

Airmen Written Testing: An Investigation in Test Legitimacy

By

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Dedication

I dedicate this to my wife Amanda and my mother and father, Karen and Alan. I love you guys.

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Abstract

Becoming an airman in America requires one to pass one or more Federal Aviation Administration (FAA) knowledge tests. For some airmen tests, commercially available study guides exist which contain a question and answer database nearly identical to the database used to generate official FAA knowledge tests. This research determined whether deliberate memorization of questions and answers from a commercially available source is a common study method. This research also examined whether airmen knowledge test applicants performed more poorly on an unpublished assessment of aeronautical knowledge than they performed on their official knowledge test. It was determined that 88% of research participants agreed or strongly agreed that they attempted to memorize questions and answers from a commercially available source while studying for their FAA knowledge test. Furthermore, on average applicants performed more poorly on an unpublished assessment of aeronautical knowledge than on their official FAA knowledge test. The difference was sufficient to be considered statistically significant when all research questions were retained. When the most ambiguous research question was omitted from the calculation of results, the statistical significance was lost.

TABLE OF CONTENTS

	Page
List of Tables	viii
List of Figures.....	ix
I. INTRODUCTION	1
FAA Knowledge Tests	1
Test Credibility.....	2
Recognizing a Problem May Exist.....	4
Initial Industry Response to FAA Solution	5
Standardized Testing in Other Arenas	9
Investigation Needed.....	10
Research Questions	11
II. METHODOLOGY	13
Participants	13
Research Construction.....	15
Instruments	17
Test Questions Examined	18
Private questions	19
Commercial questions.....	24
Instrument questions	28

Survey	32
III. RESULTS.....	33
Written Tests	33
Private group.....	33
Commercial group	34
Instrument group.....	35
Aggregate.....	37
Survey.....	39
Private group.....	39
Commercial group	43
Instrument group.....	46
Aggregate.....	50
IV. DISCUSSION.....	54
Recommendations	56
Limitations and Future Research.....	57
References	59
Appendix A: IRB Approval	63
Appendix B: IRB Consent Form	64
Appendix C: Private Pilot Questions	66
Appendix D: Commercial Pilot Questions.....	69

Appendix E: Instrument Pilot Questions.....	72
Appendix F: Survey	75

List of Tables

Table		Page
1	Raw Scores and means for private group.....	34
2	Raw scores and Means for commercial group.....	35
3	Raw scores and means for instrument group.....	36
4	Raw data and means for instrument group with question 6 omitted.....	37
5	Raw data and means for all groups with no question omissions.....	38
6	Raw data and means for all groups with question 6 from instrument research test omitted.....	39

List of Figures

Figure	Page
1 Participant response to survey question 1 indicating that participant attempted to memorize questions and answers from test prep software or literature while studying, private group.....	40
2 Percentage of questions participants reported recognizing on their FAA knowledge test from their studies, private group.....	41
3 Participant response to survey question 3 regarding participant perception that commercially available test prep material was an effective means of studying for and passing their FAA knowledge exam, private group.....	41
4 Participant response to survey question 4 regarding agreement that using commercially available test prep material prepared them to be a safe and effective pilot, private group.....	42
5 Participant response to survey question 5 regarding hours dedicated to studying for their FAA knowledge exam with commercially available test prep material, private group.....	42
6 Participant response to survey question 1 indicating that participant attempted to memorize questions and answers from test prep software or literature while studying, commercial group.....	44

Figure	Page
7 Percentage of questions participants reported recognizing on their FAA knowledge test from their studies, commercial group.....	44
8 Participant response to survey question 3 regarding participant perception that commercially available test prep material was an effective means of studying for and passing their FAA knowledge exam, commercial group.....	45
9 Participant response to survey question 4 regarding agreement that using commercially available test prep material prepared them to be a safe and effective pilot, commercial group.....	45
10 Participant response to survey question 5 regarding hours dedicated to studying for their FAA knowledge exam with commercially available test prep material, commercial group.....	46
11 Participant response to survey question 1 indicating that participant attempted to memorize questions and answers from test prep software or literature while studying, instrument group.....	47
12 Percentage of questions participants reported recognizing on their FAA knowledge test from their studies, instrument group.....	48
13 Participant response to survey question 3 regarding participant perception that commercially available test prep material was an effective means of studying for and passing their FAA knowledge exam, instrument group.....	48

