THE RELATIONSHIP BETWEEN THE INTRODUCTION TO NAVIGATION TEST AND JOINT UNDERGRADUATE NAVIGATOR TRAINING PERFORMANCE

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PREFACE

This study was conducted to identify the Introduction to Navigation test as a predictor of success or failure in Joint Undergraduate Navigator School (JUNT). JUNT students who do not successfully complete training costs the Air Force funds and reduce the number of trained navigators in the active duty force structure. The specific objective of this study was to identify a JUNT Introduction to Navigation test score that would indicate failure as a military aviator. Aviators must have the ability to process information quickly and accurately, then apply that information in a three dimensional plane. The inability to process, prioritize, and apply this information can be fatal for any aviator. Therefore, the establishment of the Introduction to Navigation test as a predictor can save military funds, resources, and lives.

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TABLE OF CONTENTS

LIST OF TABLES

Table | Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Background

The United States Air Force and Navy spend large amounts of money training aircrew members to operate the fleet of war fighting aircraft. The systems built into these aircraft have become increasingly complex, requiring more highly trained personnel. This increased training is costly and critical to mission success. Missions flown by the Air Force and Navy demand a high degree of precision in delivery of munitions and low-level navigation. Each year, the Air Force and Navy, in a Joint training environment, train navigators to aid pilots in successfully accomplishing these tasks.

The United States military's Joint Undergraduate Navigator Training School (JUNT) course is based at Randolph Air Force Base, Texas, and Pensacola Naval Air Station (NAS), Florida. The course is 45 weeks long, the second longest training course in the Air Force. Training is broken down into two parts: initial navigator training, the Core curriculum, which is 22 weeks long, and specialized or "Track" training. This track system provides the students with tailored instruction to prepare them for follow-on assignments to either large multi-place aircraft or fighter-bomber aircraft. The specialized training is 23 weeks long and concludes with students being awarded their aeronautical ratings as navigators. Initial navigator training is conducted at Pensacola NAS, with the specialized training at Randolph AFB. This research will concentrate on the Air Force training at Randolph AFB, Texas.

According to the Air Education and Training Command Public Affairs office, the cost to train each navigator from initial entry to award of his or her aeronautical rating is approximately $500,000. Air Force students entering training come from one of four commissioning sources: the Air Force Academy, Air Force Reserve Officer Training Commission (ROTC) detachments, Air Force Officer Training School, and the Air National Guard's Academy of Military Science. All students are college graduates, but their degrees and majors can vary widely.

The process of recruiting Air Force officers is guided by the type and quantity of officer job vacancies that exist at a particular time, according to Rogers, Roach, and Shorts study Mental Ability Testing in the Selection of Air Force Officers: A Brief Historical Overview (1986). For example, the nationwide recruiting goal for a particular time period may be 85 pilots, 40 navigators, 20 missile launch officers, and so on until all vacancies are identified. An individual can apply for a specific job only when a vacancy for that job exists. Assuming a job is open, the applicant must go through a sequential selection process that may include completion of specific courses, a specific degree program, and physical requirements.

Each person seeking to enter the Air Force as an officer is given an initial aptitude test, the Air Force Officer Qualification Test (AFOQT). This test assesses basic verbal and quantitative skills. Headquarters Air University decides, using this test, who will get a navigator training allocation. Upon arrival at JUNT at Randolph AFB, Texas, each student is given another test, the pre-navigator test, that assesses verbal, math, spatial awareness, and interpretive skills. The score on the test is used to identify students who are more likely to have problems in the course for increased supervisory monitoring. The Introduction to Navigation test is the first given in the track curriculum that searches for a correlation between book knowledge and application of aviation concepts. The results of this test, it is hypothesized, are a greater indicator of success or failure in the JUNT program than either the AFOQT or the pre-navigator test.

Statement of the Problem

The specific problem this study addressed was the identification of the Introduction to Navigation test to predict success or failure in Joint Undergraduate Navigator School (JUNT). Any JUNT student who does not successfully complete training costs the Air Force additional funds and reduces the number of trained navigators in the active duty force structure. A method must be found to identify, early in training, potentially unsuccessful students who will not be able to learn the requisite knowledge to function as a navigator.

Purpose of the Study

This study assesses if a better system can accurately predict successful completion of JUNT, which would save the Air Force money and allow programming of a more accurate number of students to meet projected vacancies. If an accurate predictor of student performance could be found, it would allow training to be allocated more efficiently. Students with little or no chance of successfully acquiring requisite knowledge could be removed from training early. Those students with a better chance of success could be given the instruction needed to ensure their likelihood of completing the program. Such a predictor could also be used to screen students before they are considered for navigator training.

Statement of the Hypothesis

The hypotheses of the study are as follows:

H.1. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail at least one academic examination than are all other students.

H.2. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail at least one flight or simulator evaluation than are all other students.

H.3. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail more than one flight or simulator evaluation than are all other students.

H.4. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to be eliminated from training for deficient performance than are all other students.

Assumptions

For the purpose of this study, the investigator accepted the following assumptions:

1. Student performance by the navigators trained at the Randolph Air Force Base campus of Joint Undergraduate Navigator Training between June 1999 and June 2000 can be assumed to accurately reflect the performance of future students.
2. The quality of training received by those students was assumed to be of the same quality as students will receive in the future.
3. Students were assumed to be giving their best effort at answering each question correctly on the Introduction to Navigation test.
4. Instructor Navigators were assumed to give equal amounts and quality of instruction to students with high and low Introduction to Navigation scores.

Limitations

The investigator accepts the following limitations:

1. An inability to access Privacy Act data that could be used to correlate other factors to successful course completion.
2. Lack of historical data from the over 50 years of navigator training at Randolph Air Force Base, Texas, Pensacola Naval Air Station, Florida, Mather Air Force Base, California, as well as navigator training done at other Army Air Corps Bases prior to training at Mather AFB.

Terminology

The following definitions are provided to clarify terms used in this study:

Air Education and Training Command (AETC)–United States Air Forces Major Command specializing in initial ground and flight training and education for all officers and enlisted career specialties.

Air Force Officer Qualification Test (AFOQT)–Primary accession and career placement test for all Air Force officers. The test has five sections: Verbal, Quantitative, Administrative, Pilot-specific, and Navigator-specific.

Instructional Systems Development (ISD)–preferred United States military training method, especially effective in training highly technical curricula.

Joint Undergraduate Navigator Training (JUNT)–Joint Air Force, Navy, marine, and Allied training school; trains Navigator and Naval Flight Officer students in basic navigation skills.

Navigator–Aircrew member responsible for aircraft position, track, ground speed, and timing in relation to an air position over the earth. Primary aircrew officers responsible for threat reaction, low-level flight safety, and the precision delivery of munitions.

Scope of the Study

The study focused on the assessment and use of the Introduction to Navigation test to predict success or failure at JUNT.

Organization of the Study

Chapter I lays the foundation of the study by providing background into the current selection process for acceptance into JUNT. Chapter II reviews literature pertaining to the history of military testing, the Instructional Systems Development (ISD) method of instruction used at JUNT, give an overview of the JUNT program, and review previous military studies completed concerning predictive testing. Chapter III describes the design of the study, sampling techniques, how the data were collected, and the statistics used to measure the results. Chapter IV is an analysis of the data and a list of findings. Chapter V contains a summary of the study, includes conclusions, lists recommendations, and offers recommendations for further study.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The review of the literature was conducted to determine what information was available that related to the use of testing as a predictor in a military training setting. This chapter will review the following topics:

1. History of Testing in Military Aviation
2. The Instructional Systems Development Method and Joint Undergraduate Navigator Training (JUNT)
3. The JUNT Program
4. Predictive Testing
5. Summary

History of Testing in Military Aviation

Military manpower and personnel research has been in the forefront of technological development ever since the innovative work in World War I to design tests and procedures to assess military conscripts. In instances such as the World Wars, the work was driven by the necessity to address severe military operational problems rapidly.

Researchers have also been motivated, however, by the push of technology and its potential for application within a military environment.

The military has a long history of screening candidates for service. During the first World War, the United States Army developed one of the first aptitude tests to screen the massive influx of personnel for likely officer candidates. According to the book Modern Educational Measurement: A Practitioners Perspective (Popham, 1990), the Army eventually tested over 1.7 million soldiers, 1.2 million of them with the Army Alpha test. That testing, however, did not screen for any special skill or aptitude.

Colonel R. M. Yerkes, United States Army, presided over the administration of the Alpha and Beta tests during World War I. At the conclusion of the war, Yerkes (1921) stated, "mental testing helped win the war. At the same time, it has incidentally established itself among the other sciences and demonstrated its right to serious consideration in human engineering" (p. 581). The writers of the Army tests developed two types of tests. Literate recruits were given a written test, the Army Alpha. Illiterate and personnel who failed the Alpha test were given a pictorial test, the Army Beta. According to the Psychological Examining in the United States Army (Yerkes, 1921), Army psychologists would grade each individual from A to E and offer suggestions for military placement. Yerkes (1921) suggested that recruits with a score of C should be marked as "low average intelligence-ordinary private. Men of grade D are rarely suited for tasks requiring special skill, forethought, resourcefulness, or sustained alertness. D and E men could not be expected to read and understand written directions" (p. 194).

Yerkes military career was highlighted by the issue of military psychology not receiving its due respect, despite its accomplishments in World War I. During World War II, Yerkes (1941) argued that the Nazis were

> upstaging America in their proper use and encouragement of mental testing for military personnel. Germany has a long lead in the development of military psychology. The Nazis have achieved something that is entirely without parallel in military history. What has happened in Germany is the logical sequel to the psychological and personnel services in our own American Army during 1917-1918. (p. 209)

The Army Alpha and Beta tests gave way to the Army General Classification Test (AGCT). Popham (1990) described the AGCT as a test of "general learning ability," aimed at "reliably sorting new arrivals according to their ability to learn quickly the duties of a soldier" while "keeping at a minimum items greatly influenced by amount of schooling and cultural inequalities" (p. 7). In World War I, aviators were selected almost exclusively for pilot training (no formal navigator or observer training existed) on the basis of desire and the suitability of entry into the officer corps. This failure to select based on objective performance standards led to a tragically high rate of training fatalities. An excerpt from Davis (1992) amplified this data:

> So stringent were the air branch's physical standards that only the finest specimens entered its training programs. Men who flew in open, unheated cockpits at altitudes well over 10,000 feet at all times of the year, without oxygen, in aircraft lacking most types of power-assisted controls required extraordinary stamina. On average, about 40 percent of each entering class completed both stages of training, although in some classes as few as 25 percent graduated. Charles A Lindbergh, who underwent flight training in 1924, recalled that only 17 of 103 members of his class completed training, and the Air Corps passed only 128 of 592 students in fiscal 1928. Moreover, from 1921 to 1938, 95 flying cadets died in air accidents. (p. 9)

The widespread use of the Army Alpha test led to the rapid proliferation of standardized tests throughout American society after the war. During that period, according to Popham (1990), the first formal training schools for military flight instructors were developed to standardize instruction and improve the quality of training. Those schools developed and administered the first flight specific standardized tests. From that beginning, standardized testing grew to encompass all areas of education and personnel education. The military continued its role as an innovator in standardized testing, testing extensively to determine individual training specialties in World War II.

With the advent of World War II, the Army Air Corps was faced with the need to train huge numbers of aviators as soon as possible. That expansion occurred within the pilot training community and in the fledgling navigator training community. A division of Embry-Riddle School of Aviation, in the middle of 1941, trained the first Air Corps navigators. At the peak of wartime production, the Army Air Corps trained 4,000 navigators a year.

Since World War Two, navigator duties have evolved from simply keeping track of aircraft position into managing increasingly complex systems. Popham (1990) relates as the career field changed, so did the testing to screen aviation candidates. The current test battery, the Air Force Officers Qualification Test (AFOQT), is administered to every potential officer before acceptance for officer training. The test is made up of sections applicable to all officer specialties: Verbal, Quantitative, and Administrative, as well as specialized sections for Pilot and Navigator aptitude. Rogers, Short, and Roach (1986), stated

> the AFOQT composite score is roughly analogous to sections of the Graduate Record Examination (GRE) and the Scholastic Aptitude Test (SAT). The pilot composite is used for classification into Undergraduate Pilot Training (UPT), and the Navigator-Technical score is used for classification into Undergraduate Navigator Training. (p. 2)

The test score is a principal factor in the acceptance of a candidate for navigator training.

Captain Deborah Rogers, Lieutenant Colonel Lawrence Short, and Bennie Roach published Mental Ability Testing in the Selection of Air Force Officers: A Brief Historical Overview (1986) which addressed the use of officer selection and classification tests from the early 1940s to 1986. Rogers, et al., stated: "Presently, pre-commissioning programs are indirectly linked to obtaining academic degree. The selection of candidates for pre-commissioning training originated out of efforts to obtain qualified students for training as military aviators" (p. 2).

The Air Force Officer Qualifying Test (AFOQT) has a long history of extensive research and development, which began with the establishment of the Aviation Psychology Program in the early 1940s. Prior to United States involvement in World War II, the Army Air Corps began to expand. With World War II came an increasing demand for aircrew personnel, requiring the need for selection and classification methods that would bring the necessary manpower but also assure quality of personnel. According to Military Personnel Measurement: Testing, Assignment, Evaluation, (Wiskoff & Rampton, 1989), the mission of the Aviation Psychology Program was to develop these selection methods. Beginning in 1920, the educational requirement for entrance into Army aviation training was high school graduation or its equivalent. Because of the increasing number of applicants for aviation training, in 1927 the educational requirement was increased to two years of college or its equivalent.

Rogers, et al., (1986) found that prior to World War II, qualification for pilot training was based on age, educational qualification, and a thorough medical evaluation, which only about 20% of the applicants could pass. Rogers, et al., continued,

> since the demand for pilots was less than 300 per year, the large number of medical eliminations was not a major concern. Most of the pilot selection work was done by the flight surgeons at the Army Air Corps School of Aviation Medicine. (p. 3)

As world tension mounted, the pilot training program continued to accelerate and new advances were being made in predicting pilot success. According to Rogers, et al., (1986) the world situation led to the Medical Division to recommend the activation of a Psychological Research Agency to develop and validate new instruments for selecting pilots. To staff the Aviation Psychology Program, the first of four Psychological Research Units was activated at Maxwell Field, Alabama. Rogers, et al., (1986) stated: "the personnel recruited and commissioned to work at the research centers were psychologists, measurement specialists, and technicians from throughout the country. Most held prominent positions at the time of their commissioning in 1940" (p. 4).

Selection of aviation training cadets was redesigned into a three-stage screening process. J. C. Flanagan, (1948) in The Aviation Psychology Program in the Army Air Forces , found acceptance for training required the applicant to a) be physically qualified, b) possess a minimum level of academic ability, as evidenced by at least 2 years of college, and c) demonstrate potential as an aircrew member. Flanagan stated,

> Because of the large number of aircrew personnel needed and the shortage of physically qualified college students in 1941, one of the first tasks of the Aviation Psychology Program was development of a general studies test to replace the college requirement. (p. 48)

The bombing of Pearl Harbor in 1941 caused the requirement for aircrew personnel to increase dramatically, creating a difficulty in meeting the demand. The need for new procedures for selection and classification of aircrew personnel, pilots, navigators, and bombardier had become critical.

The test developed by the Aviation Psychology Program was a 150-item test known as the Aviation Cadet Qualification Examination (ACQE). The first test was administered to over a million men during the war years. F. B. Davis, in his The AAF Qualifying Examination (1947), stated: "the ACQE was used for the preliminary selection of only the commissioned officers and flight officers in the aircrew—pilots, bombardiers, and navigators" (p.1). The composition of the ACQE consisted of paper and pencil tests as well as psychomotor tests. The biggest changes to the test batteries came in September of 1944 when Davis (1947) stated

> It was decided that separate classifications should be made for the bomber and fighter pilots, as the training and aptitudes for these specialties differed. The original three composites—Pilot, Navigator, and Bombardier—were expanded to seven. They were Bombardier, Navigator, Bomber Pilot, Fighter Pilot, Aerial Gunner, Air Mechanic Gunner, and Radio Operator-Gunner. (p. 51)

The ACQE remained the officer selection test of choice from 1942 to 1955, when the Air Force Officers Qualifying Test came into standard use.

