THE RELATIONSHIP BETWEEN ACADEMIC PERFORMANCEAND PILOT PERFORMANCE IN A COLLEGIATE FLIGHT TRAINING ENVIRONMENT

by

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Dedicated to my family,

Thank you all for your love and support.

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Abstract

While flight time has commonly been used as a measure of a pilot's skill level, little research has been performed to determine what factors are linked to predicting a pilot's performance, particularly in a training environment. If a dependable link was found, prediction of how well an individual would do in flight training would be possible. Time, money and resources could be focused on individuals who are more likely to succeed in pilot training. Therefore, this study was designed to determine if a relationship between GPA and pilot performance exists, in order to determine if academic performance can serve as a predictor of pilot performance in a training environment. The use of historical records from Middle Tennessee State University's Aerospace Department, which included GPA information and flight training records information, was used evaluate this relationship. Results of the study indicate a statistically significant modest correlation between academic performance and pilot performance between some of the variable pairings.

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CHAPTER I - INTRODUCTION

A student's grade-point-average (GPA) is one of the most common methods used to assess a student's academic performance. Teachers assign letter grades to students that represent the student's achievement in the class and often these grades are used for admissions into programs, awarding of scholarships, and entry into the workforce. It is very common due to its simple and easily comparable nature. At Middle Tennessee State University, this GPA is particularly important for Aerospace Flight Students. In order to be eligible for a flight lab, a student must meet the minimum 2.5 GPA requirement. This requirement was established as a method of selection during a time when there were too many flight lab applicants for the number of available slots. Due to the simple and measurable nature of this requirement, it remained in place. However, some argue that the skills and characteristics necessary to be a good academic student are not necessarily the same needed to be a good pilot, and therefore GPA is not a good predictor of a student's piloting abilities. Others argue that the GPA does reflect many of the similar required skills needed in both the classroom and the airplane, and therefore a high minimum GPA requirement would help make a more selective pilot process that would in the end produce better pilots.

With a minimum GPA requirement in place in the MTSU Flight Department, it is important to assess the relevancy of the practice. Research should first be accomplished to determine whether there is any relationship between a student's academic performance and pilot performance. Research on this topic would be valuable to help determine if the current usage of GPA to allocate flight labs should be revisited, amended, or changed entirely.

Literature Review

Grade point average (GPA) has been around for over 200 years. William Farish, a British chemistry and natural philosophy tutor at the University of Cambridge, is credited with developing the grading system (Betterly, 2003). First implemented in 1792, the system eventually spread, with modifications and adaptations, to other universities and institutions. The irony behind the system is that Farish was simply trying to create a method that would allow him to mark more papers and generate more income. As a result, he was seen as one of the world's most famous lazy teacher.

Today GPAs are typically calculated by assigning numbers to letter grades and then averaging them. Although it may vary, in the United States the following 4.0 scale grading system is very common: 90-100 is an A and receives 4.0 points, 80-89 is a B and receives 3.0 points, 70-79 is a C and receives 2.0 points, 60-69 is a D and receives 1.0 points, and below 60 is an F and receives 0.0 points (Vickers, 2000).

Centuries after Farish, there is now more literature available regarding academic assessment. One particular division of this literature that seems most appropriate to focus on for this research topic is the literature on grades as an appropriate assessment and prediction of potential success. There appears to be some controversy on just how important grades are in predicting future success and thus the importance of GPA. Some of the literature is divided in the conclusions reached, but overall the literature seems to question the validly and reliability of grades. Some parts of the literature reveal a correlation between GPA and success, while others argue that there is not a strong relationship between GPA and success. The overall validity of GPA as an assessment tool continues to be reviewed by researchers since a clear answer has not been obtained.

The literature regarding GPA is particularly important for this research topic because the literature on the typical criterion used to select pilots reveals that academic achievement measure by GPA is often considered in the process. Overall, the literature reveals what skills and assets are measured by pilot training selection committees, who aim to pick individuals who will not only complete pilot training but also become successful pilots in the long run. Overall, the literature reveals differing values of GPA throughout different selection processes, and a heavy reliance on other measurable criterion more closely related to actual prediction of pilot performance.

GPA predicting job success.

The study called “College Grade Point Average as a Predictor of Adult Success” looks into the controversy regarding the importance of GPA in future success. It is one of about 50 studies to address the specific topic of the "true" relationship between GPA and job success. Unlike many of the other studies, it takes a quantitative approach using a meta-analytic review of the importance of GPA.

The meta-analysis study used 39 past studies. Six different processes were used to determine: 1) the overall effect, 2) the effect on measures of success in business, 3) the effect on measure of success in teaching, 4) the effect on measures of success in engineering, science, and medicine, 5) the effect on miscellaneous criterion measures, and 6) the effect using only graduate school GPA as the predictor (Bretz, 1989).

Overall, the study found no definite relationship between success and college GPA, however in the subgroups of business and teaching there was a significant relationship. There was also significance in the relationship between Graduate School GPA and job success. The study concluded that due to the very weak relationship and confidence, if a relationship does

exist between GPA and job success, it is “tenuous at best” and therefore other more significant predictors should be utilized (Bretz, 1989).

The study also consisted of its own empirical investigation into the effectiveness of GPA as a predictor of success. The purpose of this part of the study was to show that there are better predictors of success. A sample of 328 recent graduates from BS Business programs and MBA programs at three large universities were given questionnaires. Success was measured by starting salary, current salary, salary growth, and job satisfaction.

The empirical data supported the finding from the meta-analysis that a moderate relationship does exist between college GPA and success in business. However, it was found that hours worked while in school and the age of the individual were better predictors of starting salary. No significance was found linking GPA with salary growth, but the number of hours currently worked and the length of tenure in the organization was positively rated to salary growth.

The researcher suggests that GPA may not be a good indicator of future success for a few reasons. First, it can reflect different things from course to course and school to school since no two are the same. Students also elect to take different types of courses and GPA can be manipulated by electing to take easier courses. Therefore, GPA does not take into consideration worth ethic and knowledge if a student elects to take more rigorous courses. Additionally, GPA does not take into account extracurricular activities that may constrict a student’s GPA but may also display attractive qualities such as leadership and initiative (Bretz, 1989). Lastly, GPA is merely a measure of student achievement in classes they have specifically taken and not necessarily a measure of general intelligence. Other studies reveal that general intelligence is a

good predictor of success in jobs, and therefore GPA should not be confused as a measure of intelligence since it is too subject and situation specific (Bretz, 1989).

Another study looked at fourteen students from a high school to see how GPA and job success are related (Slade, 1980). Supervisor evaluations were used to measure job success and GPA scores were obtained from the schools. To determine if a relationship existed Pearson product- moment correlation (r) was calculated. The study found no difference in job performance between students with A, B, and C averages.

High school GPA predicting undergraduate success.

GPA, combined with other factors, is one of the most common criteria used to help make college admission decisions. College admission officials often use GPA to help predict whether or not an applicant will be successful at a higher level of education. Although GPA is only a measure of current educational achievement, it also is reliant on other factors such as effort, attendance, conformity, and motivation.

One particular study found that GPA was somewhat effective in predicting college success. The study found that high school GPA scores were effective in predicting success at the 2.00, 2.50, and 3.00 levels of first-year GPA, however, high school GPA was not an effective predictor of success at higher levels of first-year GPA (Noble & Sawyer, 2002). The data was collected from two years of historical records of American College Testing's (ATC) Prediction Research History files. It included a sample size of 219,435 first-year postsecondary students. The study concludes that college grades reflect achievement and noncognitive factors, and therefore high school GPA does not always predict college GPA (Noble & Sawyer, 2002). The study also concluded that admissions tests, such as the ACT, may do a better job at predicting

first-year college success because they offer better differentiation across levels of achievement compared to high school GPAs.

Undergraduate GPA predicting graduate school success.

Similar to the undergraduate application process, graduate programs also utilize GPA to aid in the decision process of accepting applicants. Instead of looking at high school GPA, most graduate programs require an applicant to send in undergrad transcripts for review. Typically it is assumed that applicants with lower undergrad GPAs will not be accepted at higher quality graduate program since they are less likely to do well. However, in general, the literature reveals that GPA is not always a good predictor of graduate academic success.

In one particular study, a researcher used a group of 91 students in a Department of Education Psychology program to study this topic (Bean, 1975). He used GRE scores and undergraduate GPA as predictors and used undergraduate GPA, master's comprehensive examination scores, and grades in specific graduate classes as criteria. The researcher found that there was a moderate correlation between GRE scores and some of the criterion variables, but there was no significant correlation between undergraduate GPA and any of the graduate performance measures.

In a similar study, researchers looked at undergraduate GPA and GRE scores to predict graduate GPA and comprehensive exam scores. The study included 257 students who were enrolled in a master's program. The study found that GRE was the most valid predictor of graduate student success. In another study, researchers looked at 63 medical school graduate records to determine if they correlated with in training examinations in anesthesia and orthopedic surgery. They study concluded that the graduate school records did not do a good job in predicting examination results.

GPA and technical/clinical success.

Heavy competition exists to get acceptance into professional and technical programs. Once again the acceptance process relies on many criterions, with GPA as one of the common ones. This follows the assumption that a student who performed well academically will also perform well in the clinical/technical aspect of professional training. Review of the literature regarding GPA looks to determine if a relationship exists between a student's academic achievement and their clinical performance while attending professional school.

In a specific study researchers looked at the relationship between academic achievement and clinical performance in a physical therapy education program (Rheault & Shafernich-Coulson, 1988). The researchers took a sample of 65 physical therapy graduate students from the University of Health Sciences at Chicago Medical school to determine if a correlation exists between GPA and clinical performance (Rheault & Shafernich-Coulson, 1988). The researchers examined graduates' pre-professional GPA, professional GPA, and clinical performance. After analyzing the data using Pearson product-moment correlation, they found that there was no significance between the relationship of pre-professional and professional academic achievement. They also found no significance between pre-professional academic achievement and clinical performance, although the correlation was relatively higher. However, there was significance between the relationship of pre-professional GPA and professional GPA. The researchers suggest that one of the reasons professional GPA and clinical performance do not have a significant correlation is because other variables may be related to clinical ability. They suggest factors such as problem-solving, physical dexterity, or individual attitudes are more closely related to clinical capability in comparison to academic achievement.

Another study called looked at the relationships between traditional preadmission measures and clinical skills performance on a medical licensure examination (Boulet, Langenau, Pugliano, & Roberts, 2012). This study supported the conclusion that some preadmission measures of academic ability, such as GPA, are not strongly related to clinical skill performance (Boulet, Langenau, Pugliano, & Roberts, 2012). This study specifically looked at the Medical College Admission Test (MCAT) and the undergraduate college GPA to challenge the assumption that these preadmission measures can predict clinical skill performance. They evaluated the medical licensure examination as a measure of clinical skill performance. The researchers included 3,189 individuals from 22 different medical schools. They study concluded that perhaps selection measures should be developed to more appropriately identify which students will be successful in the medical clinical areas.

