, contains a narrative discussion of the findings and implications of the study as well as recommendations for future research.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

An extensive body of research exists regarding factors affecting student performance and progression in higher education. Likewise, students in STEM-specific disciplines are also represented well in the literature. However, little research exists in collegiate aviation programs. Much of the research in aviation fields has been in military and commercial aviation contexts; however, as pilot demand has increased in recent years, more research is becoming available, specifically regarding student retention and persistence (Bjerke, 2009; Bjerke & Healy, 2010; Leonard, 2018). Collegiate aviation flight students operate in a unique environment, different from other college disciplines. The following chapter presents the research conducted to date in higher education, with a focus on STEM fields, and aviation in particular.

Input Variables

Input variables consist of student characteristics and demographic information prior to entry into the program (Astin, 1993). In some cases, input variables are exactly the same as outcome measures, serving as a pretest and posttest; however, for some outcomes, a parallel pretest is not available. In these cases, it is important to recognize which other input characteristics are likely to be strongly related to the outcome measures being examined (Astin & Antonio, 2012). Fortunately, there is a lengthy history of work on college impact (Astin, 1993). Among others, variables which might be examined for interactive effects with environmental measures include student gender, ethnicity, age, ability, and socioeconomic status (Astin & Antonio, 2012).

Gender

Many studies (Alon, 2007; Attewell et al., 2011; Huang et al., 2017; Shoulders et al., 2020) have examined differences in degree attainment and retention based on gender in higher education. Results have had mixed findings. In some studies, significant differences in degree completion between male and female students was determined (Attewell et al., 2011; Huang et al., 2017). Utilizing demographic characteristics from the 1996 to 2001 Beginning Postsecondary Students Longitudinal Study (BPS) provided by the National Center of Education Statistics under the United States Department of Education, Attewell, et al (2011) concluded that racial/ethnic differences further divided by gender were significantly associated with degree completion when examined without controls. After controlling for other factors such as financial aid, college preparation, and parental socioeconomic status, differences between groups based on ethnicity, further divided by gender, remained in the case of community colleges; however, the differences were mediated in four-year colleges (Attewell et al., 2011). In a study of two cohorts of students at a public four-year university, Huang, et al. (2017) determined that gender had a significant relationship with six year graduation rates in one of the two cohorts when examining demographic variables. Female students in the cohort were more likely to graduate from college within six years; however, when other factors were included in the model, such as high school GPA, ACT math score, and college major, the relationship between gender and graduation was not significant. Huang, et al. (2017) further state that college major must be taken into account as likelihoods are significantly different across majors.

Women make up the majority of college completers in the United States (Flashman, 2013; Parker, 2021; Skidmore et al., 2022); however, when examining science, technology, engineering, and mathematic (STEM) majors, women are underrepresented (Whalen & Shelley, 2010). Whereas previously, efforts to close the gender gap in STEM participation had been unsuccessful (French et al., 2005), more recent trends have demonstrated the gap has narrowed. Although women are increasingly enrolling in STEM programs, they remain underrepresented, but the degree of representation varies according to discipline (Marsh et al., 2019). Demonstrating findings of gender differences in STEM, Male and non-minority STEM majors are 74.6% more likely to be retained or graduate than female and minority students (Whalen & Shelley, 2010). When examining engineering majors, specifically, female engineering students were found to have a higher mean GPA at graduation, higher five-year graduation rates, and higher retention rates after five years, indicating that while female enrollments may be fewer in number, they are more likely to succeed once enrolled (Priem et al., 2019). Priem, et al. (2019) also found that female students were more willing to engage in new academic behaviors, such as studying abroad and utilizing supplemental instruction, than their male counterparts.

Similar to STEM degrees as a whole, women are underrepresented in collegiate aviation (Marete et al., 2022). A review of literature revealed that little research has been performed on gender differences in collegiate aviation programs. In a study of first-time, full-time collegiate aviation students, Bjerke and Healy (2010)) found no significant relationship between gender and second year enrollment or GPA, although the study was limited to a relatively small sample from one institution. In a similar study examining the impact of pre-entry attributes of collegiate aviation students, Leonard (2018) also did not determine a significant relationship between gender and cumulative GPA.

Ethnicity

Similar to gender, research into success in higher education using race/ethnicity as a variable has had mixed results. Shoulders et al. (2020) investigated a sample of full-time, first semester undergraduate students. In the sample, ethnicity, along with other variables such as gender and first generation student status, did not improve prediction in a logistic regression model of six-year graduation rates among university students over variables of Pell Grant eligibility, academic measures, and student satisfaction (Shoulders et al., 2020). Similarly, Attewell, et al. (2011) concluded that ethnic differences might me mediated by other variables in four-year colleges, but noted that evidence of racial gaps remain in community colleges, even after controlling for other factors. In contrast, several other recent publications determined that ethnic differences are present, with white students being more likely to graduate from college than other ethnicities (Huang et al., 2017), white and Asian students having higher six year graduation rates (Alon, 2007), and minority achieving lower GPAs than non-minority students, even when non-minority students had another disadvantage, such as first-generation or low income status (Whitcomb et al., 2021).

In STEM fields, results are more uniform. Research indicates that enrollment in STEM majors, as a whole, is mostly balanced across ethnicities, although there are significant variations in STEM subfield enrollment (Ma & Liu, 2017; Whitcomb & Singh, 2021). Analyzing data from the National Education Longitudinal Study from 1988-2000 along with the Postsecondary Education Transcript Study, which contains a nationally representative dataset, Ma and Liu (2017) found that black students were not initially underrepresented in declaring a STEM major; however, ethnic differences in success have been shown, with Asian and white students more likely to complete a STEM degree than black and Hispanic students (Ma & Liu, 2017). Even though underrepresented minorities have similar rates of enrollment, retention and graduation rates are lower for minority students (Whalen & Shelley, 2010; Whitcomb & Singh, 2021). Furthermore, minority students in STEM fields have also been found to have lower GPAs than non-minority students, demonstrating a need to investigate the lack of support, mentoring, and guidance for underserved students (Whitcomb & Singh, 2021).

Aviation is a field with predominantly white, male employees. According to the Bureau of Labor Statistics (2021), 93% of pilots and flight crew are white, and only 5.3% are women. This underrepresentation of women and minorities extends to collegiate aviation programs (Clark, 2006). While there is little research into ethnic/racial differences in collegiate aviation, what is available contrasts with findings in STEM fields as a whole. Bjerke and Healy (2010) found no significant relationship between ethnicity and second year enrollment or GPA after the first year. Leonard (2018) found no significant relationship between Caucasian/non-Caucasian status and cumulative GPA at graduation. It should be noted that both Bjerke and Healy's (2010) and Leonard's (2018) studies possessed small numbers of non-Caucasian students which were grouped for analysis.

First-Generation Status

To be a first-generation student means that neither parent had earned a bachelor's degree. Stableton and Soria (2013), utilizing the Student Experience in the Research University (SERU) survey, representing six research universities, found first-generation students are more likely than peers to have characteristics which serve as a disadvantage in higher education achievement. In a report for the Pell Institute, Engle et al. (2006) stated demographic characteristics are, in part, responsible for lower rates of college enrollment and completion. First generation students are more likely to be female, older, African American or Hispanic, and come from lower-income families than other students (Engle et al., 2006). These characteristics present challenges to first-generation students. Aruguete and Katrevich (2017) found that poor academic and social integration is a major obstacle for first-generation students, which may be compromised by students' work and family responsibilities. Similarly, a study by Jenkins et al. (2009) demonstrated a greater proportion of first-generation students work 20 or more hours a week, which may impact academic performance, retention, and graduation rates. Other researchers have found evidence to support these conclusions, with first-generation students having decreased likelihood of graduating from college (Huang et al., 2017). First-generation, low income students were found to have academic performances similar to underrepresented minorities in a public university with balanced arts and sciences (Whitcomb et al., 2021).

Annual Freshmen Survey (AFS) results of students indicated first-generation students do not ask questions of faculty or staff, and first-generation minority students demonstrated less confidence in academic ability and academic readiness than other students (A. Jenkins et al., 2009). For these reasons, increased resources and attention, such as timely advising about academic and cocurricular activities and financial aid opportunities, are important to provide an equitable educational environment (Whitcomb et al., 2021).

High School Academic Achievement

Measures typically used for college admissions are scores on the admission tests, such as the SAT (formerly the Scholastic Aptitude Test) or ACT (formerly the American College Testing) tests, and/or high school performance records such as high school class rank and high school GPA (Cohn et al., 2004). There exists a large volume of research into the predictive validity of these measures on college GPA and graduation rates. In a study which included over 190,000 first-time college students from 2000 through 2006, both ACT composite score and high school GPA were significant predictors of first year college GPA and degree completion at two-year and four-year universities (Radunzel & Noble, 2012). Another study by Cornwell et al. (2008) found that when controlling for demographic and high school achievement factors, SAT Writing (SATW) scores predict first year college student performance, with an increase in SATW score corresponding to an increase in college GPA, enrolled and earned credit hours, and withdrawal from fewer credit hours. Similarly, in a recent study, Shoulders (2020) determined high school GPA was found to be a significant predictor of six-year bachelor degree completions and persistence in first-time semester freshmen at university.

It should be noted that some universities do not require SAT or ACT tests for admission. Furthermore, as a result of inaccessibility to testing as a result of protective measures enacted during the COVID-19 pandemic, many schools temporarily dropped the requirement for ACT or SAT test scores. Some schools have retained this test-optional policy and may not return to requiring admissions tests (Schultz & Backstrom, 2021).

While the majority of research demonstrates the predictive ability of high school achievement measures, some have mixed results. Huang et al. (2017) found higher high school GPA increased the likelihood of graduating from college within six years, but ACT score did not show significant impact in the sample. STEM specific fields have also demonstrated mixed results. French et al. (2005) concluded Math SAT scores and high school rank were significant predictors of GPA in two cohorts of undergraduate engineering students. In a study examining retention and graduation of full-time freshmen, Whalen and Shelly's (2010) findings indicated that high school rank and ACT composite score had significant negative relationships with retention and graduation when modelling all students. Results indicated that, although students starting out in STEM majors had higher high school ranking and ACT composite scores than initial non-STEM majors, within the group of initial STEM majors, those who changed from STEM to non-STEM had lower ACT composite and high school rank than those that remained, and performed the worse than both those who remained STEM majors and those who started as non-STEM majors during the first year of school (Whalen & Shelley, 2010). Taken together, these results suggest high ability students initially declare a STEM major, suffer high rates of attrition, with many subsequently changing to non-STEM disciplines, which may limit the utility of measures of high school achievement (Whalen & Shelley, 2010).

The issue of adverse impact due to the use of these measures has also been an area of focus in prior research. In examining previous research, Zwick (2019) stated both high school GPA and admission test scores have demonstrated differences based on socioeconomic status, gender, and ethnicity. Previous research has demonstrated that admissions test scores over predict first year college GPA for black and Hispanic students and under predict college GPA for women (Zwick, 2019). When both high school GPA and admissions test scores are used, prediction errors for ethnic groups are smaller, but prediction errors for gender groups are larger. (Zwick, 2019). While including an SAT requirement in selection criteria improves increases the probability of student success in college, non-whites are less likely to be eligible for scholarships when SAT requirements are installed (Cohn et al., 2004). Due the potential for adverse impact, schools have a responsibility to conduct research on the impact of their admission policies (Zwick, 2019).

Bjerke and Healy (2010) examined how pre-entry attributes relate to student persistence and academic success at a collegiate aviation institution. 12 variables, including parents' education levels, family income, ACT scores, race, ethnicity, and high school GPA were gathered for 390 full-time commercial aviation students. (Bjerke & Healy, 2010). Results indicated that high school GPA had the highest predictive validity of all of the tested variables in predicting continued enrollment for a second academic year; however, no significant relationship was found between the predictor variables and the student's declared major between the first and second academic year (Bjerke and Healy, 2010). Furthermore, while ACT math and verbal scores had a significant relationship with first year college GPA, ACT composite, math, and verbal scores had no significant relationship with second year enrollment (Bjerke & Healy, 2010).

Leonard (2018) examined the impact of the pre-entry attributes used in the earlier study combined with environmental variables such as yearly academic course load, employment on campus, number of flight hours and number of days to certificate completion had on student graduation using Astin's IEO framework (Leonard, 2018). Leonard concluded high school GPA and composite ACT scores both had significant positive correlation with cumulative college GPA with a large effect and a significant relationship with graduation rates within 48 months; however, high school GPA was a better predictor of college GPA in the sample. Similar to existing literature, these results indicate more weight should be placed on high school GPA than ACT score when establishing admissions criteria; however, as the sample consisted of students at a single four-year public institution, the results may not be generalizable to other institutions (Leonard, 2018).

