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EFFECTIVENESS OF NAVAL INTRODUCTORY FLIGHT EVALUATION (NIFE)

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THESIS

EFFECTIVENESS OF NAVAL INTRODUCTORY FLIGHT EVALUATION (NIFE)

by

Christopher T. Lambert

September 2022

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The naval aviation training pipeline was modified in 2020 so that the first training phase is now the Naval Introductory Flight Evaluation (NIFE). Designed to reduce attrition and improve performance in the next phase of flight training, Primary, NIFE replaces the previous initial training phases, Introductory Flight Screening and Aviation Pre-flight Indoctrination. This research conducts statistical analysis on data from over 4,500 students to assess NIFE's effectiveness and verify whether it is reducing attrition and improving performance in Primary. The results indicate that NIFE largely accomplished its program goals. The Chief of Naval Air Training should retain NIFE in its current form. Further analyses into NIFE's impacts should account for the potential training decay effects and time-varying confounding. Additionally, a future cost benefit analysis of NIFE will provide further context to the results of this study and help decision makers assess the value of the NIFE program.

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EFFECTIVENESS OF NAVAL INTRODUCTORY FLIGHT EVALUATION (NIFE)

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

The naval aviation training pipeline was modified in 2020 so that the first training phase is now the Naval Introductory Flight Evaluation (NIFE). Designed to reduce attrition and improve performance in the next phase of flight training, Primary, NIFE replaces the previous initial training phases, Introductory Flight Screening and Aviation Pre-flight Indoctrination. This research conducts statistical analysis on data from over 4,500 students to assess NIFE's effectiveness and verify whether it is reducing attrition and improving performance in Primary. The results indicate that NIFE largely accomplished its program goals. The Chief of Naval Air Training should retain NIFE in its current form. Further analyses into NIFE's impacts should account for the potential training decay effects and time-varying confounding. Additionally, a future cost benefit analysis of NIFE will provide further context to the results of this study and help decision makers assess the value of the NIFE program.

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LIST OF ACRONYMS AND ABBREVIATIONS

API	Aviation Pre-flight Indoctrination
ASTB	Aviation Selection Test Battery
BAW	Basic Air Work
CFR	Code of Federal Regulations
CNATRA	Chief of Naval Air Training
CTS	Course Training Standards
FAA	Federal Aviation Administration
GPA	Grade Point Average
IFS	Introductory Flight Screening
IP	Instructor Pilot
JPPT	Joint Primary Pilot Training
MCG	Master Curriculum Guide
MIF	Maneuver Item File
NASC	Naval Aviation Schools Command
NATN	Naval Aviation Training Next
NFO	Naval Flight Officer
NFS	Naval Flight Student
OCS	Officer Candidate School
ROTC	Reserve Officers' Training Corps
SNA	Student Naval Aviator
USNA	United States Naval Academy
VFR	Visual Flight Rules

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EXECUTIVE SUMMARY

Background

In August 2020, the U.S. Navy introduced the Naval Introductory Flight Evaluation (NIFE) program as its new initial flight school phase. NIFE consolidates and replaces Introductory Flight Screening (IFS) and Aviation Pre-flight Indoctrination (API), programs that existed for decades (Owens 2020). This change comes amidst a series of major syllabus revisions under the Naval Aviation Training Next (NATN) initiative, and the transition to NIFE represents the first step in the Navy's modernization effort to train aviators more efficiently (Mishler et al. 2022).

NIFE's intended contribution to increasing aviation training efficiency manifests in the next phase of flight school, *Primary*. As stated in its course mission, "NIFE is designed to…decrease drop on request (DOR) and flight attrition and improve performance in Primary flight training (Chief of Naval Air Training [CNATRA] 2020). DOR attrition refers to students who choose to discontinue flight training, and flight attrition refers to students who are eliminated from the aviation pipeline due to inadequate flying performance (CNATRA 2019).

Although NIFE ostensibly reduces DOR and flight attrition and improves performance in Primary, the operational outcomes of NIFE have not yet been analyzed. This study focuses on two research questions to provide insight into NIFE's effectiveness:

- Compared to the legacy training programs (IFS and API), is NIFE associated with reduced attrition rates and earlier attrition timing in Primary flight training?
- Compared to the legacy training programs (IFS and API), does NIFE produce aviators that perform better in Primary flight training?

Within the scope of these two research questions, this study also analyzes NIFE's impact on historically disadvantaged students, to include female and minority students.

Key Findings

CNATRA and Naval Aviation Schools Command (NASC) provided data on over 4,500 Student Naval Aviators (SNA). This data was analyzed using standard statistical methods. The results are organized in three categories: attrition analysis, performance analysis, and NIFE's impact on female and minority students.

1. Attrition Analysis

NIFE completers were significantly less likely to attrite from Primary compared to IFS/API completers. The Primary attrition rate was reduced from 6.9% for IFS/API completers to 3.7% for NIFE completers. Both Primary DOR and flight attrition rates were significantly lower for NIFE completers than for IFS/API completers. Additionally, the screening rate of NIFE was significantly greater than the screening rate of IFS, increasing from 1.2% for IFS to 1.8% for NIFE. Higher screening rates in NIFE in combination with lower Primary attrition rates for NIFE completers indicate that NIFE is likely improving efficiency in the naval aviation training pipeline by removing would-be attriters before they enter Primary.

Another naval aviation training efficiency improvement lies in NIFE's impact on the T-6B flight hours among attriters. Primary attriters who completed NIFE attrited with significantly less flight hours than those who completed IFS/API. The effect was more pronounced for Primary DOR attriters. Primary DOR and flight attrition occurred significantly earlier in the primary syllabus for NIFE completers compared to IFS/API completers, as measured by T-6B hours flown.

2. Performance Analysis

NIFE completers completed the Primary syllabus in less flight hours than IFS/API completers: NIFE completers averaged 71.0 T-6B flight hours to complete Primary, while IFS/API completers averaged 77.2 T-6B flight hours. This result shows that NIFE completers were able to complete all Primary syllabus requirements more efficiently in terms of flight time.

In terms of overall raw score, NIFE completers performed significantly better than IFS/API completers. Over 65% of NIFE completers scored higher than the mean score of

IFS/API completers for overall raw score. NIFE completers outperformed IFS/API completers in ten out of the eleven Primary events designated as check rides or exams. The consistency with which NIFE completers scored higher on these exams and check flight events compared to IFS/API completers demonstrates NIFE's broad positive impact on performance throughout the course of Primary. The training students received during NIFE likely allowed them to perform at a higher level in Primary.

3. NIFE's Impact on Female and Minority Students

Among minority students, overall Primary attrition rate was significantly lower for NIFE completers compared to IFS/API completers. Additionally, among female students, overall Primary attrition rate was also significantly lower for NIFE completers compared to IFS/API completers. These results suggest that NIFE had a positive impact on the retention of historically disadvantaged students.

Among IFS/API completers, a significant difference exists in the mid-phase contact check flight and the final contact check flight scores between minority and white students. This significant difference also exists between female and male students. These results indicate that a performance gap exists for minority and female students. However, among NIFE completers, no significant difference was detected in mid-phase contact check flight and final contact check flight scores between minority and white students and female and male students. Therefore, it appears that NIFE has ameliorated the performance gap for historically disadvantaged students.

Recommendations for Further Research

1. Address Time-Varying Confounding

Because students who completed NIFE did so in a different time period than students who completed IFS/API, time is a confounding variable in this study. To investigate the potential effects of time on attrition metrics and performance metrics discussed in this study, future research should examine short-term and long-term trends for these metrics.

2. Address Training Decay

Conventional wisdom within the aviation community holds that if new student pilots do not use their skills for an extended period, these skills will perish, resulting in training decay (Semmens 2021). The results of this study indicate that NIFE confers a training advantage, but this training advantage may be lost if enough time elapses before a student begins Primary. Further research should analyze whether a correlation exists between attrition and performance metrics and wait time after NIFE.

3. Perform a Cost Benefit Analysis of NIFE

Many of the results of this study are useful for completing a cost benefit analysis of the NIFE program. Determining the net monetary value of the NIFE program informs future decision makers. If NIFE found to be not cost effective, leadership at CNATRA and NIFE can respond by investigating how to improve the NIFE program.

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I. INTRODUCTION

In August 2020, the U.S. Navy introduced the Naval Introductory Flight Evaluation (NIFE) program as its new initial flight school phase. NIFE consolidates and replaces Introductory Flight Screening (IFS) and Aviation Pre-flight Indoctrination (API), programs that existed for decades (Owens 2020). This change comes amidst a series of major syllabus revisions under the Naval Aviation Training Next (NATN) initiative, and the transition to NIFE represents the first step in the Navy's modernization effort to train aviators more efficiently (Mishler et al. 2022).

NIFE's intended contribution to increasing aviation training efficiency manifests in the next phase of flight school, *Primary*. As stated in its course mission, "NIFE is designed to…decrease drop on request (DOR) and flight attrition and improve performance in Primary flight training (Chief of Naval Air Training [CNATRA] 2020). DOR attrition refers to students who choose to discontinue flight training, and flight attrition refers to students who are eliminated from the aviation pipeline due to inadequate flying performance (CNATRA 2019). The NIFE program's ability to generate desirable outcomes in Primary have short-term and long-term impacts. In the short-term, reducing attrition and improving performance in Primary can result in cost-savings for the Navy and increased production of naval aviators, which is critical in addressing the current pilot shortage (Mishler et al. 2022). In the long-term, NIFE's benefits to student performance can better prepare future flight students for the more sophisticated and challenging training phases that will result from NATN (Owens 2020).

A. RESEARCH QUESTIONS

Although NIFE ostensibly reduces DOR and flight attrition and improves performance in Primary, the operational outcomes of NIFE have not yet been analyzed. This study focuses on two research questions to provide insight into NIFE's effectiveness:

- Compared to the legacy training programs (IFS and API), is NIFE associated with reduced attrition rates and earlier attrition timing in Primary flight training?

- Compared to the legacy training programs (IFS and API), does NIFE produce aviators that perform better in Primary flight training?

The metrics used to address these questions are described in detail in Chapter III.

B. BACKGROUND

1. Overview of Naval Flight School

Naval flight school trains naval aviators (also known as pilots) and Naval Flight Officers (NFOs). NFOs are mission specialists who perform their duties aboard an aircraft. The scope of this study is limited to Student Naval Aviators (SNAs).

Two organizations control naval flight school, Naval Aviation Schools Command (NASC) and Chief of Naval Air Training (CNATRA). NASC oversees NIFE (IFS/API prior to the transition), while CNATRA conducts all other training in flight school (Morrelli). Completing flight school takes over two years, and upon completion, SNAs earn their "Wings of Gold," becoming designated naval aviators. In 2021, over 1,100 students graduated flight school (CNATRA n.d.).

a. Student Naval Aviators

SNAs are primarily officers in the U.S. Navy, U.S. Marine Corps, and U.S. Coast Guard. Nearly all these officers are newly commissioned from either the Naval Reserve Officer Training Corps (NROTC), the United States Naval Academy (USNA), or Officer Candidate School (OCS). The Navy selects SNAs based on factors including performance within the commissioning program, college grade point average (GPA), Aviation Selection Test Battery (ASTB) scores, and successful completion of a flight physical medical examination. A limited number of international students from countries including France, Spain, the United Kingdom, and Saudi Arabia also participate in flight school.

b. Pipeline

Naval flight school currently consists of four phases: NIFE, Primary Flight Training, Intermediate Flight Training, and Advanced Flight Training (Training Air Wing Four n.d.). All SNAs complete the same syllabus in NIFE and Primary. After Primary, SNAs are selected into different training pipelines based on service needs, student performance, student preference, and Commanding Officer (CO) recommendation. These pipelines determine which operational aircraft an SNA will fly after completion of flight school. A visual representation of the training progression is provided in Figure 1.

The following format is used to describe each pipeline after Primary: Intermediate/ Advanced [name of pipeline] [aircraft flown during that phase]. The boxes on the far right indicate which operational aircraft each pipeline will deliver.

Figure 1. Current Naval Flight School Training Progression. Source: CNATRA (n.d.).

Prior to the inception of NIFE, all SNAs completed IFS and API in the legacy training progression. This legacy training progression is provided in Figure 2.

Figure 2. Legacy Naval Flight School Training Progression. Source: Naval Audit Service (2010).

2. IFS and NIFE History

Initial Flight Screening (IFS) was introduced in 2003 to reduce DOR and flight attrition in Primary by giving naval flight students more exposure to flying before entering API (Naval Audit Service 2010, Enclosure 2, Page 1). This early exposure to flying was designed to ensure that only students with the skills and attributes necessary for successful completion of Primary would enter the training pipeline (Naval Audit Service 2010, Enclosure 2, Page 1). The program underwent several major revisions; this thesis will only discuss the final version of IFS. Students in IFS flew the Cessna 172, a small general aviation aircraft. IFS culminated in a solo flight after 13.5 hours of flight time (Naval Audit Service, Appendix B, Page 1).

One of the main problems with IFS was the lack of standardization across the program (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022). IFS utilized a vendor system, where training took place at pre-existing local civilian flight schools in the Pensacola area. These flight schools trained according to 14 CFR part 141, which necessitates an FAA-approved flight training syllabus (in contrast, flight schools operating under 14 CFR part 61 have more flexibility and autonomy in how they train pilots). Although 14 CFR part 141 programs are structured, there can still be considerable variation in how the training material is delivered. Since the civilian flight schools used for

IFS were all separate companies, there existed cultural differences that may have impacted the type of training received by the student. The civilian instructors administering the training were not bound to the same regulations or standards as military instructors. Therefore, students' learning experiences in IFS were dependent on the flight school and the instructor and thus may have varied significantly (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022).