In another study research was performed to examine the relationship of admissions data and measurement of psychological constructs of dental technology student with their psychomotor performance (Dirks & Evans, 2001). The researchers used grades from three laboratory courses and found a significant correlation between the grades earned in the laboratory course and previous college GPA, along with other admissions data such as interview scores, college hours, field dependence-independence scores, block counting, trust, straightforwardness, and dutifulness. The study concluded that individual differentiation in learning ability, visual or spatial perception, and personality affect psychomotor learning.

Issues and alternatives to GPA.

There is a large section of the literature that researches the problems associated with GPA and its use as a tool for academic assessment. Typically, a student's GPA is calculated by the following process: In each class a final letter grade is recorded by averaging over an array of

assignments. A weighted average of the grade points assigned to each letter grade is then calculated based on the potential credit the student could earn. In one study researchers looked at and highly scrutinized the GPA calculation process and determined alternatives to the traditional calculation of GPAs (Tindal & Volwerk, 2012). The study concluded that there are many issues with this system, the first of these being the disproportional lowering of the GPAs for any student who does not earn an "A" letter grade. According to the study, when there are lower letter grades, such as B, C, D and F, in a student's transcript, there is an even more significant disproportional lowering of the GPA (Tindal & Volwerk, 2012). Therefore, there is an increase in the difference between high and low achieving students simply as the result of a calculation artifact (Tindal & Volwerk, 2012). Another calculation issue the study found regarding GPA calculation is the problem that there is no room at the top. A score between 90 and 100 leads to the addition of 4.0 grade points, and therefore the GPA does not distinguish between a student who consistently obtains scores in the higher 90s versus a student who consistently earns scores in the lower 90s. The GPA's nonlinear ordinal scale loses some of the information about a student's overall performance (Tindal & Volwerk, 2012).

The study also found that GPA can be easily skewed and exaggerated even though percentages may be very similar. For example, if student A takes two courses and receives a 90 in both classes, he/she is awarded two A letter grades, resulting in a 4.0 GPA. If student B is also taking two classes and receives a 90 in one class and an 89.3 in the other, he/she is awarded an "A" and a "B," which resulting in a 3.5 GPA. There is only a fraction of percent difference in the classroom percentages but a significant difference in the GPA differences even though the achievement was essentially identical.

The third problem the study concluded was that there is not much room at the bottom regarding GPA. It is standard that any percentage below 60 receives zero points awarded. Therefore, there is once again a problem with distinguishing someone who received a 59.9 percent and did some of the work, and someone who earned a 10 percent because they did virtually nothing. Due to this system, there is little motivation for a student with a high failing grade to continue working in order to receive the highest percentage possible (Tindal & Volwerk, 2012).

Due to the nature of how GPA is calculated, the study argues that it is not the best tool to evaluate and compare student's achievement and ability, or to predict their future potential. Instead, the study provides an alternative method to the traditional GPA method. The study proposes that the letter grade system be abolished and replaced with a term they coin as "percent point average" (PPA) (Tindal & Volwerk, 2012). This would involve converting a classroom percentage into percentage points awarded using a linear scale. This would allow for points awarded from a continuous range that are directly proportional to the awarded classroom percentages. The advantage of using this PPA system is that it would eliminate all of the problems discussed earlier.

In order to test the feasibility of the PPA system, a pilot longitudinal study took place at a high school. Sixty randomly selected students reported letter grades, classroom percentages, and credit earned at the end of a term. Both the GPA and the PPA were calculated and compared. The results show that the PPA helped bring up the lower end by "correcting for the GPA calculation artifact that results from the scaling problem (Tindal & Volwerk, 2012)."

Pilot skills.

Many sources indicated that airmanship, knowledge, and judgment are the key factors that a good pilot possesses (Wallace, 2010). The knowledge area simply involves the ability to study, learn, observe, listen, and memorize. Airmanship comes from developing the skills to master the art of flying an aircraft. Good judgment is also an important factor is making a good pilot, which is why the FAA now requires aeronautical-decision-making training in pilot training. Research shows that poor judgment is usually a big factor in the accident chain. As a former astronaut stated, "A superior pilot uses his superior judgment to avoid situations which require the use of his superior skill" (Lokowich, 2012).

According to the FAA, there are certain skills that, if properly developed, can help make a pilot safer. These skills are good pilot judgment, also known as aeronautical decision making (ADM) and risk management. Studies were performed to test if pilots who received ADM training had fewer in-flight errors compared to those without ADM training. The studies found that there was a significant difference ranging from 10 to 50% fewer judgment errors (FAA, 2008). Due to these finding, the FAA began requiring ADM for flight training in the regulation. This action shows that the FAA believes that contrary to popular belief, good judgment can be taught.

The ability to maintain good situational awareness is another key aspect associated with being a good pilot (O'Hare, 1997). Situational awareness refers to the cognitive practices that are involved in human interface with complex, dynamic environments, such as inside the cockpit (O'Hare, 1997). These varieties of situations require the operator, or in the aviation world the pilot, to handle several tasks at once, which requires them to monitor, prioritize and manage.

According to Endsely and Bolstad, individuals achieve varying levels of situation awareness because of differences in skills including working memory capacity, perceptual speed, pattern-matching ability, cognitive complexity, mental stimulation, and attention sharing (O'Hare, 1997). In order to measure these abilities different tests, such as MICROPAT and BAT have been used to measure pilot performance during training. These tests have been moderately valid in their prediction for initial flying training success, but less so for advanced performance (O'Hare, 1997).

Common variables measured to predict pilot performance.

Predicting how successful an individual may be in pilot training and thereafter has proven to be a challenging task. Due to the typically high cost of pilot training, this is a particularly important topic in the aviation industry for those who are involved in selecting and training pilots. In order to best select individuals who pose the greatest potential for success, there appears to be common criteria used by differing training programs throughout of the industry.

A study was conducted to compile a description of the criteria and variables used to measure pilot performance for the selection and screening of pilots of many different pilot training programs (Bates, Colwell, King, Siem, & Zelenski, 1997). The researchers outline and integrate the different variables used to predict and measure pilot performance. They study found that typically a multi-disciplinary and multi-model approach appears to be the best process. According to the researchers there are five major categories in which the variables affecting pilot performance can be divided: psychomotor coordination, background information, information processing ability, general cognitive ability, and personality traits (Bates et al., 1997).

Cognitive ability is the most commonly tested area in pilot selection (Bates et al., 1997). This is because studies show that general cognitive ability is a prediction of job performance.

Cognitive tests are also relatively cheap and can be distributed in mass quantities easily. Studies of undergraduate pilot training students show that superior general intelligence is common among pilots. In these studies, average IQ was 120, which is over one standard deviation above the average (Bates et al., 1997). Different branches of the military use different cognitive tests to assess cognitive ability.

Psychomotor Coordination is another valued pilot quality that is tested and measured in order to better predict pilot performance (Bates et al., 1997). Normally, psychomotor refers to eye-hand-foot coordination, and this is sometimes combined with skills such as information processing, problem solving, and reaction time. Psychomotor tests examine one's coordination of thinking and doing tasks at the same time, or in a sequence. Many of the psychomotor test involved computer technology. Studies have indicated validity in the Air Force's Two Hand and Complex Coordination Test, accounting for about 5-10% of the variance in pilot training performance (Bates et al., 1997). The Navy's psychomotor test was also found to count for 19.5% of the variance in flight grades (Bates et al., 1997). In another study in the Netherlands, there was a modest relationship between psychomotor tests scores and flight grades (Bates et al., 1997). Studies also show that psychomotor tests also correlate with video game playing.

Biographical information is another variable that was examined in many studies. This involves background tests to determine what the person has done in the past. This is typically used as a motivational factor, which otherwise could not be measured properly (Bates et al., 1997).

Information processing is another skill that many selection processes use to predict pilot performance (Bates et al., 1997). It refers to how an individual attends to, selects, and internalizes information, and then how they eventually use to make decisions. This variable does

not contribute greatly to predicting pilot performance, but it does determine how a pilot will cope with difficult aviation tasks and environments (Bates et al., 1997). The military utilizes different tests to measure information processing.

Personality is also measured by many selection processes in hopes of predicting pilot performance (Bates et al., 1997). Studies have mixed conclusions on which personality factors predict pilot performance. One reason may be that many of the studies rely on self-reported information and therefore have low reliability and validity (Bates et al., 1997). In one study, the only personality trait that had a significant correlation was extrovertism (Bates et al., 1997). In another study, the researcher found that self-confidence was an attribute that correlated with pilot training success (Bates et al., 1997). In general, studies found that pilot tend to be psychologically stable and adaptive.

Military selection process.

Typically in a military setting, there is a rigorous selection process due to the high costs associated with the training of a pilot. Different selected measures are constantly being reviewed to evaluate the effectiveness of the criteria in order to decrease the 25% attrition rate. The military attempts to generate a system that will choose the best candidates with the best potential to do well in flight school so that money is not wasted.

In the United States Air Force, the pilot selection process includes the review of medical fitness, anthropometric standards, educational achievement, aptitude tests, and performance in a flight screening program (Carretta, 2000). The two aptitude tests most utilized by the USAF include the Air Force Office Qualifying Test (AFOQT) and the Basic Attributes Test (BAT). The AFOQT measures general cognitive ability in the following subjects: math, verbal, spatial, aviation knowledge, and perceptual speed. The BAT is used only for pilot selection and measure

cognitive ability, psychomotor ability, and attitudes towards risk. The results from the AFOQT Pilot composite is combined with the BAT score to produce a Pilot Candidate Selection Method (PCSM). Research has shown that the PCSM has proven to be related to the number of flight hours needed to complete training, class ranking, and fighter qualification (Carretta, 2000). A higher PCSM scores has been associated with requiring less hours to complete training, an increase in probability of completing jet training, a higher class rank, and a better chance at being fighter qualified.

The Air Force Academy is one route to take to become an Air Force pilot, and some of the things this institution look at are academic records and AFOQT scores (Carretta, 2000). Applicants to attend Officer Training School (OTS), which is another way to become a pilot in the USAF, also are judged on their experience, academic performance, experience, potential and adaptability. These factors are measured through employment history, flying history, academic history, PCSM score, and recommendations. The Reserve Officer Training Corps (ROTC) route to becoming a pilot utilizes a selection process in which factors are evaluated to make a composite Categorization Order of Merit (COM) score. This score includes an evaluation of potential by the commander through a Relative Standing Score (RSS), college GPA, AFOQT scores, and a fitness test. Unlike the other selection methods, prior flying experience is not put into the equation.

A study was performed to determine which criteria were most heavily utilized in the USAF pilot selection process (Carretta, 2000). The study found that the cumulative GPA, flight screening performance, and cumulative military performance averages were most relied on for selection process in the Air Force Academy. OTS selection boards heavily relied on college GPA and PCSM score. For the ROTC selection process, COM score was the most important factor,

which consists of officer potential (47.8%), college GPA (19.8%), fitness test score (11.5%), AFOQT Verbal (11.5%), and AFOQT Quantitative (9.4%). A further analysis of COM scores showed a correlation of .639 with college GPA, .921 with officer potential, .437 with fitness, .290 with the Verbal composite, and .325 with the Quantitative composite.