Financial Status

Financial constraints may hinder student performance (Millea et al., 2018). In a synthesis of 1,200 meta-analyses, encompassing over 65,000 studies examining factors relating to academic achievement, Hattie (2015) calculated a small effect size for finances. Although most of the sampled meta-analyses were derived from K-12 education settings, many were from the postsecondary sector (Hattie, 2015). A similar meta-analysis was performed by Sneyers and De Witte (2018) on 25 quasi-experimental studies in postsecondary settings in the United States, Canada, and Europe, with a similarly small effect size for need-based grants. Although most of the studies included in this meta-analysis were from the United States and Denmark, higher tuition costs in the United States may result in higher effect size when examining studies in this region, alone (Sneyers & De Witte, 2018).

Research into the impact of financial status on college retention and success often uses financial aid records due to the availability of data (Goldrick-Rab et al., 2016; Millea et al., 2018; Sneyers & De Witte, 2018; Stater, 2009; Williams et al., 2018). Financial aid typically comes in the form of scholarships, grants, or loans. Scholarships and other forms of institutional aid are usually based on merit or academic achievement, whereas government aid in the form of grants or loans are typically based on need, or financial status (Millea et al., 2018). Need-based financial aid is closely linked to financial status and family income (Sneyers & De Witte, 2018). Factors used to determine eligibility for need-based financial aid include expected family contribution, student status, and number of dependent family members (Sneyers & De Witte, 2018).

Studies regarding the impact of financial aid on college student success have differed in results based on eligibility requirements (merit-based or need-based) and type of financial aid (grants, scholarships, or loans) (Curs & Harper, 2012; Herbaut & Geven, 2020; Stater, 2009; Zhan et al., 2018). Zhan et al. (2018) examined the relationship between student loans and college graduation rates in the United States using data representing 3,445 students from the National Longitudinal Survey of Youth 97. The results indicated a significant positive relationship existed, up to a point; at higher education loan amounts, incremental benefits decreased and have the potential to even turn negative (Zhan et al., 2018). In contrast, Goldrick-Rab, et al. (2016) examined the impact of need-based grants on a graduation rates in a sample of students in the University of Wisconsin System. Results indicated a significant and substantive increase in four-year graduation rates among grant recipients (Goldrick-Rab et al., 2016). In a study of 13,000 first-time freshmen at a midsized public university in the United States, Millea et al., (2018) concluded that while financial aid was a significant and large factor in graduation rates, the type of aid determined the relationship, with grants having a positive and loans having a negative impact. These results indicate that the type of financial aid is important for need-based applicants. Notably, financial aid, especially in the form of grants, may help to equalize racial/ethnic differences and increases minority student persistence (Alon, 2007).

Merit-based aid and need-based aid also have varying relationships with student success (Stater, 2009). An examination of academic records for 18,748 students concluded merit-based aid had a larger effect on college GPA than need-based aid (Stater, 2009).

Financial status may have a larger impact on students in flight-based collegiate aviation programs than other programs due to the high cost of training. A 2018 Government Accountability Office report surveyed 45 collegiate flight programs and found that 27 had flight training costs in excess of $50,000, with the most expensive program costing approximately $81,000, not including undergraduate tuition (U. S. Government Accountability Office, 2018). Results of previous studies have been mixed. Bjerke and Healy (2010) did not determine a significant relationship between adjusted family gross income and continued enrollment to the second year or cumulative GPA. Leonard (2018), on the other hand, concluded a significant relationship existed between family gross income and four year graduation rates, but also found no significant relationship with cumulative GPA.

Transfer Student Status

Hills (1965) first described the tendency for students to experience a drop in performance upon transferring from a 2-year college to a 4-year college as "transfer shock." Research into educational attainment has consistently indicated transfer students' baccalaureate degree completion rates and time-to-degree are lower than non-transfer students (Hu et al., 2018; Hu & Ortagus, 2019, 2019; P. Jenkins & Fink, 2016; Long & Kurlaender, 2009; Monaghan & Attewell, 2015).

The cause of decreased academic performance and achievement among transfer students has been attributed to a variety of social and academic challenges (Eggleston & Laanan, 2001). In an examination of 2,467 natural resource majors at a mid-sized public university, Johnson (2005), in contrast to previous research, did not find evidence for a statistical difference between transfer student and "native" student GPA. In harmonizing these findings with prior research, Johnson (2005) noted the small class sizes, the geographic isolation of the university, and the focus on laboratory and field-trip sessions caused a larger degree of social interaction between transfer and non-transfer students, which might reduce the impact of transfer shock. Further evidence transfer shock varies with the field of study is provided by Carlan and Byxbe (2000), who compared data for 717 students admitted to a major public university over a three-year period. Findings indicated that not only did transfer students experience a GPA decrease in their first-semester post-transfer, but transfer students in different colleges were variously affected. Students transferring into Business and STEM majors fared the worst (Carlan & Byxbe, 2000).

More recently, the impact and contributing factors of transfer shock on STEM majors have been highlighted. Utilizing data from the BPS: 04/09, Hu & Ortagus (2019) examined data of 2,330 students enrolled in STEM majors. Results indicated students starting at a community college were less likely to obtain a bachelor's degree or persist in STEM fields when compared to non-transfer students; however, when broken down by gender, these results were not true for the female subsample (Hu & Ortagus, 2019). In a qualitative study exploring factors contributing to transfer shock, Elliott and Lakin (2021) interviewed 37 transfer students at two geographically distinct universities, which revealed normative differences between the community colleges and the transfer university. Emergent themes included the availability of faculty for academic support, difficulty adjusting to divergent exam norms, and adapting to norms that placed greater emphasis on independent learning, especially in STEM courses (Elliott & Lakin, 2021).

Flight training in the United States takes place in three distinct environments: collegiate aviation schools, non-collegiate vocational pilot schools, and non-collegiate flight instructor-based schools where training is performed by independent flight instructors (United States Government Accountability Office, 2011). Collegiate aviation schools provide the training necessary to become a commercial pilot as well as offer an undergraduate aviation-based degree, although most commercial pilots in the United States utilize flight instructor-based schools as their initial training environment (United States Government Accountability Office, 2011). As these training environments differ in social and academic norms, students transferring from one to another may experience transfer shock, although little research exists, and further study is required to examine the presence and impact of this phenomenon in aviation education.

Environmental Variables

Environmental variables, in the broadest sense, consist of everything a student experiences throughout the course of attending an educational program. Environmental variables representing between-institution research design are primarily institutional characteristics, such as academic programs, policies, faculty, and peers; however, variables for within-institution studies typically focus on student experiences, such as social and institutional climate, pedagogical techniques and personality of professors, and cocurricular activities or programs, courses taken, the amount of time devoted to various activities, living arrangement, and employment status (Astin, 1993; Astin & Antonio, 2012).

Ongoing University Achievement

Academic credit load, whether a student enrolls part-time or full-time, not only serves as an indicator of the amount of time a student may dedicate to academic learning, but also may demonstrate a student's level of commitment to academic achievement (Wang, 2009). The concept of academic momentum, pioneered by Adelman (1999, 2006), seeks to explain college undergraduate degree completion or non-completion, noting that students who progress through their degree at a faster rate have more momentum and higher rates of degree attainment. Using data from the National Educational Longitudinal Study (NELS) 1988, Adelman (1999, 2006) found students who engaged in momentum-enhancing activities such as immediately transitioning from high school to college, taking precollegiate courses, taking a high number of credits during the first year, and enrolling during summer months were strongly associated with degree completion.

Attewell et al. (2012) noted that, on a theoretical level, momentum-increasing behaviors, such as taking an increased course load, might better integrate undergraduates into the common life of students or share college culture in greater measures than part-time students. Utilizing growth curve modeling on a sample of NELS:88/2000 students, Attewell et al. (2012) found students who enrolled part-time or took fewer credit hours than average during their first year were associated with worse long-term degree outcomes than students enrolled full-time; however, students who engaged in heavy course loads during the first year suffered no discernable penalty when compared to average load students. Summer school attendance at the end of the first academic year also increased the likelihood of graduation (Attewell et al., 2012)

Martin et al. (2013) posited that ongoing academic performance is predictive of future academic performance. Utilizing a sample of 904 Australian undergraduate students in a longitudinal study, findings indicated that as students progressed in degree programs, the effects of high school achievement on subsequent academic performance diminished while the effects of university performance on subsequent performance were additive (Martin et al., 2013).

Results of these studies point toward the importance of initial and ongoing university achievement on degree attainment (Adelman, 1999, 2006; Attewell et al., 2012; Martin et al., 2013). These findings suggest close monitoring of course load and GPA should be implemented and interventions should begin early in students' university life (Martin et al., 2013).

Student Employment

Astin (1975) concluded work setting, on or off-campus, determined the relationship between employment and student retention. Students engaged in on-campus employment experienced lower dropout rates than other students. Importantly, the results were similar regardless of the type of work, whether in an academic-related department or non-academic part of campus (Astin, 1975). On the other hand, employment off-campus was negatively associated with student retention except in the case of the freshman year, and of the students who reported their job was detrimental, a larger percentage held off-campus jobs. Whereas working full-time off-campus had a uniformly negative impact, working full-time on campus only had a negative impact on women and no discernable impact on men. These results are likely due to economic and psychological factors. Students who hold a job are financially secure, and holding an on-campus job increases student involvement in campus life and identification with the institution

(Astin, 1975). Reproducing these results, Astin (1993) found that working full-time as a student was the single largest negative effect on retention in an analysis of 11,079 students. Working part-time off campus was also negatively related to student retention (Astin, 1993, p. 196).

More recent research has largely had similar findings. Kulm & Cramer (2006) found a positive relationship between the number of hours employed and student persistence in a sample of 500 mid-western undergraduate students, although they did not differentiate between on-campus and off-campus employment, and that the more time a student spends on campus, the more likely the student will succeed. In an evaluation of records for 80,452 students at Eastern Kentucky University, Willis (2022) determined students who held on-campus jobs had higher GPAs and degree completion rates than students who worked off-campus.

Research in collegiate aviation contexts is limited. A 2008 study of 793 aviation-related undergraduates found students who worked 1-10 hours per week possessed higher mean GPAs than students who did not work or worked more (Bjerke & Higgins, 2008). Leonard (2018) concluded that whether a student worked on campus, if a student worked on-campus in an aviation-related job, and whether a student worked as a CFI while enrolled as a student had significant relationships with graduating in 48 months; however, none of the variables were significantly associated with cumulative GPA.

Training Disruption

Training disruption involves an event occurring during training that limits or prohibits the skill from being practiced for a prolonged period of time. These periods of skill disuse may result in skill decay. The degree to which skills decay depends on a variety of factors, but may occur to a noticeable degree after only days or months of disuse (Lohre et al., 2021). Determining factors include initial skill level (Lohre et al., 2021), type of knowledge required by the task (Cecilio-

Fernandes et al., 2018), task complexity (Cecilio-Fernandes et al., 2018), and time since initial training (Haslbeck & Hoermann, 2016; Volz & Dorneich, 2020). A 2018 study by Cecilio-Fernandes et al. reviewed 11 articles on surgical skill decay, finding that when initial training was spaced out rather than massed in a short period of time, participants scored higher on retention tests after periods as long as one year, reducing decay. The authors noted that declarative knowledge decays over time, and so complex tasks which utilize declarative knowledge benefit from spaced training intervals, but the optimum training schedule for long-term retention remains unclear (Cecilio-Fernandes et al., 2018). Examining skill decay due to training disruptions from the COVID-19 pandemic, Lohre et al. (2021) noted that the decay of orthopedic skills, which consist of cognitive and manual skills, as a result of the pandemic should be of great concern. Similarly, Fero et al. (2020) found that 51% of urology training programs expressed agreement with a survey statement regarding feelings of anxiety regarding competency upon training completion due to a prolonged period without skill practice.

Research into skill decay among pilots has had similar results to those from the medical profession. Childs & Spears (1986) stated that flight skills begin to decay rapidly after cessation, with some skills decaying faster than others. In particular, cognitive and procedural skills decay more rapidly than control-oriented skills. Control-oriented skills represent the motor response to cues, learned well during initial training, and are retained over longer periods of time. On the other hand, the pilots have difficulty identifying and categorizing cues due to the decay of the perceptual and cognitive processes (Childs & Spears, 1986).