A version of the Air Force Officer Qualifying Test was designed in 1951 with the goal of predicting success in Officers Candidate School (OCS) as well as screening for aircrew training. Valentine and Creager, (1961) in Officer Selection and Classification Tests: Their Development and Use stated:

> Beginning with AFOQT, Form C, a three-year usage cycle across officer procurement programs (including Air Reserve and Air National Guard) was introduced. Each new form of the battery was used in selecting one Air Force Academy class, and then implemented operationally in other officer procurement programs (excluding Air Reserve and Air National Guard). One year later the form was released for use in the Air Reserve and Air National Guard programs. A new form of the battery was produced each year. This usage cycle continued without interruption through Form E which, in 1959, was put into use in the Air Force's new Officer Training School program as well. (p. 4)

During the first four decades of operational use, the AFOQT used four different normative bases: West Point cadets, United States Air Force Academy (USAFA) cadets, an indirect link to USAFA using experimental test batteries, and an experimentally designed, representative sample of the ideal applicant population, according to Roach and Rogers (1982) in Development of Common Metric. Each form of the test battery was standardized on some identifiable reference group. A method was developed in 1980 which placed three successive forms (L, M, and N) of the AFOQT on a common measurement scale.

In each new AFOQT form, a certain proportion of items were obtained from the previous version. These items are known as anchor items and are used to provide continuity between successive forms. W. H. Angoff in his Scales, Norms, and Equivalent Scores (1971), stated:

> Through the use of anchor items and a method of equi-percentile equating, it is possible to equate AFOQT Form M to Form N. Thus, two successive forms of the AFOQT were linked to the same normative base to each other. The most immediate advantage of this procedure has been the

> development of a very large database which has improved AFOQT research and development. (p. 508)

A variety of measures are currently used to screen aviation candidates. College grades, college entrance examination scores, AFOQT scores, work experience, and the like were incorporated into the selection process, as predictive values of each became apparent. The use of aptitude measures and other tests designed specifically for aviation selection has evolved over the years as well. Wiskoff and Rampton (1989) conclude that although some documentation of the development of officer and aviation selection tests exists, little (and incomplete) historical information exists on other selection measures and the development of the selection process as a whole.

The question of why the selection of a comparatively few individuals for aircrew training has received so much attention has often been posed. Some argue that it is because of the essential nature of the aviator's job, the level of responsibility for an increasingly expensive aircraft, and the aviator's relative independence of action. Wiskoff and Rampton (1989) believe that in the final analysis the answer centers on money. Aviation training is, almost without exception, the most expensive of the many training programs conducted by the military services. Two factors contribute to this expense. First, it takes a long time to train an aviator. The second is the cost of operating the aircraft in initial and subsequent operational transition training.

Because of high training costs, each service has developed extensive procedures for screening aviation trainee applicants. All services administer paper and pencil cognitive ability tests. Some services, notably in the United States, have developed extensive paper and pencil test batteries, according to Wiskoff and Rampton (1989), which take many hours to administer. Other countries, however, such as the British, use only a single paper and pencil test, and place more emphasis on psychomotor coordination testing. With the exception of the Unites States, which abandoned psychomotor testing in the early 1950s, all countries have psychomotor tests. The use of personality and biographical measures is also widespread, with some countries, like the United States, using a short biographical inventory. Others, like the Scandinavian countries, have an extensive battery of personality tests.

In 1982 the Department of Defense (DoD) published a report, Profile of American Youth: 1980 Nationwide Administration of the Armed Services Vocational Aptitude Battery, which had a principal objective of assessing the vocational aptitudes of a nationally representative sample of youth and to develop current national norms for the Department of Defense enlistment test. The results of this study have proven helpful in addressing the issue of the compatibility between complex and demanding military weapon systems and personnel capabilities.

From the mid-1940s until 1980, according to the 1982 Department of Defense report, the aptitude levels of military recruits were referenced statistically to the extensive testing of adult males that took place in World War II. The Department of Defense and Congress questioned the appropriateness of using World War II "reference population" as a primary basis for interpreting the test scores during the 1980s and beyond. In 1979 the vocational abilities of youth were examined to gain a better understanding of the quality and representatives of military accessions.

The National Opinion Research Center administered the norm-referencing test to a national sample of nearly 12,000 young men and women during July through October 1980. The sample was already under study in the National Longitudinal Survey of Youth Labor Force Behavior, sponsored by the Departments of Labor and Defense. The young people tested were representative of all youth in the United States, ages 16 to 23. The sample contained approximately equal proportions of males and females, including individuals from urban and rural areas, and from all major census regions. The analyses conducted in the profile study focused upon young people who were 18 to 23 years of age at the time of testing. Four sub-tests, word knowledge, paragraph comprehension, arithmetic reasoning, and numerical operations, served as the general measure of trainability and the primary criterion for enlistment. The test was used as an index for comparing the test performance of civilian and military groups. The analyses contained in this report included comparisons of the 1980 youth population with the World War II reference population. The results included:

1. The median test percentile score for 1980 male youth was 53, compared to 50 for World War Two populations of adult males.
2. Males scored higher than females on Mechanical, General, and Electronics composites, while females outscored males on the Administration composite.
3. The average score for whites was considerably higher than those of either Hispanic or black heritage.
4. Test scores showed a clear relationship to levels of educational attainment.

5. Average percentile scores were highest in the New England and West North Central regions of the country, and lowest in the three southern regions (p. 19).

Navigator Training

For a better understanding of how the Introduction to Navigation (IN) test relates to using the test as a predictive measure for overall Navigator training, a closer look at the history and background of military Navigator training is required. According to Launor F. Carter, editor of Psychological Research on Navigator Training (1947), little was known about training requirements for navigators prior to World War II because of little aviation experience. Just before the start of World War II, the Army Air Corps initiated a program of psychological research on the problem of selecting candidates for aircrew training. The intent of the program was to develop a procedure for the selection of navigation candidates based on job requirements and tests, which at the time, seemed to measure the skills required of a navigator.

Carter (1947) started defining the measures required navigators by stating four phases of the navigator job description:

1. A complete description of navigation and the navigator's job.
2. The training of the navigator.
3. A description of the navigator in combat.
4. The attributes of a successful navigator.

Carter's (1947) work was the first in the area of looking at the navigator position and by analyzing the job requirements and training stresses, attempted to predict the attributes necessary for successful completion of training. Carter (pp. 27-28) noted differences in the following areas:

1. Learning technical vocabulary.
2. Fear of technical terms.
3. Trigonometry (practical understanding essential).
4. Visualizing spatial relations.
5. Arithmetic inspection.
6. Computer use.
7. Draftsmanship (ability to draw and label clearly).
8. Motor skill.
9. Method planning (ability to organize details into efficient courses of action.)
10. Adaptability to varying conditions (ability to adjust to new conditions suddenly).
11. Confidence in results of own work.
12. Interest.

Carter's (1947) next step was to determine the attributes necessary for a successful completion of navigator training. He found the primary attribute to be "intellectual ability." He stated,

> It is essential to have enough educational background and verbal comprehension to complete navigator training. Other attributes included the ability to perform numerical operations quickly and accurately, to reason and solve arithmetically in minimum of time, to make good judgements on the basis of his knowledge, to deal correctly with a multitude of details, and to organize a sequence of operations into an efficient plan and follow it methodically with distinct carefulness. These characteristics are partly intellectual abilities and partly work habits stemming from personality traits. (p. 28)

The emotional or personality traits of a successful navigator were difficult to define. While the navigator must work methodically, Carter (1947) believes he or she must be flexible enough to adjust readily to new circumstances and be able to change plans at the last minute and improvise when unforeseen difficulties arise. He must adapt to inconveniences such as cramped working quarters in turbulent flight and not too rigid to adapt to new circumstances or become unduly disturbed when things frustrate him. He must do accurate and routine work under strain and emotional conditions. He must have confidence in his work and not be readily willing to discount it when it does not agree with expected results. He is also characterized by interest in his job, and satisfaction from solution of mathematical and navigational problems. In addition, he must be willing to accept the responsibility the job necessitates.

While Carter's work was the first to attempt predicting success in navigator training, little research was done in the post World War II era. During this period of little research into the makeup of a successful navigator, technology has been continuously changing the requirements and job description. Along with changing technology has come a changing world, and increased budgetary pressures internal to our own military. Reduced training budgets have impacted the numbers of navigators entering training.

Historically, the United States has always scaled back military strength in times of peace. According to Snow and Drew (1994), in From Lexington to Desert Storm, this trend started after immediately after the American Revolution. Snow and Drew stated "The Continental Army in 1784 had a total active duty strength of 80 soldiers protecting military stores" (p. 261). The peace trend, coupled with increased automation and dwindling numbers of multi-place aircraft, caused navigator training demand to drop throughout the Cold War to a post-World War II low of 120 in fiscal year 1992. The 2000 Air Force Almanac identifies overall active duty Air Force strength dropping from 426,000 in 1994, to a projected 357,000 in 2001 and active duty officers have declined from just over 81,003 in 1994 to 69,587 in 2000. The peace dividend has been reflected in the dwindling Air Force budget, as the Almanac identifies a decline in constant Fiscal Year (FY) 2001 dollars from over $112.1 billion in 1994 to $83.7 billion in FY 2000.

The emergence of the United States as the lone superpower has thrust the United States Air Force into the increasingly demanding role of global force projection. During the Cold War, the use of the military Instrument of Power was relegated to defense of what the United States National Security Strategy defines as vital interests. American vital interests are those broad, overriding interests that are important to the survival, safety, and vitality of our country. Among those are "the physical security of our territory and that of our allies, the safety of our citizens, the economic well being of our society, and protection of our critical infrastructures" (p. 1). Since the end of the Cold War, however, the military has been engaged in efforts considered important or humanitarian levels of interest. Just since 1994, according to a staff briefing given by

Lieutenant Colonel Ronald Wiegand, the United States has been involved in Operations Uphold Democracy in Haiti, Vigilant Warrior in Somalia, Southern Watch in Saudi Arabia, Northern Watch in Turkey, the Counter Drug effort in Central and South America, Desert Fox and Desert Thunder in Saudi Arabia, and Allied Force in Kosovo. The associated increased operational tempo has sharply increased the demand on the training production of navigators.

During a February 2000 telephone interview with Joy Noerthern, chief of 12th Operational Support Squadron Student Accounting office, current plans project a steady state production from JUNT of three hundred and fifty Air Force navigators each year through the year 2004. This increased production comes at a time of fiscal austerity and manning shortages among the ranks of experienced operational navigators. The shortage is being exacerbated by a dwindling number of instructor navigators. The instructor shortage limits the ability to increase student population. While increased production has been mandated, a proportional slippage in graduate quality has not. With dwindling Air Force manpower and tighter budgets, JUNT must find a way to allocate its training more efficiently and effectively. Such an allocation is needed to ensure graduate quality and also to eliminate the unnecessary drain on both funds and instructor time.

The Instructional Systems Development Method and JUNT

Any use of testing as a predictor of future success or failure must ensure that all students receive the same opportunities to learn. No student should have an advantage over another in the attention or methodology of individual instructors or in the use of training apparatus. To ensure standardization of training, methodology, and instruction, JUNT utilizes the Instructional Systems Development (ISD) method of teaching academics.

Instruction by objectives in the ISD format can have pitfalls. McConkey (1972) wrote a checklist of pitfalls which can cause failure to any system revolving around objective based criteria. The 20 practices as spelled out by McConkey (pp. 8-9) and synthesized for instruction are:

1. Consider the objectives a cure-all.
2. Tell instructors their objectives.
3. Leave out phase (or middle) managers.
4. Delegate executive direction.
5. Create a paper mill.
6. Ignore feedback.
7. Emphasize the techniques versus the procedures required for performing the objective.
8. Implement overnight.
9. Fail to reward excellence.
10. Have objectives but no plans.
11. Stick with original program.
12. Be impatient.
13. Quantify everything.
14. Stress objectives, not the goal of learning a skill.

15. Dramatize short-term objectives.

16. Omit periodic reviews.

17. Omit refresher training. AETC refers to this as additional training.

18. Don't blend objectives. (fail to coordinate all objectives)

19. Be gutless. Fail to establish priorities. Avoid expressing your own objectives in specific terms.

20. Refuse to pay attention to detail.

In Implementation of Instructional System Development in the U.S. Army, Anderson, O'Neil, and Baker (1991), the focus is on the first 10 years of ISD implementation by the Department of Defense, keying on the Army. Interview data collected from key military training practitioners and researchers throughout the Department of Defense revealed a number of recurring themes that may be helpful in understanding ISD difficulties within the military. These themes include:

1. Renewed interest in conventional instructional approaches.

2. Negative review of computer-based instruction.

3. Computer-assisted instruction used as an expensive automated page turner when a book could serve just as well.

4. The resource intensive nature of the ISD process.

5. Documentation of ISD is not particularly helpful.

6. The lack of adequate professional education and training for the ISD personnel responsible for implementing the process.

The 1991 study did not provide a single answer for the ISD problems, but seemed to focus on management and its key role in ISD implementation.

A meaningful instructional system to accurately standardize training is absolutely essential in our fiscally restrained times. It is a virtual prerequisite to ensure that trainees are learning what they are expected to learn at a reasonable rate, and to be certain that training devices and methodology are supplying satisfactory conditions for learning.

JUNT is faced daily with the complex problem of deciding what devices are best suited to a given training goal, and how to best equip instructors with a means for increasing student progress for purposes of evaluation and feedback. A derivative, but crucial, use for reliable instructional systems is that they can tell us how successful existing devices are in accomplishing their intended purpose, and how improvements may be achieved in future devices or methodologies.

Learning is an ongoing process. The ISD training scheme provides optimum conditions for learning and is adept at handling changing requirements. To ensure that training is periodically adapted to the needs of the student and instructor, procedures for reviewing the effectiveness of the training are necessary. Prior to instructing a classroom full of students, each instructor is required to attend Academic Instructor School (AIS). This course teaches instructors on the procedures and techniques associated with platform academic instructing by objectives. The course was taught at Randolph Air Force Base, Texas, until 1995, when the course was transferred to Shepard Air Force Base (AFB), Texas. The evaluation to complete the course is for each individual to instruct a course he or she developed utilizing the Instructional Systems Development format of instruction. The actual course content undergoes periodic review by the 619th Operations Support and Training Squadron at Randolph AFB.

After completion of AIS, instructors must complete the follow-on-training (FOT) before instructing in a classroom by themselves. The initial step in the FOT process is to acquire an instructor's guide (IG) for the subject matter to be taught. The IG contains the objectives for each block of instruction. The individual instructor has the responsibility to fill in the IG with personal techniques to ensure the overarching objectives are met. After personalizing his or her IG, the instructor sits through the entire course, monitoring a fully qualified academic instructor teach the material. The final step in the FOT process requires the student instructor to teach the academic courses, while being observed by the fully qualified instructor.

Instructor guides are designed to provide the instructor with the information necessary to accomplish the unit of instruction. The objectives for each unit are stated in specific behavioral terms and identify exactly what the students are expected to accomplish. The instructor guides are prepared in a columnar format. The column on the left side of the page specifies information that must be presented. The right column lists instructor/student activities and is used for instructor notes.

The required items to be included in the beginning of an instructor's guide for a specific block of instruction include the lesson title, the lesson identification number, the student/instructor ratio, and the time required to complete the block of instruction. This information is generally referred to as header information. An example of header information is shown in Figure 1.

Lesson ID	Title	Student/Instructor ratio	Hours
IQC 01	Introduction to Core	20:1	1

Figure 1. Instructor Guide Header Information.

Statement of the lesson objectives is next. The statement must include the given materials and the required behavior at the end of the session. The objective of the above stated lesson, Instructor's Qualification Course (IQC) 01, as stated in the Randolph Air Force Base Navigator/Naval Flight Officer (NFO)/Electronic Warfare Officer (EWO) Instructor Guide, N-V9D-IT is: Using Core publications and a briefing on the Core Instructor Qualification Course, become familiar with the Core Instructor Qualification Course. This objective, while very broad, is appropriate for an introductory session introducing a student instructor to the course they are about to take.

The scope statement gives an overview of where the student is in training in relation to the rest of the course and ties in the stated objectives of this block of instruction to the greater syllabus. An example of a scope statement for our IQC course example is:

> The instructor trainee has completed Basic Aircrew Qualification training and has a working knowledge of T-43 operations. This unit will serve as the background for the remainder of Instructor Qualification training.

All methods of instructional aids an instructor would need to teach the course are listed next. Also listed are the required items for the student to successfully complete the block of instruction. The instructional aids required for IQC 01 are:

1. Instructor

    a. Checkout folder (one per student instructor)

    b. Dead Reckoning Student Workbook and Integrated Navigation Student Workbook

    c. Core Missions Instructor Guide

    d. Slide kit

2. Instructor trainee

    a. Core Missions Instructor Guide

The instructor has the responsibility to review the required items prior to the beginning of each course. The instructor also has the responsibility to ensure each student is cognizant of the required items to successfully complete the block of instruction.

The Introduction for the block of instruction is then given. The required items in the Instructional Systems Development format to begin the actual block of instruction include an introduction, a motivation step, review of previous blocks of instruction, and a preview of the block of instruction about to be covered. The introduction, motivation, and review are at the discretion of the instructor to meet the needs of each individual class. The preview is given to the instructor in the instructor guide. The preview for the IQC 01 course is:

1. ITS administrative procedures

2. Core overview

3. Instructor training events

4. Initial instructor checkride requirements

Therefore, the instructor is required to cover those items in the information given in the class.