Overall, the USAF pilot selection showed an emphasis on measures of officership rather than measures of ability since most pilots come from AFA or ROTC (Carretta, 2000). Officership includes military performance average and RSS, while ability was measured by academic performance, flight screening performance, and aptitude test scores.

Further investigation was used to evaluate the predictive value of officership using 469 ROTC cadets who attended undergraduate pilot training. This research showed that there was virtually no relationship between officership ratings and pilot training attrition (Carretta, 2000). The value of PCSM was also researched using it against T-37 pilot training. Research found that higher PCSM scores were significantly related to greater probability of successfully completing training in the T-37 phase, fewer flight hours needed to complete the training, higher class rank, and greater chance of being fighter qualified.

A study was specifically conducted to evaluate the relationship between the AFOQT test and performance in undergraduate pilot training and undergraduate navigator training (Arth, Steuck, Sorrentino & Burke, 1990). The researchers took AFOQT scores and compared them with training success. The AFOQT is divided into Pilot, Navigator-Technical, Academic Aptitude, Verbal, and Quantitative, and within each composite they are even further divided into subtests. The researchers individually correlated the composites with training success.

The researchers found that composites being used by the USAF have significant correlation with success in the training world (Arth et al., 1990). They also found that some of

the composites currently being used had no significant correlation with training success. The concluded that there were five subtests that correlated with undergraduate navigator success: Arithmetic reasoning, math knowledge, scale reading, block counting, and rotated blocks (Arth et al., 1990). The general science subtest proved no significance with navigator training success. No subtests with large verbal components were found to have significance. Overall, the composites that had significant correlation were Pilot, Navigator-Technical, and Quantitative.

For undergraduate pilot training, four subtests had significance: Mechanical Comprehension, scale reading, instrument comprehension, and aviation information (Arth et al., 1990). The four that did not reach significance were verbal analogies, electrical maze, block counting, and table reading. The Pilot and Navigator-Technical composites were the only two that had significant correlation with undergraduate pilot training.

Summary.

The true value of an individual's GPA as a predictor of future success appears to be relatively limited. According to the literature researched, GPA does not have a strong link to future success. Most studies found either found very weak or no significance at all when GPA was measured with undergraduate school academic success, graduate school academic success, technical/professional school academic success, and job success. There was some effectiveness in high school GPA predicting undergraduate GPA, but only in the first year and only in the middle grade range. With regards to predicting graduate school success, admissions tests, such as the GRE proved to be a more valid measure in predicting success. In technical/professional schools, there was mixed conclusions reached throughout the literature regarding the value of GPA. Some studies found no link between pre-professional GPA and clinical performance or

professional academic achievement, while others found a significant relationship between grades in technical lab courses and previous college GPA.

Throughout the literature different theories are concluded as to why GPA may not serve as a reliable predictor of success. Most common is that GPA only reflects academic achievement at that moment and does not reflect other personality traits or characteristics that also may affect success. GPA is not a measure of general intelligence or skill. It also can be manipulated or easily skewed and disproportionally lowered when an "A" is not received. Many of the studies conclude that there are other measures available that can be more heavily relied on to predict success, such as admissions tests. In professional school, there are a variety of variables needed to success that involve both cognitive and noncognitive abilities. Psychomotor learning is vital in professional/technical school, which relies heavily on problem-solving, physical dexterity, spatial perception, and learning ability.

The literature regarding the pilot selection process used by different institutions reveals GPA and academic achievement is often one of several factors measured to predict potential pilot success. Although GPA is a consideration, most selection processes rely heavily on the measurement of other skills, including general cognitive ability, psychomotor ability, attitudes towards risk, working memory, and perceptual speed. Studies have revealed that pilots who perform well in flight training, more specifically military flight training, usually have higher general intelligence, measured by IQ scores, higher psychomotor skills, and tend to be psychologically stable and adaptive. Overall the literature agree that success pilots have overall good judgment, decision making skills, psychomotor skills, and airmanship abilities.

Statement of the Problem/Research Questions

At MTSU, a student's GPA is particularly important for Aerospace Flight Students. In order to be eligible for a flight lab, a student must meet the minimum 2.5 GPA requirement. This requirement was established on the premise that a student who performs better in the classroom is more likely to perform better in the airplane. Some argue that the skills and characteristics necessary to be a good academic student are not necessarily the same needed to be a good pilot, and therefore GPA is not a good predictor of a student's piloting abilities. Others argue that the GPA does reflect on the required skills needed in both the classroom and the airplane, and therefore a high minimum GPA requirement would help make a more selective pilot process that would in the end produce better pilots.

With a minimum GPA requirement in place in the MTSU Flight Department, it is important to assess the validity of the practice. Research should first be accomplished to determine whether there is any relationship between a student's academic performance and pilot performance. Research on this topic would be valuable to help determine if the current usage of GPA to allocate flight labs should be revisited, amended, or changed entirely. Therefore, my research will look to answer a few questions. The overall research question is the following: Is there a correlation between academic performance and pilot performance. More specifically, the study will focus on answering these questions:

1. Is there a relationship between student GPA and stage check passage rate?
2. Is there a relationship between student GPA and FAA Practical Test passage rate?
3. Is there a relationship between student GPA and FAA Written Exam scores?

4. Is there a relationship between student GPA and the length of time it takes to complete the certificate/rating?
5. Is there a relationship between GPA and number of hours its takes to complete the certificate/rating?

CHAPTER II – METHODOLOGY

In order to determine if a relationship exists between students' academic performance and pilot performance in a collegiate flight training environment, a quantitative research method was pursued. This approach was most appropriate since numerical data was collected to answer the research questions. The data was collected through the review of historical records of both flight information and academic information. This method allowed for the most accurate method of data collection since the information came directly from official records kept by Middle Tennessee State University and the Middle Tennessee State University flight school. GPA was collected to measure academic performance and the following was collected to measure pilot performance: FAA written exam score, the calendar time it took to obtain the certificate/rating, the flight time it took to obtain the certificate/rating, Practical Test passage rates, and stage check passage rates. The data was then analyzed to determine if a relationship exists between the variables. The study was approved by the IRB protocol number: 13-239 (see Appendix A).

Participants

A sample group was utilized to carry out this study consisting of MTSU Aerospace students enrolled in the either the Private flight lab (AERO 2201/Professional Pilot I) or the Instrument flight lab (AERO 3202/Professional Pilot II) from the summer of 2009 through the fall of 2011. A decision was made to only include Private and Instrument students to obtain the most revealing results. Initially, the researcher intended to use participants who had graduated from the Pro-Pilot undergraduate degree, and therefore would have completed at least three certificates/ratings through MTSU. However, using this approach would have resulted in data that was skewed for two reasons. First, those who completed the program would have had to keep the minimum GPA of 2.5 throughout their flight training, as required by the Aerospace

Department. Secondly, those students would have had to develop and sustain sufficient pilot skills to achieve the three certificate/ratings. Therefore, by using only graduates of the Pro-Pilot program, the data would have been skewed since it would have been looking at the only those who were able to achieve these stipulations. A large portion of students may have been excluded who were enrolled in flight labs but did not complete the major, perhaps due to too low a GPA or a lack of piloting skills. For example, a student may have been able to complete the Private flight lab, but during the time they were enrolled their GPA fell below the minimum of 2.5. If that person never raised their GPA up to the required minimum, that individual would not have been able to stay in the Pro-Pilot major. However, their data is still relevant and needed for the study. Therefore a new approach was designed so that these individuals would be included. In order to include a broader range of participants in the study, instead of just the top achievers, only Private and Instrument students were used. When students first enter the Aerospace flight program, they typically start at either the Private or Instrument level. Therefore, the use of entry-level flight labs allowed for a wider range of participants to be included since they are less likely have been eliminated by GPA restrictions or lack of ability.

Students were not required to have been enrolled in both the Private and Instrument flight lab. Each lab was reviewed and analyzed individually. Therefore some students are participants twice in the study if they took both the Private and Instrument lab within the used time frame. Although data from the Private lab was looked at separately than the Instrument lab, some conclusions were drawn looking at the data from each group as a whole.

Participants were taken from the following semesters: Summer 2009, Fall 2009, Spring 2010, Summer 2010, Fall 2010, Spring 2011, Summer 2011, and Fall 20011. Students from prior semesters were not included due to major changes in the flight lab curriculum. Prior to Summer

2009, up to three different courses were offered for a single certificate/rating until a full transition was made to the current program in Summer 2009. In order to most accurately analyze the data, it was important to make sure that all participants underwent similar training. Since the three syllabi were noticeably different, a decision was made to eliminate anyone enrolled prior to Summer 2009, which is when the new Private and new Instrument program were fully implemented. Participants who were enrolled after Fall 2011 were not included to ensure the participants had sufficient time to complete the certificate or rating so that a complete set of data was available. Not every student is able to finish the lab in one semester and therefore training could potentially still be in progress for students enrolled past fall 2011.

There were a total of 264 participants included in the study. More students were enrolled in the selected labs during the desired time frame than were included in the final number of participants. Students were eliminated for various reasons. Students who were enrolled in the lab but withdrew before flight training began were automatically eliminated from the study since they had no data to collect. There were also some students who were enrolled, but their flight records could not be located. Some of these students finished the lab, while others withdrew at some point. These students were eliminated as well. Students who started flight training but withdrew from the lab before completing their Practical Test were included in the study, although were not included in each analysis step. In total, 5 Private and 15 Instrument students were eliminated due to lack of record access. Additionally, 11 Private students and 7 Instrument had withdrawn during the course of the semester and therefore only a limited set of data was used in the study from those participants.

Since the data collected was retrieved from historical records, an informed-consent form was not required. Again, permission from the IRB was granted to access the student academic

and flight records. Additionally, permission was granted for access to historical GPA information by the MTSU Records Office.

Instruments

The study utilized data collection from historical records kept by MTSU. GPAs were obtained from student academic records that were made available through Pipeline access. Transcripts of each participant were reviewed in order to determine the first semester the student was enrolled in the lab and to determine the student's cumulative GPA at the end of that first semester.

Flight training records kept by the MTSU flight school were also used to gather data for this study. From these records the necessary information was collected to compute Practical Test and stage check passage rates, along with FAA written scores, calendar months and flight time necessary to complete the certificate/rating. Records were kept in folders filed away in various locations. Some were located at the flight school or in the flight school's simulator building. Others from years farther back were stored in a maintenance storage facility in an off-campus location. Access was granted to all locations in order to locate the physical folders. Some information was also available electronically from the flight school's Assistant Chief Pilot. The flight school's Records Manager also granted the researcher access to the flight school's "Z-drive" in order to gain access to flight record information.