Hendrickson et al., (2006) noted little research exists in aviation fields regarding decay as directly related to flight skills and the interval between training sessions. Utilizing airline pilot data for continuing qualification either six months or twelve months post-training, Hendrickson et al. found the pilots performing the maneuvers after twelve months performed worse than the six-month group, concluding that performance on both normal and emergency procedures suffered more decay with an increased retention interval; however, a refreshment briefing directly prior to practicing the maneuver benefited performance after a period of disuse (Hendrickson et al., 2006).

Much of the literature on skill decay in aviation comes not from concern over training disruption, but from the use of automation. Gillen, (2008) performed an experiment in which captains and first officers employed by airlines were tasked with performing instrument maneuvers in a simulator. Gillen concluded that through the use of automation and the lack of "hands-on" flying, the pilots' performance on instrument maneuvers had fallen below the minimum required for the issuance of an Airline Transport Pilot certificate and were closer in performance to that required for an instrument rating (Gillen, 2008). The Federal Aviation Administration has, likewise, demonstrated concern over the decay of pilot skills due to automation (Federal Aviation Administration, 2013b). A 2016 study by Haslbeck & Hoermann had similar findings to Gillen, tasking 126 airline pilots to perform a manual precision approach and concluding that manual flying skills are subject to decay, further stating that the level of practice, training, and time elapsed since initial training have a significant influence on fine-motor flying skill. Volz & Dorneich (2020) performed an experiment in which 46 undergraduates with no prior aviation experience were taught flight planning skills. After training, they were separated into three groups: manual flight planning, alternating manual and automated flight planning, and only using automated flight planning. At the end of the five-week period, all groups demonstrated a decrease in performance and reported an increase in perceived workload, with the automation group having significantly worse performance and reporting the highest workload. Results indicated decay of cognitive skills associated with calculations and estimations, and larger decreases in performance with larger times between practice (Volz & Dorneich, 2020).

Little research exists, as of yet, into the impact of the COVID-19 pandemic on piloting ability and proficiency; however, Olaganathan & Amihan (2021) examined National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) reports from before and during the pandemic. The authors noted flying is a combination of motor and cognitive processing, dependent on the frequency of practice, and that the COVID-19 pandemic limited the availability of practice for pilots. A comparison of incident reports demonstrated a significant increase of 1,000% for incidents attributed to pilot proficiency or currency after the onset of the pandemic (Olaganathan & Amihan, 2021).

Scant research exists regarding skill decay due to training disruption in aviation, especially due to the COVID-19 pandemic. While results of studies in aviation contexts have shown similar results to those in other fields, particularly the medical field, it is important to note that these studies have largely been conducted using trained pilots (Childs & Spears, 1986; Gillen, 2008; Haslbeck & Hoermann, 2016; Hendrickson et al., 2006; Olaganathan & Amihan, 2021). As the motor control aspect of flying is typically well-learned and acquired during training (Childs & Spears, 1986), skill decay onset prior to training completion may have more severe results.

Outcome Variables

Outcome measures are those which relate to student characteristics after exposure to the environment. Outcomes may be classified by type of outcome (affective or cognitive) or type of data (behavioral or psychological) (Astin, 1993; Astin & Antonio, 2012). Affective outcomes refer to student values, self-concept, and aspirations, whereas cognitive outcomes refer to the use of higher-order mental processes such as reasoning and logic. As such, cognitive outcomes are clearly relevant to educational objectives (Astin, 1993). Psychological data relates to the internal state or traits of the student, whereas behavioral data relates to observable activities. Examples of cognitive behavioral outcome variables given by Astin (1993) and Astin and Antonio (2012) include career development, educational attainment, awards or special recognitions, and persistence in college.

Aviation Outcome Variables

Degree attainment and time-to-degree have been used as outcome variables by many researchers (Aihara, 2019; Beckett, 2006; Foley, 2013; Gayles & Ampaw, 2011; Leonard, 2018; Zhou & Castellanos, 2013). Degree attainment as an outcome variable represents the culmination of students' educational goals upon entry into an academic program. As such, when examining a course of pilot training, certificate attainment serves the same function as degree attainment: the achieved goal at the end of an educational program.

Likewise, time-to-degree has a flight training-specific equivalent in hours of aeronautical experience. Aeronautical experience is the measure of concern to students engaged in aviation flight programs due to the high cost of training. The Government Accountability Office (2018) report stated most students needed to use family resources or take private loans to pay for the cost of flight training, with some students who were initially able to secure loans unable or unwilling to secure further loans to complete training. Cost due to aeronautical experience, more so than time, is the variable of import to flight students.

While some research exists in collegiate aviation contexts, they are largely confined to the use of traditional academic variables. The major difference which distinguishes this study from previous literature is the inclusion of outcome variables specific to collegiate aviation students: certificate attainment and aeronautical experience. Chapter III will detail the methodology used in this study.

CHAPTER III

METHODOLOGY

This chapter contains a detailed explanation of the methods and procedures used to study commercial pilot certificate attainment in professional aviation majors. The chapter begins with a detailed overview of the setting in which the research was conducted, followed by a description of the sample used in the study. The chapter concludes with a discussion of the procedures used for data collection and analysis.

Setting

This study was conducted utilizing students enrolled in the aviation program at a public, four-year, research-intensive university located in the southern United States. In Fall 2021, there were 11,173 students enrolled in programs ranging from baccalaureate to professional and doctoral degrees. These programs are divided among five colleges. The College of Liberal Arts houses the Department of Professional Aviation.

The Department of Professional Aviation currently offers two Bachelor of Science degree programs: Professional Aviation and Aviation management. Both degree programs are accredited by the Aviation Accreditation Board International (AABI). As part of the Professional Aviation degree, students must attain the following FAA certifications and ratings: Private Pilot Certificate, Instrument Rating, Commercial Pilot Certificate, and Flight Instructor - Airplane Single Engine Certificate. Students enroll in the Commercial Pilot – Airplane training course after completion of the Private Pilot – Airplane and Instrument Rating – Airplane courses, typically in their Junior year. The Commercial Pilot Training Course Outline specifies that students will achieve a minimum of 120 hours of aeronautical experience. These 120 hours include, at a minimum, 24 hours of instruction in an Aviation Training Device, and 96 hours of time acquired in the airplane. A minimum of 34 hours of the 96 required hours of airplane time must be flight instruction received from a Certificated Flight Instructor. The remainder of the 96 hours in the airplane not accomplished as flight instruction received is solo flight time. Any There are three stage checks required through the course of training, two intermediate stage checks and a final stage check. The first stage check covers advanced instrument procedures, the second stage check examines a student's ability to perform the flight maneuvers necessary for the Commercial Pilot practical test, and the final stage check tests the student on all subject areas on the practical test.

Enrollment at the university is selective. Admission requirements for Freshmen vary between in-state and out-of-state students. In-state students must have either a High School Core GPA of at least 2.5 with a minimum composite ACT score of 15 or an ACT composite score of at least 23 to qualify for admission into the university. Out-of-state students must meet in-state requirements, or have a minimum ACT composite score of 26 along with a High School Core GPA of 2.0 or greater, or have a minimum ACT composite score of 23 along with a High School GPA on at least 17 of the core courses of at least 2.5.

The university utilizes quarters for academic terms, consisting of Fall, Winter, Spring, and Summer terms. Full-time enrollment for undergraduate students is eight semester hours for a given quarter. The maximum allowed load for a quarter without obtaining special permissions is 12 credit hours. Credit loads of 13 or more hours require permission from the dean of the college in which the student is enrolled. Credit loads of 15 or more hours require the permission of the Vice President for Academic Affairs.

Enrollment in the department of Professional aviation was capped in 2017, based on application date. Selective admissions based on initial application date, cumulative GPA, and standardized test scores were implemented beginning in Fall 2018. High school seniors and transfer students applying to the department are required to have, at a minimum, a 3.0 GPA and a 23 composite ACT score. The following table indicates how many students were enrolled in the Professional Aviation and Aviation Management majors from 2017 – 2020.

Table 1. Aviation Majors.

Term	Professional Aviation	Aviation Management	Total
Fall 2017	156	51	207
Fall 2018	131	41	172
Fall 2019	123	41	164
Fall 2020	147	32	179

Ethical Considerations

When conducting research in which human subjects are involved, it is important to respect the dignity and worth of all people as well as protecting the rights of individuals to privacy, confidentiality, and self-determination (American Psychological Association, 2017). It is essential the researcher anticipate and examine any potential ethical concerns which may arise. Prior to data collection, this research project was reviewed and approved by the Institutional

Review Board at the University of North Dakota to ensure regulatory compliance with requirements for human subject research.

An important ethical consideration to note for this study is that the primary researcher is currently a faculty member within the Department of Professional Aviation at the university in which research was performed. This relationship to the research setting could have been problematic due to researcher bias, interpretation, and the possibility of findings which would negatively impact the Department of Professional Aviation. In order to mitigate bias and interpretation error, only quantitative data were utilized in the analysis. In considering the discovery of findings which would negatively affect the department, this researcher had the role of student progress monitoring and training course assessment.

When conducting research utilizing institutional data of students, concerns arise regarding confidentiality and anonymity. To alleviate these concerns, procedures were used in this study to protect the anonymity of students. As the data collected were from multiple sources, the Office of Institutional Effectiveness, Research, and Planning (OIERP) served as a collection and merging point for all data. In this office, student identification information was removed before the final data set was released to the primary researcher.

Sample

The sample for this study consists of students who enrolled in the commercial pilot training course outline and completed or withdrew from the course between the Fall 2017 and Fall 2022 academic terms. The reason for selection of this range was to ensure adequate sample size and to achieve a data set which includes both students whose flight training was affected by the COVID-19 pandemic and those whose training was unaffected. Fall 2017 was selected as the start date as the department acquired a new fleet of aircraft for flight training at this time. Students enrolled in the Commercial training course prior to this date received training in aircraft with different avionics and capabilities.

Data Collection

Data for this study was obtained from four sources: academic institutional records, financial aid records, human resource records, and flight records. The Office of Financial Aid provided employment information and the Office of Institutional Effectiveness, Research and Planning provided input and environmental academic record information. Institutional data are maintained on an IBM Mainframe and accessed through IBM Customer Information Control System (CICS). In addition to maintaining institutional academic information, once a student is enrolled in the university, demographic information, ACT/SAT scores, high school GPA are uploaded to the system. Information collected on Free Application for Financial Aid (FAFSA) is also maintained on this system. All data are entered manually by university employees.

Flight training information was gathered using the Talon Systems Education and Training Administration (Talon ETA) database of student records. Talon ETA is used by the Department of Professional Aviation as a tool to track and maintain student flight records as required by the Federal Aviation Administration. Flight data are entered manually by university flight instructors.

Prior to data collection, permission was obtained from the Institutional Review Board of both the subject institution and the University of North Dakota. A letter of permission was obtained from the Department of Professional Aviation which allowed the researcher to access the information housed on Talon ETA. This information was sent to the OEIRP where demographic, academic, and employment records were added to the dataset. The OEIRP forwarded the dataset to the Office of Financial Aid, where financial records were added and the data de-identified prior to being returned to the researcher.

This study utilized a quantitative approach to identify factors which influenced the attainment of a commercial pilot certificate. The dependent variables in this study included the completion status of the commercial pilot training course and the number of aeronautical experience hours conducted in the commercial pilot training course. This study has several independent variables which are divided into the categories of input variables and environmental variables, as defined by Astin's I-E-O model.

Input Variables

Student input variables consist of the following: gender, ethnicity, age, high school grade point average, ACT composite score, ACT math score, ACT English score, adjusted family gross income, parental education level, student transfer status, and level of flight training prior to enrollment in the department. The level of flight training for students was identified by the initial flight course in which the student was enrolled. Students entering the program with no prior flight certificate will enroll in the Professional Aviation 110 flight lab and be entered into the Private Pilot course in Talon ETA. Student who have attained a Private Pilot Certificate prior to enrollment in the department enter into the Professional Aviation 242 flight lab, are credited a "Satisfactory" grade for Professional Aviation 110, and are entered into the Instrument Rating course in Talon ETA. These students are identified by the absence of the Private Pilot course in their Talon ETA record. Table 2 clarifies the input variables.