The other issue with IFS was its lack of consistency with the rest of naval aviation training (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022). The 14 CFR part 141 programs used in IFS are designed for civilian students pursuing civilian ratings. Some of the standards and procedures outlined in 14 CFR part 141 are different from naval aviation standards and procedures. For example, students in 14 CFR part 141 fly the "box" landing pattern while naval aviation flies the racetrack landing pattern (CNATRA 2020, IV-1). In addition, students in IFS did not brief or debrief flights in the same manner as required in all future naval flying. When students reported to Primary, they had to relearn how to conduct operations as naval aviators. If the Navy's initial flight training incorporated military standards and procedures from the beginning, this needless relearning is avoided.

To remedy these issues, Naval Aviation Schools Command (NASC) created the NIFE program to replace IFS. NIFE provides flight training through contractors instead of vendors to address the lack of standardization and consistency within IFS (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022). By switching to contractors, NASC now has more oversight on how flight training is conducted: instead of training to 14 CFR part 141 standards, the contractor flight school trains to military standards as outlined in the Master Curriculum Guide (MCG) for NIFE. The MCG explicitly states that part of the course mission is to "introduce students to military procedural-based aviation training and performance standards" (CNATRA 2020, v). While civilian flight instructors still conduct the majority of flight training, the check-ride in NIFE must be conducted by a military instructor pilot (IP) as stated in the MCG. Military IPs enables quality control by ensuring students are performing to the military course training standards (CTS) during check-rides. NIFE also incorporates Navy Air Training and Operating Procedures

Standardization (NATOPS), which is the standard used throughout the rest of naval flight training (Owens 2020).

3. NIFE Curriculum

NIFE is divided into two phases: NIFE 1, ground training, and NIFE 2, initial flight training. NIFE 1 is conducted over six and a half weeks and includes academic coursework in aviation topics such as aerodynamics, air engines, flight rules and regulations, weather, and air navigation. Students must manage a fast pace of instruction; within three weeks, they must pass eight graded exams on these aviation topics (CNATRA 2020). Water and land survival training are also covered in hands-on courses.

NIFE 2, conducted over two weeks, consists of initial flight support and initial flight training. Initial flight support includes six hours of instruction in preflight procedures and the proper use of in-flight flows, checklists, and procedures. Initial flight training includes 9.1 flight hours over seven flights for contact training. Contact training in NIFE encompasses day flight familiarization and procedures (CNATRA 2020).

NIFE was originally meant to culminate in a solo flight as IFS did, but to reduce cost, the program culminates in a check-flight after less flying hours. NIFE was revised to replace API in addition to IFS in another cost-saving and streamlining measure. NIFE 1 is the direct replacement of API and NIFE 2 is the direct replacement of IFS. In NIFE 1, ground school was shortened from four weeks in API to three weeks. All original topics of study are still covered, but details were removed to facilitate the shorter timeline (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022).

IFS originally preceded API (see Figure 2) but in NIFE, the IFS replacement (NIFE 2) now follows the API replacement (NIFE 1). This new order is designed to give students a broader base of aviation knowledge before beginning flight operations. The order also reduces the time between students' introductory flying experience and the more complex flying they will be doing in Primary. Under the previous schedule, some students spent over six months between IFS and Primary. Since flying is widely considered a perishable skill, once a student starts flying, it is crucial to continue training without any significant time gaps (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022).

4. Primary Curriculum

Primary flight training consists of a ground training phase and the following four flying stages, each encompassing a specific flight training regime: Contact, Instrument, Navigation, and Formation (CNATRA 2017, I-1). Contact training includes day and night flight familiarization, aerobatic maneuvers, and out-of-control flight procedures (CNATRA 2017, xix). Instrument training teaches students how to fly the aircraft by reference to only instruments for operation in instrument meteorological conditions. Navigation training includes mission planning and cross-country flying in both day and night visual flight rules (VFR). Formation training teaches students how to fly in close proximity to other aircraft to maintain a formation (CNATRA 2017).

Each stage is further divided into training blocks, which contain a specified number of flights (CNATRA 2017, I-1). These flights are also known as *events*, and all events are coded according to the following format in Table 1 (CNATRA 2017, xxi).

Table 1. Lesson Designator Key. Source: CNATRA (2017).

Char	Meaning	Remarks
1st–2nd	Stage	C—Contact F—Formation G—Ground I—Instrument IN—Inst Flt Support N—Navigation SY—Systems NA—Nav Flt Support PR—Operating Procedures
3rd	Media	0—Ground Training 1—Flight Support 2—T-6B UTD 3—T-6B OFT 4—T-6B
4th	Block	Sequential, indicating block within stage.
5th & 6th	Event/Check Identifier	Sequential, indicating event within block, or other event types as shown below: 84—Adaptation 85—Practice Sim 86—Warmup 87—Extra Training 88—Initial Progress Check 89—Final Progress Check 90—Check Flight/Exam

Training in Primary is conducted through five different forms of media: ground training, flight support, Unit Training Device (UTD), Operational Flight Trainer (OFT), and the T-6B aircraft (CNATRA 2017). Ground training is administered through a combination of traditional classroom lectures, computer aided instruction (computer-based lessons completed independently by the student), and training devices including a static simulator and a Flight Management System trainer. Flight support refers to ground-based training that utilizes these same methods of instruction but for information directly related to an upcoming flight lesson. UTDs are fully functional T-6B simulators with no surrounding visuals, whereas OFTs are fully functional T-6B simulators with wrap-around outside visuals. Ground-based instruction and simulators are utilized prior to every event conducted in the T-6B aircraft (CNATRA 2017).

Figure 3 illustrates the course flow through Primary for UTD, OFT, and T-6B events. After the Contact Solo Flight, labeled C4501 in Figure 3, multiple sequences for the remaining flight/device events exist; if all prerequisites for an event are met, then the student is eligible to complete that event. The complete course flow chart referenced in the legend of Figure 3 is available in Appendix A.

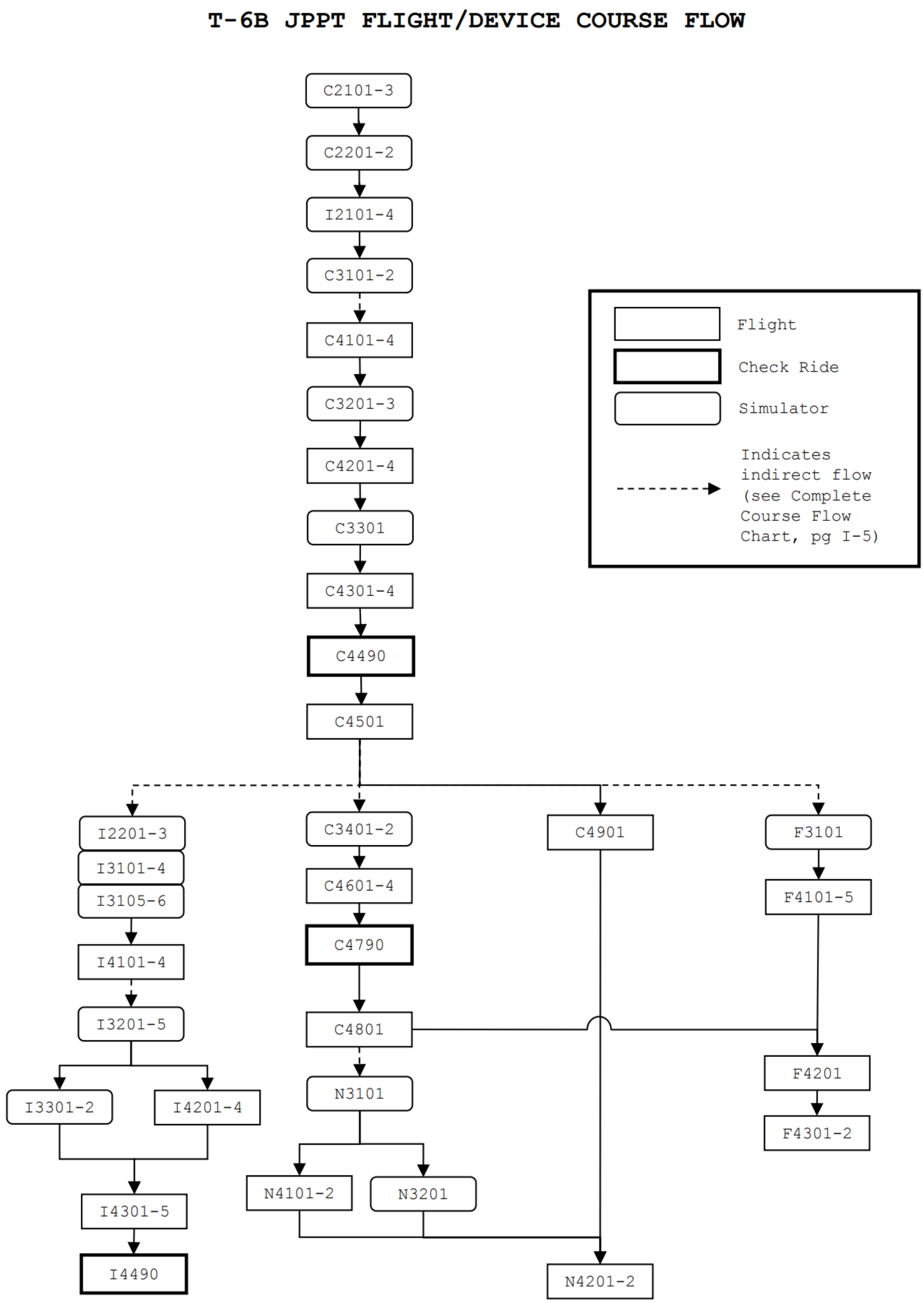

Figure 3. Primary Flight/Device Course Flow. Source: CNATRA (2017).

5. Theoretical Impact of NIFE on Primary

This section discusses the theoretical impact of NIFE of three aspects of Primary: DOR attrition, flight attrition, and performance.

a. Impact on DOR Attrition in Primary

NIFE aims to reduce the Primary DOR attrition rate. DOR is usually caused by a student's lack of motivation towards naval aviation (CNATRA 2019). Therefore, one method to reduce the rate of DOR attrition in Primary is to increase the motivation towards naval aviation in students who are considering DOR. If the training in NIFE is able to provide a motivational boost to these students, then the NIFE program can act as a preventative measure against DOR attrition. This mechanism reduces Primary DOR attrition through increased retention of students.

Alternatively, the reduction of Primary DOR attrition can be achieved through increased flight screening of students. Flight screening is the process where students are removed from the training pipeline in an early phase to avoid attrition in later phases (Morrison 2006). Effective screening improves the efficiency of the training pipeline. Students that would have attrited in Primary are instead screened during NIFE, thus reducing lost training costs and opening slots in Primary for other students who are more likely to succeed. If this is the mechanism by which NIFE reduces Primary DOR attrition, the decrease in Primary attrition rate shall be accompanied by an increase in the pre-Primary attrition rate, also known as the *screening rate*.

According to Morelli and Hoyt, the latter mechanism is more likely how NIFE operates (personal communication, March 2, 2022). NIFE is designed to give students early exposure to naval aviation operations, which should theoretically allow future attriters to discover their desire to DOR sooner in training. The sooner a student is exposed to naval aviation operations, the more opportunity provided for that student to determine their attitudes towards naval aviation.

This theory suggests that DOR attrition is a slow process whereby a student gradually discovers their desire to attrite as they gain more experience in naval aviation. If this is the case, then analysis of Primary attrition timing can provide additional insight that analysis of Primary attrition rate and screening rate fail to capture. For example, consider two students: the first is a Primary DOR attriter who completed IFS/API, and the second is a Primary DOR attriter who completed NIFE. Ideally, both students would have been screened before entering Primary. However, given that the attriters began Primary, the next most efficient outcome is for these students to attrite as soon as possible. If NIFE training confers a quicker understanding of what it means to be a naval aviator (as compared to IFS/API training), then those students who are not motivated to become naval aviators can realize this sooner and thus DOR earlier in Primary. Analysis of Primary DOR attrition timing can detect this theorized positive effect of NIFE.

b. Impact on Flight Attrition in Primary

The theoretical impact of NIFE on Primary flight attrition is closely related to Primary DOR attrition. Again, analysis of attrition rate, screening rate, and attrition timing will provide key insights on NIFE's impacts. While DOR attrition is student-initiated, flight attrition is instructor-initiated. Flight attrition is due to sustained substandard flight performance (CNATRA 2019). Therefore, if NIFE aims to reduce flight attrition, it must prevent poor flight performance to a higher extent than IFS/API.

As with reducing Primary DOR attrition, reducing Primary flight attrition is a matter of either increased screening or increased retention. The mechanism by which increased screening reduces Primary flight attrition is the same as for Primary DOR attrition: students who would have attrited in Primary are instead attrited before Primary. However, unlike for Primary DOR attrition, increased screening is not thought to be the primary mechanism by which NIFE reduces Primary flight attrition. The flying in NIFE is not designed to be overly challenging or strenuous. Instead, the flying in NIFE is meant to give students early exposure to piloting in a less complex, easier to handle plane than the T-6B. This flying exposure should produce students who are better prepared for the flying in Primary.