Design

Due to the nature of the topic, a basic correlation research design was used. This means that the scores for the variables of interest were obtained for each member of the sample, and the paired scores were then correlated. The result of this were expressed as a correlation coefficient, which shows the degree of relation between the two variables chosen. The following variable

pairs were examined: 1) GPA and calendar time required to complete the certificate/rating GPA and Practical Test passage rates, 2) GPA and FAA written exam score, 3) GPA and Practical Test passage rate, 4) GPA and stage check passage rate, and 5) GPA and flight hours required to complete the certificate/rating.

GPA was used to measure academic performance. This measure was the best available option since it is one of the only concrete records of a student's academic performance. Exit exams were not utilized since some of the participants were still enrolled at the University, and some of the participants left the university before graduating and therefore did not take an exit exam. The GPA consisted of the students' cumulative GPA of the semester he or she was first enrolled in the lab. The current overall GPA from the semester enrolled in the lab was not utilized in order to avoid skewed results. For example, students enrolled during the summer often only take the lab and no other courses. Upon completion of the lab an A would be received and therefore summer students would reflect a 4.0 current GPA during the enrolled semester, which may be less representative of their overall academic performance. The cumulative GPA consisted of all courses taken at MTSU through the semester of enrollment in the lab. Although originally desired, a GPA for aerospace-only classes was not available on the transcript.

Pilot training performance was determined through a series of measures. These include the FAA written exam score, the calendar time it took to obtain the certificate/rating, the flight time it took to obtain the certificate/rating, Practical Test passage rates, and stage check passage rates. Each of these variables is a different method of determining student-pilot performance in flight training. FAA written exams tend to reveal ground knowledge, an important aspect during flight training. Lower scores reveal weaker ground knowledge while higher scores reveal more depth of ground knowledge. The calendar time was utilized to measure pilot training

performance in order to reveal possible struggles that would cause a student to have slow progress. This could be in areas of ground or flight ability. The number of flight hours required to complete the training necessary to pass the Practical Test was also a variable that could reveal possible struggles in flight training. The assumption was made that less flight hours required was a indication of better pilot performance during training. Stage check passage rates were also calculated to reveal performance during training. Lower stage check passage rates were indications of failures of stage checks, which reveals deficiency in pilot performance. Practical Test passage rates were also used to measure pilot performance. Lower rates indicate failed Practical Test and deficiencies in either ground or practical knowledge or skill.

Procedure

After IRB approval was received, the first step in the study was to create a master list of students who were eligible to be a participant in the study. In order to generate this list, Pipeline was used to look up the enrollment of AERO 2201 and AERO 3203 during the requested semesters. During this step the student's name, student identification number, type of lab and semester enrolled were recorded in an Excel spreadsheet. During this time those who were enrolled in the course but dropped the lab before the semester even began were eliminated. Evidence that they withdrew was indicated with a W and "web-dropped" with the date of the drop published next to the name. After all of the AERO 2201 and AERO 3203 students were recorded for the given time period, duplicates were deleted from the Excel sheet. There were duplicates because some students were enrolled in the same lab in multiple semesters if they did not finish it in one semester.

Once the master list was created, a copy of the list was sent out to the Assistant Chief Flight Instructor and the Records Manager at MTSU's flight school to ensure records would be

available to access and to determine where to find each students' records. As a result, the Chief Flight Instructor gave the researcher access to the available flight records in electronic format. This included an Excel sheet that provided the student's name, date of enrollment, date of initial Practical Test, date of a second attempt for the Practical Test (if necessary), total calendar time enrolled in the lab (in day and month formats) and FAA written scores (first and/or last attempt). Most of the participants were included in this spreadsheet, although some were not, and others had some of their information incomplete.

The Records Manager provided the researcher with a list of the location of the files of each of the individuals on the master list that was provided to him. The records were stored in various boxes that were at different locations, so this information was vital in gaining access to the correct records. The boxes were all given letter identifications and the appropriate box letter-identification was provided by the Records Manager. In order to gain access to the records at the maintenance storage facility, MTSU maintenance personnel escorted the researcher and the Records Manager to the facility to locate the boxes at that location. The boxes were taken from that location and moved a new location for ease of access. A key was also issued to the researcher for access to the boxes located in the MTSU simulator building. The majority of records were housed in these two locations. The researcher also was given a key to the MTSU flight school records office which housed the remainder of the records. Once all the boxes were accessible, the researcher went one-by-one through each file in the boxes. Since the boxes were organized by semester, each one contained Private, Instrument, and Commercial lab student records. The Commercial records were ignored, but those that were tabbed with the label "PVT" or "INST" were reviewed.

Each record was approached in the same manner. First, the name of the tab was verified with the master list to confirm that the record was of that of a participant in the study. Then the researcher searched through the file to search for any additional data not given electronically by the Assistant Chief Flight Instructor. The researcher also double-checked the information that was provided electronically in order to verify the information was accurate. Typically on the left side of the file the researcher found the enrollment certificate, a copy of the FAA written exam, a copy of the 8710 form, and a copy of the temporary certificate. The date on the enrollment certificate was used to determine the start date of the lab for the participant. The date of the temporary certificate was used to determine the end date for the participant. Each of these dates were recorded in the Excel spreadsheet which utilized a formula to produce the total number of days and months from the enrollment date to the date of Practical Test passage. The FAA written exam results were also recorded, along the attempt number, which was located on the copy of the results. Some students had multiple attempts, but only the passing score copy was located in the file. If multiple copies were found, each attempt was recorded. If the participant failed the Practical Test, this was determined by a few ways. First, the 8710 sheet would have marked "YES" under "Have you failed a test for this certificate or rating?" Secondly, a copy of the letter of disapproval was found on the left side of the file. On the right side of the file, the flight training time was found by searching through the completed syllabus. For each lesson in the syllabus for both the Instrument and Private course a log of the flight time was kept, along with a running total. Therefore the last lesson in the syllabus was found and used to determine total training flight time. For Private participants, total flight time was found under the column labeled as "TOT FLT" under lesson 37. This included all flight time in an actual airplane that the student utilized during training up to the Practical Test. For Instrument participants, total flight time

consisted of both flight time in the airplane, and time in the simulator. Often times during Instrument training a flight training device (FTD) was used in lieu of an actual aircraft and therefore both were combined to create a total flight time amount. This information was found on lesson 40. Numbers from the column "FTD" and 'TOT FLT" were combined to create one number that was recorded in the Excel sheet as the total flight time. Stage check information was also found on the right side of the file, behind the syllabus. For each stage check, the stage check instructor filled out a form that revealed the outcome of the stage check. The notation "MM" or "P" was evidence the student passed the stage check. If the student failed, an "I" or "F" was noted on the evaluation form as appropriate to the number of failures. Private students are required to pass a series of four stage checks throughout the syllabus while Instrument students encounter three stage checks. The number of attempts and failures were recorded as appropriate. Some of the stage check evaluation sheets were incomplete or too ambiguous to interpret. Several methods were utilized to attempt to determine results. The researcher often referred to the lesson number tied to that stage check to determine if more than one flight or ground lesson was recorded, which was evidence of a failure. Reference to the "school notes" page and the "daily activity sheet" were also cross-referenced to determine failures. If there was still uncertainty, the researcher looked up the stage check on the "Z-drive" at the flight school, which has recorded the number of attempts of stage checks. Once the number of attempts and number of failures for each participant was determined, a stage check passage rate was calculated. This was done by taking the total number of stage checks required by the syllabus and dividing it by total number of attempts by the student. For example, if it was recorded that a Private student failed two stage checks, that means they attempted six totals (4 passed and 2 failed). Therefore the number passed, which is always 4 as required by the syllabus, was divided six. This results in

a stage check percentage of 67%. This method was used to account for every failure, since some students failed one specific stage check multiple times. A similar method was used to determine the Practical Test passage rates. The total number of passes (which would be 1) was divided by attempts. If the student passed on the first try they received a score of 100%. Those who required a second attempt were given a 50%. No participant required more than one additional attempt.

Some records were unable to be located either by the Records Manager or by the researcher even after additional searching. These 5 Private students and 15 Instrument students were then eliminated from the study, even if partial information was obtained. This decision was made since there was a large enough sample and there were few missing files.

Once all the raw data was entered into Excel, a new "cleaned-up" spreadsheet was created. This allowed for a format that could be analyzed. The spreadsheet consisted of the participants GPA, days enrolled in the lab, Practical Test passage rate, stage check passage rate, number of stage check failures, first attempt on the FAA written exam, passing score of FAA written exam, total number of attempts on the FAA written exam, and total flight hours. The participant's name and M-number was deleted at this point since it was not longer necessary to pair the variables together.

At this point, the data of those who had withdrawn from the course but had completed some of the training was separated from the other complete data. This was because those who withdrew did not have complete data since they did not finish the course. These participants were not eliminated from the study completely though, as their GPA was analyzed to determine if there was a significant difference between the GPA of those who completed the lab and those who did not.

Once the data collection process was complete, several analyses were carried out in effort to answer the proposed research questions. A quantitative analysis approach was utilized. The statistics used yielded interesting results that are discussed in the following chapter.

CHAPTER III - ANALYSIS OF RESULTS

Quantitative data analysis techniques were used to analyze the data gathered through the review of records. Table 1 shows a summary of the data through descriptive statistics for the Private group. Table 2 shows a summary of the data collected through descriptive statistics for the Instrument group.

For the Private group, the mean GPA was 3.2623, the mean calendar time was 5.1 months, the mean score for the first FAA written attempt was 82.13, the last written attempt score average was 82.55, and the average number of written attempts was 1.1149. For the Private group, the mean Practical Test passage rate was 0.916, the mean stage check passage rate was 0.810, the mean number of failed stage checks was 1.28, and the mean number of flight hours required to pass the certificate was 50.9 hours.

For the Instrument group, the mean GPA was 3.306, the mean calendar time was 5.1 months, the mean score for the first FAA written attempt was 76.86, the last written attempt score average was 79.70, and the average number of written attempts was 1.290. For the Instrument group, the mean Practical Test passage rate was 0.907, the mean stage check passage rate was 0.715, the mean number of failed stage checks was 1.58, and the mean number of flight hours required to pass the certificate was 46.9.

Table 1

Descriptive statistics for Private participants

	GPA	Time	Score 1	Score 2	Written Attempts	PT Rate	SC Rate	Failed Stage Checks	Flight Hours
M	3.263	5.1	82.13	82.55	1.149	0.916	0.810	1.28	50.9
SE	0.042	0.2	0.79	0.69	0.052	0.0189	0.019	0.15	1.0
Mdn	3.285	4.5	83.00	83.00	1.000	1.000	0.800	1.00	49.3
Mode	4.000	4.4	87.00	87.00	1.000	1.000	1.000	0.00	48.1
SD	0.423	2.1	7.77	6.94	0.517	0.188	0.187	1.54	10.2
S	0.179	4.5	60.41	48.09	0.268	0.035	0.035	2.36	103.6
Range	2.000	13.5	41.00	28.00	3.000	0.500	0.600	6.00	69.6
Min.	2.000	2.4	57.00	70.00	1.000	0.500	0.400	0.00	30.8
Max.	4.000	15.9	98.00	98.00	4.000	1.00	1.000	6.00	100.4
N	101	101	96	101	101	101	101	101	101

Note. "Score" refers to the FAA written exam. "Score 1" refers to the first attempts on the FAA written exam. "Score 2" refers to the final/passing score on the FAA written exam. PT = Practical Test passage rate; SC = stage check passage rate.