The information section to be covered in the course gives more detail to ensure the objectives and scope are sufficiently completed with the required information. If the block of instruction is a course to expose the class to data, then the information section would be very detailed. If the block of instruction is a course to physically complete a skill, then the information section may make only one broad statement. The instructor determines how to best present the procedures associated with that skill. Because our IQC 01 example is an introductory course, it makes sense that only data would be passed on to the student and no skill be performed. Therefore, we would expect a detailed information section, which is the case. The information section for IQC 01 is as follows:

1. Instructor Training School (ITS) administrative procedures
    a. Turn in: 60-1 folders and packets, and 60-1 completed critiques
    b. Distribute instructor folders and Dead Reckoning and Integrated Navigation study guide workbooks.
    c. Call in daily—1530-1700
    d. Discuss scheduled adjustments: Duty Not Including Flight (DNIF) status, appointments, household goods shipment, baby due, physicals, altitude chamber, key personnel brief, records review, etc.
    e. Go by squadron and sign all copies of 60-1 qualification checkride
    f. Check boxes at ITS and squadron

2. Core overview

   a. Phases of training

   b. Flying/simulator events

   c. Track system

3. Instructor training events

ITS Core Instructor Qualification Handout

   a. 4 flights, 2 simulators

   b. ITS checkout—explain

   c. Stress importance of preparation for each sim/flight

   d. Explain how to prepare:

      (1) Flight

      (2) Simulator

   e. Instructor Grade Sheet

      (1) Heading

      (2) Subtask area grades

      (3) Original and carbon copies—where they go

4. Initial instructor checkride

   a. I-2/I-3—2:1 ratio

   b. Students—Core phase

   c. Don't forget question and answer from qualification check (emphasis will be on instructor scenarios)

Noticeable in the example is that the format followed in the information section follows the preview section exactly.

To bring the block of instruction to a close, a conclusion section is included in the instructor guide. Items included in the conclusion are the summary, remotivation step, and any assignment the students need to complete before the next class session.

The students are given a test at the end of each phase to ensure they have acquired the knowledge and skills necessary to continue training. But who watches the instructors after the FOT process to ensure a measure of quality of instruction is present in each and every class? A review process is in place in the Air Education and Training Command chain of command which requires an instructor's Flight Commander to monitor an instructor teach a minimum of once every six months. Additionally, the phase manager (the instructor responsible for course content correctness), is required to monitor the instructor once every six months as well. Therefore, every instructor is required to be monitored instructing an academic course a minimum of twice every six months. Additionally, the squadron or operations group standardization/evaluation office is required to give an academic "checkride" for every instructor at least once a year.

> To be effective, evaluation of training and development must be conducted in such a way that it is consistent with the purposes, objectives, and goals of the training activity and is in accordance with accepted and proven principles of evaluation. (Tracey, 1968, p.14)

The JUNT Program

According to the 1997 National Military Strategy of the United States of America, the United States . . .

> Armed Forces are the preeminent military force in the world, persuasive in peace and decisive in war...Equally critical to the success of strategy are the men and women who comprise our military forces. We must continue to recruit, train, and maintain a high quality force to ensure our nation's security. (p. 4)

The Air Force JUNT program produces the most highly trained navigators in the world. This high quality is accomplished through an incremental, standardized training program, known as the "building block approach" (Nineteenth Air Force, 1999). Students are taught a series of individual tasks and then taught how to link these tasks together to perform the navigator mission. As the student progresses through training, task difficulty is increased, while the number of tasks to accomplish also increases.

The nation needs service members who are educated and trained. The way military forces are used in highly charged and complex "peacetime" politicomilitary environments clearly require more than a military man or woman narrowly attuned to a combat task. According to S.F. Kime in his Army Times article, "Train First But Educate, Too," (1997) what a superpower military establishment must have in a modern world is an individual whose mind and spirit have been stretched beyond his or her narrow task-related identity. Kime states, "The ideal service member is trained to the highest possible level to complete the tasks associated with the military mission, and educated to his or her capacity to adapt to a rapidly changing and complex environment" (p. 27).

Kime (1997) continues to promote the importance of military training in the coming millennium by stating that increased emphasis on training causes the force to develop intellectually, enhance promotion potential, and allow full implementation of national policy. He promotes the concept of training the entire person, not to specialize only in technical education.

Navigator training encompasses academics, aircraft ground based flying simulator, and actual flight training. In the JUNT curriculum student academic training covers Aerospace Physiology, Weather, Flight Regulations, Introduction to Navigation (which covers individual navigator skills), Dead Reckoning (the basic form of navigation), Integrated Navigation (which introduces RADAR and navigational computers), Instrument Procedures, Crew Resource Management, and Airmanship (slow speed low-level navigation). Each of these tests is graded on a percentage of correct answers. A minimum passing score is 85%. Any combination of three academic failures, simulator evaluation failures, or flight evaluation failures will result in elimination from navigator training (Nineteenth Air Force, 1999).

Flight training and aircraft simulator training make up the performance areas of JUNT training. Throughout performance training, students are evaluated using an objective grading scale. Each mission is broken down into its component parts, or sub-areas. Each sub-area is graded on a scale of 0 to 4. A 0 indicates that an item was demonstrated by the instructor to the student. A score of 1 indicates that the student was unable or unsafe in performing the task. A score of 2 indicates limited proficiency, the ability to accomplish the task while receiving instructor assistance. A score of 3 indicates that a student is proficient and can accomplish the task within the standard outlined in the syllabus of instruction. A score of 4 indicates that a student's performance was skillful, smooth, efficient and while not error free, only minimal deviations occurred. Students are expected to achieve the proficient (or 3) level by the completion of each performance phase. Dead Reckoning, Integrated Navigation, Airmanship, and Instrument Procedures are the performance evaluation known as a checkride. The Integrated Navigation phase contains an additional checkride conducted in the simulator near the end of that phase. If a student fails to achieve at least a 3 level in every graded sub-area on a checkride, he or she fails the checkride. Any combination of three checkride or academic test failures while in JUNT training results in student elimination. The course training standards are contained in the Nineteenth Air Force Syllabus of Instruction, N-V8V-C, Joint Undergraduate Navigator Training. The process for student training elimination is contained in Air Education and Training Command Regulation 51-1 Flying Training, Undergraduate Flying Training.

Predictive Testing

The common purposes served by measurement and assessment of human performance are useful and important. Angel, Shearer, and Berliner, (1964) in Study of Training Performance Evaluation Techniques stated: "a recapitulation of those major purposes may provide a part of the background for considering performance evaluation in the training environment" (p. 28). Following are what the study sees as the three foremost reasons for assessing performance by the application of standard and objective measurement operations (p. 33):

1. To determine the adequacy with which an activity can be performed at the present time, without regard, necessarily, for antecedent events or circumstances. These are measures of achievement.
2. To predict the level of proficiency at which a person might perform some activity in the future, if, say, he were to be given instruction concerning the activity. These are measures of aptitude.
3. To observe the effects upon performance of variation in some independent circumstances such as (a) instructional techniques, (b) curriculum content, (c) selection standards, (d) equipment configurations, or the like. These are measurements of treatment efficacy.

This list of measurement purposes is shorter than many other such lists. Additional reasons for measuring performance are frequently offered, according to Angel, et al., (1964), such as the diagnosis of strong and weak areas of proficiency, selection of persons for promotion or advancement, and plotting the rate at which learning is taking place. Our study focuses on the second of the three listed reasons for assessing performance, which is the measure of aptitude.

The purposes which aptitude measurement is intended to serve determine, or at any rate they interact with, the time when measurement operations are applied. Because three major purposes of performance evaluation exist, Angel, et al., (1964) believed three general periods exist in which to obtain measures of performance proficiency. These are (a) before any instruction is given, (b) after the completion of training, and (c) while training is ongoing. It is convenient to refer to these as initial measures, terminal measures, and interim measures.

The JUNT Introduction to Navigation test falls under the category of a terminal measure. According to Angel, et al., (1964) terminal measures are post-training measures ordinarily made when the testees are "on the job." These measures are intended to provide evidence of the adequacy with which a task or a mission is currently being performed. Assessing criterion performance will almost always involve sampling from the large number of specific behaviors and activities involved in the performance of a job. It will also involve, more likely than not, the use of actual operational equipment. The Introduction to Navigation test fits the terminal measure definition perfectly, with the use of a test to sample specific flight related activities with actual equipment the students will use operationally.

While the actual Introduction to Navigation test may be a terminal measure, use of the test as a predictive tool constitutes an interim measure. Interim measures evaluate training during training. The Introduction to Navigation test falls near the beginning of the JUNT curriculum. Assessing this test as an interim training predictor of success or failure is the overarching purpose of our study.

A number of specific reasons exist for evaluating performance during training other than the financial concerns of the Air Force. The measures may be used to assess the effectiveness of the training program, or of some component of the total training system; they may be used to identify trainees who require additional or different instructions; they may also be used to maintain a high level of motivation. Basically, though, Angel, et al., (1964), believed interim performance measures are made because they are more accurately predictive of terminal proficiency than are measures made earlier, before any job-relevant activities had been experienced.

> Interim measures should be more accurately predictive, because learners, during the training process, will have been exposed to circumstances, events, and equipment which resemble those they will encounter on the job. Interim measures which take such experience into account ought to provide better information about trainees' chances of performing a job satisfactorily than measures which do not include such experience. (p. 44)

According to Angel, et al., (1964), "the application of interim performance measuring procedures as a predictor during a training program inevitably results in some attrition of the student population" (p. 51). Assessments made at different times (that is, after testees have had different amounts of job-relevant experience) may lead to different results. The measuring tool used for initial selection cannot easily take into account many of the things which may be importantly related to job success, but interim measures take more and more of these into account as the training goes forward.

More than anything else, Angel, et al., (1964) stated: "improvement in the accuracy with which measures predict terminal performance levels is a function of the similarity of the testing conditions to the operational conditions" (p. 64). This statement takes us back to the role of standardized instructional format (ISD) and training equipment during training.

In researching the uses of testing to predict future performance several facets gained importance. The use of standardized tests to guide institutional personnel decisions was well researched by Cronbach and Gleser (1965) in Psychological Tests and Personnel Decisions. They stated that:

> Tests are especially helpful when used in connection with institutional decisions about personnel for here is a backlog of information from similar situations in the past, and the expectation is that many similar decisions will have to be made in the future. The institution is not likely to be hurt badly by a single bad decision about the selection or rejection or classification of any individual. And tests, in their place, can provide information that may increase the accuracy of prediction in the long run. (p. 73)

The JUNT Introduction to Navigation test fits this situation. Cronbach and Gleser (1965) continued on to state that the standardized tests were not a good tool for individuals to use because they do not possess the ability to accurately interpret what the score is telling them. This problem of interpretation crops up over and over in the literature. Testing professionals are unequivocal in their support for the tests to be created, administered, and interpreted by professionals. Interpretation of test results was stressed most strongly by Lyman (1978) in his book Test Scores and What They Mean. A key aspect to test score interpretation is identifying the type of test being administered. The Introduction to Navigation test falls into the category of Maximum-Performance tests.

A Maximum-Performance test asks the examinee to do his or her best work as opposed to their typical effort, and it measures ability, either attained or potential. Maximum-Performance tests assume all subjects are equally and highly motivated. According to Lyman (1978), "At least three determinants are involved in every score of a test of maximum-performance: innate ability, acquired ability, and motivation" (p. 117). With the Introduction to Navigation test the source of ability is moot. Motivation is easily assumed to be high because of the competitive process involved in obtaining a training allocation. Popham (1990) lists some examples of when tests can be used for institutional decision making: Fixed Quota Settings, choosing the most qualified; Requisite Skills Settings, where basic skills needed to progress are assessed; Counseling; Program Evaluation; Institutional Design; and Large-Scale Resource Allocation. The Introduction to Navigation test falls most easily into the Requisite Skills area. Popham (1990) goes on to detail evaluation factors for tests. He asks questions such as the following: Does it describe the measured behavior? Would missing one question entail poor assessment of ability in that area? What is the scope of the measured behavior? Is it checking for entry level or graduate skills? What is the reliability of the test? How consistent is the test? Is the test a valid predictor? Does it measure what it is supposed to measure? Is the test free of bias, either cultural or institutional? Is the test easy to administer?

A great deal has been written about bias on standardized testing after the controversies of the 1960s and 1970s. These cultural biases, if contained in the Introduction to Navigation test, would have no bearing as the Introduction to Navigation test measures ability. Possessing the ability to continue training, regardless of the source of this ability, is the concern for the Air Force. The National Academy of Science's Ability Testing: Uses, Consequences, and Controversies (1982) is an excellent book detailing the extent of cultural bias. It has one point pertinent to the application of the Introduction to Navigation test scores. It states that on standardized tests, hard cutoffs are bad. A candidate who scores barely below the cutoff is no more likely to fail than a candidate who scores barely above it.

The Introduction to Navigation test, like all tests, does not test just innate ability. Victor Martuza (1977) stated in Applying Norm-Referenced and Criterion Referenced Measurement in Education, "tests don't measure only innate ability; they measure a great deal more . . . any ability test (aptitude, intelligence, or achievement) always measures some combination of innate ability, the influence of one's environment, and one's motivation" (p. 148). The Introduction to Navigation test that is administered immediately after 15 hours of classroom academics in that phase of training can be used as a point of reference for the student's supervisor to target the student for additional help. The Introduction to Navigation test evaluates general arithmetic, individual navigator skills, and translating aviation concepts to application using the MB-4 computer, also known as the Whiz Wheel.

The military has conducted predictive tests on many officer and enlisted career specialties in the past half century. A 1962 Navy study conducted by Wollack and Guttman attempted to predict Officer Candidate School (OCS) and post-OCS success using Officer Candidate School ten experimental speeded tests. The purpose of Wollack and Guttman's (1962) Prediction of OCS Academic Grades and Post-OCS Performance of Junior Officers with a Battery of Speeded Tests was to maximize the predictive value of selection instruments for the Bureau of Naval Personnel.

Wollack and Guttman (1962) examine the relationship of officer performance, at OCS and post-OCS duty stations, to selection tests containing a large speed component. Their rationale was derived from interviews with OCS instructors who suggested that the ability to work under speeded conditions, as the heavy OCS schedule demands, might be critical to success. Wollack and Guttman tested 405 members of two OCS classes in 1961. The experimental speeded tests included (p. 2): arithmetic reasoning, numerical operations, arithmetic memory, verbal reasoning, reading speed, reading comprehension, color naming, hand skills, error finding, and problem solving. Two criteria were used. First were the OCS academic grades, and the second consisted of Officer Fitness Reports and Junior Officer Activity checklists for the post-OCS period.

Wollack and Guttman (1962) found that speeded tests "did not consistently add to the prediction of OCS academic grades" (p. 8) for the first criterion. Results from the second criterion also showed that speeded tests did not predict post-OCS performance.

In 1962 Louis P. Willemin conducted the study Prediction of Officer Performance for the United States Army Personnel Office. The study goal was to "develop improved techniques and prerequisites for identifying officers who have aptitudes and other characteristics to meet the demands for successful performance in different types of officer command responsibility" (p. 7). The Army Personnel Office centered the study of prediction of ability to meet the psychological requirements of three types of officer assignment—technical, administrative, and combat. The research program developed a battery of experimental tests called the Differential Officer Battery and the determination of the tests effectiveness in predicting officer performance in the three areas. The predictive battery tests were validated by the Officer Evaluation Center in June 1961 and were administered to over 6500 officers in 1962. Completion required two days of pencil and paper tests, plus one hour for the physical skills test, and another hour for Officer

Potential Ratings. The tests were given in the seventh week of the Officer Orientation Course at several training bases.

The Army Personnel Officer (1962) study found a significant correlation between the technical, administrative, and combat tests and officer performance. The experimental tests were utilized as "new personnel management tools that will permit greater discrimination in the assignment of officers, particularly newly commissioned Reserve Officer Training Commission (ROTC) graduates serving a two year obligated term of service" (p. 44).

The United States Navy compared predictive tests in a study done by Edward F. Alf, Jr.(1963), Comparison of Predictive and Concurrent Validities of Basic Test Battery Test Scores. In the study, the same test, the Basic Test Battery, was administered twice to the same individuals. The United States Navy used the test scores on training day four as a predictor of capabilities for placement in student leadership positions. In this study, the test scores given on training day four were labeled "predictive" (p. 2) and the test scores attained after graduation were labeled "concurrent" (p. 2).