In the context of flight attrition, increased retention is accomplished by better preparation of students for flying in Primary. Better preparation will likely not only prevent poor flight performance in struggling students, but also broadly improve flight performance across the entire student body. These effects are further discussed in the following section about performance analysis.

c. Impact on Performance in Primary

According to the NIFE Master Curriculum Guide (MCG), one of NIFE's course missions is to improve student performance in Primary. NIFE aims to better prepare students for naval aviation operations by introducing naval aviation concepts and standards as soon as students begin flying (CNATRA 2020). In particular, NIFE emphasizes headwork (also known as situational awareness), procedures, and Basic Air Work (BAW). NIFE is designed to build a strong foundation in these areas, each of which has a specific meaning in the context of naval flight training. CNATRA defines these three terms:

> a. Headwork. The ability to understand and grasp the meaning of instructions, demonstrations, and explanations; the faculty of remembering instructions from event to event; the ability to plan a series or sequence of maneuvers or actions; the ability to anticipate and avoid possible difficulties; and the ability to plan and execute alternative options.
>
> b. Procedures. The demonstrated knowledge of sequential actions which are required to perform curriculum maneuvers and actions during the brief, flight, or debrief, and the ability to recall and execute these sequential actions.
>
> c. Basic Air Work (BAW). The demonstrated technique and mastery of the power and flight controls to consistently obtain the desired attitude, altitude, heading, and airspeed through a range of maneuvers. (CNATRA 2017, 6–3)

These three concepts comprise the foundation of naval flying, and each skill is graded as a "maneuver" in nearly every event in the Primary syllabus.

Although headwork, procedures, and BAW are graded in every event, we expect the largest performance difference between NIFE completers and IFS/API completers in the headwork, procedures, and BAW grades to occur in the Contact stage. This is because those who completed IFS/API will not possess the same degree of foundational understanding as those who completed NIFE. Additionally, a student who has a firm grasp on these three concepts should theoretically also perform better on other graded maneuvers (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022). While NIFE potentially has a broadly beneficial effect on all aspects of a student's performance in Primary, the effect is theoretically most pronounced during the beginning of Primary in the Contact stage. The largest improvement is expected to occur in Primary's Contact stage for two reasons.

First, NIFE focuses on day Contact training, which directly corresponds to initial flying done in Primary's Contact stage (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022). NIFE provides students a preview of what they will learn in Primary. Conducting day contact training in a Cessna 172 before doing the same in a T-6B represents a progression of flying skills. The Cessna 172 is commonly used in civilian initial flight training, while the T-6B is a complex, high performance aircraft that would require additional training endorsements to operate in the civilian world.

Second, by later stages of Primary, students who did not complete NIFE (IFS/API completers) will have already learned the skills NIFE was designed to impart. Students that did not complete NIFE will be familiar with these concepts by later stages of Primary, so NIFE training no longer provides an advantage relative to those who did not complete NIFE; everyone will possess a similar level of familiarity in these areas (Edward Morelli and Mason Hoyt, personal communication, March 2, 2022).

C. OVERVIEW OF THESIS

The remainder of this thesis is organized in the following chapters:

Chapter II presents existing research and analyses related to this thesis' research questions. U.S. Air Force studies on flight screening programs, a Naval Postgraduate School thesis on the effectiveness of IFS, and a naval audit on IFS are evaluated. The literature review establishes the context for this research, as well as the originality and necessity of this study's research objectives.

Chapter III presents the research methodology used to investigate the research questions. The datasets are explained with descriptions of the relevant variables in the data. Then, the statistical analysis methods used to analyze the data are described.

The results of the statistical analysis are presented in Chapter IV. This thesis uses the APA style of reporting outcomes of statistical analyses. Plots and tables are included where applicable to enable the reader to visualize the data. Chapter IV concludes with a summary table of key results.

Chapter V begins with a discussion of the results presented in Chapter IV. The discussion focuses on key findings. Areas of further study are then proposed, and each recommendation is described in enough detail to guide future researchers. The thesis concludes with a brief summary of the study.

II. LITERATURE REVIEW

The objective of this thesis is to evaluate the effectiveness of NIFE in terms of its impact on attrition rates and performance scores in Primary. Other researchers have also evaluated the effectiveness of flight screening programs within military pilot training. In this literature review, studies on both USAF and USN flight screening programs are discussed to identify how these flight screening programs impact aviator performance and attrition rates in later phases of flight training. Although researchers within the Navy are currently examining larger flight training curriculum changes such as Project Avenger, there has not yet been an effort to examine NIFE.

A. AIR FORCE STUDIES ON FLIGHT SCREENING

Flight screening in military pilot training began in 1952 with the implementation of the USAF's Revitalized Pilot Training Program, designed to reduce attrition rates (Hussey 2004, iii). At the time, the purpose of flight screening in light planes was to eliminate students who exhibited insurmountable fear of flying, incurable air sickness, or lack of motivation. Flight screening in light planes allowed the Air Force to detect aviation cadets and officers not suited for flight training at a significantly lower operating cost compared to the trainers used in later phases of pilot training (Hussey 2004).

In 1956, President Dwight Eisenhower signed Public Law 879 which authorized the Air Force to give flight instruction in light planes to senior cadets in the Air Force Reserve Officer Training Corps (AFROTC). AFROTC is a training program at colleges and universities across the U.S. that produces commissioned officers for the Air Force, some of whom become pilots. The Air Force implemented concepts from the light plane screening in the Revitalized Pilot Training Program of 1952 to create the Flight Instruction Program (FIP) to identify those not suited for flight training even earlier in the process of producing a pilot: instead of screening those already selected for pilot training, FIP screened pilot applicants (Hussey 2004). The Air Force provided contracts to colleges and universities which then contracted local private flight schools with Civil Aeronautics

Administration (the predecessor to the Federal Aviation Administration (FAA)) approved flight training curriculums (Hussey 2004).

The Air Force's Air Training Command (ATC) studied the effect of FIP completion on primary flight training attrition in 1958 (Miller 1966). Because not every AFROTC unit was based at a college or university that offered FIP, the program was not mandated for AFROTC graduates (Miller 1966). In addition, FIP was not offered to officers from the other commissioning sources (US Air Force Academy and Officer Training School). As a result, ATC could calculate the primary attrition rates among three groups that completed primary flight training at the same time. They found primary attrition rates of 6.3% among 380 FIP completers, 24.7% among 1,012 non-FIP AFROTC graduates, and 18.5% among 1,125 other pilot candidates. Based on the comparison of these attrition rates, ATC concluded that FIP was an effective means to reduce primary flying attrition (Miller 1966). However, a more in-depth statistical analysis should have been conducted to support this claim. Although the FIP completers demonstrated the lowest primary attrition rate, this does not guarantee that FIP was effectively reducing the primary attrition rate.

Stoker et al. from the Air Force Human Resources Laboratory conducted a more rigorous analysis of the effectiveness of flight screening in 1987. By then, FIP had been replaced by the Flight Screening Program (FSP), which was required for all pilot candidates without a civilian Private Pilot's License. FSP consisted of 14 hours of instruction in the T-41 (the military equivalent to a Cessna 172F, a light piston-engine aircraft) and culminated in a Final Evaluation Flight in which an instructor assessed the student's basic flying skills and determined whether they were fit to proceed to the rest of pilot training, referred to as Undergraduate Pilot Training (UPT). Stoker et al. used the following questions to guide their research:

- Does the FSP have any effect on UPT attrition rates?
- If the FSP does affect attrition rates, is the effect from screening, training, or both?
- If the effect is from screening, does it screen by elimination for flying training deficiency (FTD) or by self-initiated elimination (SIE), or both?

- Does the FSP confer a flight training and/or experience benefit?

- If there is a training/experience effect, would a longer program of FSP flying significantly increase the training/experience benefit?

- How are lesson grades received in the FSP related to success or failure in UPT? Would a shorter FSP provide adequate prediction of UPT results (Stoker et al. 1987)?

Instead of only examining the relationship between FSP completion and attrition rates in UPT, Stoker et al. sought to also determine whether the training or screening aspects of FSP was responsible for the impact on attrition rates. Additionally, Stoker et al. explored the implications of a longer or shorter FSP.

The subjects in this experiment were given five different treatments:

- Group I: No FSP participation

- Group II: Extended FSP (flight hours increased from 14 hours to 20 hours)

- Group III: Normal FSP

- Group IV: Normal FSP, but allowed to progress to UPT regardless of performance

- Group V (sub-group of Group IV): FSP failures due to FTD (Stoker et al. 1987)

The researchers made comparisons between these groups to draw conclusions for their research questions. To determine the effect of FSP on UPT attrition, Group I and Group III attrition rates in the T-37 phase as well as the entirety of UPT were compared. Stoker et al. (1987) found that “students who had been through FSP had lower attrition rates in the T-37 phase and overall UPT for both FTD and all other reasons” (4). However, these lower attrition rates could either be attributed to FSP’s ability to effectively screen potential UPT failures or FSP’s value as additional flying training and experience. A comparison of Group V, the FSP failures allowed to continue training, and the FSP graduates from Group IV showed that the FSP failures showed significantly higher overall FTD attrition rates during the T-37 phase. This higher attrition rate among FSP failures suggests that FSP is effectively screening those who are more likely to attrite from UPT due to FTD (Stoker et al. 1987).

B. NAVY STUDIES ON IFS

Stoker et al. found that successful completion of FSP resulted in lower attrition rates during the next phase of flight training, and Morrison's 2006 study examining the effectiveness of the Navy's IFS program drew a similar conclusion. Morrison (2006) obtained data on 2112 naval flight students who completed Primary between October 2001 and September 2004. Among these students, 1283 did not complete IFS and 790 completed IFS. A comparison of the FF (flight failure, equivalent to the Air Force's FTD) attrition rates between the IFS and non-IFS groups showed a significant difference at the 95% confidence level, with the IFS completers' Primary FF rate 1.58% lower than that of the non-IFS group (Morrison 2006). However, Morrison also found that there was no significant difference between the DOR (drop on request, equivalent to the Air Force's SIE) rate in Primary for the IFS and non-IFS groups (Morrison 2006). Nevertheless, the combined Primary DOR and FF attrition rate for the IFS group was significantly different (also at the 95% confidence level) from the non-IFS group, with the IFS group attrition rate 1.74% lower (Morrison 2006). Morrison (2006) explains that this decrease in combined Primary DOR and FF attrition rate fell short of the Navy's expected 3.8% decrease.

While Morrison's findings provide some understanding of IFS's impact on Primary DOR and FF attrition rates, the chosen statistical methodology is not appropriate for the research question. Morrison was investigating if there was a "significant difference between the non-IFS and IFS groups in Primary flight training with respect to both DOR and FF rates" (2). The statistical methodology best suited for answering this research question is hypothesis testing for the difference in two population proportions. Morrison's chosen method, confidence interval for proportions, is useful for characterizing the DOR and FF rates but is insufficient to detect a significant difference between the non-IFS and IFS groups' DOR and FF rates.

It should also be noted that Morrison's comparison of the non-IFS and IFS groups are subject to numerous confounding variables due to the difference in timing associated with each group. The non-IFS group predominately started Primary between 2002 and 2003, while the IFS group predominately started Primary in 2004. Morrison acknowledges that "the Involuntary Removal from Active Duty (IRAD) policy, accession standards, maturity of Multi-Service Pilot Training System (MPTS) syllabus and associated grading system, leadership guidance (production requirements vs. quality control), and culture of the squadrons are some areas that may have affected the groups differently" (57). These potential confounding variables impose limitations on the reliability of the conclusions drawn from this study.

In addition to examining Primary DOR and FF attrition rates, Morrison (2006) also examined the differences in T-34 flight time per Primary DOR and FF among the non-IFS and IFS groups (at the time of Morrison's study, the T-34 aircraft was used in Primary instead of the T-6). Results indicate that non-IFS completing Primary DOR students' T-34 flight hours ($M = 10.08$, $SD = 15.30$) were significantly less than IFS completing Primary DOR students' T-34 flight hours ($M = 18.42$, $SD = 23.14$), $t(105) = 2.24$, $p = 0.03$. Morrison concludes that IFS completion may have led to students deciding to DOR later in the Primary syllabus, resulting in an undesired increase in the average cost of a DOR attrition. In contrast, non-IFS completing Primary FF students' T-34 flight hours ($M = 48.71$, $SD = 26.05$) were not significantly different from IFS completing Primary FF students' T-34 flight hours ($M = 55.73$, $SD = 28.03$), $t(55) = 0.955$, $p = 0.34$.

The final aspect of Morrison's research involved determining whether the net savings from the IFS program outweighed the IFS investment. The return-on-investment analysis showed that IFS resulted in a net loss in terms of cost (Morrison 2006). Morrison (2006) proposes that IFS must screen and train pilots with more rigor to justify its high costs. Because NIFE incorporates many aspects of Morrison's recommendations, the recommendations are thoroughly discussed below.

To incorporate more rigorous screening and training procedures, Morrison (2006) first recommends revisiting the goals of IFS. As outlined in the TESCO report that established the basis for IFS, the Navy intended to reduce the Primary attrition rate due to

DOR and FF by at least 3.8% as a result of IFS. IFS was viewed solely as a screening tool. Morrison (2006) suggests that "the goals of IFS should incorporate both screening and training aspects with the objective of making IFS a cost-effective program." The emphasis on both screening and training is evident in NIFE's course objective: "this course will *assess* [emphasis added] aeronautical adaptability and *prepare* [emphasis added] students for follow-on aviation training" (Naval Aviation Schools Command [NASC] 2022).