Table 2

Descriptive statistics for Instrument participants

	GPA	Time	Score 1	Score 2	Written Attempts	PT Rate	SC Rate	Failed Stage Checks	Flight Hours
M	3.306	5.1	76.86	79.70	1.290	0.907	0.715	1.58	46.9
SE	0.035	0.2	0.80	0.54	0.047	0.016	0.017	0.12	0.9
Mdn	3.309	4.4	78.00	80.00	1.000	1.000	0.750	1.00	44.3
Mode	4.000	4.1	83.00	83.00	1.000	1.000	0.750	1.00	43.7
SD	0.416	2.7	9.25	6.55	0.564	0.195	0.204	1.40	11.3
S	0.173	7.3	85.54	42.93	0.318	0.038	0.042	1.97	126.6
Range	1.653	14.5	47.00	30.00	3.000	0.500	0.670	6.00	66.2
Min.	2.347	1.7	48.00	65.00	1.000	0.500	0.330	0.00	27.1
Max.	4.000	16.2	95.00	95.00	4.000	1.000	1.000	6.00	93.3
N	145	145	135	145	145	145	145	145	145

Note. "Score" refers to the FAA written exam. "Score 1" refers to the first attempts on the FAA written exam. "Score 2" refers to the final/passing score on the FAA written exam. PT = Practical Test passage rate; SC = stage check passage rate.

First, scatter plots were created for the following variable combinations: 1) GPA and time in months, 2) GPA and the score on the first FAA written exam, 3) GPA and the score on the last attempted/passing FAA written exam, 4) GPA and number of attempts on the FAA written exam, 5) GPA and Practical Test passage rate, 6) GPA and stage check passage rate, 7) GPA and number of failed stage checks, and 8) GPA flight time required to complete the rating/certificate. These plots may be seen in Figure 1 through Figure 16. These graphs give an overall picture of any correlation or pattern.

The correlation coefficient was then calculated for each variable pairing. The technique specifically used was Pearson's *r*, since all of the variables were expressed as continuous (i.e., ratio or interval) data. Pearson's *r* also provides a more precise estimate of correlation. The strength of correlation coefficient produced by Pearson's r was interpreted using the following scale:

Coefficient	**Relation between Variables**
Between 0.0 and +.20 or 0.0 and -.20	Weak or none
Between +.20 and +.40 or -.20 and -.40	Modest
Between +.40 and +.60 or -.40 and -.60	Moderate
Between +.60 and +.80 or -.60 and -.80	Strong
Between +.80 and +1.0 or -.80 and -1.0	Very Strong

Since the accessible critical value tables used to determine the significance of Pearson's *r* did not have the exact *df* for the samples used in the study, a conservative approach was taken. For the larger sample sizes (145, 135) the n=120 number (.178) was used. For the smaller sample sizes (101), the n=100 number (.195) was used, and for the smallest sample size (96), the n=90 (.205) was used.

The common variance was also calculated for each variable pairing. This was accomplished by squaring the correlation coefficient. The purpose of this was to determine the extent to which variables vary in a systematic way. In order to make sure results were not by chance, a test of statistical significance was conducted during the data analysis phase to determine if *r* was significant. The standard statistical significance of .05 was used, meaning that a correlation of this size, for this population, would occur no more than 5 out of 100 times. A two-tailed test was used and the appropriate critical values were looked up in a statistics book and compared with each calculated *r* value. The results of the correlation coefficient for each variable paring are displayed in Table 3 and Table 4, and will be discussed in detail below.

Table 3

Correlation coefficients for Private participants

	GPA
Calendar Time	-0.1473
Score 1	0.4184
Score 2	0.3949
No. of Written Exams	-0.3206
PT Passage Rate	-0.0670
SC Passage Rate	0.2407
No. of Failed SC	-0.2430
Flight Hours	0.061

Note. "Score" refers to the FAA written exam. "Score 1" refers to the first attempts on the FAA written exam. "Score 2" refers to the final/passing score on the FAA written exam. PT = Practical Test passage rate; SC = stage check passage rate.

Table 4

Correlation coefficients for Instrument participants

	GPA
Calendar Time	-0.3437
Score 1	0.4221
Score 2	0.4438
No. of Written Exams	-0.2889
PT Passage Rate	0.2500
SC Passage Rate	0.36934
No. of Failed SC	-0.3576
Flight Hours	-0.1241

Note. "Score" refers to the FAA written exam. "Score 1" refers to the first attempts on the FAA written exam. "Score 2" refers to the final/passing score on the FAA written exam. PT = Practical Test passage rate; SC = stage check passage rate.

Calendar Time

In order to determine the relationship between GPA and how long it takes a student to complete the Private certificate or Instrument rating, the correlation coefficient was calculated between the two variables, $r(101) = -0.1474$, $p > .05$. Within the Private participants, since r was calculated to be -.147, this shows a weak, negative correlation between GPA and time. The correlation between GPA and time was not statistically significant for the Private group since the critical value was determined to be .195. The weak to zero correlation between these two variables is visible in the scatter plot in Figure 1. The coefficient of determination, r^2, was calculated to be 0.0217. This means that only 2% of the variation in time can be explained by the linear relationship between GPA and time. The other 98% is unexplained.

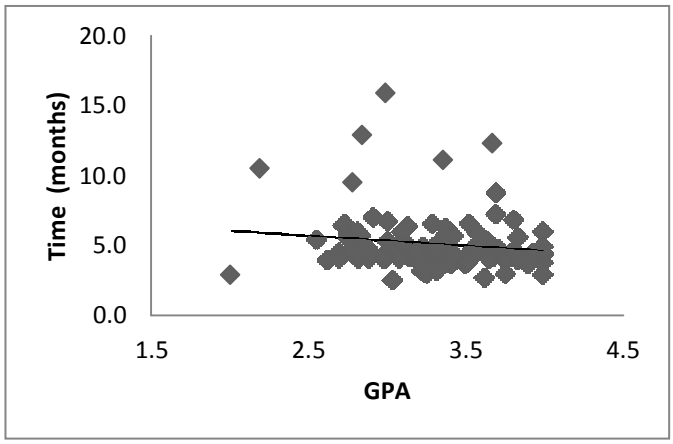

Figure 1: Linear relationship between time and GPA for Private participants

Within the Instrument participants, $r(145) = -0.344$, $p > .05$. This shows a modest, negative correlation between GPA and time. The correlation between GPA and time was statistically significant for the private group since the critical value was determined to be .178. The modest linear relationship between these two variables is visible in the scatter plot in Figure 2. The coefficient of determination, r^2, was calculated to be 0.118. As a result, 12% of the variation in time can be explained by the linear relationship between GPA and time, and the other 88% is unexplained.

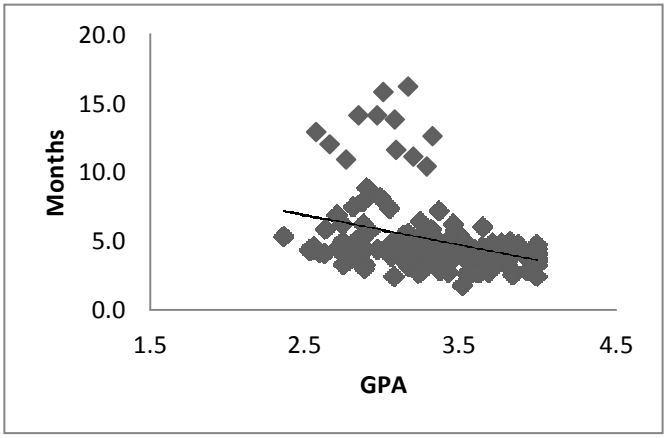

Figure 2: Linear relationship between time and GPA for Instrument participants

FAA Written Exams

In order to determine whether GPA and scores on the FAA written exams were related, the correlation coefficient was calculated using Pearson's *r*. Three different analyses were run for this data. The first analysis included all of the participants who had a "first attempt score." This group includes participants who may have failed the exam and had that attempt recorded. Some of the participants were not included in this analysis because their first attempt was not available through the records. Since only the final attempt score is required to be recorded, not all participants have a first attempt if they failed the exam at least once.

Within the Private participants, for the first attempt $r(96) = 0.4184$, $p > .0$. This shows a moderate, positive correlation between GPA and first attempt scores on the FAA written exam. The correlation between GPA and this score was statistically significant for the private group since the critical value was determined to be .205. The moderate correlation between these two variables is visible in the scatter plot in Figure 3. The coefficient of determination, r^2, was calculated to be 0.1751. This reveals that 18% of the variation in written scores can be explained by the linear relationship between GPA and time. The other 82% is unexplained.

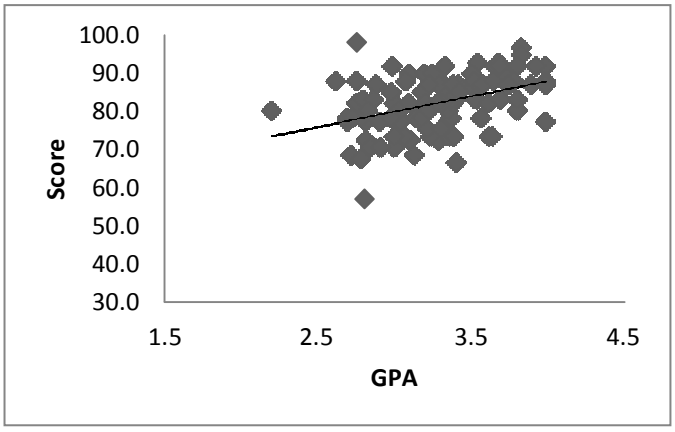

Figure 3: Linear relationship between FAA written exam first attempt score and GPA for Private participants

Within the Instrument participants, for the first attempt, $r(135) = 0.4221$, $p > .05$. This shows a moderate, positive correlation between GPA and first attempt scores on the FAA written exam. The correlation between GPA and this score was statistically significant for the Instrument group since the critical value was determined to be .178. The moderate correlation between these two variables is visible in the scatter plot in Figure 4. The coefficient of determination, r^2, was calculated to be 0.1782. This means that 18% of the variation in written scores can be explained by the linear relationship between GPA and first attempt scores on the FAA written exam. The other 82% is unexplained.