The Navy study showed a 5% increase in scores between the predictive and concurrent tests (p. 7). The apparent superiority of the concurrently administered test could have been a function of "practice effects. These practice effects should be minimal, however, inasmuch as three or more months elapsed between test administration" (p. 6). An alternative explanation for the higher concurrent scores instead of practice effects "more consistent with the data, is that it is the time of testing which is important; the test performance of some recruits may be unduly lowered by the excitement of the first days in the Navy" (p. 6). The presumption being that the recruits were more relaxed and had attained a more stable adjustment to the Navy environment after graduation.

The Comparison of Predictive and Concurrent Validities of Basic Test Battery Test Scores (1963) findings

> tend to suggest that differences between predictive and concurrent validities and means might well be a function of the type of test being used. A more thorough knowledge is needed of the degree to which different types of tests are affected by differences in testing times and conditions. (p. 6)

The study concluded: .

> Consequently, an investigator would be well advised to question the apparent superiority of an experimental test, even if it seems, on the basis of concurrent validation, that its validity is significantly higher than the predictive validity of its operational counterpart. (p. 7)

The United States Army sponsored a June 1965 study Prediction of Success in Army Aviation Training. The Army, like the Air Force, has experienced a continuing personnel management concern since the formation of the Air Force in 1947. The Army design was to establish requirements for the development of instruments to select officers as fixed-wing pilot trainees. To meet the requirement, experimental testing of 1200 officers and 1200 Reserve Officer Training Commission (ROTC) cadets was conducted.

Previous to the Army's Prediction of Success in Army Aviation Testing, the Air Force had conducted some research on fixed-wing pilot selection. To take full advantage of the Air Force products, initial Army research on fixed-wing selection was limited to the modification and adaptation of Air Force instruments and follow-up studies to determine their effectiveness in Army pilot training. According to the Army study, the first test battery was based on Air Force tests and included "background information, aeronautical information, mechanical principles, aircraft orientation, and flight visualization tests" (p. 4). Predictor data were obtained by administering the adapted Army test at Camp Gary, Texas beginning in August 1957 for a one-year period. For Army fixed-wing aviation, the policy of adopting, and adapting, Air Force instruments proved economical and fairly satisfactorily, because the training performance to be predicted was essentially the same.

The Prediction of Success in Army Aviation Training (1965) findings stated:

> selection tests initially developed by the Air Force and modified for Army use were effective in predicting fixed-wing training success for officers and ROTC cadets. Selection tests developed by the U.S. Army Personnel Research Office were effective in predicting the success of enlisted applicants for warrant officer candidate preflight and rotary-wing training. (p.71)

The study further recommended the consolidation of the separate selection procedures into a comprehensive program.

McGrevy, Knouse, and Thompson's (1974) Relationships among an Individual Intelligence Test and Two Air Force Screening and Selection Tests investigated the relationship of the Armed Forces Qualification Test (AFQT) and the Airman Qualifying Examination (AQE) to the general mental ability of different racial groups of airman. A sample of 100 black and 100 white Air Force basic trainees were administered an established test of general mental ability. The Intelligence Quotient (IQ) test scores of the sample population were then compared to their AFQT and AQE scores. The purpose of the study was to ensure the initial screening and subsequent classification of applicants occurred to accurately define the abilities of the manpower available, while maintaining a fair and unbiased selection process.

McGrevy, et al., (1974) found significant positive relationships between AFQT and AQE performance and performance on a standardized IQ test. They also found consistent differences in test scores among the races. In general, the black airman scores significantly lower than white airman on all Air Force selectors. When performing regression analysis, however, McGrevy, et al., (1974) found "black and white regression lines shared a common intercept and slope when the AFQT was compared with the IQ test" (p. 9).

L.D. Valentine's (1977) study, Prediction of Air Force technical training success from ASVAB and educational background, had three purposes. First, to investigate the validity of the Armed Services Vocational Aptitude Battery (ASVAB) and of educational data for Air Force technical training. Second, to investigate unique predictive contributions of both educational data and test data in predicting Air Force technical training success. And third, to assess homogeneity of prediction equations for sub-groups defined by race and sex. Valentine's data were collected using the ASVAB for all Air Force accessions from September 1973 to October 1975.

Valentine's (1977) findings suggest that "while predictions based on joint consideration of test and educational data have useful validity across race and sex groups, selection strategies which consider race and sex may further improve the system" (p. 19). The data indicate that test data and educational background data demonstrated usefulness for prediction of Air Force technical training performance. Moreover, Valentine finds "when used in combination with each other, more accurate predictions are possible than through the use of either data alone" (p. 19). Generally, test data alone provided more accurate predictions than did educational background data alone. Valentine also found that, "in many instances, separate race or sex group prediction equations are not homogeneous" (p. 20).

The use of race and gender test validity has been questioned in the application of aviation concepts since World War II. According to Charlie and Ann Cooper (1996) in their book, Tuskegee's Heroes, the Army War College commissioned a 1925 study to investigate the feasibility of blacks in combat. The Army War College found that blacks did not have the physical dexterity or the mental aptitude to fly complex fighter aircraft. The Tuskegee experiment was "bound for failure! Senior leaders of the U.S. Army Air Corps were simply unable to believe that blacks could learn to fly or to perform in combat; their training, their experience, and their ultra-conservative attitude prevented it" (p. 43). The performance of the Tuskegee Airmen during World War II proved the study wrong. Since that time, the United States military testing has focused on the application of principles, regardless of background.

The United States Air Force has conducted studies concerning student test scores and undergraduate training. Finegold and Rogers (1982) investigated the relationship between the Air Force Officer Qualifying Test (AFOQT) composite scores and student performance in Air Force air weapons controller training. The genesis of the 1982 study was a concern that an unacceptably large number of air weapons controllers were not performing satisfactorily during training. Finegold and Rogers (1982) stated their primary objective as "development of a selection strategy, based on Air Force Officer Qualification Test scores, for the air weapons controller career field" (p. i). In 1982, air weapons controllers had no special selection criteria. Pilots and navigators have specific test areas on the AFOQT for selection criteria. The study found a "significant positive correlation between AFOQT Academic Aptitude composite scores and successful completion of training" (p. 7). While the study did not recommend the advent of a new section of the AFOQT as selection criteria for air weapons controllers, the study did recommend a range of cutoff scores on the academic aptitude section of the test. A separate data analysis of demographic factors, including age, and source of commission showed no significant relationship between those factors and student performance.

Ree and Earles (1992), in Relationships of General Ability, Specific Ability, and Job Category for Predicted Training Performance, investigated over 78,000 Air Force enlistees in 82 jobs. The Ree and Earles study centered on the sub-tests, such as science, math, reading, vocabulary, clerical, mechanical, or technical knowledge, of the Armed Services Vocational Aptitude Battery (ASVAB). Ree and Earles (1992) believed that performance in different jobs is best predicted by the sub-tests whose content appears to be closely related to the jobs. The study found "general ability was by far the best indicator for training grades, however, specific abilities improved the predictive accuracy by a small amount" (p. 7).

The U.S. Air Force has continued to improve the tests used to select aviators. Thomas R. Carretta's September 1996 study Preliminary Validation of Several New U.S. Air Force Computer-Based Cognitive Pilot Selection Tests evaluated forty-five computer based tests for use in the selection process for U.S. Air Force pilots. Carretta's subjects were 1,855 officers attending the 53 week pilot training program in 1992. The pilots completed three common tests from the Basic Attributes Test (BAT) and a subset of another 42 tests. Carretta (1996) stated:

> Although traditional measures of general cognitive ability (i.e. verbal, math, spatial) are still widely used in pilot selection, there is a trend toward the use of other methods of measuring general cognitive ability such as chronometric measures and cognitive components. Chronometric measures are typified by reaction time, choice reaction time, and neural conductive velocity. Cognitive components such as information processing speed and working memory have been shown to measure general cognitive ability. (p. 1)

The purpose of Caretta's study was to examine the psychometric characteristics of the 45 tests and make recommendations regarding their use in pilot selection.

Carretta (1996) found correlational analyses showed 21 of the 45 tests were significantly related to graduation/elimination from pilot training. Tests with verbal content were less likely to be valid (two of 12 tests) predictors of flying training outcomes than were those with either numerical/quantitative content (eight of 15 tests) or spatial content (11 of 18 tests). Carretta stated "when characterizing the tests in terms of cognitive components such as processing speed and working memory, tests of procedural learning were least valid. Tests of processing speed and timing were most consistently valid" (p. 19).

When attempting to use an academic test as a predictor to select applicants for navigator training, the final verdict, according to R.A. Weitzman (1983) in Racial Bias and Predictive Validity in Testing for Selection, on test bias must also take into account subsequent performance on the job or in the classroom. Weitzman stated, "Because in selection the purpose of a test is prediction rather than measurement, "ability" in this definition refers not to a latent trait, like intelligence, but to the manifest criterion performance to be predicted."

Summary

The correct utilization of an academic test as a predictor for future training performance is essential given the cost of training. Historically, the military has utilized generic testing for all officer positions to allocate training slots for all flying billets. The Air Force Officers Qualification Test is the major discriminator when selections are made to fill flight-training slots. This same generic test was used in the 1940s, when aviation schools were producing record numbers of graduates, and is still in use today.

According to Introduction to Navigation phase manager, Lieutenant Colonel Nate Gray, in a September 2000 interview, the training process in place at JUNT is outstanding. The training required to become a platform academic instructor is rigorous. The JUNT program has kept up with changing technologies and revamped its syllabus to maintain currency with those changes. Air Education and Training Command has had a model in place since 1982 to enhance training via improved technologies in the following areas:

1. Computer-based education
2. Computerized-adaptive testing
3. Simulation and gaming
4. Video disc technology
5. Voice technology
6. Artificial intelligence

7. Instructional development/authoring aids

8. Job-oriented basic skills training

Student training is standardized to the point where no student gets an unfair advantage to receive the assignment of his or her choice, but at the same time, is flexible enough to ensure students receive more than enough additional training in the event that they stumble.

The use of the Introduction to Navigation test as a predictor by the Air Force could be more accurate than the Air Force Officers Qualification Test. The Introduction to Navigation academic phase and the associated test is the first phase and test cycle in the training syllabus flow, which actually tests real time application of aviation concepts.

CHAPTER III

METHODOLOGY

Introduction

This study determined if the Introduction to Navigation (IN) test could be used as a reliable predictor of future performance with Joint Undergraduate Navigator Training (JUNT). The Air Force selects officers to train as navigators aboard its fleet of war fighting aircraft using pre-selection tests and competitive board actions. Navigator students, like all Air Force officers, are college graduates and no restriction is placed on their academic specialty.

The research hypotheses were derived from the author's experience while teaching the material from 1993-1996. The population of an entire years training allocation of 314 students at Randolph Air Force Base (AFB), Texas, who were enrolled in JUNT from June 1999-June 2000 were used. The research hypotheses were:

H.1. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail at least one academic examination than are all other students.

H.2. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail at least one flight or simulator evaluation than are all other students.

H.3. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail more than one flight or simulator evaluation than are all other students.

H.4. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to be eliminated from training for deficient performance than are all other students.

Subjects

The population of interest to this study was student navigators to be trained at Randolph Air Force Base in the future. The population to be tested was the 314 student navigators who have entered and completed Core training, both successfully and unsuccessfully, between June 1999 and June 2000 at Randolph AFB, Texas. Those students entered navigator training from the United States Air Force (USAF), Air National Guard (ANG), the Air Force Reserves (AFRES), the United States Navy (USN), and several allied nations. The collection and interpretation of data concerning these 314 students was used to make inferences to and generalizations about all future training of navigators conducted at Randolph AFB, Texas. Table 1, Student Navigator Sources, 1999-2000, subdivides the 314 students, primarily by military service. The United States Air Force enrolled 202 students, the United States Navy had 78 students, the Guard and

Reserves had 30 students, and only four Allied students were enrolled from June 1999-June 2000.

TABLE 1

STUDENT NAVIGATOR SOURCES JUNE 1999- JUNE 2000

Source	Number Entered
U.S. Air Force	202
U.S. Navy	78
ANG/AFRES	30
Allied Air Forces	4
Total	314

Sample

The ready availability of the data, importance of the subject matter, and the extent of generalizations to be made concerning a large and, as yet, undetermined population, the entire class of 1999-2000 was tested.

Instruments

The instruments used were the results of the Introduction to Navigation test. Joint Undergraduate Navigator Training possesses two Introduction to Navigation test banks of 32 questions each, according to Ms Angie Jones-Sutter of the 12th Operational Support Squadron. A computer randomly selects 27 questions among the 32 available for each individual student. For students, the Introduction to Navigation test is a 27-question, multiple-choice test developed by the United States Air Force. The test requires the student to accomplish simple rate-time-distance problems, flight instrument interpretation, interpolation, spatial relationship problems, and basic geometry problems using the MB-4 computer. Students are given 70 minutes to complete the testing. Students who consider English as a second language can use up to 50 percent more time to complete the test. For example, a German student may use up to 105 minutes to complete the test. The test is administered on the last day of the Introduction to Navigation academic phase, which occurs on approximately training day 18. An Introduction to Navigation 50 question review test (Appendix A) is given on training day 16 to prepare the students for the actual test. The Introduction to Navigation training phase is the second phase of Core training after Aerospace Physiology.

Once the IN test is taken and scored, the test results are reviewed by the student's immediate supervisor, the Flight Commander, before forwarding the test scores to Student Accounting for grade processing. The Flight Commander uses these scores to anticipate student-training difficulties, and proactively seek additional training for students with low or failing test scores. Any student failing the test must retake the test until he or she passes or the test has been failed three times, initiating student elimination. The test was developed and maintained by Air Education and Training Command's 619th Operations Support and Training Squadron. The test was originally developed in the early 1960s and is reviewed on a semi-annual basis for question content and validity. The data was gathered from the 12th Operational Support Squadron Student Accounting Office.

The author's experience teaching the Introduction to Navigation material led to the development of the hypotheses. The author noticed a correlation between those students failing the IN test and those students being eliminated from training. It was assumed some score higher than the 85 percent failure score would accurately predict success or failure in JUNT. After receiving the test data, the mean, median, mode, and standard deviation were derived. The one standard deviation below the mean test score was used to analyze the hypotheses.

Validity and Reliability

Validity

The content validity of the Introduction to Navigation test is gauged by certified subject matter experts following the completion of each test and semi-annually. According to the Introduction to Navigation Phase Manager, Lieutenant Colonel Nate Gray, validity for race and sex is not determined at this level of training. Race and sex validity is a significant validity issue in the development of the Air Force Officer's Qualifying Test (AFOQT). Once Air Force officers are selected, however, specialty-training tests are only gauged by content validity. Flying is inherently dangerous and mistakes made 200 feet above the ground at 500 miles per hour can be fatal regardless of sex or race. Therefore, according to Lieutenant Colonel (Lt Col) Gray, Joint

Undergraduate Navigator Training focuses on the accomplishment of tasks regardless of the background of the individual.

Subject Matter Experts, according to Lieutenant Colonel Gray, complete the procedure for content analysis. Semi-annually, the phase manager reviews the questions to ensure the objectives are covered in the reading and/or classroom discussion. If a question was missed by greater than 20 percent of the class in the semi-annual period, the question is scrutinized for relevancy and adequacy. The phase manager, in conjunction with the 619th Operations Support and Training Squadron subject matter expert, will then improve the test question to meet the stated objective in the lesson. During the last semi-annual Introduction to Navigation phase review, conducted in May 2000, no question was missed by more than 20 percent of the students, with an average correct percentage of 92.

Following the administering of each test, the Course Instructor and the class Flight Commander will examine the test questions to see if a majority of the class missed any one question. If a question is missed by greater than 50 percent of a class, the Course Instructor and Flight Commander may approach the Phase Manager to have the question thrown out for that class. Throwing out test questions for an individual class test occurs infrequently, according to Lieutenant Colonel Gray, because standardization of instruction is monitored through the Instructional Systems Development (ISD) process to ensure all objectives are covered correctly.

Reliability

All sixty-four total Introduction to Navigation test questions in the master question bank are derived from the course objectives and reviewed by the 619th Operational Support Squadron, the IN phase manager, the Flight Commander, and the course instructor. The IN phase manager, Lieutenant Colonel Gray, reports a .98 reliability factor for all 1998-1999 test bank questions. The systematic nature of the ISD training format provided a very stable basis for testing and the testing procedures are replicated for each class.

Research Design

This study took scores from students who were under the Core Syllabus, N-V8N-C between June 1999 and June 2000 and tested to determine if a correlation existed between a low Introduction to Navigation test score and poor training performance, as defined by the hypothesis. The data to conduct this study was readily available and not protected from publication. The four items collected were: (a) academic test failures, (b) all student flight evaluation failures, (c) all student simulator evaluation failures, and (d) all students eliminated from training for deficient performance. This information was kept in the student's training squadron in the form of compiled class data for each class. These data were kept, electronically by class, by the 12th Flying Wing Student Accounting section. The data for this study were collected from the individual flight commanders and the 12th Flying Wing Student Accounting section, and verified using the data held by the same accounting section. From these data, individuals who satisfied any of the stated conditions in the hypotheses were extracted. These included, for example, all students with an Introduction to Navigation test score more than one standard deviation below the mean, all who failed a flight or simulation evaluation, and all who were eliminated from training.