Figure	Page
14 Participant response to survey question 4 regarding agreement that using commercially available test prep material prepared them to be a safe and effective pilot, instrument group.....	49
15 Participant response to survey question 5 regarding hours dedicated to studying for their FAA knowledge exam with commercially available test prep material, instrument group.....	49
16 Participant response to survey question 1 indicating that participant attempted to memorize questions and answers from test prep software or literature while studying, sample aggregate.....	51
17 Percentage of questions participants reported recognizing on their FAA knowledge test from their studies, sample aggregate.....	51
18 Participants response to survey question 3 regarding participant perception that commercially available test prep material was an effective means of studying for and passing their FAA knowledge exam, sample aggregate.....	52
19 Participant response to survey question 4 regarding agreement that using commercially available test prep material prepared them to be a safe and effective pilot, sample aggregate.....	52
20 Participant response to survey question 5 regarding hours dedicated to studying for their FAA knowledge exam with commercially available test prep material, sample aggregate.....	53

CHAPTER I - INTRODUCTION

Becoming an airman in America requires one to pass one or more Federal Aviation Administration (FAA) knowledge tests. These tests are computer based and timed at various lengths, usually around two hours. Every test consists of questions with three multiple choice answers to choose from. An applicant is shown one question at a time until all are answered or the applicant runs out of time. After completion, the applicant is informed of their score nearly immediately.

At present, many companies and businesses offer training solutions designed to simplify the study process. Some of these professionally rendered training aids have question and answer databases associated with them which are very representative of the actual FAA question and answer databases used to generate official airmen knowledge tests. An individual studying to pass many of the various FAA airmen knowledge tests can purchase literature or software that contains a database of hundreds if not thousands of questions and answers representative of the actual questions and answers used by the FAA to generate official knowledge tests.

FAA Knowledge Tests

At present, many sample questions for many airmen knowledge tests are available on the Federal Aviation Administration (FAA) website (Sample airmen knowledge, n.d.). Up-to-date questions, along with answers which are not available from the FAA website, are made commercially available. Private companies endeavor to provide complete comprehensive databases. Consider this claim made by one publisher, Aviation Supplies and Academics: "ASA's Test Preps include questions and answer stems representative of all FAA knowledge exams" (ASA: test prep series, n.d., para. 1). Another publisher,

Gleim, claims to offer “the easiest, fastest, and least-expensive means of passing the FAA knowledge test” (Gleim products: private pilot FAA knowledge test, n.d., para. 1). This provision of questions and answers does not necessarily encourage the applicant to understand the subject. When the questions and answers to tests are made commercially available, the possibility that applicants will endeavor to obtain a passing grade through rote memorization instead of genuine scholarship and study becomes a reality.

Publishing the questions and answers to tests creates a powerful temptation for the applicant to memorize questions and answers and may be falsely inflating applicants’ knowledge test scores. However, it is important to note that the FAA does not presently publish the entire question database (Airman knowledge test questions, n.d.). It is also important to note that even if a student were to study solely by attempting to memorize questions and answers from commercially available databases, the student would still garner some aeronautical knowledge. Consider that an aviation rulemaking committee convened to study the issues with airmen knowledge testing stated “rote learning of facts may assist in understanding and is often a necessary part of learning” (A report from the airman testing standards and training aviation rulemaking committee to the Federal Aviation Administration, n.d., p. 3). The committee also found that “some areas of the test require verbatim recall of specific data and knowledge of aviation that simply has to be memorized” (A report from the airman testing standards and training aviation rulemaking committee to the Federal Aviation Administration, n.d., p. 3).