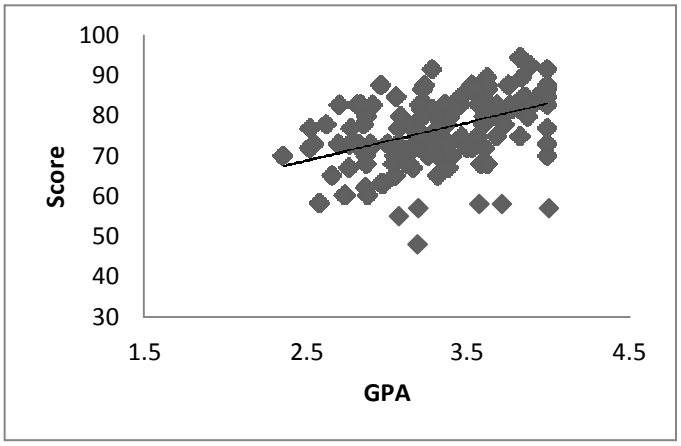

Figure 4: Linear relationship between GPA and first attempt FAA written score for Instrument participants

The second analysis of written scores includes all of the participants' last, or passing attempt score. Therefore, all of the scores in this analysis were that of a passing grade. Within the Private participants, $r(101) = 0.39499$, $p > .05$. This shows a modest to moderate, positive correlation between GPA and final attempt scores on the FAA written exams. The correlation between GPA and this score was statistically significant for the private group since the critical value was determined to be .195. The modest to moderate correlation between these two variables is visible in the scatter plot in Figure 5. The coefficient of determination, r^2, was calculated to be 0.1559.

Therefore, 16% of the variation in written scores can be explained by the linear relationship between GPA and last attempt scores on the FAA written exam, while the other 84% is unexplained.

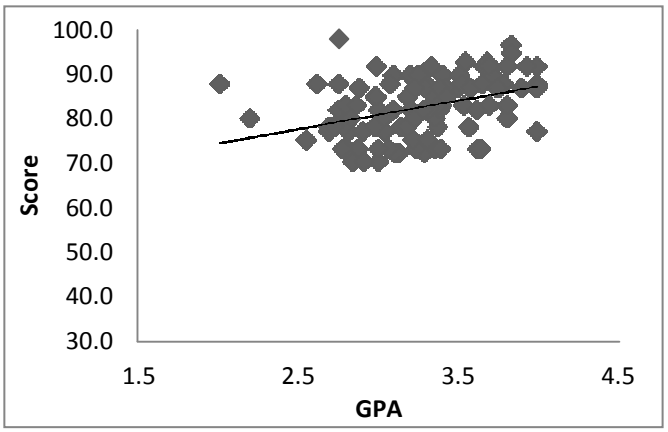

Figure 5: Linear relationship between GPA and final attempt score on FAA written exam for Private participants

Within the Instrument participants, $r(145) = 0.4438$, $p > .05$. This shows a moderate, positive correlation between GPA and final attempt scores on the FAA written exams. The correlation between GPA and this score was statistically significant for the Instrument group since the critical value was determined to be .178. The moderate correlation between these two variables is visible in the scatter plot in Figure 6. The coefficient of determination, r^2, was calculated to be 0.1969. This shows that 20% of the variation in written scores can be explained by the linear relationship between GPA and last attempt scores on the FAA written exam and the other 80% is unexplained.

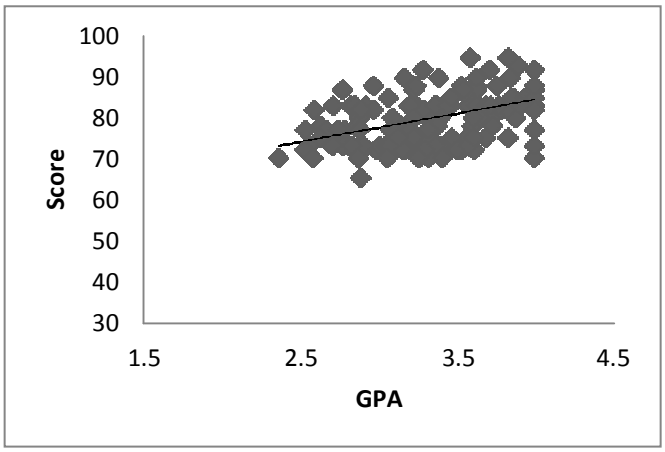

Figure 6: Linear Relationship between GPA and final attempt score on FAA written exam for Instrument participants

A third analysis on FAA written exams was performed to determine if a relationship exists between GPA and the number of attempts required to pass the exam. Within the Private participants, $r(101) = -0.3206$, $p > .05$. This shows a modest, negative correlation between GPA and number of attempts. The correlation between GPA and number of attempts was statistically significant for the Private group since the critical value was determined to be .195. The modest correlation between these two variables is visible in the scatter plot in Figure 7. The coefficient of determination, r^2, was calculated to be 0.1028. This means that 10% of the variation in the number of attempts can be explained by the linear relationship between GPA and the number of attempts. The other 90% is unexplained.

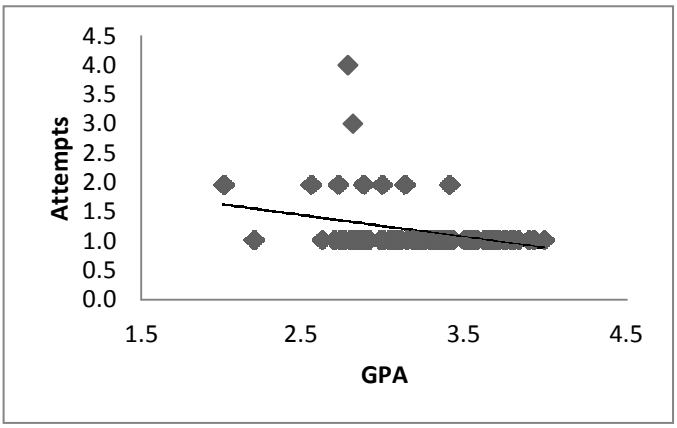

Table 7: Linear relationship between GPA and number of written exam attempts for Private participants

Within the Instrument participants, $r(145) = -0.2889$, $p > .05$. This shows a modest, negative correlation between GPA and number of attempts. The correlation between GPA and number of attempts was statistically significant for the Instrument group since the critical value was determined to be .178. The modest correlation between these two variables is visible in the scatter plot in Figure 8. The coefficient of determination, r^2, was calculated to be 0.0835. This means that 8% of the variation in number of attempts can be explained by the linear relationship between GPA and the number of attempts. The other 92% is unexplained.

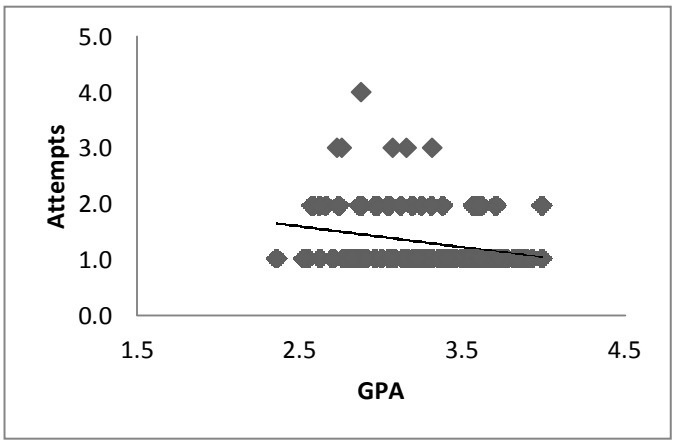

Table 8: Linear relationship between GPA and number of written exam attempts for Instrument participants

Practical Test

In order to determine the relationship between GPA and Practical Test passage rates for the Private certificate or Instrument rating the correlation coefficient was calculated between the two variables. Within the Private participants, $r(101) = -0.06706$, $p > .05$. This shows a weak to none, positive correlation between GPA and Practical Test passage rates. The correlation between GPA and the pass rate was not statistically significant for the Private group since the critical value was determined to be .195. The weak to zero correlation between these two variables is visible in the scatter plot in Figure 9. The coefficient of determination, r^2, was calculated to be 0.0045. Only 1% of the variation in rates can be explained by the linear relationship between GPA and Practical Test passage rates, while the other 99% is not explained.

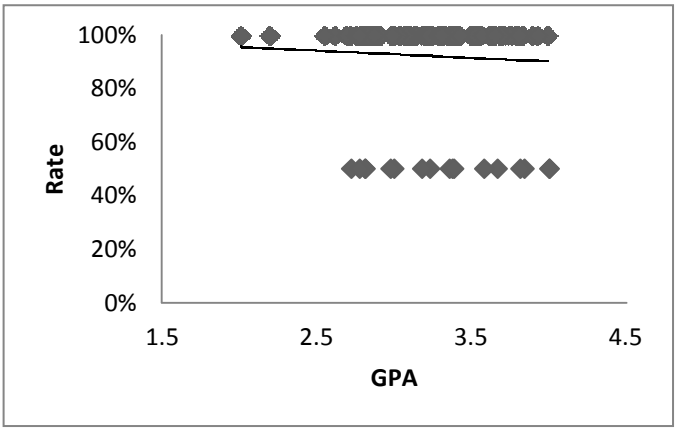

Figure 9: Linear relationship between GPA and Practical Test passage rates for Private participants

Within the Instrument participants, $r(145) = 0.2500$, $p > .05$. This shows a modest, positive correlation between GPA and Practical Test passage rates. The correlation between GPA and the pass rate was statistically significant for the Instrument group since the critical value was determined to be .178. The modest correlation between these two variables is visible in the scatter plot in Figure 10. The coefficient of determination, r^2, was calculated to be 0.0625. This

means that 6% of the variation in rates can be explained by the linear relationship between GPA and Practical Test passage rates. The other 94% is unexplained.

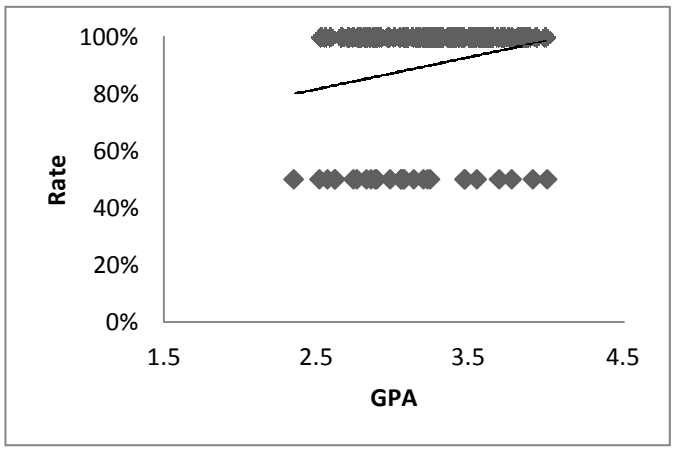

Figure 10: Linear relationship between GPA and Practical Test passage rates for Instrument participants

Stage Checks

In order to determine whether GPA and stage check passage rates are related, the correlation coefficient was calculated using Pearson's *r*. Two different analyses were run for this data. The first analysis compared GPA with the stage check passage rate. Within the Private participants, $r(101) = 0.2407$, $p > .05$. This shows a modest, positive correlation between GPA and stage check passage rate. The correlation between GPA and this rate was statistically significant for the Private group since the critical value was determined to be .195. The modest correlation between these two variables is visible in the scatter plot in Figure 11. The coefficient of determination, r^2, was calculated to be 0.0579. This means that the linear relationship between GPA and stage check passage rates only accounts for 6% of the variation in stage check rates. The other 94% is unexplained.