The 12th Flying Wing Student Accounting Office identified individual student test scores solely by a four-digit student number. The student number is not associated with the individual outside of the Air Force's Air Education and Training Command to ensure no student could be identified by test score. The Student Accounting Office correlated student number performance data against the four hypotheses. Only the Introduction to Navigation test as a predictive tool of student poor performance was evaluated.

This study sought a standard by which a flight commander could look at a given Introduction to Navigation test score and make a reasonable prediction of the student's potential. An absolute relationship resulting in failure will not be drawn so that all students who fail a flight or simulator evaluation will have an Introduction to Navigation test score below a certain level. Rather a certain Introduction to Navigation test score will determine where the likelihood of failing at least one (in the case of hypothesis number three) flight or simulator evaluation was significantly increased.

Procedures

The Introduction to Navigation test score was extracted for each of the 314 students. The scores were totaled and divided by the total number of students in the same class to find the mean score. Using these scores, the standard deviation was determined. Once the standard deviation was determined, students were sorted into those scoring more than one standard deviation below the mean and all other students.

A Chi Square test was computed to determine relationships between the Introduction to Navigation test score and each condition. Because each hypothesis is strictly nominal, the Chi Square was used to test the relationship between the performance of those with an Introduction to Navigation test score more than one standard deviation below the mean and another for each of the hypotheses. The 99% level of significance was used to determine whether to accept or reject each hypothesis. The 99% significance level with one degree of freedom is 7.9.

To calculate the Chi Square test, a number expected was gained from the Introduction to Navigation Phase Manager, Lieutenant Colonel Nathan Gray. The number expected to meet each hypotheses was derived from a five year percentile average of students who met the criteria (see Table 2, Percent of JUNT Students Meeting the Hypotheses Criteria, 1993-1998). The five-year average of JUNT students failing an academic examination was 15%. Eighteen percent failed one simulator or flight evaluation. JUNT averaged a nine percent failure rate for more than one flight or simulator evaluation and JUNT had experienced a six percent elimination rate from 1993-1998.

TABLE 2

PERCENT OF JUNT STUDENTS MEETING HYPOTHESES CRITERIA, 1993-1998

Hypotheses	Percentage
Academic Failure in JUNT Training	15
Simulator or Flight Evaluation Failures in JUNT Training	18
Students Failing More Than One Flight or Simulator Evaluation Failure	9
Elimination from JUNT Training	6

Summary

The review of related literature provided the basis for examining past attempts by the United States military to adequately predict performance using testing dating from World War I to the present. The focus on military application of air power centers not on sex, age, or color bias, but on the ability to perform in a multi-task environment against a thinking enemy. The JUNT training process provides the standardization of instruction necessary to ensure no student received an unfair advantage in the competitive training environment. The students with the best test, simulator, and flight evaluation scores receive their first choice of aircraft for assignment.

Chapter III examined the Introduction to Navigation test scores as the instrument to be studied. The entire annual student population between June 1999-June 2000, 314 student navigators, was used in a search for a correlation between low IN test scores and subsequent poor performance in JUNT.

Chapter IV displays the results of the data collection and presents an analysis of the data in textual form.

CHAPTER IV

FINDINGS

Introduction

The goal of this study was to search for a better system to accurately predict successful completion of Joint Undergraduate Navigator Training (JUNT). The accurate prediction of JUNT completion would allow the United States Air Force (USAF) to save money by more accurately programming student numbers against projected vacancies. Any JUNT student who does not finish the program costs the military a training slot, the associated funds, and reduces the total number of navigators in the active force structure. The military currently uses results from the Air Force Officers Qualification Test (AFOQT), keying in on the pilot and navigator specialty sub-test scores, as well as looking at the whole person concept to select navigator training candidates.

The test results from the 314 student navigators who have entered and completed Core training, successfully and unsuccessfully, between June 1999 and June 2000 at Randolph AFB, Texas, formed the basis for this assessment. Those students were drawn from the United States Air Force (USAF), Air National Guard (ANG), the Air Force Reserves (AFRES), the United States Navy (USN), and several allied nations. The collection and interpretation of data concerning these 314 students was used to make inferences to and generalizations about all future navigator training conducted at Randolph AFB, Texas. No student was aware of the study and performance was not enhanced or curtailed in any manner as all data was collected post Introduction to Navigation tests. No Privacy Act data were requested as the Student Accounting office provided all raw test scores and all data that correlated those test scores with later performance in training. Because the data collected were test score results, the committee determined an Institutional Review Board (IRB) was not required.

This chapter reviews the instrument and details the specifics of the Introduction to Navigation phase. The following examines the relationship between the collected data and the hypotheses.

Data Collection

The 314 navigator students observed from June 1999 to June 2000 had an Introduction to Navigation mean test score of 97.15, a mode test score of 100, and a median test score of 97.9 (Figure 2). The scores ranged from 100 percent to a low of 74 percent. The standard deviation was 4.07. The students that scored more than one standard deviation below the mean had test scores less than 93.08. The 93.08 figure is just below the 93.6 percentage score a student would receive for missing three test questions.

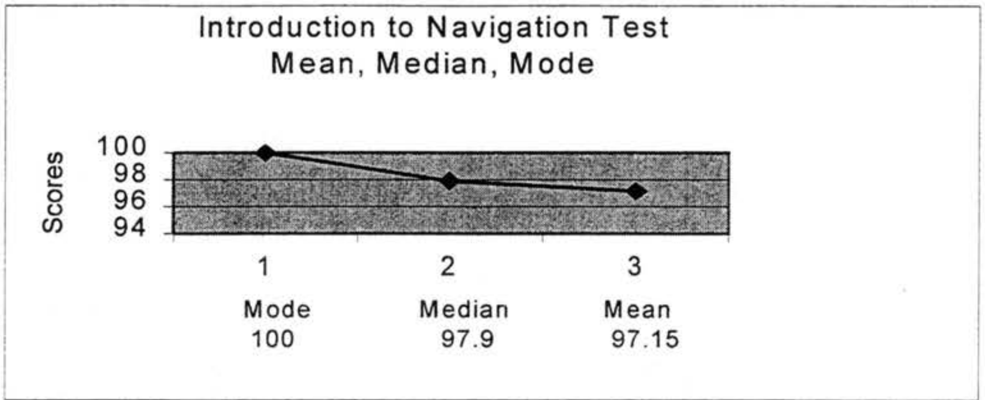


Figure 2. Introduction to Navigation Mean, Median, and Mode Scores.

Figure 3 visually depicts the raw 314 test scores in relation to the 97.15 mean and the 93.08 score signifying one standard deviation below the mean.

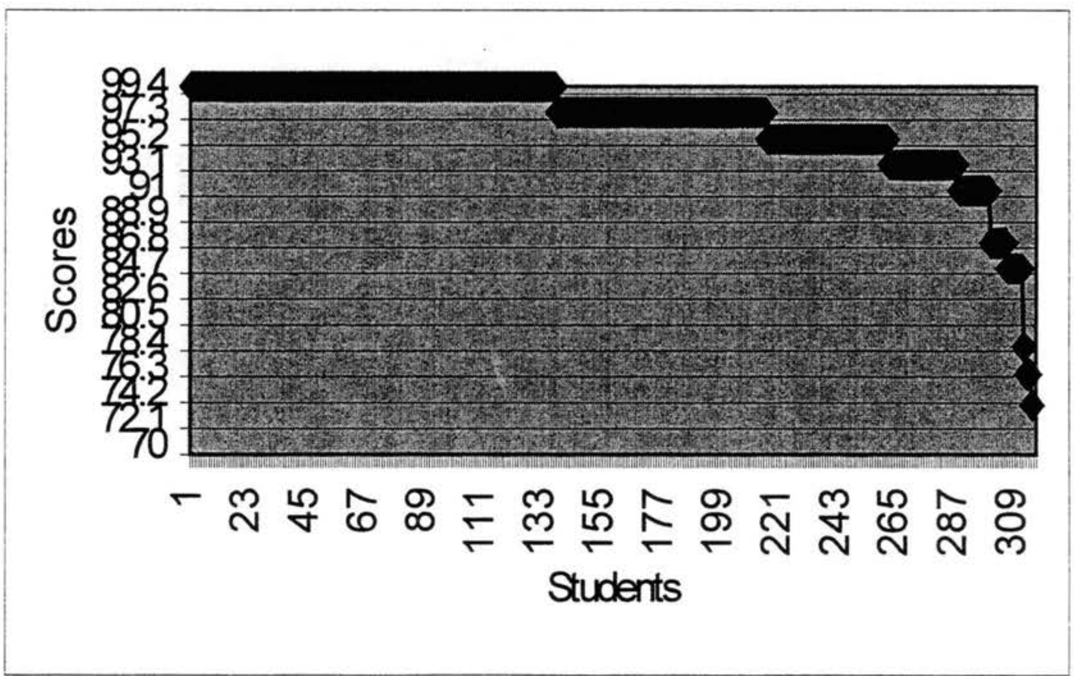


Figure 3. Introduction to Navigation Test Scores for All Students. Note: Dark line at 97.15 signifies test Mean. Dark line at 93.08 signifies one standard deviation below the mean.

Table 3 shows the raw scores broken down numerically and by percentage of the entire class population. A total of 136 students, or 43.3 percent of the population, scored a perfect 100 percent. Seventy-eight students, or 24.8%, scored 97.9 percent. Forty-six students, representing 14.7% of the class, scored a 95.7. Twenty-six students, or 8.3 percent, scored a 93.6. Twelve students, or 3.8%, scored more than one below the standard deviation of 93.08 by achieving a 91.5 percentage score. Six students scored 87.2% for 1.9% of the total population and 6 more students, representing the same population percentage, scored the minimum passing score of 85.1%. Four students failed the Introduction to Navigation test, with one student or .3% of the population, scoring 78.7%, two students, or .6% scoring 76%, and finally one student, .3%, scoring a low of 74%.

TABLE 3

RAW INTRODUCTION TO NAVIGATION TEST SCORES

Score	Number of students	Percentage of students
100	136	43.3
97.9	78	24.8
95.7	46	14.7
93.6	26	8.3
91.5	12	3.8
87.2	6	1.9
85.1	6	1.9
78.7	1	0.3
76	2	0.6
74	1	0.3

The data were also tabulated (Table 4) showing the number of students with a score more than one standard deviation below the mean who satisfy the condition. The table also shows the number who scored higher than one standard deviation below the mean who failed to satisfy the condition.

TABLE 4

STUDENTS WITH INTRODUCTION TO NAVIGATION TEST SCORES SATISFYING THE HYPOTHESES CONDITION

	Academic Test Failure	Evaluation Failure	Flight or Simulator Subsequent Failure	Elimination	Total Students
Students > 1 SD below mean	15	21	15	14	28
Students not > 1 SD below mean	19	43	25	8	286
Total	34	64	40	22	314

Out of the total student annual population of 314, 28 (8.9%) students met the hypotheses criteria of scoring greater than one standard deviation below the mean. A total of 286 (91.1%) students scored greater than the 93.07 required to score more than one below the standard deviation.

Of the 314 total students, 34 (10.8%) failed one academic examination. Among the 34 students who failed one academic test, 15 (4.8%) scored greater than one standard deviation below the mean to satisfy the hypothesis condition. Nineteen students (6%) failed an academic examination but did not score greater than one standard deviation below the mean on the Introduction to Navigation (IN) test. Of the 15 students meeting the hypothesis criteria, only four (1.2%) failed the Introduction to Navigation test.

Of the 314 student sample population, 64 (20.3%) failed a flight or simulator evaluation. Twenty-one (6.6% of the total population) of the 64 students who failed a flight or simulator evaluation scored greater than one standard deviation below the mean on the Introduction to Navigation test to meet the hypothesis criteria. Forty-three students (13.7%) experienced one evaluation failure but did not score greater than one standard deviation below the IN mean.

Forty students (12.7%) failed at least two flight or simulator evaluations. Fifteen (4.8%) of the 40 students satisfied the hypothesis condition and scored greater than one standard deviation below the mean on the Introduction to Navigation test. Twenty-five students (7.9%) failed two flight or simulator evaluations, but scored better than one standard deviation below the IN test mean.

Among the 314 students enrolled in JUNT during July 1999-June 2000, a total of 22 (7%) were eliminated. Of these 22 eliminated students who satisfied the hypothesis condition, 14 (4.4%) scored greater than one standard deviation below the mean on the Introduction to Navigation test. Eight students (6%) were eliminated but scored greater than one standard deviation below the IN test mean.

Correlation

Of the 314 students, 28 students had scores more than one standard deviation below the mean, with scores ranging from 74 percent to 91.5 percent. For a complete breakdown of students' scores see Appendix B. After extracting the subset of 28 students scoring more than on standard deviation below the mean, the following relationships were observed. The committee determined no Institutional Review Board (IRB) review was required due to the nature of data received.

Hypothesis One

JUNT Students Scoring More than One Standard Deviation below the Mean on the Introduction to Navigation Test Are More Likely to Fail at Least One Academic Examination than Are All Other Students

Of the 28 students observed who met the criteria, 15 failed an academic exam (See Table 5, Academic Failure in JUNT Training, 1999-2000). Lieutenant Colonel (Lt. Col.) Nathan Gray, the Introduction to Navigation Phase Manager, stated students have a 15% historical average of failing an academic test. This value was derived from a historical five year running average of all JUNT students. Fifteen percent of 28 students equate to 4.2 students expected to fail an academic examination. The 15 students who meet the criteria and who failed an academic examination at some point during the JUNT curriculum exceed the 4.2 expected. The calculated chi square value of 32.7 was statistically significant at the 99% confidence level. Hypothesis one is accepted.

TABLE 5

ACADEMIC FAILURE IN JUNT TRAINING, 1999-2000

	Students with no failures	Students with one or more failures
Observed	13	15
Expected	23.8	4.2

Hypothesis Two

JUNT Students Scoring More than One Standard Deviation below the Mean on the Introduction to Navigation Test Are More Likely to Fail at Least One Flight or Simulator Evaluation than Are All Other Students

Of the 28 students observed, 21 had failed a single flight or simulator evaluation (Table 6, Simulator or Flight Evaluation Failures in JUNT Training, 1999-2000). Lt. Col. Nathan Gray, the Introduction to Navigation Phase Manager, stated students have a 18% historical average of failing one simulator or flight evaluation. This value was derived from a historical five year running average of all JUNT students. Eighteen percent of 28 students equate to 5.04 students expected to fail a simulator or flight evaluation. The chi square value calculated used five students expected to fail one simulator or flight evaluation. The 21 students failing one flight or simulator evaluation far surpass the five expected. The calculated chi square value of 62.5 was statistically significant at the 99% level. Hypothesis two is accepted.

TABLE 6

SIMULATOR OR FLIGHT EVALUATION FAILURES
IN JUNT TRAINING, 1999-2000

	Students with no failures	Students with one or more failures
Observed	7	21
Expected	23	5

Hypothesis Three

JUNT Students Scoring More than One Standard Deviation below the Mean on the Introduction to Navigation Test Are More Likely to Fail More than One Flight or Simulator Evaluation than Are All Other Students

Of the 28 students observed, 15 total more than one flight or simulator evaluation (Table 7). Lt. Col. Nathan Gray, the Introduction to Navigation Phase Manager, stated students have a 9% historical average of failing more than one simulator or flight evaluation. This value was derived from a historical five year running average of all JUNT students. Nine percent of 28 students equate to 2.52 students expected to fail more than one simulator or flight evaluation. The calculated chi square value of 67.92 was statistically significant at the 99% level. Hypothesis three is accepted.

TABLE 7

STUDENTS WITH MORE THAN ONE FLIGHT OR
SIMULATOR EVALUATION FAILURE,
1999-2000

	Students with Less than Two Failures	Students with Two or More Failures
Observed	13	15
Expected	25.48	2.52

Hypothesis Four

JUNT Students Scoring More than One Standard Deviation below the Mean on the Introduction to Navigation Test Are More Likely to Be Eliminated from Training for Deficient Performance than Are All Other Students

Of the 28 students observed, fourteen were eliminated from training (Table 8, Elimination from JUNT Training, 1999-2000). Lt. Col. Gray stated a 6% probability exists of being eliminated from JUNT. This value was derived from a historical five year running average of all JUNT students. Six percent of 28 students equate to 1.68 students expected to be eliminated from JUNT. The calculated chi square value of 96.12 was statistically significant at the 99% level. Hypothesis four is accepted.