Morrison's other recommendation is to investigate three alternatives for increasing the effectiveness of IFS. The first alternative is to set performance standards for each maneuver required in the final check-flight of IFS. Civilian flight instructors conducting IFS may have used lenient grading and lax standards, so the formalization of expected performance standards on the final check-flight would ensure that pilots completing IFS can perform at the expected level (Morrison 2006). Morrison's second alternative is to expand the IFS program so that it culminates in each student earning a civilian Private Pilot Certificate (PPC) in under 50 flight hours. The checkride for the PPC is conducted according to Practical Test Standards (PTS) established by the Federal Aviation Administration (FAA). The PTS addresses the standardization issue Morrison discusses in the first alternative. At the time, the USAF, under their Introductory Flight Training program, was utilizing a version of this alternative. The third and final alternative Morrison proposes is the following:

> To achieve ideal screening and training, a contractor-run, USN-controlled, single training site may be the optimal solution. This will allow for complete Navy control on training, grading, and screening procedures. Use of a single site will make standardization easier. A single site program will also provide to make modifications of flight hour requirements easier to implement. The Navy can align the program with a military training style and pace to increase the training value of IFS, and help establish the appropriate skill set in prospective aviators from the beginning. (Morrison 2006, 40)

At the time, the USAF was pursuing this alternative with a 25 flight-hour program. Currently, they have implemented this format as Initial Flight Training (IFT). With NIFE, the Navy has adopted a model nearly identical to Morrison's first three alternatives. In contrast to the USAF's 25 flight hour program, NIFE only provides 7 flight hours, in line with Morrison's first recommendation to make the program cost-effective.

Morrison's study concludes by discussing areas for further study. This thesis addresses two of the areas that Morrison highlights (albeit through an examination of NIFE compared to IFS instead of IFS compared to non-IFS). The first is studying the effects of IFS on minorities and determining to what extent IFS balances the inequalities of disadvantaged demographics. The second is determining whether IFS completers perform better than non-IFS students in day VFR flying, a flight stage closely related to the skills introduced in IFS.

C. NAVAL AUDIT ON IFS

In contrast to Morrison's recommendations to improve IFS, a 2010 audit on IFS performed by the Naval Audit Service recommended terminating the IFS program and redirecting those funds elsewhere. At the request of Chief of Naval Operation personnel, this audit was conducted to verify whether IFS was worthwhile in terms of reducing student pilot attrition during Primary (Naval Audit Service 2010). Naval Audit Service (2010) concluded that the Navy "cannot show that the Introductory Flight Screening program has achieved its intended purpose to appreciably lower student attrition in Primary flight training" (4).

Citing high average cost per attriter and a low IFS attrition rate of only 3.5%, the Naval Audit Service advocated discontinuing the program. The average cost per attriter and IFS attrition rate are measures of performance (MOPs) of IFS. These MOPs may not provide adequate insight on the effectiveness of IFS: a measure of effectiveness (MOE) should have been considered in this analysis, especially because the Naval Audit Service characterized their study as "an analysis of the effectiveness of Introductory Flight Screening as it relates to the Joint Primary Aircraft Training System" (Enclosure 2, Page 5). An appropriate MOE would be the student pilot attrition rate in Primary, as identified in the Naval Audit Services' explanation for the reason of the audit, as paraphrased above. The Naval Audit Services' failure to analyze the impact of IFS in terms of student pilot attrition rate calls into question the validity of their conclusions. One of this thesis' goals is to analyze the impact of NIFE in terms of student pilot attrition rate in Primary.

In a series of memos to the Naval Audit Service, CNATRA defends the IFS program and explains their disagreement with the recommendation to discontinue IFS. Citing Morrison's 2006 thesis, CNATRA acknowledges that the return on investment from IFS is not positive. However, CNATRA claims that "IFS has provided intangible benefits through improved preparation of students to start military flight training and positioning minority and female students for success in training." CNATRA elaborates on the first point by stating that IFS training will support the knowledge and skillset necessary to succeed in the new Primary syllabus based on the T-6 aircraft, which due to additional complexity and improved performance will almost certainly be more difficult to operate that the then-current T-34 aircraft used in Primary. However, CNATRA admits that there is no data to verify this claim because all T-6 based Primary students completed IFS (there is no non-IFS control group with which to make a comparison).

Regarding the second "intangible" benefit, CNATRA cites a then-recent in-house study that found that "prior to IFS, minorities and females attrited out of Primary flight training at higher rates than majorities (16% vs 11%) and males (21% vs 11%), [but] since the implementation of IFS, minorities and females attrition rates are roughly the same or lower than majorities and males" (Naval Audit Service 2010, Appendix C). CNATRA explains that one of the objectives during the development of IFS in 2003 was to "level the playing field" for minority and female students. Because fewer minority and female students arrived at naval flight training with prior flight experience, providing the flight experience gained through IFS was meant to bring everyone to the same baseline (Naval Audit Service 2010, Appendix C). In response to CNATRA's claims, the Naval Audit Service stated the following:

> It is our opinion that these other "intangible" benefits of the program mentioned by Commander, Naval Air Forces/Chief of Naval Air Training cannot be attributed to the Introductory Flight Screening program. Commander, Naval Air Forces/Chief of Naval Air Training has not performed controlled studies to show that Introductory Flight Screening is responsible for the "intangible" benefits. (Naval Audit Service 2010, 10)

The research in this thesis will attempt to show that NIFE, in comparison to IFS, provides these "intangible benefits." The "improved preparation" for Primary will be measured by NIFE's effect on student performance in Primary, and the "positioning of minority and female students for success in training" will be measured by NIFE's effect on minority and female attrition in Primary. If, as CNATRA claims, IFS already provided benefits in terms of preparation for Primary and minority and female students' ability to succeed in Primary, then NIFE's potential improvement over IFS represents a substantial benefit over the absence of an introductory flight program. The analysis in this thesis will provide statistical validation of NIFE's efficacy so that CNATRA can provide evidence for the benefits of NIFE, especially in case of a future audit on NIFE.

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III. RESEARCH METHODOLOGY

Chapter III explains the research methodology used to answer the research questions of this study:

- Compared to the legacy training programs (IFS and API), is NIFE associated with reduced attrition rates and earlier attrition timing in Primary flight training?
- Compared to the legacy training programs (IFS and API), does NIFE produce aviators that perform better in Primary flight training?

A. INTRODUCTION

The Human Performance Research department under the CNATRA provided the initial dataset. This dataset contains information on 4669 Naval Flight Students (NFS) who began Primary flight training between April 21, 2017 and October 15, 2021 and completed between October 26, 2017 and December 9, 2021. NASC later provided a dataset that contains more information on the same students. Both datasets were de-identified.

B. DATA

The data obtained for this study comes from two sources: CNATRA and NASC. Both datasets are described below.

1. CNATRA Dataset

The initial dataset from CNATRA contains information on 3881 completers of IFS/ API and 788 completers of NIFE, all of whom attempted the same syllabus of Primary flight training, CNATRAINST 1542.166B. The syllabus for Primary is updated every several years, and the current syllabus is now CNATRAINST 1542.166C. This dataset provides information in three main categories: demographics, Primary completion status, and Primary performance scores.

a. Demographics

The demographics data includes each student's training wing, squadron, branch, sex, and race. There are two training wings for Primary, TW-4 and TW-5. TW-4 is based in NAS Corpus Christi, TX, and TW-5 is based in NAS Whiting Field, FL. TW-4 consists of squadrons VT-27 and VT-28, and TW-5 consists of squadrons VT-2, VT-3, and VT-6. Although all squadrons in the dataset conducted flight training according to the same syllabus (CNATRAINST 1542.166B), minor cultural and procedural differences may exist between the squadrons. These potential differences are not likely to manifest as differences between NIFE completers and IFS completers.

The U.S. Navy trains both American and international military flight students. International students hail from Germany, France, Italy, Norway, Spain, Japan, and Saudi Arabia. American students are officers from the Navy, Marine Corps, Coast Guard, or Army. Because the only Army student was not required to complete all events in the Primary syllabus, the student was removed from the dataset.

Race was recorded as one or more of the following categories: white, black or African American, Asian, American Indian or Alaska Native, or Native Hawaiian or Other Pacific Islander. Students that did not provide racial information were recorded as "Declined to Respond," and students whose racial information could not be determined were recorded as "Unknown" or "ID Pending." To simplify the racial categorization, we relabeled any student who chose more than one race as "Mixed" and any student whose racial information was missing as "Unknown." We also created an additional categorization scheme that relabeled any minority student (non-white) as "Minority."

b. Primary Completion Status

The dataset contains the Primary training start dates for each student as well as the end dates for those who completed the syllabus. 4279 students successfully completed Primary, while 390 student attrited. For each student who attrited, one of the following reasons is given: academic, DOR, flying, or one of several administrative reasons. Attrition due to academics involves multiple failures of an academic event. Likewise, attrition due to flying involves multiple failures of a flying event. DOR is the term used when a student requests to drop out from the program. Because NIFE is designed to impact students' flying ability, academic ability, and motivation towards flying, students who attrited due to reasons other than flying, academics, or DOR were removed from the dataset.

c. Primary Performance Scores

Most of the data provided by CNATRA are performance scores. There are three levels of performance scores: ordered in decreasing granularity, these three levels are *maneuver*, *event*, and *phase*. In this section, each level of performance score is explained as well as the rationale for why a specific type of score was or was not used in the analysis.

(1) Maneuver-level Data

Maneuver-level data refers to the numerical grade given by the instructor pilot (IP) to a student for each maneuver completed on a given flight. A flight may contain over 40 graded maneuvers (CNATRA 2017). Grading is accomplished on the absolute scale presented in Table 2. According to the Primary MCG, the scale "shall be interpreted and used by instructors the same way for all items on all events. NFS (Naval Flight Student) performance as referred to in the scale below should be judged only against the CTS (Course Training Standards) provided for a given item in this MCG" (Chief of Naval Air Training 2022, I-18). The initial dataset provided by CNATRA did not include maneuver level data.

Table 2. Maneuver Absolute Grading Scale. Adapted from CNATRA (2017).

Demonstrated (NG/1 Level)	Enter NG/1: 1. When the IP demonstrates the maneuver and the student does not subsequently perform it during the event. 2. For solo flights, where an IP cannot observe individual flight maneuvers. 3. To indicate accomplishing all SSRs for that block or event. Specify the completed SSRs in the ATF's maneuver item content line and document date of exposure via the SSR button on the ATF menu bar.
Unable (U/2 Level)	Performance is unsafe or lacks sufficient knowledge, skill, or ability. Deviations greatly exceed CTS, significantly disrupting performance. Corrections significantly lag deviations or aggravate the deviations.

	Student requires constant coaching. A comment is required unless MIF is U/2 for that maneuver.
Fair (F/3 Level)	Performance is safe, but with limited proficiency. Deviations exceed CTS, detracting from performance. Corrections noticeably lag deviations, and may not be appropriate. Student requires moderate coaching.
Good (G/4 Level)	Characteristic performance is within CTS. Deviations outside CTS are allowed, provided they are brief, minor, and do not affect safety of flight. Corrections must be appropriate and timely.
Excellent (E/5 Level)	Greatly surpasses CTS. Performance is correct, efficient, and skillful. Deviations are very minor. Corrections, if required, are initiated by the student and are appropriate, smooth, and timely. Student requires no coaching. A comment is always required for a grade of E/5.

(2) Event-level Data

Event-level data summarizes a student's performance across all maneuvers in each event through the following equation:

Event score = Sum of Maneuver Grades in Event / Total MIF for Event

MIF stands for Maneuver Item File, which is "a listing of required maneuvers and associated proficiency levels for each block of training" (Chief of Naval Air Training 2017, xxi). Each event within a block will have the same MIF, but MIF will change as a student progresses to the next training block. The proficiency level in MIF is set as the minimum grade needed for each maneuver. Therefore, if a student receives a grade higher than specified in the MIF, they are said to be performing "better than MIF" for that maneuver. It follows then that an event score greater than 1.0 represents a student on average performing better than MIF for that event. Total MIF for the event can vary between students because there are optional maneuvers in MIF. The dataset provided by CNATRA contains the event score for each event in the Primary syllabus.

It should be noted that the event score described above only applies to flying events. Non-flying events (such as pen or pencil and paper exams and pass/fail events) are recorded as percentage scores. Pass/fail non-flying events were marked with either 100 (pass) or 0 (fail). However, since data entry for these pass/fail non-flying events was often incomplete, these events were eliminated from the dataset.

(3) Phase-level Data

Phase-level data captures a student's overall performance in a particular phase. The metric designed to describe overall performance in Primary is the Navy Standard Score (NSS). Computing NSS involves many steps, and a full explanation is beyond the scope of this study. In brief, NSS is based on a t-score distribution that rescales the data so that M is set to 50 and SD is set to 10 (CNATRA 2017, H-6). The original M and SD are computed from the norm group, which consists of the previous 200 completers of Primary from the same squadron. Because NSS is normalized to these previous 200 completers, comparing scores from different time periods (and thus different norm groups) will not yield any significant differences. The students who completed IFS did so in a different time period than those who completed NIFE: the first class of NIFE began on 17 August 2020 and all students thereafter were enrolled in NIFE instead of IFS (personal communication CDR Yates). Therefore, NSS is not a useful metric for comparing the performance of IFS to NIFE completers. The overall raw score provides a better basis for this comparison because it is an unadjusted value based only on the student's sum of maneuver grades in the phase and the total MIF for the phase:

Overall Raw Score = Sum of Maneuver Grades in Phase/ Total MIF for Phase

As was true for the event scores, an overall raw score above 1.0 indicates that the student on average performed better than MIF.