Table 2. Input Variables.

Variable Name	Variable Description	Values	Source
GENDER	Gender	1 - Woman 2 - Man	Institutional Record
AGE	Age at Training Start	17-48	Institutional Record
ETHN	Ethnicity	1 – Minority 2 – White	Institutional Record
HSGPA	High School Grade Point Average	0-5.0	Institutional Record
ACT_C	Composite ACT Score	6-36	Institutional Record
ACT_M	Math ACT Score	3-36	Institutional Record
ACT_ENG	Verbal ACT Score	6-36	Institutional Record
TRANSFER	Student Transfer Status	0 – No 1 - Yes	Institutional Record
PILOTCERT	Prior Flight Training Level	0 –No Prior Training 1 -Private Pilot	Talon ETA
INCOME	Adjusted Gross Income	Numeric	FAFSA
FIRST_GEN	First Generation Student Status	0 – No 1 - Yes	FAFSA

Environmental Variables: Academic Involvement

Academic involvement environmental variables were collected from the OIERP, Talon ETA, and the Office of Financial Aid. Data were collected for the period of time the student was enrolled in the Commercial Pilot training course. Data included: average academic credit load, calculated GPA, employment on-campus, department of employment, and number of stage check attempts.

Average academic credit load and GPA were calculated from the time all grades were marked complete. This is necessary to note, as students receive a grade of “IB,” or incomplete with a “B” grade used for GPA calculation, for a flight lab in which they are enrolled until passing the relevant stage check. It is common practice that students complete the stage of training and pass the stage check after the end of the enrolled academic term. If the incomplete grade were used, the course credit would be missing and the GPA calculation would be affected.

Students vary in the time required to complete the Commercial Pilot flight labs. While there are three flight labs in the Commercial Pilot training course, students may take as long as six quarters or more to complete flight training. It is also common practice that students enroll in the next flight lab in the series ahead of their current stage of training under the assumption that flight lessons will progress at a rate which allows them to begin training in the lab during the enrolled period; however, this may not be the case. Students enrolled in the first Commercial Pilot flight lab for a given academic quarter may be delayed and not begin lessons for that flight lab until a later academic term. For these reasons, average credit hours were calculated for the period beginning when the first Commercial Pilot training course activity was conducted until completion of the Commercial Pilot training course. Cumulative GPA in aviation courses was also calculated for this period to prevent grades attained prior to Commercial Pilot training from influencing the environmental variables.

Table 3. Environmental Variables: Academic Involvement.

Variable Name	Variable Description	Values	Source
CREDITAVG	Mean enrolled credit hours	0-14	Institutional Record
GPA	Calculated cumulative GPA	0-4.0	Institutional Record
GPAPRAV	Calculated GPA for Aviation Courses	0-4.0	Institutional Record
EMPLOYCAM	Employed on campus	0-No 1-Yes	Financial Aid
EMPLOYDEP	Employed in department	0-No 1-Yes	Financial Aid
STAGE1	Number of attempts on the first stage check	1-5	Talon ETA
STAGE2	Number of attempts on the second stage check	1-5	Talon ETA

Environmental Variables: Training Disruption

Training disruption variables were collected from Talon ETA. The training disruption presence variable indicates whether a student experienced a training disruption during Commercial Pilot training. Many students in the sample affected by training disruptions caused by the COVID-19 pandemic ceased flight training and resumed on or near the same dates. For this reason, training disruption was coded as a categorical variable; students who experienced at least 60 days without a flight training activity were labelled as having experienced a training disruption. This interval is in keeping with previous literature as the short-term period of disuse, but is large enough to exclude disruptions with smaller intervals, such as extended weather delays, vacations, and resource unavailability. The disruption count variable signifies whether a student experienced a single training disruption or multiple, whereas the COVID variable signifies if a student's flight instruction was affected by cessation of flight training during the COVID-19 pandemic.

Table 4. Environmental Variable: Training Disruption.

Variable Name	Variable Description	Values	Source
TRAINDISRP	Training Disruption Presence	0-No 1-Yes	Talon ETA
DISRPCOUNT	Number of Training Disruptions Experienced	1-Single 2-Multiple	Talon ETA
COVID	Student Flight Training Impacted by COVID-19	0-No 1-Yes	TalonETA

Figure 4 provides a visual representation of Astin's I-E-O model as applied to this study. The areas analyzed in this research include student input variables, environmental variables and how they influence the attainment of a Commercial Pilot Certificate. Key differences in this application of the model from previous literature is the use of training disruption as an environmental variable and the use of aeronautical experience as an outcome variable, which allows closer examination into how flight training is impacted.

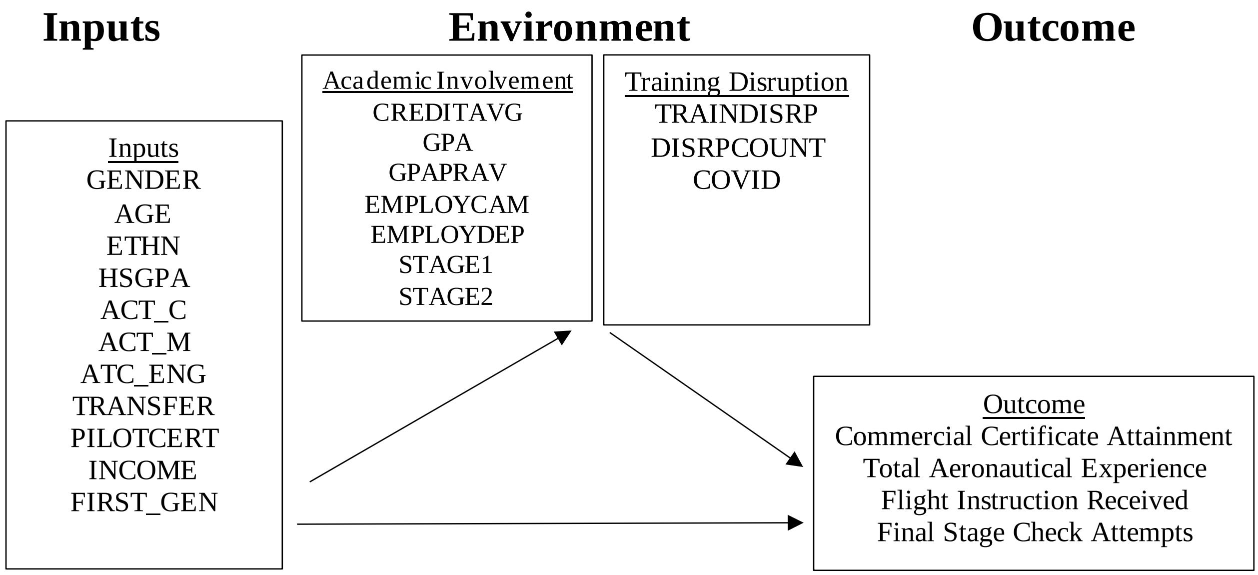

Figure 4. Proposed Framework for Study (Variables).

Data Analysis

The data for the study came from four main sources: institutional records, financial aid records, human resource records, and Talon ETA. Talon ETA data was entered into a Microsoft Excel document by the researcher, merged with university records, and had all identifying information removed. The completed dataset was imported into IBM Statistical Package for the Social Sciences (SPSS) for analysis.

Initial data analysis was descriptive. Frequencies were tabulated for each input, environmental, and outcome variable. Next, standard deviations were calculated for the variables.

Due to the large number of variables utilized in this study, each research question was first examined by determining the correlations between the independent and dependent variables. Significance for this study was set at the .05 level.

Next, the first two research questions were examined using simultaneous multiple regression. Multiple regression is used to evaluate theories which utilize several variables which influence an outcome variable. In this method, all independent variables are entered in one step and the predictive usefulness of each variable is assessed while controlling for any linear association with all other predictor variables (Warner, 2013). Secondly, a forward stepwise, or statistical, regression was utilized. In forward stepwise regression, variables are added to the regression equation in order from those which most contribute to the prediction to those which contribute least (Astin & Antonio, 2012).

The third research question was also examined utilizing stepwise forward regression. The use of regression analysis in examining the relationships between input, environment, and outcome variables is consistent with previous literature (Aihara, 2019; Beckett, 2006; Foley, 2013), and the use of stepwise regression allows the analyst to examine the direct effect of an input variable and reveals which variables mediate the indirect effects (Astin & Antonio, 2012).

CHAPTER IV

RESULTS

This chapter presents the results in the following sections: purpose of the study, description of the sample, the results of the three research questions, and a summary. Statistical significance for the study was set at the .05 level.

Purpose of the Study

The purpose of this study was to utilize Astin's Input-Environment-Outcome theory of student success to examine the relationship between variables for Commercial pilot students in collegiate aviation. Independent variables were grouped based on time. Variables experienced by a student prior to enrollment in the collegiate aviation program (gender, age, ethnicity, high school GPA, ACT score, transfer status, level of pilot certification prior to enrollment, household income, and parental education level) are input variables. Environmental variables (credit load, college GPA, student employment status, stage check pass rate, and presence of a training disruption) were experienced while students were enrolled in the Commercial pilot program. Outcome variables were the dependent variables of Commercial Pilot Certificate attainment, total aeronautical experience in airplane during the Commercial Pilot training course, and hours of instruction received during training.

Description of the Sample

Input Variables

The sample for this study consisted of students who enrolled in the Commercial Pilot training course on or after Fall 2017 and completed or withdrew from the training course prior to the end of the Spring 2023 term. This sample was selected to provide a sufficiently large total sample size and included students who were affected by training disruption due to the COVID-19 pandemic as well as those who were not affected. The sample represents 112 students who met these criteria. Demographic information about the sample is presented in Table 5.

Table 5. Demographic Information on Gender, Age, Ethnicity.

Characteristics	N	%
Gender		
Women	18	16.1
Men	94	83.9
Age		
18 and Younger	18	16.1
19	25	22.3
20	38	33.9
21	17	15.2
22 and older	14	12.5
Ethnicity		
Minority	8	7.1
White	99	88.4
Not Reported	5	4.5

The sample included 18 women students (16.1%) and 94 men (83.9%). The age of students at the beginning of enrollment in the training course ranged from 17 to 48 years old, with a mean of 20.6 and a standard deviation of 4.4. The majority (88.4%) of students were white, with the remaining sample being other ethnicities (7.1%) or whose ethnicity was not reported (4.5%).

The frequencies in Table 6 depict academic achievement prior to entry in the Commercial Pilot training course. This includes High School GPA; ACT composite, math, and English scores; transfer student status; and level of pilot certification prior to enrollment.

High school grade point average is depicted on a weighted 5.00 scale with a minimum of 2.46 and a maximum of 4.09 and 2 records (1.8%) missing. The mean high school GPA for the sample was 3.52 with a standard deviation of .38. ACT composite score ranged from a minimum of 16 to a maximum of 33 with a mean of 25.43 and a standard deviation of 3.83. ACT math scores in the sample had a low of 15 and a high of 33 with a mean of 24.62 and a standard deviation of 3.55. ACT English scores ranged from 16 to 36 with a mean of 26.41 and standard deviation of 4.84. Records for all ACT scores were unavailable for 17 (15.2%) students. 41 (36.6%) of students in the sample held a private pilot certificate prior to entry to the university, whereas the remaining 71 (63.4%) of the sample attained a private pilot certificate at the university. 16 (14.3%) students in the sample transferred to the university after previously enrolling at another institution, while 96 (85.7%) enrolled at the university as first-time freshmen.

Table 6. Academic Achievement Prior to Entry.

Characteristics	N	%
High School Grade Point Average		
2.00-2.50	2	1.8
2.51-3.00	9	8
3.01-3.50	35	31.3
3.51-4.00	52	46.4
Above 4.00	1	0.9
Missing	13	11.6
ACT Composite Score		
16-19	6	5.4
20-21	5	4.5
22-23	20	17.9
24-25	22	19.6
26-27	16	14.3
28-33	26	23.2
Missing	17	15.2
ACT Math Score		
15-19	12	10.7
20-21	6	5.4
22-23	11	9.8
24-25	23	20.5
26-27	25	22.3
28-33	18	16.1
Missing	17	15.2
ACT English Score		
16-19	6	5.4
20-21	7	6.3
22-23	12	10.7
24-25	22	19.6
26-27	14	12.5
28-36	34	30.4
Missing	17	15.2
Private Pilot Prior to Entry		
No	71	63.4
Yes	41	36.6
Transfer Student		
No	96	85.7
Yes	16	14.3

Family background characteristics are given in Table 7. It includes first-generation college student status and adjusted gross family income.