TABLE 8

ELIMINATION FROM JUNT TRAINING, 1999-2000

	Students Not Eliminated	Students Eliminated
Observed	14	14
Expected	26.32	1.68

Further Testing

To reinforce the correlation significance between scoring more than one standard deviation below the mean on the Introduction to Navigation test and poor JUNT performance, further testing is prudent. The same criteria used in the previous hypotheses were evaluated first against students who scored better than one standard deviation below the mean on the IN test, then against the entirety of the sample population. The four criteria are: 1) failing one academic examination; 2) failing one flight or simulator evaluation; 3) failing two or more flight or simulator evaluations; and 4) being eliminated from JUNT training. This section uses the same Chi Square test at the 99% significance level as the main research hypotheses.

Criteria One—Failing One Academic Examination

Table 4 showed 34 students failing one JUNT academic examination from 1999-2000. The research hypothesis studied only those 15 students scoring more than one standard deviation below the mean. Table 9 shows the entering arguments for the 19 students scoring greater than one standard deviation below the mean on the IN test, but still failing one academic examination at some point in the JUNT syllabus. These 19 students were tested against the remaining 286 students who scored better than the 93.08 score, that was one standard deviation below the mean. Lt. Col. Gray provided the expected 15% academic failure rate. The calculated Chi Square value of 15.66 was greater than the 7.9 value at the 99% significance rate. Therefore, if a student did not score lower than one standard deviation below the mean on the IN test, a significant risk exists of failing another academic examination.

TABLE 9

ACADEMIC FAILURE IN JUNT TRAINING
1999-2000, PART II

	Number of students with no failures	Students with one or more failures
Observed	267	19
Expected	243.1	42.9

Performing this same test on the entire student population is exemplified in Table 10 (Academic Failure in JUNT, 1999-2000, Part III). This tested all 34 students who failed academic examination against the entire 314 person population. The calculated Chi Square score of 4.27 is not significant at the 99% level. Thirty-four students failed an academic examination from June 1999- June 2000. The 10.8% failure rate is well below the 15% of the previous five years and no correlation is evident concerning the entire population.

TABLE 10

ACADEMIC FAILURE IN JUNT TRAINING
1999-2000, PART III

	Number of students with no failures	Students with one or more failures
Observed	280	34
Expected	266.9	47.1

Criteria Two—Failing One Flight or Simulator Evaluation

Table 4 showed 64 total students failed at least one flight or simulator evaluation. The main research hypothesis tested the 21 students scoring greater than one standard deviation below the IN mean. This section will first investigate the 43 other students who failed a flight or simulator evaluation, but who score better than 93.08 on the IN test. Similar to the main hypothesis, this study used the same 18% expected failure rate. Table 11 (Simulator or Flight Evaluation Failures in JUNT Training, 1999-2000, Part II) shows the Chi Square entering arguments. The calculated Chi Square value of 1.40 is not significant at the 99% level. Therefore, scoring greater than one standard deviation above the IN test mean cannot be correlated with failing a simulator or flight evaluation.

TABLE 11

SIMULATOR OR FLIGHT EVALUATION FAILURES
IN JUNT TRAINING, 1999-2000, PART II

	Students with no failures	Students with one failure
Observed	243	43
Expected	234.52	51.48

Performing this same analysis on the entire population is exemplified in Table 12 (Simulator or Flight Evaluation Failures in JUNT Training, 1999-2000, Part III). This tested all 64 students with one flight or simulator evaluation failure against the entire 314 student population. The calculated Chi Square value of .99 was not significant at the 99% level. While the 64 failures constitute 20.3% of the student population, greater than the 18% programmed rate, no correlation is evident within the entire population.

TABLE 12

SIMULATOR OR FLIGHT EVALUATION FAILURES IN
JUNT TRAINING, 1999-2000, PART III

	Students with no failures	Students with one failure
Observed	250	64
Expected	257.48	56.52

Criteria Three—Failing Two or More Flight or Simulator Evaluations

Table 4 showed 40 total students failed more than one flight or simulator evaluation. The main research hypothesis tested the 15 students scoring greater than one standard deviation below the IN mean. This section first investigated the 25 other students who failed more than one flight or simulator evaluation, but who scored better than 93.08 on the IN test. Similar to the main hypothesis, this study used the same 9% expected failure rate.

Table 13 (Students with More Than One Flight or Simulator Evaluation Failure, 1999-2000, Part II) shows the Chi Square entering arguments. As is evident from the information presented in Table 13, the 9% programmed value is almost exact for this group. The calculated Chi Square value of .02 is not significant at the 99% level. Therefore, scoring greater than one standard deviation above the IN test mean cannot be correlated with failing more than one simulator or flight evaluation.

TABLE 13

STUDENTS WITH MORE THAN ONE FLIGHT OR SIMULATOR EVALUATION FAILURE 1999-2000, PART II

	Students with less than two failures	Students with two or more failures
Observed	261	25
Expected	260.26	25.74

Performing this same analysis on the entire population is exemplified in Table 14 (Simulator or Flight Evaluation Failures in JUNT Training, 1999-2000, Part III). This tested all 40 students with more than one flight or simulator evaluation failure against the entire 314 student population. The calculated Chi Square value of 5.36 was not significant at the 99% level. While the 40 failures constitute 12.7% of the student population, greater than the 9% programmed rate, no correlation is evident within the entire population.

TABLE 14

STUDENTS WITH MORE THAN ONE FLIGHT OR SIMULATOR EVALUATION FAILURE 1999-2000, PART III

	Students with less than two failures	Students with two or more failures
Observed	274	40
Expected	285.74	28.26

Criteria Four—JUNT Elimination

Table 4 showed 22 total students were eliminated from JUNT training from June 1999- June 2000. The main research hypothesis tested the 14 students scoring greater than one standard deviation below the IN mean. This section will first investigate the eight other students who were eliminated from training, but who scored better than 93.08

on the IN test. Similar to the main hypothesis, this study used the same 6% expected failure rate.

Table 15 (Elimination from JUNT Training, 1999-2000, Part II) shows the Chi Square entering arguments. Although eight students comprise just 2.6% of the student population, well below the programmed 6% attrition rate, the calculated Chi Square value of 5.2 is not significant at the 99% level. Therefore, scoring greater than one standard deviation above the IN test mean cannot be correlated being eliminated from JUNT..

TABLE 15

ELIMINATION FROM JUNT TRAINING
1999-2000, PART II

	Students not eliminated	Students eliminated
Observed	278	8
Expected	268.84	17.16

Performing this same analysis on the entire population is exemplified in Table 16 (Elimination from JUNT Training, 1999-2000, Part III). This tested all 22 students who were eliminated against the entire 314-student population. The calculated Chi Square value of .56 was not significant at the 99% level. While the 22 failures constitute 7% of the student population, greater than the 6% programmed rate, no correlation is evident within the entire population.

TABLE 16

ELIMINATION FROM JUNT TRAINING
1999-2000, PART III

	Students not eliminated	Students eliminated
Observed	292	22
Expected	295.16	18.84

Summary

This chapter supplied the reader with the raw data gleaned from the results of the Introduction to Navigation test obtained from the 12th Student Accounting Office. Chapter V summarizes the study, presents conclusions based on the data in this chapter, makes recommendations, and lists recommendations for further study.

The data assessed in Chapter IV highlights a significant relationship between poor performance on the IN test and JUNT as a whole. All four hypotheses were supported. Further testing showed no correlation between the student population scoring greater than one standard deviation below the mean and JUNT performance with one exception. If a student did not score lower than one standard deviation below the mean on the IN test, a significant risk of failing another academic examination exists.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study investigated if a correlation existed between scoring more than one standard deviation below the mean on the Introduction to Navigation test score and poor performance at Joint Undergraduate Navigator Training (JUNT). The group tested was the 314 student navigators who entered and completed Core training, successfully or unsuccessfully, between June 1999 and June 2000 at Randolph AFB, Texas. Those students were drawn from the United States Air Force (USAF), Air National Guard (ANG), the Air Force Reserves (AFRES), the United States Navy (USN), and several allied nations. The collection and interpretation of data concerning these 314 students was used to make inferences to and generalizations about all future navigator training conducted at Randolph AFB, Texas.

From experience teaching the material at JUNT from 1993-1996, the author had seen first hand what appeared to be a direct correlation. The data from the 12th Student Accounting office were assessed. The test results at the 99% significance level confirm positive correlation. Moreover, further testing was warranted to assess if any correlation existed between scoring greater than one standard deviation above the mean on the IN test and poor performance. Testing was also conducted on the entire student population in a search for further correlation. The results are analyzed in the conclusion section of this chapter.

The review of related literature reveals past military attempts to make a correlation between test and aircraft performance dating from the infancy of air power application concepts in World War I to the present. The History of Military Aviation section examined the Army's use of the Army Alpha and Beta tests to screen applicants for World War I service (Popham, 1990; Yerkes 1921). The Alpha and Beta, however, did not screen applicants for any special skill or aptitude, but tested general intelligence.

The Army Alpha and Beta tests gave way during the inter-war period to the Army General Classification Test (AGCT). The AGCT was a test of general learning ability (Popham, 1990) and aviators were selected only on their personal interest to enter aviation training.

The Aviation Psychology Program was charged in the 1940s with a mission to develop a selection method for aircrew (Wiskoff & Rampton, 1989). During World War II, the Aviation Psychology Program developed the Aviation Cadet Qualification Examination (Davis, 1947). This 150 question test was used for the selection of aircrew from 1942-1955.

The Aviation Psychology Program was not finished developing tests for aviation training. In 1951 a version of the Air Force Officer's Qualification Test (AFOQT) was initiated and the AFOQT continues today (Rogers, Short, & Roach, 1986 October). The AFOQT is divided into five sections: Verbal, Quantitative, Administrative, Pilot, and

Navigator. The pilot and navigator sub-test scores are the primary vehicles for selection to Undergraduate Pilot or Undergraduate Navigator Training.

In 1982 the Department of Defense (DoD) realized the population norm used for scoring the AFOQT was not the same as in the 1940s. The DoD report sampled military age youth from 16 to23 as an index for comparing 1980s youth with their predecessors. The results were as expected with test scores showing a clear relationship to levels of education attained.

The Navigator Training section took a closer look at the history and background of military navigators (Carter, 1947). Carter was the first researcher to define navigator requirements and analyzing the attributes necessary to successfully complete navigator training. Understanding the importance of accurately defining a navigator's requirements is amplified in a fiscally constrained environment. The reduction of military forces is nothing new to this country (Snow & Drew, 1994; 2000 Air Force Almanac). With dwindling resources, the necessity to develop an accurate predictor for navigator training is highlighted. Finding an accurate predictor of JUNT success would eliminate an unnecessary drain on both funds and instructors.

JUNT uses the Instructional Systems Development (ISD) format to ensure standardization of instruction and to ensure no student receives an unfair advantage in the highly competitive training environment. McConkey (1972) studied the pitfalls associated with the ISD process. A later study (Anderson, O'Neil, & Baker, 1991) focused on the first ten years of ISD use by the United States Army. The ISD format was found to be most useful in learning the application of technical information. Last, to better understand how JUNT executes the ISD system, a thorough review of the ISD process was given.

A review of the JUNT program begins by tying the requirement to train the highly trained navigators to the 1997 National Military Strategy. The discussion ends with a curriculum overview and JUNT's grading criteria (Nineteenth Air Force, 1999).

The review of predictive testing begins by establishing the purpose served by the measurement and assessment of human performance (Angel, et al., 1964). Using the Angel, et al., (1964) definition of testing categories, the Introduction to Navigation test falls into the terminal measure category. Terminal measures are post-training measures ordinarily made when testees are on the job. However, when the IN test is used as a predictor, the test becomes an interim measure, or a measure used to assess the effectiveness of a training program. The use of tests as predictors was further studied in the section (Cronbach & Glaser, 1965; Lyman, 1978; Martuza 1977; National Academy of Science, 1982; Popham, 1990).

The last section of predictive testing centered on specific military studies searching for a correlation between test and job performance (Alf, 1963; Carretta, 1996; Finegold & Rogers, 1982; McGrevy, Knouse, & Thompson, 1974; Ree & Earles, 1992; United States Army, 1965; Valentine, 1977; Weitzman, 1983; Willemin, 1962; Wollack & Guttman, 1962). While the results of each individual test varied, a few recurring themes were noticeable. First, a strong correlation exists between educational levels and achievement. Second, little to no correlation occurred between demographic groups, including ages and source of commissioning. Third, general ability was an excellent indicator of training performance, however, specific abilities improved the predictive accuracy. Last, tests processing the speed and timing of aviation concepts were most consistently valid.

Conclusions

This study was designed to determine if a low Introduction to Navigation Test score was an indicator of poor performance in JUNT. Four hypotheses were formulated:

H.1. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail at least one academic examination than are all other students.

H.2. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail at least one flight or simulator evaluation than are all other students.

H.3. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail more than one flight or simulator evaluation than are all other students.

H.4. JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to be eliminated from training for deficient performance than are all other students.

The procedure chosen was to use the Chi Square to test the relationship between those with Introduction to Navigation Test scores greater than one standard deviation below the mean. The Chi Square test compared those with low Introduction to

Navigation Test scores with those with the higher Introduction to Navigation Test scores. The Chi Square was chosen because the data appears to provide a correlation. Once the hypotheses were tested and confirmed, further testing was conducted to investigate if any additional correlation could be made.

What follows are a number of conclusions based on the effect of the findings in Chapter IV on the stated hypotheses. Of the 314-student population sample, 28 students (8.9%) met the criteria of scoring more than one standard deviation below the IN test mean.

Hypothesis One

Hypothesis one stated JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation (IN) test are more likely to fail at least one academic examination than are all other students. Of the 28 students observed who met the criteria, 15 (53.6%), failed an academic exam. Lt. Col. Nathan Gray stated students have a 15% probability of failing one academic test in JUNT among all groups. This value was derived from a historical five year running average of all JUNT students. Fifteen percent of 28 students equate to 4.2 students expected to fail an academic examination. Obviously, the 15 students who meet the criteria and who failed an academic examination at some point during the JUNT curriculum exceed the 4.2 expected. The calculated chi square value of 32.7 was statistically significant at the 99% confidence level. Therefore, hypothesis one is accepted.

Because of the significance of the test results, further testing was accomplished to see if a correlation existed between those who scored above one standard deviation on the IN test and failing an academic examination. Nineteen students scored greater than one standard deviation below the mean on the IN test, but still failed one academic examination at some point in the JUNT syllabus. Those 19 students who scored better than the 93.08 score were tested against the remaining 286 students. The same expected failure rate 15% was used. The calculated Chi Square value of 15.66 was greater than the 7.9 value at the 99% significance rate. Therefore, if a student did not score lower than one standard deviation below the mean on the IN test, there was still a significant risk of failing another academic examination.

The entire student population was also tested for correlation. This tested all 34 students who failed academic examination against the entire 314-person population. The calculated Chi Square score of 4.27 is not significant at the 99% level. This is highlighted by the fact that 34 students failed an academic examination from June 1999-June 2000. The 10.8% failure rate is well below the 15% of the previous five years and no correlation is evident concerning the entire population.

Hypothesis Two

Hypothesis two stated JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail at least one flight or simulator evaluation than are all other students. Of the twenty-eight students observed, twenty-one (75%) had failed a single flight or simulator evaluation. Lt. Col.

Gray stated JUNT students have an 18% probability of failing one simulator or flight evaluation in JUNT. This .18 figure was derived from a historical five year running average of all JUNT students. Eighteen percent of 28 students equate to 5.04 students expected to fail a simulator or flight evaluation. The chi square value calculated used five students expected to fail one simulator or flight evaluation. Just as in hypothesis one, it is obvious that the 21 students failing one flight or simulator evaluation far surpass the five expected. The calculated chi square value of 62.5 was statistically significant at the ninety-nine percent level. Therefore, hypothesis two is accepted.

As with hypothesis one, the statistical data for hypothesis two indicated further testing would be prudent to search for any further correlation. Forty-three of 286 (15%) students failed a flight or simulator evaluation, but scored better than 93.08 on the IN test. Similar to the main hypothesis, this study used the same 18% expected failure rate provided by Lt. Col. Gray. The calculated Chi Square value of 1.40 is not significant at the 99% level. Therefore, scoring greater than one standard deviation above the IN test mean cannot be correlated with failing a simulator or flight evaluation.

The entire 314 student population sample was also tested for this hypothesis. This tested all 64 students with one flight or simulator evaluation failure against the entire 314 student population. The calculated Chi Square value of .99 was not significant at the 99% level. While the 64 failures constitute 20.3% of the student population, greater than the 18% programmed rate, no correlation is evident within the entire population.