2. NASC Dataset

The dataset from NASC contains the additional information for each student, including arrival dates to the NASC command, flight training start dates (API or NIFE), flying hours in Primary, number of flights, and percentage scores for each exam completed during API or NIFE 1.

The students in the NASC dataset were assigned the same ID number as in the CNATRA dataset which allowed us to merge the two datasets. Students in the NASC dataset that did not have a matching ID to a student in the CNATRA dataset were removed.

C. STATISTICAL ANALYSIS METHODS

Both datasets from CNATRA and NASC were received in Microsoft Excel. The datasets were imported into *R* as comma-separated values (CSV) files and merged. All statistical analysis was conducted in *R*.

1. Attrition Analysis

The analysis begins with this study's first research question: compared to the legacy training programs (IFS and API), is NIFE associated with reduced attrition rates in Primary flight training? First, the Primary attrition rates for the NIFE completers and the IFS completers were visualized in bar charts: one for DOR attrition, one for flying attrition, and the final one combining DOR and flying attrition. Next, we completed hypothesis testing for the difference between two population proportions (combined attrition rate is represented as a proportion). Effect size was then calculated to quantify how large of a difference was observed between the two population proportions for combined attrition. 95% confidence intervals for the population proportion were also reported. The hypothesis testing, effect size calculation, and confidence interval calculation was repeated for DOR attrition and for flying attrition.

After analyzing the difference in attrition rates, we examined the difference in attrition timing between NIFE students and IFS students. Flying hours serve as a proxy for the amount of the Primary syllabus completed. Not all students finish Primary with the same amount of flying hours due to factors such as optional flying events, remediation flying events, or waived flying events. Histograms were constructed to visualize the distributions of flying hours per attriter for NIFE students versus IFS students. Two sample t-tests were conducted to detect the difference in population mean between the flying hours per attriter in NIFE students compared to IFS students. Effect size was also calculated. This process was repeated for DOR attrition and flying attrition.

The last step in our analysis of attrition focused on the attrition of females and minorities. Again, we are interested in the potential difference in attrition rate and attrition timing for females and minorities, and whether the enrollment in NIFE versus IFS has any impact on these results. To assess attrition rates, we used logistic regression with sex (male or female) and race (white or minority) as predictor variables and syllabus status (complete or attrite) as the response variable for the IFS population. This same logistic regression model was used for the NIFE population, and any differences were noted and discussed. To assess attrition timing, a two-way analysis of variance (ANOVA) was conducted with sex and race as predictor variables and hours flown in Primary as the response variable. Tukey's Honestly-Significant-Difference (HSD) test was used as a post-hoc test to determine which levels were different. The ANOVA and Tukey's HSD test were repeated for both the NIFE and the IFS populations and observed differences are discussed.

2. Performance Analysis

All attriters were removed from the dataset before continuing analysis regarding the second research question: compared to the legacy training programs (IFS and API), does NIFE produce aviators that perform better in Primary flight training? We began this analysis by considering phase-level data to understand NIFE's impact over performance in all of Primary. The chosen phase-level metric is overall raw grade for reasons discussed in the *Phase-level Data* section. Box plots for the overall raw grade for NIFE and IFS completers were constructed. Then, using a two-sample t-test, we compared the overall raw grade between NIFE and IFS completers. Effect size was calculated to quantify the magnitude of the difference.

This process for analyzing overall raw grade (box plots, t-test, effect size) was then repeated for each event within the Contact stage. NIFE's impact on performance in Primary was hypothesized to manifest in the Contact stage as discussed in Chapter I. To understand how the differences between NIFE and IFS students changes as the students progress through the rest of the Primary syllabus, we analyzed (using the same box plot, t-test, and effect size method) every checkride in the remaining stages (events ending with a 90 designator). Checkrides were chosen because they function as a summative assessment for the corresponding stage. Therefore, checkrides give us a strong indicator of a student's performance for an entire stage.

We also specifically examined the performance of females and minorities. NIFE was designed to ameliorate the performance gap in females and minorities as discussed in Chapter 1. To test this claim, we conducted a two-way ANOVA on the IFS completers with sex and race as predictor variables and overall raw grade as the response variable. Tukey's HSD test was utilized to determine which groups had significant differences. This process (ANOVA and Tukey's HSD) was repeated for NIFE completers and the differences are discussed. Then, this method (ANOVA and Tukey's HSD for IFS and NIFE separately) was repeated with each event in the Contact stage as the response variables.

The results of the above methodology are presented and discussed in Chapter IV.

IV. RESULTS

This chapter presents the results of the statistical analyses gathered from the methods explained in Chapter III. A discussion of these results follows in Chapter V. The results are presented in the following sections of analysis: attrition rates, attrition timing, and performance in Primary. Each category contains multiple comparisons of metrics between IFS/API and NIFE. The statistical models used and the test results are described and depicted visually where applicable.

A. ATTRITION RATES

This section presents the results of the comparisons of attrition rates between IFS/API students and NIFE students. First, the rates for Primary DOR and Primary Flight attrition are compared between minority and female students and NIFE students. Then, these same comparisons are examined for IFS/API students. Finally, pre-Primary attrition rates for the IFS track and the NIFE track are compared. The pre-Primary attrition rate can also be described as the screening rate for IFS or NIFE.

1. Overall Primary Attrition Rates

A chi-square test of independence showed that NIFE completers were less likely to attrite from Primary compared to IFS/API completers, X^2 (1, N = 5247) = 14.35, $p < .001$. The Primary attrition rate for NIFE completers was 3.7%, while the Primary attrition rate for IFS/API completers was 6.9%. The odds a student attrites from Primary is 1.9 times greater for IFS/API completers than for NIFE completers.

2. Primary DOR Attrition Rates

There was a significant difference in the Primary DOR attrition rate between NIFE completers and IFS/API completers, X^2 (1, N = 5132) = 3.28, $p = .035$. The Primary DOR attrition rate for NIFE completers was 3.0%, while the Primary flight attrition rate for IFS/API completers was 4.3%. The odds of DOR attrition from Primary is 1.4 times greater for IFS/API completers than for NIFE completers.

3. Primary Flight Attrition Rates

The Primary flight attrition rates for NIFE completers was lower than that of IFS/API completers, X^2 (1, N = 5042) = 15.96, p < .001. The Primary flight attrition rate for NIFE completers was 0.7%, while the Primary flight attrition rate for IFS/API completers was 2.9%. The odds of flight attrition from Primary is 4.2 times greater for IFS/API completers than for NIFE completers.

4. Attrition Rates among Minorities

Among IFS/API completers, minority students were more likely to attrite from Primary than white students, X^2 (1, N = 4140) = 17.12, p < .001. The Primary attrition rate for minority students was 11.2%, while the Primary attrition rate for white students was 6.2%. Among IFS/API completers, the odds of attrition from Primary are 3.7 times greater for minority students than for white students.

In contrast, a chi-square test of independence showed that for NIFE completers, there is no significant difference in the Primary attrition rate between minority students and white students, X^2 (1, N = 973) = 0.13, p = 0.719.

Among minority students who completed NIFE, the Primary attrition rate was lower than for minority students who completed IFS/API, X^2 (1, N = 1200) = 28.25, p < .001. The Primary attrition rate for minority students completing NIFE was 3.3%, while the Primary attrition rate for minority students completing IFS/API was 11.2%. Among minority students, the odds of attrition from Primary are 3.7 times greater for IFS/API completers than for NIFE completers.

5. Attrition Rates Among Females

Among female students, completion of NIFE resulted in a lower Primary attrition rate than completion of IFS/API, X^2 (1, N = 595) = 5.90, p = .015. The Primary attrition rate for female students completing NIFE was 2.2%, while the Primary attrition rate for female students completing IFS/API was 8.8%. Among female students, the odds of attrition from Primary are 4.3 times greater for IFS/API completers than for NIFE completers.

6. Screening Rates of IFS/API and NIFE

The screening rate of NIFE was greater than the screening rate of IFS, X^2 (1, N = 9104) = 3.85, p = .0496. The screening rate of NIFE was 1.8%, while the screening rate of IFS/API was 1.2%. The odds of attrition from NIFE are 1.5 times greater than the odds of attrition from IFS/API.

B. ATTRITION TIMING

This section presents the results of the comparisons of attrition timing between IFS/API students and NIFE students. Attrition timing is assessed by T-6 hours flown in Primary. First, the timing of Primary DOR and Primary Flight attrition are compared between IFS/API students and NIFE students. Then, these same comparisons are examined for minority and female students.

1. Primary DOR Attrition Timing

The distributions of T-6B flight hours in Primary among DOR attriters for both NIFE and IFS/API completers is shown in Figure 4. Both distributions exhibit a strong right skew with many data points at zero or near zero. This right skew is expected because DOR attrition generally happens earlier in training phases (Miller 1966).

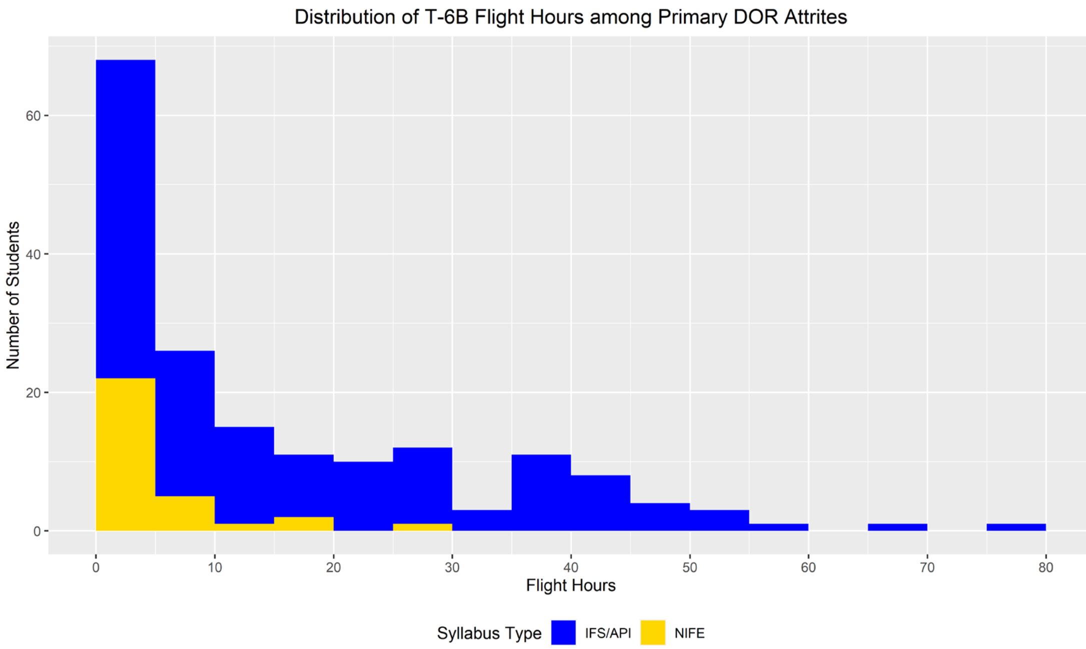
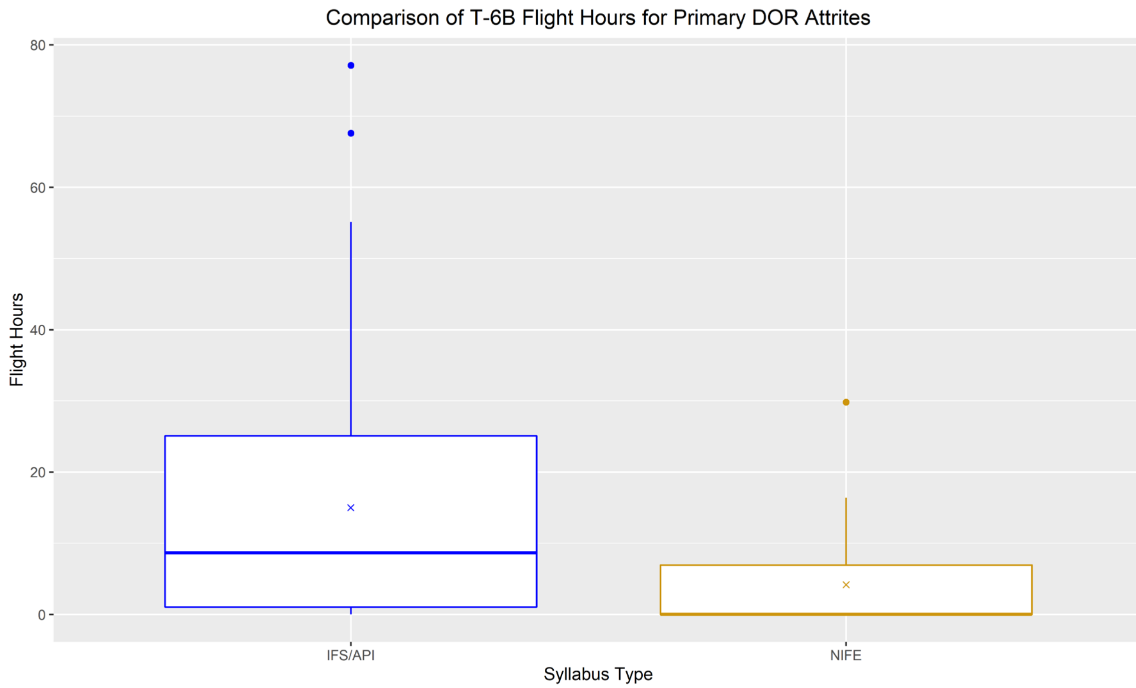


Figure 4. Histogram of Primary DOR Attrition Timing by Syllabus Type.