Test Credibility

Much has been written about the credibility of tests designed to evaluate knowledge for the issuance of credentials. According to authors Norcini and Shea,

credibility depends greatly on standards. With regard to standards, Norcini and Shea ask, “(a) Who set the standard? (b) how was the standard set? and (c) is it realistic?” (Norcini & Shea, 1997, p. 40). One of the most important criteria Norcini & Shea set is that “standard setters should have the right qualifications” (Norcini & Shea, 1997, p. 41). Do entities that exist in order to profit monetarily from selling test prep literature and software possess the proper qualifications necessary to set appropriate standards for the very tests their literature and software address? At the behest of such groups, the FAA currently involves interests like Aviation Supplies and Academics (ASA), Aircraft Owners and Pilots Association (AOPA) and Gleim in the process of evaluating testing policy (Namowitz, D. n.d.a).

Additional research is needed to evaluate the effectiveness of FAA knowledge tests. As previously stated, authors Norcini and Shea assert that the credibility of a test is partly determined by the test standard and whether or not it is realistic (Norcini & Shea, 1997). Is it realistic to accept a passing score on a test, for which the applicant had advance knowledge of the questions and answers, as evidence that the applicant understands the subject? To be sure, airmen knowledge test results do not indicate what methodology the applicant used while studying. However, the existence of test database facsimiles stipulates that question and answer memorization cannot be precluded as a possible study method.

Authors Fanjoy, Young and Dillman suggested that exit exams may be useful for collegiate aviation programs. Traditionally administrators have relied on FAA issued certificates to serve this purpose (Fanjoy, Young & Dillman, 2005). These concerns

suggest doubt may exist within the industry concerning how well FAA airmen knowledge tests evaluate aeronautical knowledge.

Investigations have been made to determine if students at two year or four year collegiate Airframe and Powerplant (A&P) programs perform better on FAA knowledge tests. Data showed negligible differences in scores (Summey, Schultz, Schultz, 2004). Could this be because the FAA knowledge test applicants involved in that study had advance notice of what questions were on their tests? Authors Evers, Sijtsma, Lucassen, and Meijer (2010), while discussing the Dutch review process for evaluating the quality of psychological tests, make the following statement:

Construct-related evidence should support the claim that the test measures the intended trait or ability. This concerns answers to questions such as “what does the test measure?” and “Does the test measure the intended concept or does it partly or mainly measure something else?” (p. 306)

To that end, how well are FAA airmen knowledge tests measuring aeronautical knowledge? A powerful temptation to study the questions and answers to FAA airmen knowledge tests is created by the existence of commercially available question and answer databases. Is the existence of such databases correlated to test scores?

Recognizing a Problem May Exist

Recently, the FAA recognized that there may be issues associated with airmen knowledge testing procedures and took action. Early in 2011 changes were made to the databases used to compile at least three FAA airmen knowledge tests. As one might expect, this resulted in “unusually high numbers of pilot-applicant failures” (Changes to FAA knowledge test question banks affecting testing scores, 2011, March 3, para. 1).

Does this support the claim that some test applicants memorize question and answer pairings from commercially available databases to study? More investigation is needed to answer this question.

Initial Industry Response to FAA Solution

Regardless of what these increases in failure rates indicate about possible study methods employed by test applicants, test prep businesses went on damage control. Dauntless, a provider of software based training aids for FAA airmen knowledge tests rebuked the change, stating, “we fully agree with the FAA that knowledge test content should be updated periodically to reflect changes in technology, regulation, doctrine and other factors. However, simply dumping completely new content into test banks without making this information known to test prep and training providers is counterproductive” (Statement regarding recent FAA test question changes, n.d., para. 4). AOPA, along with the National Association of Flight Instructors (NAFI) also expressed a lack of satisfaction with the database change and even went so far as to request an elimination of the new test questions associated with the three first affected tests. “In a joint letter with the National Association of Flight Instructors (NAFI), AOPA called on the FAA to restore the previous test questions, and expunge failures of new tests from student records” (Namowitz, D. n.d.a, para. 3).