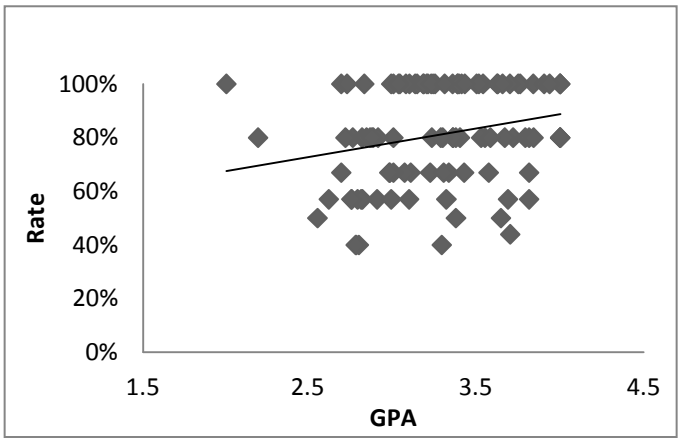

Figure 11: Linear relationship between GPA and stage check passage rate for Private participants

Within the Instrument participants, $r(145) = 0.3694$, $p > .05$. This shows a modest, positive correlation between GPA and stage check passage rate. The correlation between GPA and this rate was statistically significant for the Instrument group since the critical value was determined to be .178. The modest correlation between these two variables is visible in the scatter plot in Figure 12. The coefficient of determination, r^2, was calculated to be 0.1364. Therefore 14% of the variation in stage check rates can be explained by the linear relationship between GPA and stage check passage rates, but the other 86% is unexplained.

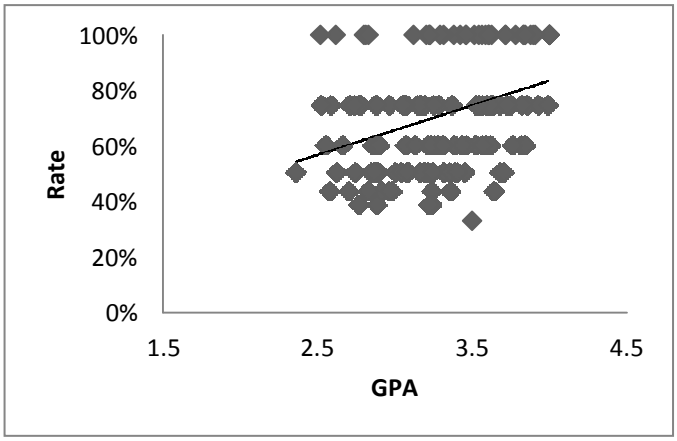

Figure 12. Linear relationship between GPA and stage check passage rate for Instrument participants

A second analysis of stage check information was performed to see if a relationship exists between GPA and the number of stage checks a participant failed. Therefore, Pearson's *r* was calculated between GPA and the number of failures for that certificate/rating. Within the Private participants, $r(101) = -0.2430$, $p > .05$. This shows a modest, negative correlation between GPA and number of stage check failures. The correlation between GPA and failures was statistically significant for the Private group since the critical value was determined to be .195. The modest correlation between these two variables is visible in the scatter plot in Figure 13. The coefficient of determination, r^2, was calculated to be 0.1364. This means that 14% of the variation in stage check rates can be explained by the linear relationship between GPA and stage check passage rates. The other 86% is unexplained.

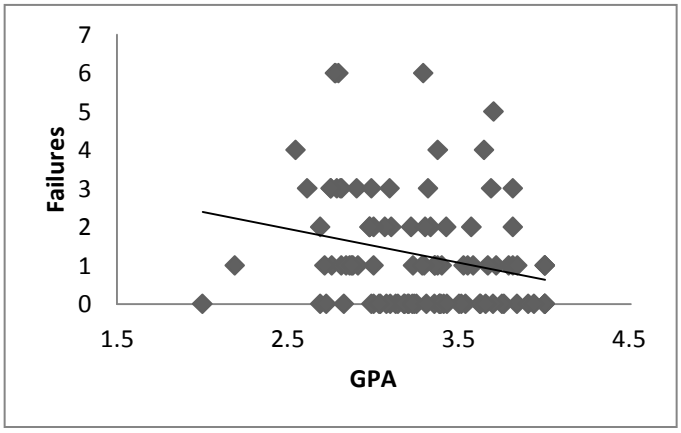

Figure 13: Linear relationship between GPA and number of stage check failures for Private participants

Within the Instrument participants, $r(145) = -0.3576$, $p > .05$. This shows a modest, negative correlation between GPA and number of stage check failures. The correlation between GPA and failures was statistically significant for the Instrument group since the critical value was determined to be .178. The modest correlation between these two variables is visible in the scatter plot in Figure 14. The coefficient of determination, r^2, was calculated to be 0.1279. This

means that the linear relationship between GPA and stage check passage rates only explains 13% of the variation in stage check rates. The other 87% is unexplained.

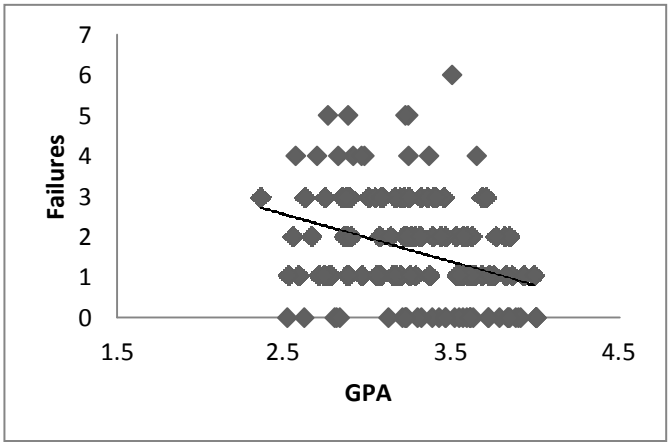

Figure 14: Linear relationship between GPA and number of stage check failures for Instrument participants

Flight time

In order to determine the relationship between GPA and the amount of flight time required to achieve the Private certificate or Instrument rating the correlation coefficient was calculated between the two variables. Within the Private participants, $r(101) = 0.0610$, $p > .05$. This shows a weak to zero, positive correlation between GPA and flight hours. The correlation between GPA and flight hours was not statistically significant for the Private group since the critical value was determined to be .195. The weak to zero correlation between these two variables is visible in the scatter plot in Figure 15. The coefficient of determination, r^2, was calculated to be 0.0037. As a result, less than 1% of the variation in rates can be explained by the linear relationship between GPA and flight hours, and the other 99% is unexplained.

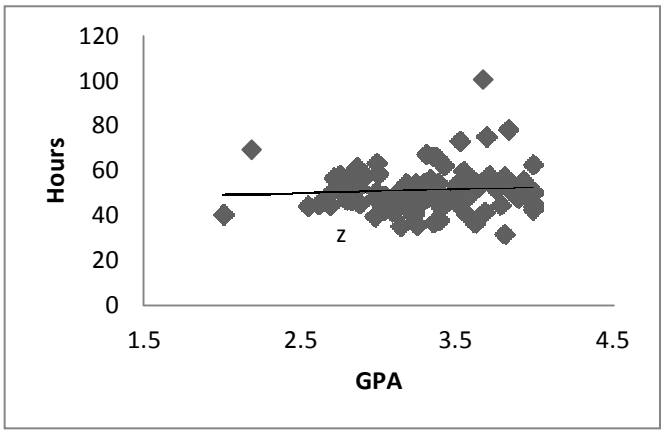

Figure 15: Linear relationship between GPA and flight hours for Private participants

Within the Instrument participants, $r(145)$ = be -0.1241, $p > .05$. This shows a weak to zero, negative correlation between GPA and flight hours. The correlation between GPA and flight hours was not statistically significant for the Instrument group since the critical value was determined to be .178. The weak to zero correlation between these two variables is visible in the scatter plot in Figure 16. The coefficient of determination, r^2, was calculated to be 0.0149. This means that less than 2% of the variation in rates can be explained by the linear relationship between GPA and flight hours. The other 98% is unexplained.

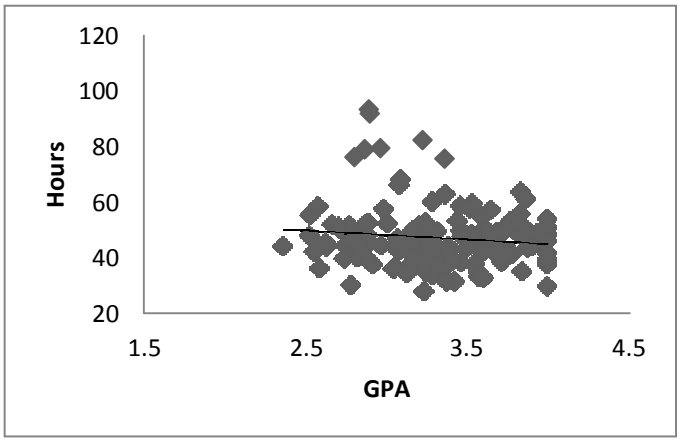

Figure 16: Linear relationship between GPA and flight hours for Instrument participants

GPA and Completion of Training

The participant's GPA was compared to each of the variables used to measure pilot performance by calculating a correlation coefficient value. Only those who had a complete set of data were included in this analysis. Those who had withdrawn during the course of their training were only analyzed using descriptive statistics, which was compared to the descriptive statistics of the participants who had completed training and had a full set of data, as seen in Table 5.

Table 5

Descriptive statistics of GPA

	Private-F	Private-W	Instrument-F	Instrument-W
M	3.2623	2.730	3.306	2.718
SE	0.042	0.302	0.035	0.082
Mdn	3.285	3.000	3.309	2.722
Mode	4.000	N/A	4.000	N/A
SD	0.4231	1.002	0.416	0.218
S	0.179	1.004	0.173	0.048
Range	2.000	3.769	1.653	0.556
Min.	2.000	0.231	2.347	2.457
Max.	4.000	4.000	4.000	3.013
N	101	11	145	7

Note. F= Finished training; W=Withdrew during the semester after flight training begun

A final analysis was performed to determine if there was a difference between the GPA of those who completed the certificate/rating and those who did not. The average GPAs were calculated using the mean and were displayed in Table 5. A 2-sample 2-tailed t-test was performed assuming unequal variance. For the Private group, there was no significance in the difference between the mean GPA of those who completed the certificate and those who withdrew during the course of training, $t(10) = 1.7452$

,$p > .05$. For the Instrument group, the difference between the mean GPA of those participants who completed the rating and those who withdrew was statistically significant, $t(8) = 6.5059$, $p > .0$. Although the mean GPA of those who withdrew in both labs was very similar, 2.730 and 2.719 respectively, the variance and standard deviation was much greater for the Private participants compared to the Instrument participants.