Figure 5 presents a box plot comparison of the Primary T-6B flight hours between IFS/API completers and NIFE completers. IFS/API completers exhibit more outliers in the upper range of flight hours as compared to NIFE completers. The number of outliers in the lower range is similar for both distributions, though there appears to be more extreme outliers in the lower range for NIFE completers. The box plots suggest that the mean flight hours of NIFE completers is lower than that of IFS completers.



Note: solid dots indicate outliers, and “x” indicates means.

Figure 5. Box Plots of Primary DOR Attrition Timing by Syllabus Type

Primary DOR attriters who completed NIFE (M = 4.2, SD = 6.9) flew significantly less hours before attriting than Primary DOR attriters who completed IFS/API (M = 15.0, SD = 16.7), $t(106) = 6.11$, $p < .001$, $d = 0.85$, 95% CI [7.3, 14.3]. The effect size indicates that 80.2% of the Primary DOR attrites who completed NIFE flew less hours than the mean of the Primary DOR attriters who completed IFS/API. We are 95% confident that the mean hours flown for Primary DOR attriters who completed NIFE is between 7.3 and 14.3 hours less than the mean hours flown for Primary DOR attriters who completed IFS/API.

2. Primary Flight Attrition Timing

A Mann-Whitney *U* Test showed that Primary flight attriters who completed NIFE (*Mdn* = 0) flew significantly less hours before attriting than Primary flight attriters who completed IFS/API (*Mdn* = 34.2), $U = 654.5$, $p < .008$, $r = 0.24$, 95% CI [4.9, 40.3]. The effect size indicates a small effect. The given 95% confidence interval estimates the median of the difference between a sample from the NIFE group and a sample from the IFS group.

3. Primary DOR Attrition Timing among Females and Minorities

A three-way analysis of variance yielded a main effect for the syllabus type that was significant, $F(1, 195) = 11.80$, $p < .001$, consistent with the results presented in section 1. The main effect of race was not significant $F(1, 195) = 1.60$, $p = .207$, and the main effect of sex was also not significant $F(1, 195) = 1.27$, $p = .261$. The Primary DOR attrition timing of both females and minorities are not significantly different from males and white students, respectively.

4. Primary Flight Attrition Timing among Females and Minorities

A three-way analysis of variance yielded a main effect for the syllabus type that was significant, $F(1, 112) = 12.01$, $p < .001$. The significance of the syllabus type's effect is consistent with the results presented in section 1 and 3. The main effect of race was not significant $F(1, 112) = 3.21$, $p = .076$, and the main effect of sex was also not significant $F(1, 112) = 0.89$, $p = .347$. The Primary flight attrition timing of both female and minority students are not significantly different from both male and white students, respectively.

C. PERFORMANCE IN PRIMARY

This section presents the results of the comparisons of performance metrics between IFS/API students and NIFE students. The following performance metrics are assessed: overall raw grade in Primary, total hours flown in Primary, mid phase contact check flight scores, final contact check flight scores, and all remaining check flights and exams. The performance of females and minorities are specifically analyzed as well.

1. Overall Raw Score in Primary

The distributions of overall raw scores in Primary for NIFE completers compared to IFS/API completers is shown in Figure 6. Both distributions appear approximately normal.

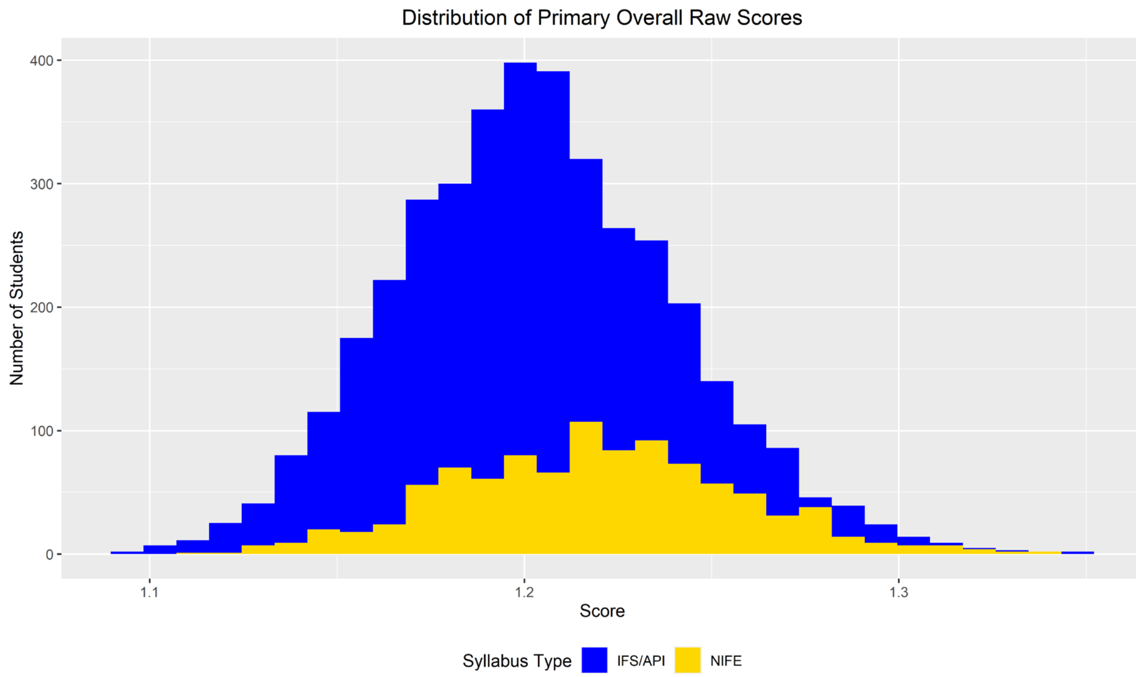
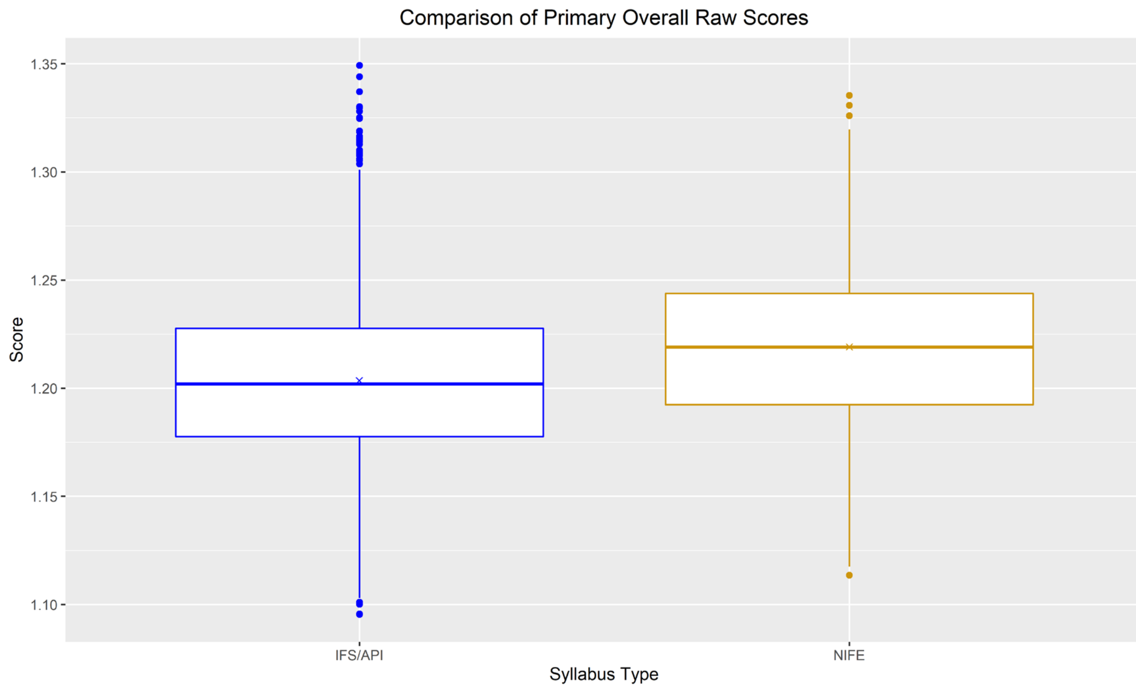


Figure 6. Histogram of Primary Overall Raw Score by Syllabus Type.

Figure 7 presents a boxplot comparison of the Primary overall raw score between IFS/API completers and NIFE completers. The boxplots suggest that the mean overall raw score of NIFE completers is higher than that of IFS completers.



Note: solid dots indicate outliers and “x” indicates means.

Figure 7. Box Plots of Primary Overall Raw Scores by Syllabus Type.

NIFE completers (*M* = 1.22, *SD* = .038) had higher Primary overall raw scores than IFS/API completers (*M* = 1.20, *SD* = .037), $t(1503) = 11.58$, $p < .001$, $d = 0.41$. The effect size indicates that 65.9% of NIFE completers scored higher than the mean of IFS/API completers.

2. Total Hours Flown in Primary

The distributions of T-6B flight hours in Primary for NIFE and IFS/API completers is shown in Figure 8. Both distributions appear approximately normal.

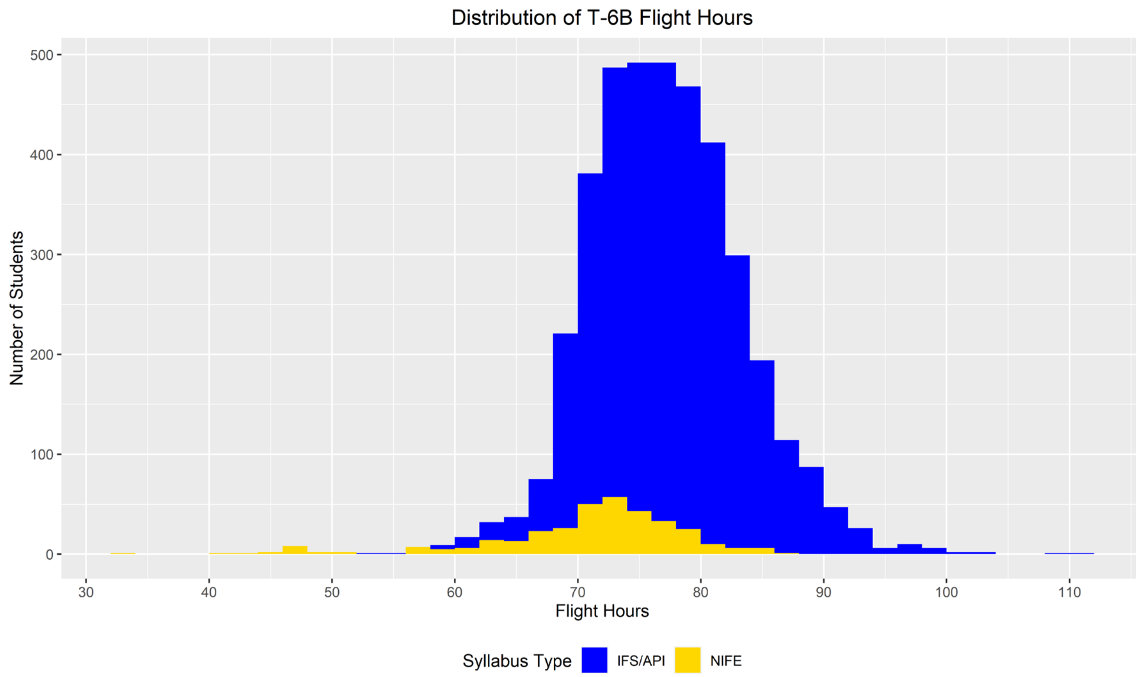
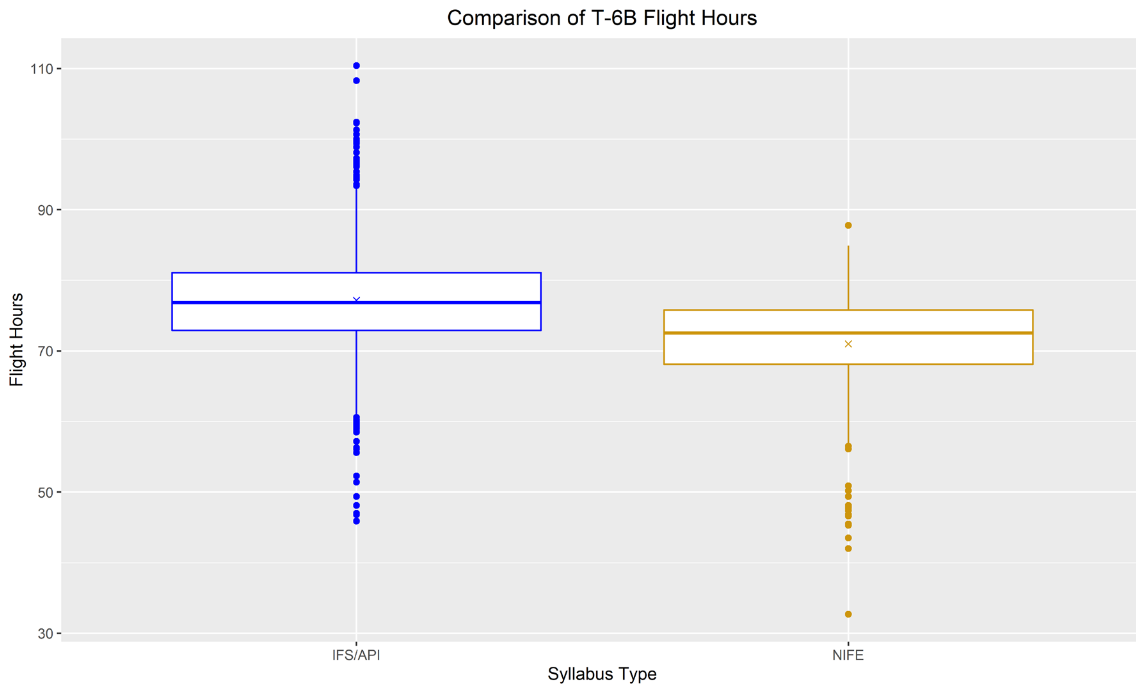


Figure 8. Histogram of Primary T-6B Flight Hours by Syllabus Type.