In response to these database changes, AOPA and other industry groups have advocated less abrupt changes to the test databases. Industry groups want to be included in the process of changing and updating airmen knowledge test databases. “The FAA, responding to an outpouring of criticism from AOPA and others for unannounced changes to the knowledge testing system, has promised better coordination with the flight

training industry on future reforms” (Namowitz, D. n.d.a, para. 1). AOPA reports that “officials of the FAA’s Airman Testing Standards Branch met April 20 with AOPA and other industry participants to address concerns about changes that without notice altered the content of numerous knowledge test question banks, spiking failure rates” (Namowitz, D. n.d.a, para. 2). The industry shareholders who attended this meeting included “NAFI, the General Aviation Manufacturers Association, the Society of Aviation and Flight Educators, King Schools, Jeppesen, Aviation Supplies and Academics (ASA), Gleim, Computer Assisted Testing Service (CATS), LaserGrade, and others” (Namowitz, D. n.d.a, para. 19).

In response, the FAA convened a committee to “provide a forum for the U.S. aviation community to offer its experience and expertise in the elements of aeronautical knowledge and aeronautical experience required for safer operation in today’s National Airspace System (NAS)” (Aviation rulemaking committee (ARC) reports, n.d., notice of availability summary section, para. 1). After being under review for some time, the FAA is reported to have “embraced a majority of an advisory committee’s recommendations for improving the testing materials in a prompt show of support for the joint effort with the aviation industry to improve pilot knowledge tests” (Namowitz, D. n.d.b, para. 1). The report from the airman testing standards and training aviation rulemaking committee makes nine broad recommendations concerning FAA airmen knowledge test construction policies. Recommendation five is of great concern.

(A report from the airman testing standards and training aviation rulemaking committee to the Federal Aviation Administration, n.d.) found the following in recommendation five:

The FAA should return the knowledge test item question bank to the public domain by December 31, 2012, in a way that maintains the integrity of questions requiring calculations on interpolations in accordance with the guidance below:

- Remove numbers from questions that require calculations or interpolations.
- For scenario-based questions testing risk management skills, remove any facts and numbers that determine the appropriate course of action, such as wind direction.
- For questions that appropriately test rote knowledge, provide a sufficient number and variety of questions to ensure broad knowledge (such as airspace requirements, regulations, and airport signage and markings).

After 3 to 5 years, the FAA should determine whether it is appropriate to make the question bank, completely or in part, nonpublic, provided the following conditions have been met:

- The advisory group identified in recommendation 1 has been operating for a minimum of 3 years and will continue to operate for knowledge tests for every certificate or rating.
- The advisory group has reviewed all test questions in use.
- Correlation between knowledge tests and practical tests indicates that the new testing system has not been effective in creating

airmen who demonstrate improved knowledge and risk management skills. (p. 31)

This recommendation suggests the FAA should publish questions and answers in the short term and should consider discontinuing the practice of publishing questions and answers in the future. The recommendation is predicated on the existence of an “advisory group identified in recommendation one” (A report from the airman testing standards and training aviation rulemaking committee to the Federal Aviation Administration, n.d., p. 31). According to recommendation one, the aviation rulemaking committee specifically views it as appropriate that the advisory group be partially made up of “providers of aviation training materials” (A report from the airman testing standards and training aviation rulemaking committee to the Federal Aviation Administration, n.d., p. 7). Some of these advisory group members may profit from preserving a status quo in which test applicants who purchase the latest training software or literature, specifically tailored to individual airmen knowledge tests, will have a reasonable expectation of seeing many of the exact or extremely similar questions on their official tests as they saw during their studies. Necessarily, business interests predicated on selling these databases wish to see their continuation. Is it possible for an industry who sells “the easiest, fastest, and least-expensive means of passing the FAA knowledge test” (Gleim products: private pilot FAA knowledge test, n.d., para. 1) to promote test soundness if doing so would negatively impact profits? The important question is: what impact does the existence of such databases have on the airmen knowledge tests? More specifically, can it be shown that a positive correlation exists between the existence of these commercially available test prep question databases and

test scores instead of a positive correlation between applicant actual aeronautical knowledge and test scores?