Table 7. Family Background Information.

Characteristics	N	%
First-Generation Student Status		
No	63	56.3
Yes	9	8
Missing	40	35.7
Family Adjusted Gross Income		
<30,000	5	4.5
30,000-60,000	5	4.5
60,001-90,000	4	3.6
90,001-120,000	14	12.5
>120,000	41	36.6
Missing	43	38.4

Of the sample, 9 (8%) were first-generation college students, while 63 (56.3%) were not. 40 records were unavailable. Family adjusted gross income ranged from $0 to $537,043 annually, with a mean of $157,929.20 and a standard deviation of $102,898.32. Income information was missing from 43 (38.4%) records as this information was only available if a student completed a Free Application for Federal Student Aid.

Environmental Variables

The frequencies in Table 8 depict the academic involvement variables of credit load, GPA, student employment status as a student worker on campus, student employment as a student worker within the department, intermediate stage check pass rate and final stage check pass rate.

Table 8. Academic Involvement Variables.

Characteristics	N	%
Average Credit Load Per Quarter During Training		
<6	29	25.9
6-8	26	23.2
9-11	37	33
>11	18	16.1
0	2	1.8
GPA in Aviation Courses During Training		
1.50-2.00	1	.9
2.00-2.50	1	.9
2.51-3.00	3	2.7
3.01-3.50	28	25
3.51-3.99	54	48.2
4.00	23	20.5
None	2	1.8
Employed as a Student Worker		
No	88	78.6
Yes	24	12.5
Employed as a Student Worker in Aviation		
No	95	84.8
Yes	17	15.2
Number of Stage 1 Check Attempts		
1	93	83
2	6	5.4
Did not Attempt	13	11.6
Number of Stage 2 Check Attempts		
1	81	72.3
2	14	12.5
3	3	2.7
4	0	0
5	1	0.9
Did not Attempt	13	11.6

The average number of academic credit hours in which students were enrolled during Commercial Pilot training ranged from 0 to 14 with a mean of 7.6 and a standard deviation of 3.24. Two students (1.8%) were not enrolled in any academic courses while accomplishing Commercial Pilot training. These students had enrolled in the Commercial Pilot flight labs during academic quarters prior to the actual start of flight training, received incomplete grades for those flight labs, and did not enroll in any other courses during the time Commercial Pilot flight training took place. The grade point average maintained by students for professional aviation courses while accomplishing the Commercial Pilot certificate training ranged from 1.5 to 4.0, with a mean of 3.64 and a standard deviation of 0.37. 24 (12.5%) students in the sample were employed by the university as student workers, whereas the majority (88%) were not. 17 students (15.2%) were employed as student workers for the Department of Professional Aviation, while 95 (84.8%) were not. Students in the sample completed the first stage check in one or two attempts, with a mean of 1.06 attempts and a standard deviation of 0.24. Students in the sample took between one and five attempts to complete the second stage check, with a mean of 1.24 and a standard deviation of .61. 13 students (11.6%) did not attempt either of the intermediate stage checks due to withdrawal from the training course.

Table 9 depicts the training disruption variables. These variables include whether or not a student experienced a training disruption during Commercial Pilot Certificate training, if students experienced a single or multiple training disruptions, and whether training disruptions were a result of cessation of flight training during the COVID-19 pandemic.

Table 9. Training Disruption Variables.

Characteristics	N	%
Training Disruption		
No	59	52.7
Yes	53	47.3
Number of Disruptions		
None	59	52.7
Single	38	33.9
Multiple	15	13.4
Disruption due to COVID-19		
No	81	72.3
Yes	31	27.7

53 students (47.3%) in the sample experienced a training disruption of at least 60 days. 59 students (52.7%) did not experience a training disruption. Of those who experienced a disruption, 38 (33.9%) experienced a single training disruption, whereas 15 (13.4%) experienced two or more disruptions. Of the 112 students in the sample, 81 (72.3%) were unaffected by the COVID-19 pandemic during their Commercial Pilot training, and 31 (27.7) were affected while accomplishing Commercial Pilot training.

Outcome Variables

The frequencies in Table 10 detail the outcome variables of Commercial Certificate attainment, total aeronautical experience, flight instruction received, and the number of attempts to complete the final stage check. 97 students (86.6%) completed Commercial Pilot training and attained their Commercial Pilot Certificate. 15 students (13.4%) withdrew from training. Total aeronautical experience required to complete Commercial Pilot training ranged from 120 to 183.3 hours, with a mean of 130.6 and a standard deviation of 10 hours. Students in the sample required a minimum of 35.6 hours of instruction received and a maximum of 108.5 hours to complete training, with a mean of 54.5 and a standard deviation of 13.9 hours. 15 students (13.4%) had missing entries for aeronautical experience and flight instruction received due to withdrawing from the training program prior to completion. Students completed the final stage check between one and four attempts (M = 1.35, SD = 0.68). None of the 15 (13.4%) students who withdrew from the course accomplished the final stage check.

Table 10. Outcome Variables.

Characteristics	N	%
Commercial Certificate Attainment		
No	15	13.4
Yes	97	86.6
Total Aeronautical Experience		
120-130	56	50
130.1-140	28	25
140.1-150	8	7.1
>150	5	4.5
Missing (Not Completed)	15	13.4
Flight Instruction Received		
34-40	11	9.8
40.1-50	36	32.1
50.1-60	22	19.6
60.1-70	15	13.4
>70	13	11.6
Missing (Not Completed)	15	13.4
Final Stage Check Attempts		
1	72	64.3
2	18	16.1
3	5	4.5
4	2	1.8
Did not Attempt	15	13.4

Research Questions

Research Question 1

What is the relationship between collegiate aviation student input and outcome variables? Initial analysis examined the impact of input variables on whether a student attained a commercial pilot certificate. Since the outcome variable was categorical and input variables were both categorical and continuous, first, bivariate correlations were computed between input variables and the outcome variable to identify significant relationships. Logistic regression was then utilized to further evaluate the relationship between variables identified as significant and the outcome variable. Subsequent analysis examined the impact of input variables on total aeronautical experience and on flight instruction received. As both of these outcome variables were continuous and input variables were both categorical and continuous, multiple linear regression was utilized to examine the relationships.

Both logistic regression and multiple linear regression require that there be a lack of multicollinearity among the independent variables. To test this assumption, correlation coefficients were computed for the input variables. Table 11 details the correlations.

Based on the results of the correlations, Composite ACT score has a high significant correlation with ACT Math score $r_s = .76$, $p < .01$, and ACT English score $r_s = .82$, $p < .01$. Due to these large significant correlations, Composite ACT score was omitted from regression analysis as Math and English scores provide greater data granularity.

Table 11. Input Variable Correlations.

Variable	1	2	3	4	5	6
1. Age	-	-.29**	-.20	-.25*	-.07	-.12
2. HSGPA	-.29**	-	.47**	.41**	.38**	.17
3. ACT Comp.	-.20	.47**	-	.76**	.82**	.08
4. ACT Math	-.25*	.41**	.76**	-	.50	.14
5. ACT English	-.07	.38**	.82**	.5	-	.06
6. Income	-.12	.17	.08	.14	.06	-

* Indicates significance at the 0.05 level
** Indicates significance at the 0.01 level

Input variables vs. Commercial Pilot Certificate attainment. To examine this question, a bivariate correlation was conducted to determine if any strong linear relationships were present between input variables and Commercial Pilot Certificate Attainment. Table 12 shows the results. Age was the only variable which was found to be significantly related to commercial certificate attainment with younger students more likely to complete training r_{pb} = -.20, p = .04.

Table 12. Bivariate Correlation of Input Variables and Commercial Certificate Attainment.

Variable	N	Corr.	Sig,
Age	112	-.20*	.04
High School GPA	99	.02	.89
ACT Math	95	.12	.24
ACT English	95	.19	.07
ACT Composite	95	.16	.13
Income	69	.09	.48

* Indicates significance at the 0.05 level

Following the results of the bivariate correlation, a logistic regression was performed on to further explore the relationship of age on Commercial Pilot Certificate attainment. The results of the regression are provided in Table 13. The resulting regression model was not statistically significant, X^2 (1, N = 112) = .27, p = .61 with a Nagelkerke R^2 of .00, indicating that age was not a significant predictor of Commercial Certificate attainment.

Table 13. Logistic Regression of Age on Commercial Certificate Attainment.

Variable	Beta	SE Beta	Wald's χ^2	Sig.	Odds ratio
Age	-.03	.05	.30	.59	.97
Constant	2.46	1.14	4.68	.03	11.72

Input variables vs. total aeronautical experience. Multiple linear regression was utilized to examine the relationship between input variables and total aeronautical experience. The first analysis was conducted by entering all factors in a full regression model simultaneously to determine the *Beta* weights, *t* values for the *Beta* weights, significance of *t*, and the correlation coefficients of the independent variable with total aeronautical experience. Table 14 shows the results.

Table 14. Simultaneous Multiple Regression of Input Variables with Total Aeronautical Experience.

Characteristics	Beta	t	Sig. of t	Corr.	Sig.
Gender	-9.76	-2.21	.03	-.38**	<.01
Age	.41	.30	.76	.03	.43
Ethnicity	-2.5	-.56	.56	-.14	.17
High School GPA	3.68	.98	.33	.17	.12
ACT Math	-.48	-.91	.37	-.11	.22
ACT English	.56	.75	.46	.14	.46
Transfer Status	2.24	.51	.61	.06	.35
Pilot Certificate	1.56	.56	.58	.02	.44
Income	$1.32e^{-5}$	.91	.37	.10	.25
First-Generation	2.97	.72	.47	.12	.20

** Indicates significance at the 0.01 level

The full model analysis demonstrated a relationship between input variables and total aeronautical experience. The regression model was not statistically significant (F (10,40) = 1.17, p = .34), with an R^2 of .23; however, student gender was determined to be a significant predictor of aeronautical experience required to complete Commercial Pilot training, β = .41, t (40) = .30, p = .03.

In utilizing a stepwise forwards regression, only gender was a significant predictor of aeronautical experience. The regression equation was significant (*F* (1,49) = 8.37, $p < .01$) with an R^2 of .15. Student's predicted aeronautical experience is given by the equation Y = 150.51 - 11.07X, where where Y = flight instruction received and X equals gender, coded as 1 = woman, 2 = men.

Input variables vs. flight instruction received. Multiple linear regression was also used to examine the relationship between the input variables and flight instruction received. As before, first a simultaneous multiple regression using the enter method was performed to calculate *Beta* weights, t statistic, significance of t, and correlations of the variables. Results are provided in Table 15.

Similar to the previous analysis, the full model regression equation was not significant (F (10,40) = 1.57, $p = .15$) with an R^2 of .28; however, gender again was a significant predictor β =-17.66, *t* (40) = -2.81, $p < 01$.

A stepwise forwards regression similarly had gender as the only significant predictor. The regression equation was significant (F(1,49) = 10.71, $p < .01$ with an R^2 of .18 and is given by the equation Y = 87.51 – 18.11X, where Y = flight instruction received and X equals gender, coded as 1 = woman, 2 = man, indicating that men require 18.11 fewer hours of instruction to complete the Commercial Pilot certificate.

Table 15. Simultaneous Multiple Regression of Input Variables with Flight Instruction Received.

Characteristics	Beta	t	Sig. of t	Corr.	Sig.
Gender	-17.66	.51	<.01	-.42	<.01**
Age	1.70	-2.81	.38	.10	.25
Ethnicity	3.15	.52	.61	.01	.48
High School GPA	4.69	.88	.38	.16	.13
ACT Math	-.70	-.93	.36	-.09	.26
ACT English	.67	1.36	.18	.07	.33
Transfer Status	2.13	.34	.73	.03	.41
Pilot Certificate	5.44	1.37	.18	.11	.23
Income	$1.65e^{-7}$	.01	.99	-.04	.40
First-Generation	4.16	.72	.48	.11	.22

** Indicates significance at the 0.01 level

Input variables vs. final stage check attempts. As before, multiple linear regression was used to determine significant relationships between input variables and the number of attempts required to pass the final stage check. Simultaneous multiple regression provided *Beta* weights, t, significance of *t*, and strength of correlation. Results are provided in Table 16. The resulting regression model was not significant, F (10, 40) = .60, p = .81. Furthermore, no significant relationships were determined between input characteristics and the number of attempts required to pass the final stage check in the Commercial Pilot training course.