Hypothesis Three

Hypothesis three stated JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to fail more than one flight or simulator evaluation than are all other students. Of the 28 students observed, 15 total (53.6%) had failed more than one flight or simulator evaluation. Lt. Col. Gray stated students have a 9% probability of failing more than one simulator or flight evaluation in JUNT. This .09 figure was derived from a historical five year running average of all JUNT students. Nine percent of 28 students equated to 2.52 students expected to fail more than one simulator or flight evaluation. The calculated chi square value of 67.92 was statistically significant at the 99% level. Therefore, hypothesis three is accepted.

The statistical results for hypothesis three indicated further testing would be prudent to search for any further correlation. Twenty-five of the 286 (9.8%) students failed more than one flight or simulator evaluation, but scored better than 93.08 on the IN test. Similar to the main hypothesis, this study used the same 9% expected failure rate provided by Lt. Col. Gray. As is extremely evident, the 9% programmed value is almost exact for this population sample. The calculated Chi Square value of .02 is not significant at the 99% level. Therefore, scoring greater than one standard deviation above the IN test mean cannot be correlated with failing more than one simulator or flight evaluation.

For hypothesis three, 314 students were also tested. This tested all 40 students with more than one flight or simulator evaluation failure against the entire group. The calculated Chi Square value of 5.36 was not significant at the 99% level. While the 40 failures constitute 12.7% of the student population, greater than the 9% programmed rate, no correlation is evident within the entire population.

Hypothesis Four

Hypothesis four stated JUNT students scoring more than one standard deviation below the mean on the Introduction to Navigation test are more likely to be eliminated from training for deficient performance than are all other students. Of the 28 students observed, exactly half (50%), 14 total, were eliminated from training. Lt. Col. Gray JUNT has a programmed elimination rate of 6%. This .06 figure was derived from a historical five year running average of all JUNT students. Six percent of 28 students equate to 1.68 students expected to be eliminated from JUNT. The calculated chi square value of 96.12 was statistically significant at the 99% level. Therefore, hypothesis four is supported.

Similar to all previous hypotheses, the statistical data indicated further testing would be prudent to search for any further correlation. Eight of 286 (2.6%) students were eliminated from training, but scored better than 93.08 on the IN test. Similar to the main hypothesis, this study used the same 6% expected failure rate. Although eight students comprise just 2.6% of the student population, well below the programmed 6% attrition rate, the calculated Chi Square value of 5.2 is not significant at the 99% level. Therefore, scoring greater than one standard deviation above the IN test mean cannot be correlated being eliminated from JUNT.

The entire 314 student population sample was also tested for hypothesis four. This tested all 22 students who were eliminated against the entire 314 student population. The calculated Chi Square value of .56 was not significant at the 99% level. While the 22 failures constituted 7% of the student population, greater than the 6% programmed rate, no correlation was evident within the entire population.

Based on the tests and results, the Introduction to Navigation test is a reliable predictor of student performance because all hypotheses were accepted. Those with the lower test scores did show a significantly higher proportion of failure and elimination. The correlation indicates an increased likelihood of a single academic failure, of multiple evaluation failures, and of the elimination from training. As such a predictor, the IN test has incredible value to the individual training squadron and the Air Force as a whole.

Additionally, further testing showed, with one exception, no correlation existed between an IN test score above 93.08 and poor performance or between the entire population and poor performance. The one exception was the first criteria test for hypothesis one where it was discovered that those who scored better than 93.08 on the IN test were still at significant risk at the 99 level of failing another JUNT academic test.

As the review of literature has captured, the military aviation community has search for the golden bullet to accurately predict aviation performance since World War I. This study validates the search to accurately predict success in aviation by proving the Introduction to Navigation test can be an accurate predictor for all future Air Force, Navy, and allied navigators.

Recommendations

In a time of drastically reduced training budgets and a shortage of qualified instructor navigators, the Introduction to Navigation test becomes increasingly valuable. The reduction in force after the end of the Cold War has placed increased pressure on JUNT to produce more and better qualified navigators. Training losses for academic or flying reasons cost the Air Force dearly. These costs come in the form of training hours spent by instructors on ultimately unsuccessful students. They come from training funds allocated for flying and simulator time. They also come in the form of opportunity costs when another more capable candidate is denied entry into training because of a shortage of class space. The Introduction to Navigation test allows informed choices to be made for student training at JUNT.

At the lowest level, the individual's flight commander can use this score to identify potentially weak performers early. By doing this more additional training can easily be dedicated to raise the student up to standards. At the squadron level, supervisors can use this score as another indicator of rated potential when casting judgement on student retention or elimination.

The greatest benefit can be realized at the Air Education and Training Command. The cost savings for using the Introduction to Navigation test as a screening tool could be enormous. Based on this research the following specific recommendations are made:

1. The Introduction to Navigation test should be used as a screening device prior to an officer candidate being awarded a slot to train as a student navigator. All examinees scoring more than one standard deviation below

the mean score should be denied entry into JUNT. This training could be given in two to three days at any AFOQT test location.

2. Until the Introduction to Navigation test is used as a screening device for JUNT entry, it should continue to be given at the earliest stage of training. It should now be treated as a determinant in the extent of training allowed a student. Those students scoring lower than one standard deviation below the mean would continue training on a conditional status. Any subsequent failure or an evaluation or academic exam would automatically eliminate the student from training.

3. Additional research should be conducted to determine the score below which the students will not be able to complete training. This score could then be assigned as a minimum passing score before it is used as a screening tool. Research should also be conducted to test the ability of the Introduction to Navigation test to predict student performance in their initial training in their primary aircraft.

REFERENCES

Air Education and Training Command Regulation 51-1 (July). Flying training, undergraduate flying training. Washington, D.C.: United States Air Force.

Air Force Almanac (2000). The Air Force in facts and figures. Arlington, VA: Air Force Association.

Air Force Handout 11-203. Aircrew weather (2). Washington, D.C.: United States Air Force.

Air Force Pamphlet 11-216. Instrument procedures. Washington, D.C.: United States Air Force.

Alf, E. F. Jr., (1963). Comparison of predictive and concurrent validities of basic test battery test scores. Washington, D.C.: United States Navy.

Anderson, C. L., O'Neil, H. F. Jr., & Baker, E. L. (1991). Implementation of instructional system development in the U.S. Army: Lessons learned for research utilization. In R.F. Dillon & J. W. Pelligrino (Eds.), Instruction: Theoretical and applied perspectives (pp. 163-179). New York, NY: Praeger.

Angel, D., Shearer, J. W., & Berliner, D. C. (1964). Study of training performance evaluation techniques. Palo Alto, CA: American Institute for Research.

Angoff, W. H. (1971). Scales, norms, and equivalent scores. In R. L. Thorndike (Ed.), Educational measurement (2nd ed., pp. 508-600). Washington, D.C.: American Council on Education.

Braun, H.I., & Wainer, H. (1988). Test validity. Hillsdale, NJ: Erlbaum Associates Publishers.

Carretta, T. R. (1996). Preliminary validation of several new U.S. Air Force computer-based cognitive pilot selection tests. Brooks AFB, TX: Armstrong Laboratory.

Carter, L. F. (1947). Psychological research on navigator training. Washington, D.C.: U.S. Government Printing Office.

Clifford, J. H. (1997). Educating our NCOs. Army Times, 50.

Cooper, C., & Cooper, A. (1996). Tuskegee's heroes. Osceola, WI: Motorbooks International Publishers.

Cronbach, L. J., & Gleser, G. (1965). Psychology tests and personnel decisions. Urbana, IL: University of Illinois Press.

Davis, F.B. (1947). The AAF qualifying examination (AAF Aviation Psychology Program Research Report No. 6). Washington, D.C.: U.S. Government Printing Office.

Davis, R.G. (1992). Carl A. Spaatz and the air war in Europe. Washington, D.C.: Center for Air Force History.

Denny, W.A. (1979). Ten rules for managing by objectives. Business Horizons, 22, 66-68.

Department of Defense (1982). Profile of American youth: 1980 nationwide administration of the armed services vocational aptitude battery. Washington, DC: Officer of the Assistant Secretary of Defense (manpower, reserve affairs, and logistics).

Ebel, R. L., & Frisbie, D. A. (1986). Essentials of educational measurement (4th edition). Englewood Cliffs, NJ: Prentice Hall.

Eitelberg, M. J., Laurence, J. H., Waters, B. K., & Perelman, L. S. (1984). Screening for service: Aptitude and education criteria for military entry. Washington, D.C.: Office of the Assistant Secretary of Defense (manpower, installations, and logistics).

Finegold, L. S., & Rogers, D. (1985). Relationship between Air Force officer qualifying test scores and success in air weapons controller training. Brooks Air Force Base, TX: Air Force Human Resources Laboratory.

Flanagan, J. C. (1948). The aviation psychology program in the Army Air Forces (AAF Aviation Psychology Research Report No 1). Washington, D.C.: U.S. Government Printing Office.

Gray, N. (2000 Sept). E-mail interview.

Gronlund, N. E., & Linn, R. L. (1980). Measurement and evaluation in teaching (6th edition). New York, NY: Macmillan.

Joint Chiefs of Staff (1997). National military strategy of the united states of America. Washington, D.C.: U.S. Government Printing Office.

Jones-Sutter, A., (2000 Sept). E-mail interview.

Kaplan, H. (1965). Prediction of success in Army aviation training. Washington, D.C.: U.S. Army Personnel Research Office.

Kime, S. F. (1997). Train first but educate too. Army Times, 27.

Lyman, H. B. (1978). Test scores and what they mean. Englewood Cliffs, NJ: Prentice Hall.

Martuza, V. R. (1977). Applying norm-referenced criterion-based measurement in education. Boston, MA: Allyn & Bacon.

McConkey, D. D. (1972). 20 ways to kill management by objectives. Management Review, 61(10), 4-13.

McGrevy, D. F., Knouse, S. B., & Thompson, R. A. (1974). Relationships among an individual intelligence test and two Air Force screening and selection tests. Brooks AFB, TX: Air Force Human Resources Laboratory.

Migliore, R. H. (1977). MBO: Blue collar to top executive. Washington, D.C.: The Bureau of National Affairs.

National Academy of Science. (1982). Ability testing: Uses, consequences, and controversies. Washington, D.C.: U.S. Office of Personnel Management.

National Command Authority. (1999). A national security strategy for a new century. Washington, D.C.: The White House.

Nineteenth Air Force (1999). JUNT core syllabus of instruction, N-V8N-C.

Nineteenth Air Force (1999). Introduction to navigation, J-NA-AT-IN-IG.

Nineteenth Air Force (1999). Introduction to navigation, J-NA-AT-IN-SG.

Northern, Joy. (2000 February). Telephone interview.

Pophan, W. J. (1990). Modern educational measurement: A practitioner's perspective. Englewood Cliffs, NJ: Prentice Hall.

Randolph Air Force Base Instructor Guide (1999). Navigator/NFO/EWO instructor training, N-V9-IT.

Ree, M. J., & Earles, J. A. (1992). Relationships of general ability, specific ability, and job category for predicting training performance. Brooks AFB, TX: Air Force Human Resources Laboratory.

Roach, B. W., & Rogers, D. L. (1982). Development of the common metric. Paper presented to the Eighth Psychology in the DOD Symposium, United States Air Force Academy, Colorado, Springs, CO.

Rogers, D. L., Short, L. O., & Roach, B. W. (1986). Mental ability testing in the selection of Air Force Officers: A brief historical overview. Brooks Air Force Base, TX: Air Force Human Resources Laboratory.

Snow, D. M., & Drew, D. M. (1994). From Lexington to Desert Storm. Armonk, NY: M.E. Sharpe Publishing.

Sympson, J. B., Weiss, D. J., & Ree, M. J., (1994). Predictive validity of conventional and adaptive tests in the Air Force training environment. Brooks AFB, TX: Headquarters United States Air Force Human Resources Laboratory.

Tracey, W. R. (1968). Evaluation training and development systems. New York, NY: American Management Association.

Valentine, L. D. (1977). Prediction of Air Force technical training success from ASVAB and educational background. Brooks AFB, TX: Air Force Human Resources Laboratory.

Valentine, L. D., Jr., & Creager, J. A. (1961). Officer selection and classification tests: Their development and use (ASD-TN-61-145, AD-269 827). Lackland AFB, TX: Personnel Laboratory, Aeronautical Systems Division.

Walters, B. K., & Laurence, J. H. (1982). Information technology transfer from military R&D to civilian education and training. (FR-MPAD-82-1) Alexandria, VA: Human Resources Research Organization.

Weitzman, R. A. (1983). Racial bias and predictive validity in testing for selection. Monterrey, CA: Naval Postgraduate School.

Wiegand, R. (2000). Staff briefing. AWACS AEF Alignment. 552 Air Control Wing: Tinker AFB, OK.

Willemin, L. P. (1964). Prediction of officer performance. Washington, D.C.: U.S. Army Personnel Research Office.

Wiskoff, M. F., & Rampton, G. M. (1989). Military personnel measurement: Testing, assignment, evaluation. New York, NY: Praeger.

Wollack, L., & Guttman, I. (1961). Prediction of OCS academic grades and post-OCS performance of junior officers with a battery of speeded tests. Washington, D.C.: Bureau of Naval Personnel.

Yerkes, R. M. (1921) Psychological examining in the United States Army. Memoirs of the National Academy of Sciences(15), 194-581.

Yerkes, R. M. (1941) Man power and military effectiveness: The case for human engineering. Journal of Consulting Psychology(5), 205-209.

APPENDIXES

APPENDIX A

INTRODUCTION TO NAVIGATION

PRACTICE EXAMINATION

INTRODUCTION TO NAVIGATION PRACTICE EXAMINATION

Complete the following practice examination before class. Give yourself 2 minutes per question. Be prepared to discuss problem areas in class.

NOTE—Due to minor disparities between some MB-4s, your answers may differ slightly from the student guide answers.

1. You traveled 7.5 Nautical Miles in 54 seconds. What is your Ground Speed?

   a. 835 knots
   b. 600 knots
   c. 500 knots
   d. 455 knots

2. You traveled 24 Nautical Miles in 7 minutes. How far have you traveled in 37 minutes?

   a. 219 NM
   b. 127 NM
   c. 108 NM
   d. 94 NM

3. You burn 4900 pounds of fuel in an hour. You have 36,000 pounds. How much will you have left after one hour and 52 minutes?

   a. 26,850 pounds
   b. 29,045 pounds
   c. 35,085 pounds
   d. 35,300 pounds

4. You have traveled 621 Kilometers in 43 minutes. What is your Ground Speed?

   a. 470 knots
   b. 540 knots
   c. 610 knots
   d. 760 knots

5. You covered 7.3 Nautical Miles in 47.5 seconds. What is your Ground speed?

   a. 920 knots
   b. 784 knots
   c. 553 knots
   d. 219 knots

6. You went 37 Nautical Miles in 8.5 minutes. How far will you go in 3 hours and 9 minutes?

   a. 825 Kilometers
   b. 825 Statute Miles
   c. 825 Nautical Miles
   d. 825 miles

7. You are going to fly at 29,000 feet at Mach 0.68 with a Static Air Temperature of –32 degrees. What is your True Air Speed?

   a. 410 knots
   b. 445 knots
   c. 448 knots
   d. 462 knots

8. Which wind triangle is correctly labeled in Figure 15-1?

Figure 15-1 — Question 8

9. You started out at 1710 Zulu headed for L.A., 210 Nautical Miles away. At 1723Z, you traveled 80 Nautical Miles. When will you get to L.A.?

   a. 1801Z
   b. 1757Z
   c. 1744Z
   d. 1735Z

10. You went 49 Kilometers in 5 minutes. How many Statute Miles will you go in 12 minutes?

   a. 78
   b. 73
   c. 68
   d. 63

11. Given True Heading 323 degrees, True Air Speed 420 knots, and W/V 078/70, how many degrees and what direction must you turn to make a Track of 280 degrees?

    a. 046 degrees, left
    b. 046 degrees, right
    c. 040 degrees, left
    d. 040 degrees, right

12. Given True Course 002 degrees, True Air Speed 350 knots, and W/V 312/70, find the True Heading and Ground Speed.

    a. 353 degrees, 302 knots
    b. 351 degrees, 310 knots
    c. 010 degrees, 390 knots
    d. 010 degrees, 320 knots

13. Given W/V 187/24, True Air Speed 415 knots, and Track 050 degrees, how long will it take you to fly 89 Statute Miles?

    a. 10.5 minutes
    b. 11.5 minutes
    c. 106 minutes
    d. 115 minutes

14. The Track, True Heading, True Air Speed, distance and time between your last two fixes were 213 degrees, 203 degrees, 421 knots and 343 Kilometers and 31 minutes. What True Heading must you fly to make a True Course of 150 degrees good and what is your Ground Speed?

    a. 163 degrees, 485 knots
    b. 162 degrees, 435 knots
    c. 152 degrees, 430 knots
    d. 152 degrees, 330 knots