How well the FAA airmen knowledge tests evaluate aeronautical knowledge must be evaluated. While performing such an evaluation, one must consider the availability of test prep software and literature of a nature previously described. It is possible that current industry norms do encourage fundamental understanding of aeronautical knowledge. Perhaps the commercial availability of test database facsimiles bolsters aeronautical understanding. Perhaps students simply integrate these test prep software and literature solutions into a well-rounded study methodology. When used in conjunction with ground school, collegiate training, or textbook study, the compilations of test question databases may solidify the foundation of knowledge being gleaned in more traditional study methods. What does cast doubt on this possibility is that following the 2011 database change to three FAA airmen knowledge tests, there were “unusually high numbers of pilot-applicant failures” (Changes to FAA knowledge test question banks affecting testing scores, 2011, March 3, para. 1). More study is needed to determine with statistical certainty the cause of the elevated failure rate.

Standardized Testing in Other Arenas

Many aspects of one’s life involve written testing. In public school today, what is known as high stakes testing has become normal. Student performance is often used not only to evaluate the student, but also the teaching staff or faculty of a school system. “Today, many school districts are mandating tests to measure student performance and to hold individual schools and school systems accountable for that performance” (Appropriate use of high-stakes testing in our nation's schools, n.d., para. 2). To that end,

many teachers in public schools are teaching to the test. Literature with specific examples and strategies for modifying teacher technique as the date of such tests approaches is widely available. Some teachers and educators advocate this method of instruction as useful for augmenting student scores on standardized tests. Additionally, they proclaim that instruction techniques which are specifically tailored for the test at hand are beneficial to the students' ongoing academic success (Kontovourki, S., & Campis, C. 2011). Other studies have found that the Graduate Record Examination (GRE), another form of standardized testing, is a valuable tool when used to predict the future performance of students who are accepted into graduate programs. Finn (2004) found that "the GRE has value as a predictor of student performance" (p. 33). Other sources take a much more dim view of standardized tests. The National Center for Fair and Open Testing is an example of an organization that regards standardized testing in a poor light. "Tests that measure as little and as poorly as multiple-choice tests cannot provide genuine accountability" (How standardized testing damages education, 2007, para. 6). The National Center for Fair and Open Testing also finds that "pressure to teach to the test distorts and narrows education" (How standardized testing damages education, 2007, para. 6).

Investigation Needed

Applicant ability to treat FAA knowledge tests as nothing more than an exercise in rote memorization is a subject requiring further investigation. It has been shown that commercially available study guides designed to facilitate applicant passage of FAA knowledge tests are available. These study guides attempt to provide their customers with a facsimile of the actual database used to generate the official test for which they are

preparing. Undoubtedly, memorization of some knowledge or information is necessary in this industry. Memorization of information is not inherently unscrupulous and can complement an honest attempt to learn as much as is possible about a subject.

Investigation is needed to determine whether the existence of these commercially available databases encourages a fundamental understanding of aeronautical knowledge or whether they encourage rote memorization. Do FAA knowledge tests evaluate applicant understanding of aeronautical issues or are they assessments of memorization skills? This research will shed light on these issues and provide answers to three primary research questions.

Research Questions

Data must be collected with the intention of evaluating the effectiveness of FAA airmen knowledge tests. What is specifically interesting is how well FAA airmen knowledge tests evaluate aeronautical knowledge. It is known that commercially available databases exist which are representative of the databases used to compile official FAA airmen knowledge tests. Does the existence of such databases have a positive correlation with applicant's test scores?

This research is focused upon and designed to evaluate three primary research questions. Those questions are as follows:

1. Is memorization of questions and answers from a commercial source a common study method?
2. Is there a positive correlation between memorization of test questions and answers and official FAA test scores?

3. Is there a difference between FAA knowledge test scores and test scores on an unpublished assessment of similar aeronautical knowledge?