Table 16. Simultaneous Multiple Regression of Input Variables with Final Check Attempts.

Characteristics	Beta	t	Sig. of t	Corr.	Sig.
Gender	.57	1.43	.16	.15	.15
Age	-.01	-.06	-.7	-.05	.37
Ethnicity	.09	.24	.81	-.03	.42
High School GPA	.24	.71	.48	.01	.47
ACT Math	-.07	-1.37	.18	-.08	.28
ACT English	.03	1.09	.28	.07	.31
Transfer Status	-.30	-.77	.45	-.06	.34
Pilot Certificate	-.20	-.81	.42	-.07	.31
Income	$9.22e^{-7}$	.71	.48	.04	.40
First-Generation	.44	1.19	.24	.17	.12

Research Question 2a

What is the relationship between collegiate aviation student environmental variables of academic involvement and outcome variables? Initial analysis looked at the impact environmental variables had on commercial certificate attainment. As the outcome variable was categorical and multiple predictor variables were used, both categorical and continuous, first bivariate correlation was utilized to examine for significant relationships, followed by a logistic regression to further explore the variables identified as significant. Subsequent analysis examined the impact of Academic involvement environmental variables of the outcome variables of total aeronautical experience and flight instruction received. As both outcome variables are continuous and the environmental variables are both continuous and categorical, multiple regression analysis was utilized to examine these relationships.

Both logistic regression and multiple regression require a lack of multicollinearity among the independent variables. To examine this, correlation coefficients were computed for each variable. The results are given in Table 17.

Table 17. Academic Involvement Variable Correlations.

Variable	1	2	3	4	5	6	7
1. Credit Load	-	.18	.19	.22*	.18*	-.01	-.15
2. GPA	.18	-	.91**	.25**	.23*	.06	-.43**
3. Aviation GPA	.19	.91**	-	.22*	.21*	-.01	-.41**
4. Student Worker	.22*	.25**	.22*	-	.81**	.08	-.17
5. Work in Department	.18*	.23*	.21*	.81**	-	.02	-.12
6. Stage 1 Check	-.01	.06	-.01	.08	.02	-	-.12
7. Stage 2 Check	-.15	-.43**	-.41**	-.17	-.12	-.12	-

* Indicates significance at the 0.05 level
** Indicates significance at the 0.01 level

Two large, significant correlations were found: calculated GPA in aviation courses correlates with calculated cumulative GPA, $r_s = .91$, $p < .01$, and working as a student worker on campus correlated strongly with working as a student within the aviation department, $r_s = .81$, $p < .01$. Due to these large, significant correlations, calculated cumulative GPA and working as a student worker on campus were excluded from regression analysis.

Academic involvement variables vs. Commercial Certificate attainment. To evaluate the research question, first, a bivariate correlation was conducted to identify significant relationships between the academic involvement variables and Commercial Certificate attainment. Table 18 shows the results. Significant relationships were identified for the variables of GPA in aviation courses, $r_{pb} = .28$, $p < .01$; and number of attempts to complete the second stage check $r_{pb} = -.66$, $p < .01$; however, only two students in the sample completed either of the intermediate stage checks and did not attain the Commercial Pilot Certificate, limiting detailed analysis of this relationship.

Table 18. Bivariate Correlation of Academic Involvement Variables and Commercial Certificate Attainment.

Variable	N	Corr.	Sig,
Credit Load	112	.12	.20
Aviation GPA	110	.28**	<.01
Work in Department	112	-.05	.58
Stage 1 Check	99	.04	.72
Stage 2 Check	99	-.66**	<.01

* Indicates significance at the 0.05 level
**Indicates significance at the 0.01 level

Following the bivariate correlation results, a logistic regression was performed to further examine the relationship between Aviation GPA and Commercial Certificate attainment. The regression results are given in Table 19. The resulting regression model was statistically significant, X^2 (1, $N = 110$) = 6.72, $p = .01$ with a Nagelkerke R^2 of 11.1%. GPA in aviation courses was determined to be a significant predictor of Commercial Pilot Certificate attainment, OR = 5.73, 95% CI [1.38, 23.77].

Table 19. Logistic Regression of Aviation GPA on Commercial Certificate Attainment.

Variable	Beta	SE Beta	Wald's χ^2	Sig.	Odds ratio
Aviation GPA	1.75	.73	5.77	.02*	5.73
Constant	-4.29	2.57	2.79	.10	.01

* Indicates significance at the 0.05 level

Academic involvement variables vs. total aeronautical experience. The relationship between academic involvement variables and aeronautical experience was examined using multiple regression. First, the enter method was used to enter all factors into the regression simultaneously to calculate *Beta* weights, *t* value, significance of *t*, and correlation coefficients for each factor. The results of the simultaneous entry are provided in Table 20.

The full model analysis demonstrated relationships between academic intensity variables and total aeronautical experience. The regression model was not statistically significant (F (5, 90) = 2.05, p = .08), with an R^2 of .10. Credit load had the most significant relationship with total aeronautical experience, followed by the number of stage 2 check attempts.

Table 20. Simultaneous Multiple Regression of Academic Involvement Variables with Aeronautical Experience.

Characteristics	Beta	t	Sig. of t	Corr.	Sig.
Credit Load	-.75	-2.28	.03	-.23*	.01
Aviation GPA	-2.51	-.73	.47	-.16	.06
Work in Department	2.83	.98	.33	.03	.40
Stage 1 Check	.99	.24	.81	.01	.47
Stage 2 Check	3.92	.17	.11	.19*	.03

* Indicates significance at the 0.05 level
**Indicates significance at the 0.01 level

In utilizing stepwise forward regression, average credit load was the only variable determined to be a significant predictor out of all the academic involvement variables. The regression model was statistically significant (F (1, 94) = 5.40, p = .02), with an and explained 5.4% of the variance. The resulting regression equation is given as Y = 136.42 – 0.74X, where Y equals total aeronautical experience and X average number of credit hours enrolled per quarter.

Academic involvement variables vs. instruction received. Simultaneous multiple regression was used to examine the relationship between academic involvement variable and flight instruction received. The results of the simultaneous multiple regression are given in Table 21. The regression analysis containing all academic involvement variables demonstrated significant relationships with flight instruction received. Credit load had the strongest relationship, followed by stage 2 check attempts. The variables accounted for 14.8% of the variance (F (5, 90) = 3.13, p = .01).

Table 21. Simultaneous Multiple Regression of Academic Involvement Variables with Flight Instruction Received.

Characteristics	Beta	t	Sig. of t	Corr.	Sig.
Credit Load	-1.52	-3.40	<.01	-.33**	<.01
Aviation GPA	.02	.01	>.99	-.10	.16
Work in Department	2.99	.76	.45	-.02	.44
Stage 1 Check	.50	.09	.93	-.01	.48
Stage 2 Check	5.96	1.80	.08	.19*	.03

* Indicates significance at the 0.05 level
**Indicates significance at the 0.01 level

Utilizing stepwise forwards regression demonstrated only credit load to have significant impact on the variance. This variable explained 11.1% of the variance (F (1, 94) = 11.73, p < .01). The regression equation is expressed as Y = 66.10 – 1.48X, where Y is equal to instruction received during Commercial Pilot training and X is equal to the average academic credit load per quarter.

Academic involvement variables vs. final stage check attempts. Again, simultaneous multiple regression was used to identify academic involvement variables significantly related to final stage check attempts. The results of the regression are provided in Table 22. None of the academic involvement variables were identified as significantly related to the number of final stage checks attempts required to complete the training course. The full regression model was not significant F (5, 90) = .93, p = .47.

Table 22. Simultaneous Multiple Regression of Academic Involvement Variables with Final Check Attempts.

Characteristics	Beta	t	Sig. of t	Corr.	Sig.
Credit Load	-.02	-.95	.34	-.10	.08
Aviation GPA	-.30	-1.23	.22	-.13	.05
Work in Department	-.17	-.82	.42	-.09	.12
Stage 1 Check	.00	<.01	>.99	<.01	.49
Stage 2 Check	.04	.21	.84	.02	.23

Research Question 2b

What is the relationship between collegiate aviation student environmental variables of training disruption and outcome variables? Initial analysis examined the impact of training disruption presence on Commercial Certificate attainment.

Training disruption variables vs. Commercial Certificate attainment. A Chi-square test was used to evaluate the relationship between training disruption presence and Commercial Certificate attainment. No significant interaction was found, X^2 (1, N = 112) = .00, p = .96.

Table 23. Observed and Expected Counts for Training Disruption Presence.

		Comm. Cert Not Attained	Comm. Cert Attained
Disruption Not Present	Observed/Expected	8/7.9	51/51.1
Disruption Present	Observed/Expected	7/7.1	46/45.9

To examine the question further, a Chi-square test for association was also performed on the variable of number of disruptions experienced and Commercial Certificate attainment. No significant interaction was determined between the variables, X^2 (2, 112) > .01, p < .99, indicating a lack of relationship between training disruption and whether a student completed Commercial Pilot training in the sample.

Table 24. Observed and Expected Counts for Number of Training Disruptions.

		Comm. Cert Not Attained	Comm. Cert Attained
Disruption Not Present	Observed/Expected	8/7.9	51/51.1
Single Training Disruption	Observed/Expected	5/5.1	38/38
Multiple Disruptions	Observed/Expected	2/2	13/13

To determine whether or not training disruptions due to the COVID-19 pandemic, specifically, was significantly associated with whether or not a student completed Commercial Pilot training, a third Chi-square test was performed. As previously, no significant interaction was determined, X^2 (1, 112) = 1.78, p = .18; however, the expected count for 25% of the cells was less than 5. Due to this, a Fisher's Exact test was performed. Results of the Fisher's Exact test (p = .23) similarly do not indicate a significant relationship.

Table 25. Observed and Expected Counts for Disruption due to COVID-19.

		Comm. Cert Not Attained	Comm. Cert Attained
No Disruption due to COVID-19	Observed/Expected	13/10.8	68/70.2
Disruption due to COVID-19	Observed/Expected	2/4.2	29/26.8

Training disruption variables vs. total aeronautical experience. Regression analysis was used to determine the relationship between training disruption presence and Commercial Certificate attainment. *Beta* weights, *t*, significance of *t*, and correlation coefficient are provided in Table 26. The resulting regression was not significant, F (1, 95) = .37, p = .55.

Table 26. Regression of Training Disruption Presence with Total Aeronautical Experience.

Characteristics	Beta	t	Sig. of t	Corr.	Sig.
Training Disruption Presence	1.24	.61	.55	.06	.27

To further evaluate the question and determine the effect disruption, categorized by number of disruptions, had on total aeronautical experience, a one-way analysis of variance was performed. The results did not indicate significant effect in the sample, F (2, 94) = 1.44, p = .24.

Table 27. Analysis of Variance for Number of Training Disruptions and Total Aeronautical Experience

	Sum of Squares	df	Mean Square	*F*	Sig.
Between Groups	283.68	2	141.84	1.44	.24
Within Groups	9256.04	94	98.47		
Total	9539.73	96			

To further examine the training disruption, an independent samples *t*-test was performed comparing mean total aeronautical experience between the group of students who were affected by the COVID-19 pandemic and the group of students whose flight training in the course was unaffected. As Levene's test for homogeneity of variance was not significant (p = .13), equal variance was assumed. The resulting t statistic was not significant, t (95) = -.50, p = .62, indicating the mean flight hours did not significantly differ between these groups.

Training disruption variables vs. flight instruction received. Simple linear regression was again to examine the relationship between training disruption and flight instruction hours. The results indicate training disruption presence has a small, but significant correlation r_{pb} = .06, p <.01. The resulting regression was significant, F (1, 95) = p .02, with an R^2 of .06.

Table 28. Regression of Training Disruption Presence with Flight Instruction Received.

Characteristics	Beta	t	Sig. of t	Corr.	Sig.
Training Disruption Presence	6.62	2.4	.02	.06*	.01
**indicates significance at the 0.01 level					

To explore this relationship further, a one-way analysis of variance was performed to examine the effect the number of training disruptions had on flight instruction received. The results indicated significant effect in the sample F (2, 94) = 4.05, p = .02. *Post hoc* comparisons using the Bonferroni correction indicated that the mean instruction flight hours for students who experienced multiple training disruptions (M = 62.75, SD = 11.81) differed significantly from those with no training disruption (M = 51.38, SD = 12.69). However, mean hours for students who only experienced a single disruption, (M = 56.13, SD = 15.13) did not significantly differ from those without a disruption experience.