Figure 9 presents a box plot comparison of the Primary T-6B flight hours between IFS/API completers and NIFE completers. IFS/API completers exhibit more outliers in the upper range of flight hours as compared to NIFE completers. The number of outliers in the lower range is similar for both distributions, though there appears to be more extreme outliers in the lower range for NIFE completers. The box plots suggest that the mean flight hours of NIFE completers is lower than that of IFS completers.



Note: solid dots indicate outliers, and "x" indicates means.

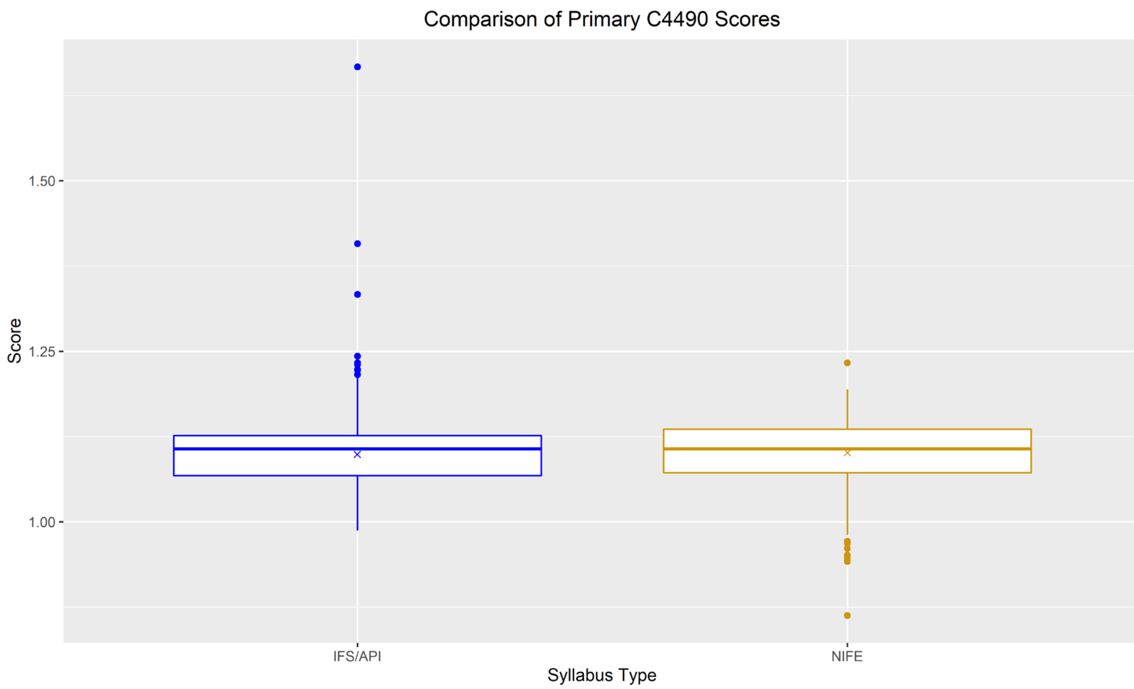
Figure 9. Box Plots of Primary T-6B Flight Hours by Syllabus Type.

NIFE completers (*M* = 71.0, *SD* = 7.4) flew significantly less hours in Primary than IFS/API completers (*M* = 77.2, *SD* = 6.5), $t(378) = 13.76$, $p < .001$, $d = 0.85$. The effect size indicates that 80.2% of NIFE completers flew less hours in Primary than the mean flight hours of IFS/API completers.

3. Mid Phase Contact Check Flight

Figure 10 presents a box plot comparison of the Primary mid phase contact check flight (C4490) score between IFS/API completers and NIFE completers. The boxplots indicate that the C4490 scores of NIFE and IFS/API completers are similar. Fewer outliers are present in the lower range of the IFS/API completers compared to the lower range of the NIFE completers. More outliers are present in the upper range of the IFS/API completers compared to the upper range of the NIFE completers. These upper range outliers are more extreme than the lower range outliers.

Outliers are more common in event-level data as opposed to the phase-level data (such as overall raw score) discussed in section 1. Event-level data is comprised of fewer data points and is therefore more subject to extreme values. Phase-level data is comprised of all the events in that phase, so any extreme values present are averaged out and thus less likely to appear as outliers.



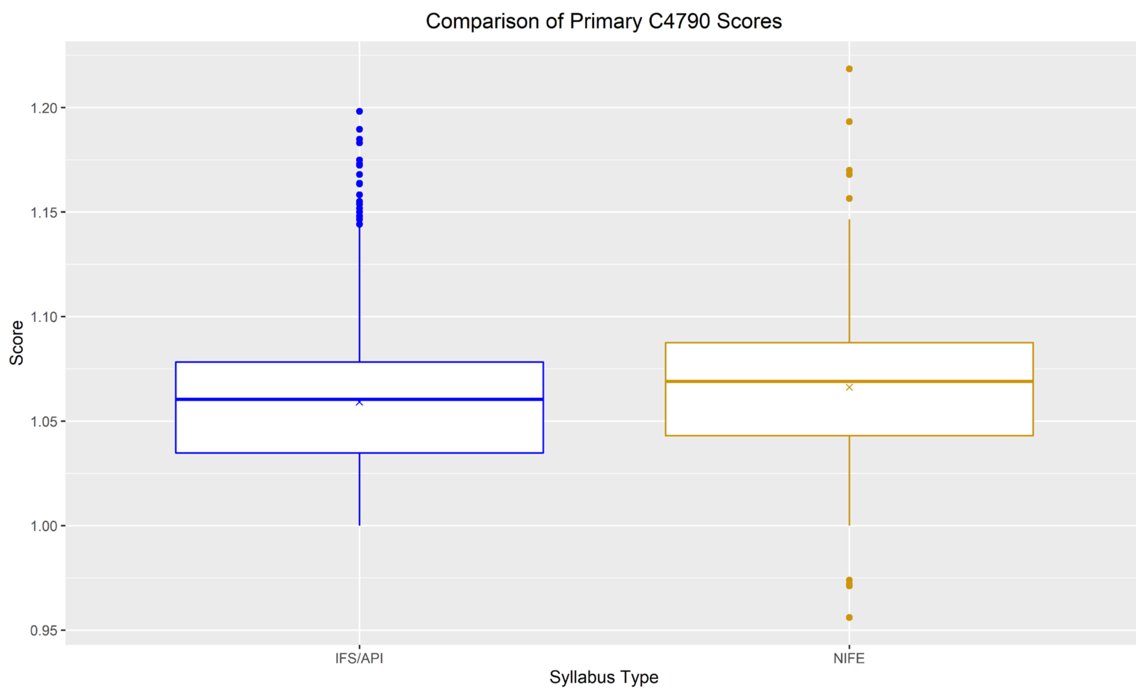
Note: solid dots indicate outliers, and "x" indicates means.

Figure 10. Box Plots of Primary C4490 Scores by Syllabus Type.

There was a significant difference between the C4490 score of NIFE completers (M = 1.10, SD = .039) and IFS/API completers (M = 1.09, SD = .044), $t(419) = 1.49$, $p <$ .001). However, these results indicate non-significant trending in the predicted direction.

4. Final Contact Check Flight

Figure 11 presents a box plot comparison of the Primary final contact check flight (C4790) score between IFS/API completers and NIFE completers. The boxplots suggest that the mean overall raw score of NIFE completers is higher than that of IFS completers. More outliers are present in the upper range for IFS/API completers compared to NIFE completers. Additionally, several outliers are present in the lower range for NIFE completers while no outliers in the lower range are present for IFS/API completers.



Note: solid dots indicate outliers, and "x" indicates means.

Figure 11. Box Plots of Primary C4790 Scores by Syllabus Type.

NIFE completers (*M* = 1.07, *SD* = .034) had higher Primary C4790 scores than IFS/API completers (*M* = 1.06, *SD* = .031), $t(1424) = 5.84$, $p < .001$, $d = 0.21$. The effect size indicates that 58.3% of NIFE completers scored higher than the mean of IFS/API completers.

5. All Exams and Remaining Check Flights

To provide a more complete picture of NIFE's effects on Primary performance, all exams and check flights were analyzed with Student's *t*-tests. The results are summarized in Table 3.

Table 3. Summary of Statistical Results for Exams and Check Flights

Event Name	Event Code	Statistics		t Test Results
		IFS	NIFE	
T-6B Aircraft Systems 1 Exam	SY0190	M = 95.0, SD = 4.4	M = 95.9, SD = 3.3	$t(453) = 4.45, p < .001, d = 0.22$
T-6B Aircraft Systems 2 Exam	SY0290	M = 94.4, SD = 4.2	M = 95.4, SD = 3.9	$t(412) = 4.33, p < .001, d = 0.24$
Course Rules Exam	G0290	M = 95.7, SD = 4.9	M = 96.9, SD = 3.5	$t(468) = 5.97, p < .001, d = 0.29$
Contact Exam 1	C1190	M = 94.2, SD = 4.8	M = 96.0, SD = 3.9	$t(436) = 7.99, p < .001, d = 0.41$
Contact Exam 2	C1290	M = 91.8, SD = 4.9	M = 93.5, SD = 4.7	$t(408) = 6.22, p < .001, d = 0.34$
Instruments Exam	IN1390	M = 95.0, SD = 4.3	M = 95.9, SD = 3.7	$t(408) = 6.22, p < .001, d = 0.22$
Instrument Check Flight	I4490	M = 1.04, SD = 0.03	M = 1.05, SD = 0.03	$t(388) = 3.84, p < .001, d = 0.23$
VFR Navigation Exam	NA1190	M = 93.9, SD = 4.7	M = 93.8, SD = 4.9	$t(371) = 0.34, p = .737$
Formation Exam	F1190	M = 96.8, SD = 5.2	M = 96.0, SD = 5.0	$t(405) = 2.84, p = .005, d = 0.16$

The events in Table 3 are organized in a potential chronological sequence. There is no one chronological sequence to these events because the Primary syllabus allows for flexibility in course flow (as explained in Chapter I under the Primary Curriculum section).

6. Female and Minority Performance

Female and minority performance was compared for IFS completers and NIFE completers using separate analyses of variances for each, then observing the differences in significance in main effects. C4490, C4790, and overall raw score were used as the response variable for the analyses of variances.

a. Performance in C4490

Among IFS completers, a two-way analysis of variance on C4490 scores yielded a main effect for race that was significant, $F(1, 3855) = 8.65$, $p = .003$, as well as a main effect for sex that was also significant $F(1, 3855) = 8.54$, $p = .004$. The interaction between race and sex was not significant $F(1, 3855) = 2.22$, $p = 0.14$.

Among NIFE completers, a two-way analysis of variance on C4490 scores yielded a main effect for race that was not significant, $F(1, 289) = 1.59$, $p = .210$, as well as a main effect for sex that was also not significant $F(1, 289) = 0.63$, $p = .430$.

b. Performance in C4790

Among IFS completers, a two-way analysis of variance on C4790 scores yielded a main effect for race that was significant, $F(1, 3852) = 8.63$, $p = .003$, as well as a main effect for sex that was also significant $F(1, 3852) = 15.33$, $p < .001$. The interaction between race and sex was not significant $F(1, 3855) = 0.51$, $p = 0.14$.

Among NIFE completers, a two-way analysis of variance on C4790 scores yielded a main effect for race that was not significant, $F(1, 288) = 0.01$, $p = .940$, as well as a main effect for sex that was also not significant $F(1, 288) = 1.58$, $p = .210$.

c. Performance in Overall Raw Score

Among IFS completers, a two-way analysis of variance on overall raw scores yielded a main effect for race that was significant, $F(1, 3855) = 32.93$, $p < .001$, as well as a main effect for sex that was also significant $F(1, 3855) = 57.50$, $p < .001$. The interaction between race and sex was not significant $F(1, 3855) = 0.15$, $p = 0.699$.

Among NIFE completers, a two-way analysis of variance on overall raw scores yielded a main effect for race that was not significant, $F(1, 289) = 1.63$, $p = .203$. However, the main effect for sex was significant $F(1, 289) = 4.68$, $p = .031$.