CHAPTER II – METHODOLOGY

The investigative method for this research was to identify individuals who had recently taken or would soon be taking the FAA private pilot, commercial pilot or instrument pilot knowledge test. These individuals were administered a brief multiple choice test. The test these individuals were administered was specifically designed for this research. Three different tests were written for this research which correspond to the private, commercial and instrument knowledge tests. In short, the research tests were multiple choice tests covering aeronautical information that was very similar to the aeronautical information covered on the official FAA knowledge test that participants had recently completed: private, commercial or instrument. Following completion of the multiple choice research test, research participants were administered a brief Likert scale survey. The survey was intended to ascertain information concerning study methods and effectiveness. Research participants provided the researcher with their official FAA knowledge test score; these test scores were then compared with research test scores using a t test. In this way, each participant served as their own control group for determining the answers to the three aforementioned research questions. Data from survey analysis also contributed to answering the primary research questions.

Participants

Permission to conduct this study was received from the Middle Tennessee State University (MTSU) Institutional Review Board (IRB). See Appendix A for IRB approval form. Written consent was obtained from participants utilizing the IRB informed consent document. See Appendix B for the informed consent document. Voluntary cooperation of flight students at MTSU was sought to obtain the sample.

These students were in pursuit of private, instrument or commercial pilot credentials. Data was collected from these volunteers using the previously mentioned Likert scale survey, multiple choice research tests and by recording their official score on their most recent FAA airmen knowledge test. During construction of the research, emphasis was placed on the brevity of the three previously mentioned research tests. Brevity was necessary in the tests so as to not discourage potential participants from voluntary participation. Acquiring enough volunteers for sufficient data collection being partially dependent on how much effort a volunteer must put into participation with the research, tests lengths were abbreviated from that of the FAA knowledge tests being represented.

These tests were administered to 41 applicants of the FAA private, instrument, or commercial pilot knowledge tests. Within the sample of 41 total participants there were seven private applicants, 19 instrument applicants, and 15 commercial applicants. To obtain the sample, it was necessary to identify individuals preparing for and intending to take the aforementioned tests. Contact was made with the chief and assistant chief flight instructors at MTSU. The assistant chief flight instructor provided a list of flight students enrolled in flight labs during the fall 2012 semester. This list included the student's name, email address, airmen test they are taking (private, instrument or commercial) and the final date they must submit a passing grade for class requirements. Typically, students are required to turn in a passing grade on the abovementioned FAA airmen knowledge tests approximately two weeks before the end of each semester. Once the aforesaid list and IRB approval was secured, the research could proceed. Contact was made with the flight students. During initial contact the research was briefly explained, via e-mail, and voluntary participation was solicited. In order to facilitate voluntary

participation, the primary researcher visited MTSU classes corresponding to the pursuit of private pilot, instrument pilot and commercial pilot credentials or AERO 2230 professional pilot I, AERO 3210 professional pilot II, and AERO 3215 commercial flight fundamentals respectively. During these visits, the research was described and the informed consent documentation was explained. Following the completion of informed consent documentation, research volunteers completed the research airmen test associated with whichever of the three FAA tests they recently completed. Research volunteers were also given a Likert scale survey concerning study methodologies they employed while preparing for their tests. The score from each participant's official FAA knowledge test was recorded. The scores from both the official FAA knowledge test and the research written test were analyzed using a matched t test. In this way, each student served as their own control group.

Research Construction

This research relied upon multiple choice tests, a survey, and participants' scores on their official FAA knowledge test in order to generate meaningful data. Multiple choice tests are particularly useful. They readily lend themselves to quantitative studies and the data produced from a multiple choice test is straightforward. This research utilized three multiple choice tests. They are representative of the FAA private pilot, commercial pilot, and instrument pilot knowledge tests. The private, commercial and instrument tests written for this research are found in appendixes C, D and E, respectively. As previously stated, these tests are representative of official FAA knowledge tests. More specifically, these tests are the same format as their FAA counterpart; multiple choice with three answer choices. The questions appearing on each