CHAPTER IV -DISCUSSION

Data Interpretation

The primary goal of this study, as established in the five research questions identified in Chapter I, was to explore the relationship between academic performance and pilot performance of students in a collegiate flight training environment. After data collection and data analysis, it was determined that there were some significant results produced revealing a relationship between the two variables in certain categories and groups. This relationship shows a slight predictor value of GPA in predicting a student's pilot performance in a training environment.

With regards to GPA and the time it takes a student to complete their certificate/rating, the Private participants revealed a weak, negative correlation. This means that in the sample there was a weak linear relationship between the variables in which as GPA tended to increased, the length of time to complete the certificate tended to decrease. However, this relationship was not statistically significant, and therefore it can be determined that this relationship was by chance and would not be found in the population. With regards to the Instrument participants, a modest, negative correlation also existed, but unlike the private participants, the relationship is statistically significant. This reveals that there is a modest relationship between GPA and length of time to complete the rating, in which as GPA increases time tends to decrease. Since the correlation is statistically significant, the relationship would be found within the population. Therefore, the answer to the research question "Is there a relationship between student GPA and the length of time it takes to complete the certificate/rating?" is no for Private participants and yes, a modest negative relationship for Instrument participants.

The next research question asked "Is there a relationship between student GPA and FAA Written Exam score?" Several different analyses were run to answer this question. The first

analysis used written scores from students' first written test attempts. Both the Private and Instrument participants revealed a moderate, positive correlation that was statistically significant. This means that in the population a modest, positive trend would be found between the two variables in which as GPA increases the first attempt score on the FAA written exam would also tend to increase. During the second analysis only the final, passing written score was analyzed. A modest, almost moderate, correlation was found with the Private group, and a moderate positive correlation was found within the Instrument group. This means that within the population, a modest, positive trend for private students and moderate, positive trend for instrument students would be found between the two variables in which as GPA increases the final attempt score on the FAA written exam would also tend to increase. It is theorized that this second analysis provided slightly weaker significance because there was less variance between the scores. This was due to the fact that all of the scores in this data set were at least of a passing grade (70%). The last analysis did not specifically answer a research question but did supplement it. It found that for Private and Instrument students, a statistically significant modest, negative relationship exists between GPA and the number of attempts required to pass the FAA written exam. Therefore, GPA and the number of attempts are linearly related so that as GPA tends to increase, the number of attempts required tends to decrease. In regards to the research question, it was determined that there is a moderate, positive relationship between GPA and FAA exam written scores.

Another research question asked "Is there a relationship between student GPA and FAA check ride passage rate?" Within the Private group, there was a very weak positive relationship between the two variables that was not statistically significant. Therefore it was determined that no relationship exists between student GPA and FAA check ride passage rates at the Private

certificate level. However, within the Instrument group, a statistically significant modest, positive correlation existed. This means that as GPA tends to increase, FAA check ride passage rates tend to increase as well in a modest linear manner. Therefore, on the Instrument level, the answer to the research question is yes, a modest, positive relationship does exits between GPA and check ride passage rates.

The fourth research question sought to answer the question "Is there a relationship between student GPA and stage check passage rate?" The study found that there was a statistically modest, positive relationship between GPA and stage check passage rates within the Private and Instrument groups. Therefore, within the population it can be determined that the variables are modestly related in a linear fashion in which as GPA tends to increase, stage check passage rates also tend to increase. Another analysis revealed that there is also a relationship between GPA and the number of failed stage checks. For both groups, a modest, negative linear relationship existed in which as GPA tends to increases the number of failed stage checks also tends to decrease.

The final research question asked "Is there a relationship between GPA and the number of hours its takes to complete the certificate/rating?" The study found that there was a weak to no relationship between the two variables within the Private and Instrument groups. Therefore, the flight time it takes a student to complete the certificate/rating is not linearly related to GPA.

The results for the study revealed similar answers to the research questions between the Private and Instrument group for 3 of the 5 questions. The two questions that revealed different results where those involving GPA and calendar time and GPA and check ride passage rates. In the Private group, for both of these variables' pairings, no relationship was found. However, within the Instrument group a slight relationship was found. This is believed to be related to the

nature of each of the ratings/certificates. Relative to Private certificate, the Instrument rating tends to involve a deeper level of ground knowledge and cognitive ability to properly understand the more advanced concepts related to the rating. The Private certificate tends to be focused more on flying abilities and tactical skill in order to develop a safe pilot who can handle the aircraft. Therefore, students who have greater cognitive abilities related to establishing Instrument skills may also have the same cognitive skills that are related to a higher GPA. As a result, GPA would be relatively more related to the pilot performance variables in the Instrument group compared to the private group.

A further analysis was conducted to determine if there was a difference in GPA amongst those who completed flight training and those who withdrew during the lab. In the Private lab, there was no significant statistical difference, but in the Instrument lab there was statistical significance. The average GPA of those who withdrew was statistically significantly less than those who finished the rating. Once again, it is theorized that the nature of the Instrument rating may be a factor in this result. Those who are not able, or have difficulty grasping concepts related to Instrument flying may lack the same qualities that help enhance one's GPA, since both have a similar focus on cognition. This finding may be one of the more applicable ones, especially since it supports having a minimum GPA requirement. Although it is unclear which minimum GPA would be required to yield the best results, there is reason to believe for the Instrument rating that a minimum GPA requirement would help ensure that the students who are enrolled are more likely to complete the rating. This would allow for open spots to be allotted to those who will continue on to pursue further certificates or ratings and not wasted on students who are more likely to drop out.

Another reason that, at the Private level, the average GPA was no different between those who finished and those who did not may be because this certificate is the first experience a student has with being a pilot. Therefore, during the course of training, some students may realize it is not what they expected, or decide to switch majors before they become too invested. At the Instrument level, there is a higher commitment factor at play since students would have already invested time, energy, and money into a flying career and therefore are less likely to switch or drop the lab for those reasons. Therefore, reasons for dropping the Instrument lab may be more related to struggles faced during training and those struggles may stem from some of the similar factors that are related to GPA.

Recommendations

As a result of this study, the recommendation is made to reconsider the minimum GPA requirement to enroll in a MTSU flight lab. Although there was some correlation between GPA and pilot training, it was not significant enough to support the use of GPA as the only criterion in the selection process. Perhaps other methods, such as some of the tests used by the Air Force, would be better methods of choosing students who would do well in pilot training and become good pilots.

With that being said, GPA is one of the easiest and most straight forward options available to aid in the selection process for flight lab allotment. Other options may be better predictors, such as some of the cognitive and tactile tests the Air Force uses, but it does not seem practical in this application. Therefore, the minimum GPA requirement may be actually be the only option available at this time and should continued to be used. If a GPA minimum requirement is kept, based on the results of this study, a suggestion is made to have a higher GPA for Instrument rating students, since there was a higher correlation in flight training success and

GPA. This recommendation is based on the result that GPA showed a relationship with more pilot performance variables in the Instrument group than the Private group. Also, within the Instrument group, the difference between the mean GPA of those participants who completed the rating and those who withdrew was statistically significant. Therefore, using GPA could be a helpful way to predict which students will be successful in pilot training.

Limitations

It is important to note that although some significant relationships were found, the correlation does not equate to causation. This study is not concluding that GPA causes any of the variables to vary a certain way, but rather concludes that there is a slight relationship between GPA and some of the other variables. Therefore, GPA may only be used as a slight predictor of pilot performance in a training environment.

It is also important to note that the study tested for linear relationships only, and therefore the statistical tests only revealed significance if this type of relation existed. Lack of significance does not necessarily equate to no type of relationship, since a different type of relationship that was not tested may exist.

Another limitation of the research was the use of the cumulative GPA of the first semester of enrollment in the appropriate flight lab. Although this method allowed for a larger scope since it provided the opportunity for a participant to fall below the required GPA minimum of 2.5 during that semester, it was also limiting. First, the data may have been slightly skewed since the participants must have had a 2.5 GPA to be able to enroll in the lab. Therefore, the data may have been diluted at the lower GPA's. Also, for some students, the GPA that was used was the first semester enrolled at MTSU, and for others, it included courses from a span of several semesters. Therefore, the classes that the GPA is comprised of are not necessarily equivalent.

There are some courses required in the Pro Pilot degree plan that are historically more difficult that may skew GPA, since some of the students may have had those classes while others did not. A final GPA may have been more reflective of overall academic performance. However this GPA could not be used because some of the participants withdrew from the university before completed a degree, while other participants are still in progress.

Another limitation revolves around the measurement of the variable of time. Generally, a certificate/rating is obtained during one semester, but there are several situations in which a student takes multiple semesters to complete the lab. Some students chose to do this over the subsequent semester, but sometimes this involves a break, such as summer or winter break. If the student chose to take this break off, the time of the break was still included in the total time to complete the certificate/rating, even if flight training was suspended.

Future Studies

This study has opened up potential for an array of future studies to further investigate the topic matter. Since GPA is a very variable measure of academic performance, a future study should be conducted by replacing it with a different measure, such as IQ scores. This would shift the focus away from academic performance and move it towards intelligence, which may yield different results. IQ is a more set measure since it is less likely to be skewed by various factors. Within this potential future study, it would also be interesting to expand the scope of participants. Another related future study could look at pilots in a training environment outside of the collegiate training environment. The specific environment examined in this study looked at a population of mostly younger college students. It would be interesting to look at training programs through FBOs, where pilots of all ranges and backgrounds train at to see if excluding the college environment is a factor.

It may also be beneficial to pair the pilot performance variables within themselves. For example, a study could explore if flight time and check ride passage rates are related. This approach would help determine if certain approaches to flight training are related certain outcomes.

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APPENDIX - IRB APPROVAL LETTER

MIDDLE TENNESSEE STATE UNIVERSITY

February 26, 2013

Carolyn Jones, Wendy Beckman
Department of Aerospace
Carolynj176@gmail.com, Wendy.Beckman@mtsu.edu

Protocol Title: "The Correlation Between Academic Performance and Pilot Performance"

Protocol Number: 13-239

Dear Investigator(s),

The exemption is pursuant to 45 CFR 46.101(b) (4). This is because the research being conducted involves the collection and study of existing data, documents and records that is being recorded by the investigator in a manner that subjects cannot be identified, directly or through identifiers linked to the subjects

You will need to submit an end-of-project report to the Compliance Office upon completion of your research. Complete research means that you have finished collecting data and you are ready to submit your thesis and/or publish your findings. Should you not finish your research within the three (3) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Your study expires on February 26, 2016.

Any change to the protocol must be submitted to the IRB before implementing this change. According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. **If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance before they begin to work on the project.** Once your research is completed, please send us a copy of the final report questionnaire to the Office of Compliance. This form can be located at www.mtsu.edu/irb on the forms page.

Also, all research materials must be retained by the PI or **faculty advisor (if the PI is a student)** for at least three (3) years after study completion. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Andrew W. Jones

Compliance Office
615-494-8918
Compliance@mtsu.edu