Table 29. Analysis of Variance for Training Disruption Number and Flight Instruction Received.

	Sum of Squares	df	Mean Square	*F*	Sig.
Between Groups	1469.32	2	734.66	4.05	.02
Within Groups	17050.40	94	181.39		
Total	18519.71	96			

To determine the effect of training disruption due to the COVID-19 pandemic on the flight instruction required to complete the Commercial Pilot certificate, an independent samples *t*-test was conducted. As Levene's test for homogeneity of variance was not significant (p = .19), equal variance was assumed. The t statistic was found to be significant, t (95) = -2.63, p = .01. The effect size for the analysis (d = .56) indicated medium effect. These results indicate students who experienced training disruption due to COVID-19 (M = 60.02, SD = 15.29) required a moderately increased amount of flight instruction to complete Commercial Pilot training than students who did not experience a training disruption due to COVID-19 (M = 52.17, SD = 12.65).

Training disruption variables vs. final stage check attempts. To examine whether the presence of a training disruption was significantly related to student performance on the final stage check, as measured by the number of attempts required to pass the check, a simple linear regression was used. The resulting regression model was not significant, F (1, 95) = 1.54, p = .22.

To examine the relationship between further, a one-way analysis of variance was computed comparing the mean number of attempts on the final stage check grouped by the number of training disruptions present during training. The results indicated a lack of significant effect in the sample, F (2, 94) = .78, p = .46.

Table 30. Analysis of Variance for Training Disruption Number and Final Check Attempts.

	Sum of Squares	df	Mean Square	*F*	Sig.
Between Groups	.72	2	.36	.78	.46
Within Groups	43.36	94	.46		
Total	44.08	96			

To determine if student performance on the final stage check as measured by the number of attempts required to pass the check was related to training disruption caused by the COVID-19 pandemic, an independent samples *t*-Test was performed. Levene's test was not significant, so equal variances were assumed. The resulting *t*- statistic was not significant, $t\ (95) = .38$, $p = .71$, indicating a lack of significance between group means.

Research Question 3

Can you predict collegiate aviation student commercial pilot certificate attainment based on input and environmental variables? This research question was analyzed by utilizing input and environmental variables previously determined to have a significant relationship with respective outcome variables. As this question assessed the relationship between multiple input and environmental variables, multiple regression was utilized as the primary method of analysis.

Significant variables vs. Commercial Certificate attainment. Analysis was conducted by forward logistic regression utilizing all variables which had previously been identified as having significant relationship to Commercial Pilot certificate attainment. These variables were age and GPA in aviation. Only GPA in aviation courses contributed to the resulting regression model. The results were significant X^2 (1, N = 110) = 6.72, p = .01 with a Nagelkerke R^2 of .11., OR = 5.73, 95% CI [1.38, 23.77].

Significant variables vs. total aeronautical experience. The second analysis was conducted by performing a stepwise multiple regression on input and environmental variables previously identified to have a significant relationship with total aeronautical experience. These variables were gender, average credit load, and number of attempts on the stage 2 check. Credit load was the only variable which significantly contributed to the resulting regression model, accounting for 5.5% of the variance, F (1, 95) = 5.52, p = .02. The regression equation is given as Y = 136.27 - .73X, where Y is equal to total aeronautical experience and X equals average credit load per quarter while enrolled in the Commercial Pilot training course.

Significant variables vs. flight instruction received. Forward stepwise regression was also used for the third analysis for variables previously identified as having a significant relationship with flight instruction received. These variables were gender, average credit load, number of attempts on the second stage check, and the presence of a training disruption. The resulting model was significant F (3, 93) = 9.59, p < .01, and explained 23.6% of the variance, with average credit load contributing the most to the regression equation, followed by gender, then number of stage two check attempts. The equation is given by Y = 82.85 - 1.42X – 13.13Z + 6.09C, where Y is equal to flight instruction received, X equals average academic credit load per quarter, Z equals gender where 0 = woman and 1 = man, and C equals the number of attempts required to pass the Stage two check.

Table 31. R^2 Change Results Based on Stepwise Forward Regression for Significant Variables Impacting Flight Instruction Received.

Factor	R	R^2	R^2 Chg.	Sig. Chg.
Credit Load	.33	.11	.11	<.01
Gender	.45	.20	.09	<.01
Stage 2 Check Attempts	.49	.24	.04	.04

Significant variables vs. final stage check attempts. No variables were identified in previous analysis as having a significant relationship with the number of attempts required by students in the sample to complete the final stage check.

Summary

This chapter presented the results using correlations and regressions to examine the relationships between input, environmental, and outcome variables in Commercial Certificate attainment in a collegiate aviation program. The results of this section are further explored and contextualized in the following chapter.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents a summary of the results and relates the findings to current literature on student success in collegiate aviation programs. This final chapter also includes recommendations for future research and practical implications.

Summary

The results of the study indicate that a relationship exists between select input and environmental variables and Commercial Pilot Certificate attainment. These results indicate these variables may be utilized to predict flight times required for students enrolled in similar programs to complete Commercial Pilot training.

Conclusions and Discussion

Research Question 1: What is the relationship between collegiate aviation student input and outcome variables?

When examining the relationship between input variables and Commercial Pilot certificate attainment, none of the input variables were found to have a significant impact on the outcome. The lack of statistically significant input variables related to the attainment of the Commercial Pilot certificate presents an area for future research. Previous studies (Bjerke, 2009; Leonard, 2018) have indicated substantial student attrition from aviation programs early in their academic career, whereas Commercial Pilot training typically takes place in the Junior academic year at the institution studied. These findings suggest that these variables may have larger impact in earlier training courses, such as Private Pilot and Instrument Rating training. Students who are affected by these input variables may already have attrited from the program in the earlier training courses. With regards to High School GPA and ACT score, this is in keeping with previous literature on ongoing university achievement, which posits that these pre-college entry attributes affect performance less as students become more senior (Martin et al., 2013).

When examining the impact of input variables on both total aeronautical experience required to complete Commercial Pilot training and the hours of flight instruction received, gender was the only variable found to have a significant relationship. Results indicate women students require more hours of total aeronautical experience and flight instruction in the Commercial course. Aviation is a predominantly male industry, and the majority of the sample were men. A qualitative analysis, potentially examining flight training records, is an area of interest for further study to explain the gender difference. One possibility is difference of assertiveness between men and women flight students, where in Commercial training, assertiveness is viewed as a valuable characteristic for the Pilot-in-Command to possess. Flight training records are recorded by the flight instructor and provide rationale as to why a lesson is graded as unsatisfactory or must be repeated.

None of the input characteristics were determined to have a significant relationship with student performance on the final stage check. This result is not especially surprising, as a student is not endorsed to take the final stage check until their instructor deems the student is prepared and will pass. A lack of significance, here, may indicate these input characteristics do not play an important role in the instructor's decision-making in determining whether a student is prepared for the final stage check.

Research Question 2a: What is the relationship between collegiate aviation student environmental variables of academic involvement and outcome variables?

When looking at the relationship between academic involvement and Commercial Certificate attainment, the only variable found to have a significant relationship was Grade Point Average in aviation courses. It should be noted that performance on the second stage check did show a correlation with certificate attainment, it could not be included in the full analysis due to an insufficient number of students in the sample who attempted the stage check and failed to attain the Commercial Pilot certificate. These results indicate that student performance in aviation academic courses is important to collegiate aviation programs seeking to increase student success in Commercial training courses. Average academic credit load and student employment status were not found to have a significant relationship with completing Commercial Pilot training and attaining a certificate. As these variables have previously been associated with higher graduation rates among college students, the lack of significance here suggests there may exist some separation between flight training and traditional academic portions of collegiate aviation and different variables may influence flight training than those which influence academic success.

Credit load and performance on the stage two check were both significantly related to the total aeronautical experience required to complete Commercial Pilot training; however, credit load was the only significant predictor. The significance of credit load echoes previous findings in literature and suggests higher levels of student involvement are related to improved outcome measures. On the other hand, the lack of inclusion of some of the other measures of student involvement previously related to improved outcomes in the significant results, such as GPA and employment on campus or within the department, suggest flight training is sufficiently different from the traditional academic outcomes with which these have been previously associated. It is possible that academic involvement is not akin to involvement in flight and other variables need to be explored. For instance, a Commercial Pilot student employed within the aviation department is not employed as pilot, but as a student worker with responsibilities in administrative or flight crew dispatch areas. Similarly, not all aviation courses are related to flight, but may focus on other aspects of the aviation field such as airport operations, fixed base operators, aviation law, or corporate aviation structure, and performance in these courses may lack a relationship to flight training. Performance on the second stage check was identified as having a significant correlation with total aeronautical experience but was not a significant predictor in the final regression. These results may be explained by the structure of the training course. Although failure on the stage check requires remedial flight training, any additional flight training accomplished may be deducted from the amount of solo flight required to meet the minimum 120 hours of total aeronautical experience.

Both academic credit load and performance on the second stage check demonstrated significant relationships with flight instruction received. Similar to previous findings, students who maintained higher enrollment required fewer hours of flight instruction to complete the training course, although the effect is small. Results indicated each increase in average credit load per term resulted in 1.48 fewer hours of flight instruction required; an increase a single three credit hour course per term would therefore result in only 4.44 fewer instructional hours. Performance on the stage two check was correlated with the amount of flight instruction required to complete the commercial pilot training but was not a significant predictor of the total amount of training required in the final regression. While failure of the second stage check requires additional flight training, so too does failure of the final stage check, limiting the predictive ability of second stage check performance measures. This result, however, does suggest performance on the second stage check is not necessarily related to performance on the final stage check. The lack of significance of GPA and student employment are of interest as it was initially expected, based on previous literature, that a relationship would be present with these variables. Further study is recommended to determine if this is true for all levels of certification, which would indicate that variables related to traditional academic success differ from variables related to success in flight training.

No variables were determined to have a significant relationship with performance on the final stage check, as measured by the number of attempts required to pass the final check. These results indicate that performance on the first and second stage check are not predictive of final performance. This may be because a student who struggled with passing the first two stage checks has learned from those failures and is unlikely to repeat the same errors on the final stage check, or that the first two stage checks do not test student knowledge, skills, and abilities in a manner which is progressively leading to the performance required on the final stage check. As the first stage check focuses on instrument procedures which, while present on the final check, do not make up a large portion of the check, this case is likely; however, the second stage check details the same maneuvers which are present on the final stage check. A comparative content analysis would be beneficial in determining the reasons for the lack of relationship between stage checks.

Research Question 2b: What is the relationship between collegiate aviation student environmental variables of training disruption and outcome variables?

The presence of a training disruption during Commercial Pilot training was not found to be significantly related to whether a student attained their Commercial Pilot certificate, nor the total amount of aeronautical experience required; however, a relationship was determined on the amount of flight instruction required to complete Commercial Pilot training. Furthermore, when examined by number and type of disruption, students who experienced multiple training disruptions, on average, required approximately 11 more hours of instruction than other groups. On the other hand, students who experienced a single training disruption, did not demonstrate such a difference. Furthermore, students affected by the COVID-19 pandemic required approximately 8 more hours of instruction than those whose Commercial Pilot training was unaffected. With flight fees of approximately $200 an hour, these results signify a large increase in cost of $1,600 to $2,200. However, the lack of significant difference between the single disruption group and the group with no disruption indicate that students at the Commercial level of training display some resilience to quick onset of skill decay. As Commercial Pilot students have a significant amount of experience, it would be of interest to examine the impact of training disruption on more junior students to see if they demonstrate similar levels of resilience to the effects of short-term training disruption. Furthermore, as other levels of pilot training require less flight training time as a minimum, the impact of disruption on the total training time required may be greater than with Commercial Pilot students. Even though Commercial students demonstrated some resiliency to training disruptions, if life events necessitate multiple disruptions, plans should change incorporate the likelihood of increased training time and cost. To increase student throughput in training courses, collegiate aviation institutions should monitor flight scheduling for such disruptions and advise students appropriately. Further research is recommended at the Private Pilot and Instrument Rating training course level, as these less experienced pilots may not demonstrate the same resilience to disruption as more experienced Commercial Pilot students.

Research Question 3: Can you predict collegiate aviation student commercial pilot certificate attainment based on input and environmental variables?