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V. CONCLUSION

This research aimed to answer the following two questions:

- Compared to the legacy training programs (IFS and API), is NIFE associated with reduced attrition rates and earlier attrition timing in Primary flight training?
- Compared to the legacy training programs (IFS and API), does NIFE produce aviators that perform better in Primary flight training?

The answers obtained are discussed in Part A of this chapter. Part B of this chapter proposes areas of further study.

A. DISCUSSION OF RESULTS

1. Attrition Analysis

NIFE completers were significantly less likely to attrite from Primary compared to IFS/API completers. The Primary attrition rate was reduced from 6.9% for IFS/API completers to 3.7% for NIFE completers. The odds of attrition from Primary for NIFE completers is almost half that of IFS/API completers.

The screening rate of NIFE was significantly greater than the screening rate of IFS, increasing from 1.2% for IFS to 1.8% for NIFE. NIFE was 1.5 times more likely to remove a student from the training pipeline than IFS. Because the screening rate of NIFE increased while the Primary attrition rate of NIFE completers decreased, the increased screening is likely removing students who otherwise would have attrited in Primary. This increased screening improved the efficiency of the naval aviation training pipeline.

A similar way of improving training pipeline efficiency is to elicit earlier attrition timing in Primary. If a student will attrite, it is preferable for that student to attrite earlier in the Primary phase so that less resources are expended. Our analysis showed that among both Primary DOR and flight attrites, those who completed NIFE attrited with significantly less flight hours. The effect was more pronounced for Primary DOR attrites.

Primary DOR attrition rates were significantly lower for NIFE completers than for IFS/API completers. The Primary DOR attrition rate was reduced from 4.3% for IFS/API completers to 3.0% for NIFE completers. DOR is usually caused by a student's lack of motivation towards naval aviation. As discussed in Chapter I, a reduction in Primary DOR attrition rate accompanied by an increase in the pre-Primary screening rate likely indicates that the increased screening in NIFE is the mechanism by which lower Primary DOR attrition rates are achieved. Therefore, NIFE enables would-be Primary DOR attriters to discover their lack of motivation towards naval aviation before entering Primary and thus attrite before taking a slot in Primary.

Primary flight attrition rates were significantly lower for NIFE completers than for IFS/API completers. The Primary flight attrition rate was reduced from 2.9% for IFS/API completers to 0.7% for NIFE completers. Flight attrition is due to poor flight performance as discussed in Chapter I. Therefore, NIFE's effect on the Primary flight attrition rate may demonstrate NIFE training's ability to better prevent poor flight performance compared to IFS/API training.

Primary DOR and flight attrition occurred significantly earlier in the primary syllabus for NIFE completers compared to IFS/API completers, as measured by T-6B hours flown. Primary DOR attriters who completed NIFE attrited after an average of 4.2 flight hours, while the same for IFS/API completers was 15 flight hours. Primary flight attriters who completed NIFE attrited after a median of 0 flight hours, while the same for IFS/API completers was 34.2 flight hours. Earlier attrition timing is favorable because less flight time per attriter directly results in operation costs savings.

2. Performance Analysis

NIFE completers completed the Primary syllabus in less flight hours than IFS/API completers: NIFE completers averaged 71.0 T-6B flight hours to complete Primary, while IFS/API completers averaged 77.2 T-6B flight hours. This result shows that NIFE completers were able to complete all Primary syllabus requirements more efficiently in terms of flight time. This efficiency suggests NIFE's preparation for Primary allowed students to grasp concepts quicker and reach proficiency in the cockpit with less repetitions than IFS/API completers.

In terms of overall raw score, NIFE completers performed significantly better than IFS/API completers. Over 65% of NIFE completers scored higher than the mean score of IFS/API completers for overall raw score. Therefore, it is likely that the training students received NIFE allowed them to perform at a higher level in Primary. To determine if this effect was more concentrated in a particular phase of Primary, we began by examining performance within the Contact phase.

In the mid phase contact check flight, NIFE completers scored significantly higher than IFS/API completers. NIFE completers also scored significantly higher than IFS/API completers on the final contact check flight. As predicted, the flying skills developed in NIFE training allowed NIFE completers to perform at a higher level in similar flying completed in the Primary Contact phase. However, this performance advantage appeared to continue throughout the rest of the syllabus. The positive effect on performance scores of NIFE training was not confined to the Primary Contact phase.

Analysis of scores in all other check flights and exams in the Primary syllabus showed that NIFE completers continued to outperform IFS/API completers in all but one exam, the VFR navigation exam (it is unclear why the training advantage of NIFE may not be applicable to the VFR navigation exam). The consistency with which NIFE completers scored higher on these exams and check flight events compared to IFS/API completers demonstrates NIFE's broad positive impact on performance throughout the course of Primary.

3. NIFE's Impact on Female and Minority Students

Among minority students, overall Primary attrition rate was significantly lower for NIFE completers compared to IFS/API completers. Additionally, among female students, overall Primary attrition rate was also significantly lower for NIFE completers compared to IFS/API completers. These results suggest that NIFE had a positive impact on the retention of historically disadvantaged students.

Among IFS/API completers, a significant difference exists in the mid-phase contact check flight and the final contact check flight scores between minority and white students. This significant difference also exists between female and male students. These results indicate that a performance gap exists for minority and female students. However, among NIFE completers, no significant difference was detected in mid-phase contact check flight and final contact check flight scores between minority and white students and female and male students. Therefore, it appears that NIFE has ameliorated the performance gap for historically disadvantaged students.

B. AREAS OF FURTHER STUDY

Three areas of further study are proposed. The first two areas of study address how future research can improve upon the statistical models created in this study. Two potential confounding variables are explained, and recommendations are given on how to account for these variables' effects. The third area of study addresses a facet of NIFE program effectiveness not analyzed in this study: cost effectiveness. This study analyzed the effectiveness of NIFE in terms of the benefits conferred on the efficiency of the naval aviation training pipeline. Performing a cost benefit analysis of NIFE will allow naval leadership to decide whether these efficiency benefits justify the cost of the NIFE program.

1. Address Time-Varying Confounding

Because students who completed NIFE did so in a different time period than students who completed IFS/API, time is a confounding variable in this study. To investigate the potential effects of time on attrition metrics and performance metrics discussed in this study, future research should first examine short-term and long-term trends for these metrics. Trend analysis may allow researchers to detect patterns or correlations that explain some of the variation observed in the data.

Future research should also consider the impact of CNATRA and NASC policy changes on attrition metrics and performance metrics. For example, if pilot production is not meeting the demand specified in production requirements, CNATRA and NASC may lower minimum standards so that more pilots are able to move through the pipeline. Conversely, if the pipeline has exceeded its maximum capacity and students are experiencing an increase in delays and wait times to start a training phase, CNATRA and NASC may raise minimum standards to increase attrition.

Furthermore, metrics such as T-6B hours flown may be sensitive to a variety of factors such as aircraft availability, weather events, squadron policies, and squadron culture. With access to more data, future research can build more sophisticated statistical models that can better explain the variation observed in the metrics of interest.

2. Address Training Decay

The wait time between the end of NIFE and the beginning of Primary varies for each student depending on factors such as the time of year (for instance, most officers commission from USNA and ROTC in May or June, which creates congestion in the pipeline throughout the summer) and the amount of backlog in the training pipeline (affected by accession numbers and current production requirements). Some students experience wait times of over one year between completing NIFE and commencing Primary. Conventional wisdom within the aviation community holds that if new student pilots do not use their skills for an extended period, these skills will perish, resulting in training decay (Semmens 2021).

The results of this study indicate that NIFE confers a training advantage, but this training advantage may be lost if enough time elapses before a student begins Primary. Training decay is a potential confounding variable in this study because for students that experienced long wait times after NIFE, the training advantage of NIFE may have been counteracted by training decay. Further research should analyze whether a correlation exists between attrition and performance metrics and wait time after NIFE. Researchers should then examine how much of the variation in NIFE attrition metrics and performance metrics is due to training decay. This analysis could reveal a larger training advantage in NIFE that this study was unable to detect. If training decay indeed reduces the training advantage of NIFE, CNATRA may be able to restructure the training pipeline so that long wait times are reduced or avoided entirely.

3. Perform a Cost Benefit Analysis of NIFE

Many of the results of this study are useful for completing a cost benefit analysis of the NIFE program. The Naval Audit Service's 2010 audit on IFS and Morrison's 2006 analysis of the return-on-investment (ROI) of IFS provide example methodologies that can inform a similar cost analysis on NIFE. The information provided by this study on the differences in screening rate between IFS/API and NIFE as well as the differences in Primary DOR and flight attrition rates between IFS/API completers and NIFE completers are well suited for use in this type of cost analysis.

NIFE's impact on screening rates and Primary attrition rates represents one of NIFE's contributions to reducing the cost of naval flight training. Another contribution is NIFE's reduction of flight hours among both Primary attriters and completers. Once the average cost per flight hour of the T-6B is determined, future researchers can use the number of flight hours saved by NIFE (provided by this study) to estimate the resulting training cost savings.

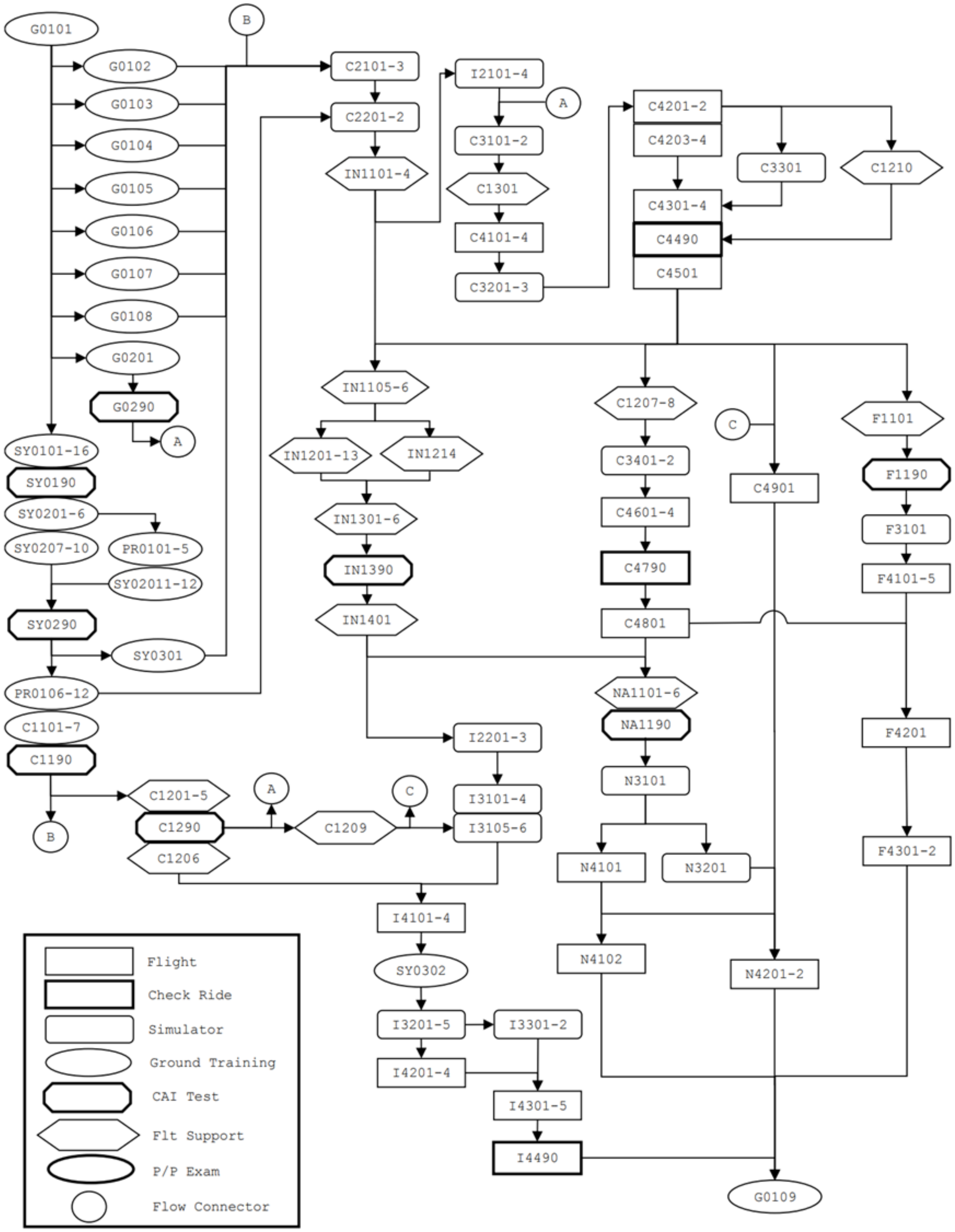
Determining the net monetary value of the NIFE program informs future decision makers. If an audit is performed on the NIFE program, this information can assist auditors in assessing NIFE's cost effectiveness. If NIFE is not cost effective, leadership at CNATRA and NIFE can respond by investigating how to improve the NIFE program.

C. CONCLUSION

NIFE is fulfilling its mission to reduce both DOR and flight attrition in Primary and improve performance in Primary. This thesis explains the likely mechanisms that allow the NIFE program to achieve these results. Our analysis also demonstrates to what extent NIFE is accomplishing its mission. Recommendations are given so that future research can further evaluate the effectiveness of NIFE.

APPENDIX. PRIMARY COURSE FLOW

T-6B JPPT COMPLETE COURSE FLOW



Source: CNATRA (2017).

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