15. Given Track 030 degrees, True Heading 026 degrees, Ground Speed 380 knots, Static Air Temperature –46 degrees, Mach 0.60, 34,000 feet, what is the wind?

    a. 070/45
    b. 163/40
    c. 343/40
    d. 360/45

16. Given True Heading 359 degrees, True Air Speed 480 knots, W/V 359/45, what is your Track and how far will you go in 24 minutes?

    a. 179 degrees, 175 Nautical Miles
    b. 179 degrees, 210 Nautical Miles
    c. 359 degrees, 175 Nautical Miles
    d. 359 degrees, 210 Nautical Miles

17. Using the information in Problem 16, how far will you go in 45 seconds?

    a. 70 Nautical Miles
    b. 54 Nautical Miles
    c. 7 Nautical Miles
    d. 5.4 Nautical Miles

18. Where do you measure distance on a Lambert Conformal Chart?

    a. Any longitude
    b. Mid-longitude
    c. Any latitude
    d. Mid-latitude

19. Given a W/V of 2132/110, True Course 313 degrees, Ground Speed 395 knots, find the True Heading and True Air Speed.

    a. 302 degrees, 380 knots
    b. 297 degrees, 390 knots
    c. 302 degrees, 410 knots
    d. 297 degrees, 430 knots

20. Which of the following is the shortest distance between points?

    a. Great line
    b. Great circle
    c. Small circle
    d. Rhumb line

21. What is the variation at the X in Figure 15-2?

    a. 18 degrees East
    b. 19 degrees East
    c. 19 degrees West
    d. 20 degrees West

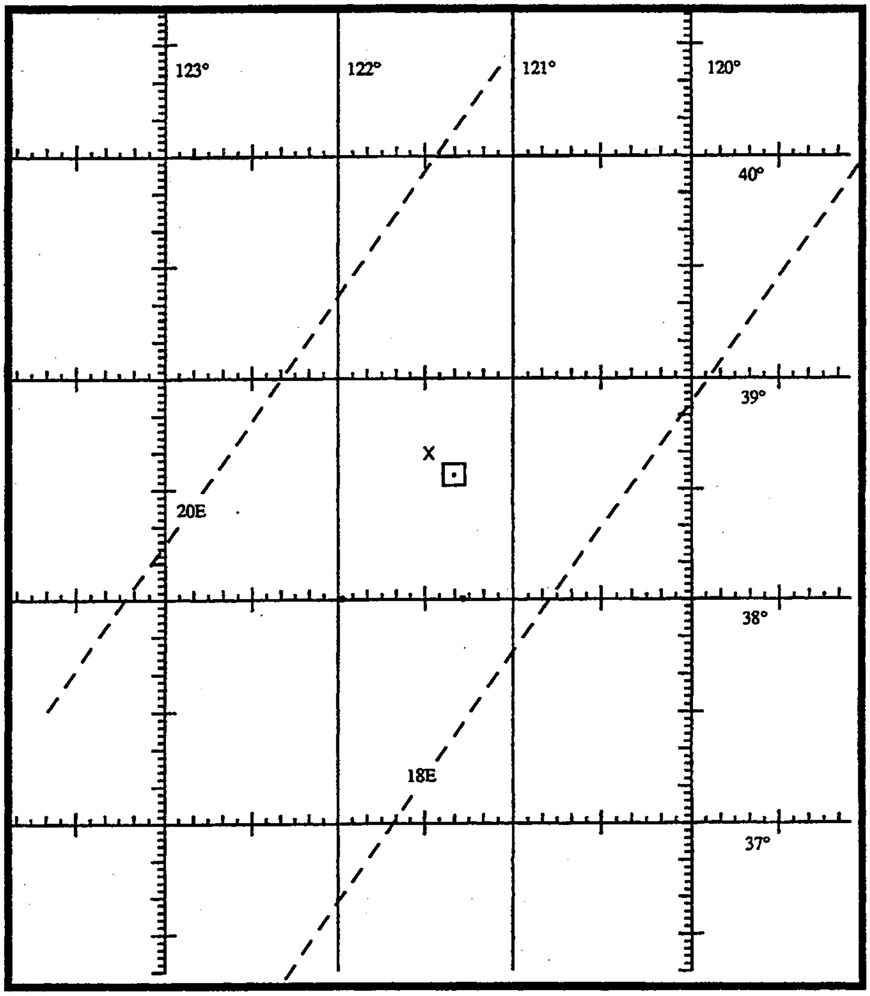


Figure 15-2 — Questions 21, 27 and 28

22. Local altimeter setting reads what?

    a. Absolute altitude
    b. Pressure altitude
    c. High altitude
    d. True altitude

23. Where is a Lambert Conformal chart the most accurate?

    a. at the equator
    b. at the Prime Meridian
    c. at the standard parallels
    d. along the main Rhumb line

24. "Calibrated airspeed corrected for compressibility" describes which type of altitude?

    a. Ground Speed
    b. True Air Speed
    c. Indicated Air Speed
    d. Equivalent Air Speed

25. "The actual height above the terrain" describes which type of altitude?

    a. True
    b. Pressure
    c. Absolute
    d. Indicated

26. You are flying due North. How many degrees would you turn to fly a heading of 345 degrees? What is the shortest direction of the turn?

    a. 15 degrees, left
    b. 15 degrees, right
    c. 55 degrees, left
    d. 55 degrees, right

27. Plot True Course 130 degrees for 25 Nautical Miles from 38-23 North 122-52 West. What are the coordinates? (Use Figure 15-2)

    a. 38-06 N 122-30 W
    b. 38-16 N 121-00 W
    c. 38-43 N 123-20 W
    d. 38-49 N 121-32 W

28. Find the distance between 40-14 North 119-52 West and 38-11 North 120-58 West. (Use Figure 15-2).

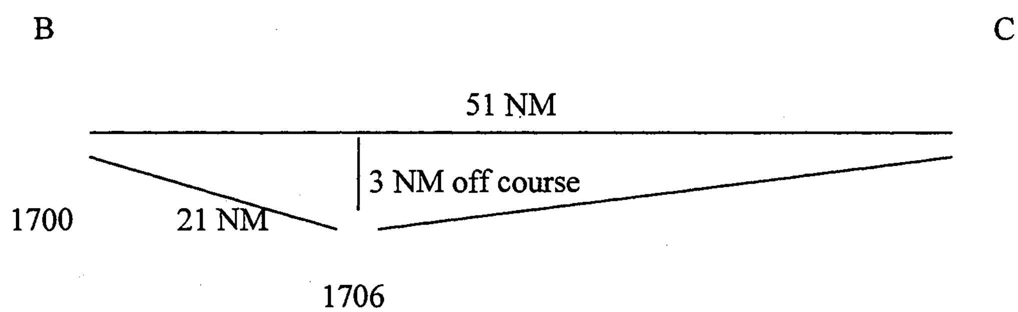
    a. 74 Nautical Miles
    b. 94 Nautical Miles
    c. 134 Nautical Miles
    d. 194 Nautical Miles

29. You passed point B at 1700 (Figure 15-3). You fixed at 1706 and found you were off course. Mentally compute what direction and how many degrees you will turn to reach point C?

    a. 6 degrees left
    b. 9 degrees left
    c. 9 degrees right
    d. 15 degrees left

Figure 15-3

True Air Speed = 240 knots
Magnetic Heading = 099 degrees



30. After taking and plotting a fix at 1245, you measured the distance and Track from your last fix taken at 1220 and found them to be 204 Nautical Miles and 222 degrees. Your True Heading was 230 degrees and True Air Speed 423 knots. What average wind have you been experiencing?

    a. 002/90
    b. 090/90
    c. 098/90
    d. 355/90

Use Figure 15-4 for problems 31 through 34.

31. What are the correct coordinates of point A?

a. 24-30 N 099-25 E
b. 24-30 N 100-35 E
c. 25-30 N 099-25 E
d. 25-30 N 100-25 E

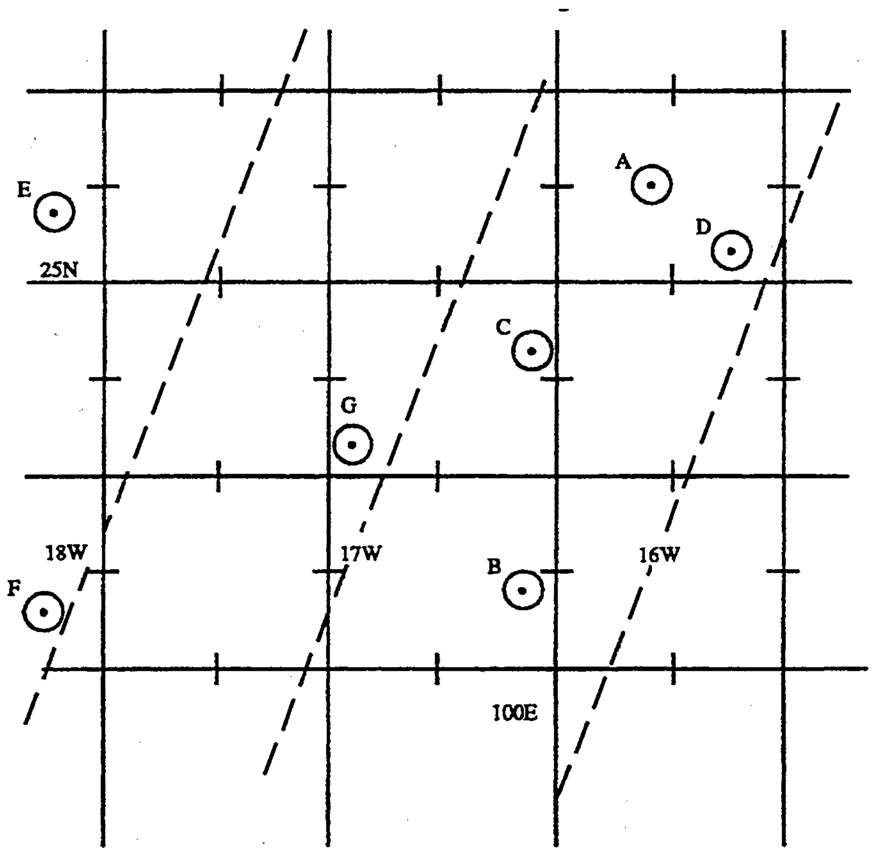


Figure 15-4 — Questions 31 through34

32. What is the variation at point B?

a. 16 degrees West
b. 17 degrees West
c. 18 degrees West
d. 18 degrees East

33. Plot a point with a True Course of 063 degrees and a distance of 120 Nautical Miles from point G. Which point is closer?

    a. A
    b. B
    c. C
    d. D

34. Draw a course line from A to B. What Magnetic Course would you fly from A to B?

    a. 031 degrees
    b. 178 degrees
    c. 195 degrees
    d. 212 degrees

35. A Rhumb line is a ____________ on an Equatorial Mercator chart?

    a. curved line
    b. mid-latitude
    c. straight line
    d. mid-longitude

36. The following is depicted on a TPC G18-A chart: x8300. What does it indicate?

    a. Actual spot elevation—8,300 Mean Sea Level
    b. Questionable elevation—8,300 Above Ground Level
    c. Questionable elevation—8,300 Mean Sea Level
    d. Approximate location-elevation 8,300 Mean Sea Level

37. On a TPC chart, MEF includes

    a. an area of latitude and longitude
    b. cultural obstructions
    c. None of the above is correct
    d. Both a and b are correct

38. Pressure altitude is based on

    a. a standard datum plane
    b. a non-standard plane
    c. high pressure
    d. low pressure

39. Use Figure 15-5 to find actual Track and Ground Speed.

a. 095 degrees, 249 knots
b. 100 degrees, 252 knots
c. 113 degrees, 245 knots
d. 119 degrees, 250 knots

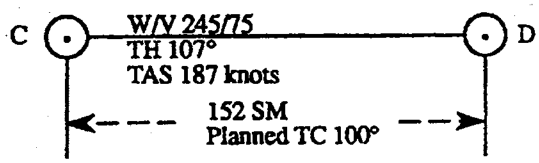


Figure 15-5 — Question 39

40. Use Figure 15-6 to find the W/V.

a. 117/50
b. 145/52
c. 203/50
d. 308/119

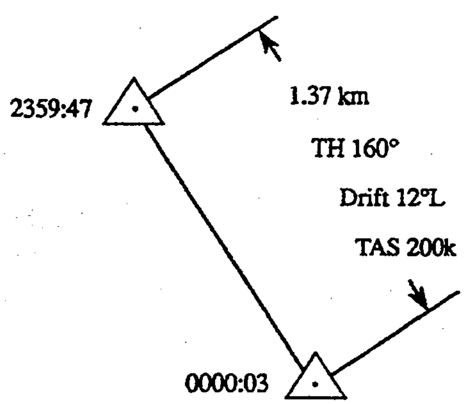


Figure 15-6 — Question 40

41. Longitude/meridian starts from 0 degrees and goes to

a. 90 degrees
b. 180 degrees
c. 270 degrees
d. 360 degrees

42. Between your 1810 and 1827 fixes, you traveled 132 Kilometers. What is your Ground Speed in knots?

    a. 252 knots
    b. 265 knots
    c. 285 knots
    d. 290 knots

43. In 18.3 seconds you traveled 5.7 Statute Miles. What is your Ground Speed in knots?

    a. 163 knots
    b. 206 knots
    c. 973 knots
    d. 1,102 knots

44. You are flying at 29,000 feet with a True Air Speed of 435 knots. Your instruments show a drift of 5 degrees right, a Ground Speed of 395 knots and a True Heading of 270 degrees. How many degrees and in which direction do you have to turn to maintain a Truce Course of 315 degrees?

    a. 45 degrees right
    b. 45 degrees left
    c. 38 degrees right
    d. 26 degrees right

45. Your drift is 15 degrees left, your Track 105 degrees, True Air Speed of 420 knots and you have traveled 185 Statute Miles in 20 minutes. What is your wind?

    a. 035/132
    b. 230/132
    c. 339/132
    d. 354/132

46. At 1700 Zulu you had 35,000 pounds of fuel on board. At 1735 you had 27,000 pounds remaining. How much longer can you fly?

    a. +58
    b. 1+02
    c. 1+58
    d. 2+02

47. Your wind is 270/110. Your Mach is 0.68, Static Air Temperature –41 degrees Celsius, and True Heading 089 degrees. What is your True Course and Ground Speed?

    a. 075 degrees, 475 knots
    b. 089 degrees, 295 knots
    c. 089 degrees, 516 knots
    d. 094 degrees, 420 knots

48. If you traveled 85 Kilometers in 10 minutes, how long will it take you to travel 75 Statute Miles?

    a. 9 minutes 25 seconds
    b. 14 minutes 12 seconds
    c. 17 minutes 35 seconds
    d. 24 minutes 05 seconds

49. Your preflight wind is 267/85. Your in-flight wind is 280/60. Your True Course is 182 degrees and True Air Speed is 420 knots. What is your True Heading and Ground Speed?

    a. 087 degrees, 365 knots
    b. 089 degrees, 516 knots
    c. 190 degrees, 423 knots
    d. 194 degrees, 403 knots

50. Your True Course is 075 degrees, True Heading 063 degrees, True Air Speed 390 knots and you traveled 385 Statute Miles in 40 minutes. How many degres and in which direction must you turn to make a True Course of 015 degrees good?

    a. 70 degrees left
    b. 60 degrees left
    c. 55 degrees left
    d. 55 degrees right

Answers to IN practice examination

1. c
2. b
3. a
4. a
5. c
6. c
7. a
8. d
9. c
10. b
11. c
12. a
13. a
14. d
15. c
16. c
17. d
18. c
19. b
20. b
21. b
22. d
23. c
24. d
25. c
26. a
27. a
28. c
29. d
30. a
31. d
32. a
33. d
34. d
35. c
36. c
37. d
38. a
39. a
40. c
41. b

42. a
43. c
44. c
45. b
46. c
47. c
48. b
49. c
50. a

APPENDIX B

IN TEST SCORES

100	100	100	100	97.9	95.7
100	100	100	100	97.9	95.7
100	100	100	100	97.9	95.7
100	100	100	100	97.9	95.7
100	100	100	100	97.9	95.7
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100	100	100	97.9	97.9	95.7
100	100	100	97.9	97.9	95.7
100	100	100	97.9	97.9	95.7
100	100	100	97.9	97.9	95.7
100	100	100	97.9	97.9	95.7
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100	100	100	97.9	97.9	95.7
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100	100	100	97.9	97.9	95.7
100	100	100	97.9	97.9	95.7
100	100	100	97.9	97.9	95.7

95.7	87.2
95.7	87.2
95.7	87.2
93.6	85.1
93.6	85.1
93.6	85.1
93.6	85.1
93.6	85.1
93.6	85.1
93.6	78.7
93.6	76.5
93.6	76.5
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2

VITA

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Candidate for the Degree of

Doctor of Education

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