Findings demonstrate GPA in aviation courses was the only predictor of Commercial Certificate attainment. No other variables were identified as significantly contributing to the model. The lack of significance for other input variables and environmental variables is contrary to previous literature on academic success. These results indicate that students engaged in Commercial Pilot training are not as impacted by these variables as students in previous studies, suggesting either flight training differs from traditional academic measures or that the large effect of these variables occurs earlier in flight training than the Commercial Certificate.

The mean enrolled credit load per academic quarter was determined as a significant predictor of the total aeronautical experience acquired completing Commercial Pilot training for the sample of collegiate aviation students. As mentioned above, the lack of significance among the other variables indicates a difference in Commercial Flight training to previously studied academic outcomes and is an area of further research.

When examining the impact of all variables previously identified as significantly related to flight instruction received, average credit load, gender, and performance on the second stage check were all identified as significant. Similar to previous research indicating increased academic involvement results in improved outcome for college students, an increase in average credit load resulted in a decreased amount of flight training required to complete the Commercial Pilot certificate; however, the effect was small. An increase of one three credit hour course per quarter would result in a reduction of flight instruction received of approximately 4.26 hours. As mentioned above, women required more flight instruction than men in the sample, indicating a gender difference in flight training. The inclusion of performance on the second stage check but not the first stage check as a significant predictor indicates that additional total aeronautical experience resulting from failure on the first stage check is primarily accomplished in the Aviation Training Device, a method other than flight instruction; however, remediation for a failed stage two check is accomplished primarily as flight instruction in the airplane. Importantly, flight instruction in airplanes is more costly to the student than other methods of training. Results of the analysis indicate students who pass the final stage check on the first attempt require approximately six fewer hours of flight instruction than students who pass on the second attempt. Although training disruption was identified as significantly relates to flight instruction required to complete the Commercial Pilot training course when examined as a lone variable, it was not a significant predictor when controlling for the effects of credit load, gender, and stage 2 check performance. One reason for this result is that not all training disruptions are equal in their effect on students. While this study was able to categorize training disruptions due to the COVID-19 pandemic, students may cease flight training for a multitude of reasons, such as taking a break during the Summer, military deployment, health, family matters, or financial reasons. During these disruptions, students may or may not continue enrollment in academic courses, affecting academic involvement. As before, no other input or environmental variables were determined to have a significant impact on flight instruction received, indicating Commercial Pilot training outcomes may require examination of variables different than those typically utilized for traditional academic outcomes.

Notably for collegiate aviation institutions, no significant impact on the outcome variables was determined based on whether a student attained their Private Pilot certificate at the institution or prior to attending the institution. Based on this result, students who enroll in a collegiate aviation program and already hold a Private Pilot certificate may complete the total flight training curriculum quicker than students who complete their Private Pilot training at the institution; however, further examination, specifically on Instrument Rating training is required.

Limitations

One limitation of this study was the selected sample. The population was limited to students who had completed or withdrawn from the Commercial Pilot training course at one collegiate aviation institution. Although accredited collegiate aviation institutions share similar standards, training courses differ among institutions. Furthermore, the institution studied implemented selective admissions during the sample period, resulting in a large portion of the sample holding high ACT score and High School GPA. The lack of students in the sample who attempted stage checks and withdrew from the Commercial Pilot training course prevented the inclusion of stage check performance in logistic regression analysis. Since the Commercial Pilot training program being studied is at a four-year, public institution, results may not be generalizable outside of this institution.

A second limitation was the due to combining data sources, which resulted in missing data. Parental education level and family income records were obtained through financial aid records and merged with flight and academic institution records. Financial aid records were only available if the student had completed a Free Application for Student Federal Aid (FAFSA). Furthermore, only ACT scores were provided to the researcher by the OIERP. While the ACT is the most common standardized test used for admission at the studied university, students who took other standardized tests had missing data. High School GPA information was also missing in academic institution records for some students in the sample. A possible category for submitted ethnicity information during the application process for students is “Prefer not to say,” which also resulted in missing data.

A further limitation to this study was the categorization of the flight training disruption variable. The researcher was able to examine flight records to determine which disruptions occurred as a result of the COVID-19 pandemic, but was unable to categorize training disruptions outside of this time period. Furthermore, some students experienced multiple training disruptions. The researcher was unable to ascertain whether students were attending academic courses during the time disruptions in flight training were experienced.

Recommendations

Implications for Astin’s Theory

Alexander Astin posited, with the Input-Environment-Outcome (I-E-O) model, that to fully asses an educational program required adjusting for input differences to produce a less biased estimate of the effect of the educational environment on outcomes (Astin, 1993; Astin & Antonio, 2012). The results appear to support Astin’s model but suggest that flight education may require evaluation of different input characteristics than are examined in other academic programs.

When looking specifically at input variables, none of the variables were found to influence the odds of attaining a Commercial Pilot Certificate. The study showed that variables which are traditionally used as selection criteria for academic programs, such as ACT score and

High School GPA may not be accurate predictors of training completion. However, student gender was shown to influence the amount of training time required.

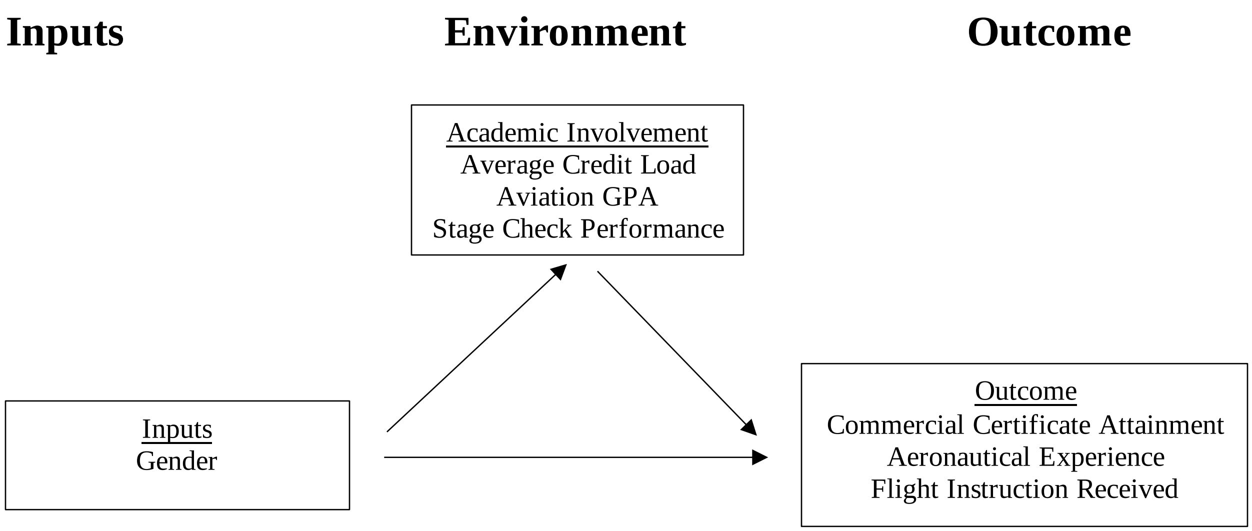

Figure 5. Significant Variables Discovered.

Examination of environmental variables demonstrated that student credit load during training, GPA in aviation courses, and stage check pass rate influenced student outcomes. While the only variable which impacted certificate attainment was aviation GPA, credit load and second stage check pass rate impacted training time required for students to accomplish the Commercial Pilot Certificate. Taken together, this indicates that students who maintain a high level of enrollment perform well while progressing through the flight training course are more likely to complete Commercial Pilot training in fewer hours.

This study adds to the existing literature by examining skill decay due to training disruption as a variable which might impact flight training outcomes. Although training disruption was not identified as a significant variable in the full model, analysis of the training disruption variable yielded results which suggest the impact of training disruption is dependent on the amount and nature of the disruption, highlighting an area for future study. Furthermore, it suggests flight training may require the examination of different variables than traditionally utilized for evaluating academic programs.

Implications for Collegiate Aviation Programs

Collegiate aviation programs have an interest in maximizing student success in flight training courses. Due to the expense to students and resource limitations these programs must attempt to minimize the training time required to complete the necessary certificates and ratings for graduation. The findings of this study suggest that ensuring students succeed on stage checks is vital to attaining a Commercial Pilot Certificate in the least amount of time. While not examined in the present study, the impact of the individual flight instructor on student progression through the training course is important. Programs should closely monitor stage check pass rates and reasons for failures among students. Instructors whose students demonstrate trends in stage check shortcomings should be provided with guidance on how to better prepare students for the stage checks. An appropriate method of providing feedback to all flight instructors on stage check trends should be implemented to increase stage check pass rates. As flight instructors depart the program and new ones are hired, new flight instructors should be trained to provide instruction on these commonly identified weaknesses.

Collegiate aviation programs may or may not have mandatory student advising prior to enrollment for each academic term. It is recommended, if not already in place, to implement regular advising sessions with students to better track and manage student progression through the program. Advisors within the program should encourage students to maintain full-time enrollment and attempt to avoid breaks in flight training. During advising sessions, academic advisors may encourage students to remain enrolled during the summer months as a means of maintaining higher levels of student academic involvement. As GPA in aviation courses was determined to have a significant relationship with completing the Commercial Pilot training course, advisors should take care during quarterly advising sessions when advising students into courses which are deemed as more difficult.

Analysis of the training disruption variable indicated students who experienced multiple disruptions required an increased amount of flight training to accomplish the Commercial Pilot certificate. Flight training scheduling software has many capabilities. Making use of the ability to track student progression and flag students who experience prolonged durations without a flight lesson should be implemented by collegiate aviation programs.

An examination of students affected by the COVID-19 pandemic demonstrated an increase in the amount of flight training required to complete the training course. While disruptions of this nature are unpredictable, some measures may be implemented to reduce the impact, even when flight instruction in a confined environment such as a light aircraft are not possible. Commercial students require a large amount of solo flight practice. If collegiate aviation programs are able to allow students to perform solo flights during these times when instructional flights are not possible due to risk of pathogen, the negative impact of the disruption may be minimized. Aviation Training Devices present another avenue to mitigate negative effects. Training devices are much less costly than airplanes to utilize and programs may be able to allow students to perform “refresher” activities during prolonged shutdowns.

Recommendations for Further Research

The premise of this research is to advocate Astin's I-E-O model can be used for improving student success in flight training in collegiate aviation programs. It is important that more research be conducted within the discipline of collegiate aviation. This research should examine not only academic outcomes and variables, but variables specific to flight training as it is believed that other variables could influence student progression through flight training courses. Several potential variables lie in flight instructor characteristics. This study did not examine the amount of experience or other variables possessed by the flight instructors providing the training. It is possible that the instructor has great impact on the students success in completing flight training in a low amount of time.

Further research should also be conducted at different training course levels. Although some variables were identified as significant to Commercial Pilot training outcomes, these variables may have differing effects at other levels of flight training, specifically at earlier stages of the aviation program, where High School academic achievement may affect student performance at the university level to a larger degree. Students with less experience may also be less resilient and more susceptible to skill decay as a result of short time-interval training disruptions.

Research may also be conducted at other collegiate aviation institutions to improve generalizability. While commonalities exist among collegiate aviation programs, they are not identical. Universities vary as to entry requirements, and different locations experience different overall weather patterns, which also affect flight training. Expanding this research to other institutions is required to determine if results hold true to other programs.

As a quantitative study, this research was limited in its ability to attribute rationale to results, specifically the result regarding gender differences. Further examination of gender differences in flight training is required. Gender was determined as having significant impact on total aeronautical experience and flight instruction received. To answer why this is the case, further research utilizing a qualitative approach is required.

Summary

The purpose of this study was to utilize traditional academic measures together with flight training variables to examine the impact on Commercial Pilot certificate attainment utilizing Astin's I-E-O model. It was found that select variables can predict measures of Commercial Pilot Certificate attainment; however, additional research is recommended to increase generalizability of these findings and determine other significant predictors.

The results of this study highlight further avenues of research in collegiate aviation flight training. Several recommendations for collegiate aviation institutions were provided to increase student success in flight training and reduce training time and cost. This is a current area of emphasis in collegiate aviation due to the growth of the aviation industry in the recovery from the COVID-19 pandemic.

By applying Astin's I-E-O model to flight training and using flight-specific variables, collegiate aviation programs may determine factors which influence student success. Through expanding research and discussion to include flight training variables, together with traditional academic variables, flight training institutions may become better equipped to provide effective and efficient training and reduce training costs, increasing both program and student success.

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