of this study's three tests were specifically tailored to be representative of, but not identical to, some of the questions and subjects covered on their FAA companions. The questions ascertain aeronautical knowledge similar to what is ascertained on the official FAA knowledge test being represented. To ensure this was true, questions were sourced and inspired by, but not identical to, the most current Gleim FAA knowledge test prep literature. Using current Gleim preparation literature, it was ensured that each question represented aeronautical knowledge that is highly likely to be part of the database currently in use for generating the FAA knowledge tests in question. The research tests used in this research were brief, much more so than the FAA knowledge tests they represent. This was necessary in order to ensure sufficient voluntary participation to produce a useful sample size for statistical analysis. Considering that the test would be brief, questions were authored for their representation of core aeronautical knowledge that is appropriate for the level of airmen certificate being sought. In order to certify that these questions met the aforementioned criteria of being appropriate for their audience, worded properly, free from unnecessary complication, confusion, misleading phraseology, and above all representative of the aeronautical knowledge that is assessed on the official FAA knowledge test in question, these research tests were vetted using a panel of aviation experts. The panel included flight instructors who currently instruct on a near daily basis, MTSU's chief and assistant chief flight instructors for its FAA regulation part 141 flight school, a professional pilot for a regional carrier, two aerospace graduate faculty members, and the department chair. This panel ensured the validity and appropriateness of the questions which constitute the tests written for this research. The

valuable opinion of these industry experts served to greatly enhance the legitimacy of the research.

This research also made use of a five question Likert scale survey. Likert scale surveys have the ability to make queries which elicit a candid response about one's experience or opinion, which make them very appropriate and useful for research such as this. The information gathered is usually qualitative in nature. What is particularly useful about Likert scales is that they allow quantitative analysis of qualitative data. The Likert scale used here was designed to ascertain data concerning study methods along with individual experiences concerning knowledge recall during official FAA testing. The Likert scale survey is found in Appendix F. This study's Likert survey was also vetted using the aforementioned panel of experts.

Instruments

The primary difference between the research tests and the FAA's knowledge tests is that applicants did not have access to the research test questions and answers before they took the tests. Compilations of the database used for the assembling of the research tests are not available for purchase and memorization.

The test questions found in the appendices are the product of a great deal of input from the previously mentioned experts. Test validity is paramount for this experiment. The feedback received from the panel of experts reviewing the research questions ensured that each question is appropriate for the knowledge being assessed. The difficulty associated with the research tests' questions is commensurate to that of the official FAA knowledge tests being represented.

Test Questions Examined

The rationale behind the subject matter and phraseology for each question from each test written for this research will be explained. Note that the entire private, commercial and instrument tests written for this research are reproduced as research participants saw them in appendices C, D, and E, respectively. The description will establish why the correct answer is correct and the aspect of each incorrect answer that is responsible for it not being true or correct. The reason for each questions' inclusion in the three research tests will be examined.

The primary tool these research questions provide in their investigative abilities to answer the three primary research questions lies not within the specific subject or phraseology of each question, but within the specific fact that these research questions are not available in commercially available study guides. Research participants did not have the ability to purchase commercially available study guides representative of the research tests' questions because such a thing does not exist. Each research question is designed to be representative of similar knowledge subject matter and difficulty as that of the official test they represent. They are also all the same format (three answer choice, multiple choice) as official FAA knowledge tests. These questions represent an investigation into aeronautical knowledge associated with private, commercial and instrument FAA knowledge tests of commensurate format and subject matter. These questions are the product of the review of the primary researcher and a committee of industry professionals and experts.

Private questions.

The first question on the private pilot research test (see Appendix C) checks for student awareness of aerodynamics regarding stalls. An understanding of aircraft performance is a basic requirement for private pilot knowledge. It is essential that aviators of all levels have a basic understanding of aerodynamics. Pilots must not only understand what a stall is, they must understand what factors contribute to stall formation or occurrence. Pilots must understand how to induce a stall if so desired and how to recover from a stall if necessary. An understanding of the consequences of power-on and power-off stalls, including spin entry and recovery, is essential knowledge for any safe aviator. With aerodynamics being inextricably connected to flight, it was necessary for this research to include aerodynamics questions in its' private pilot test. An entire chapter of the Gleim 2012 private pilot knowledge test study guide is dedicated to aerodynamics (Gleim, I. N., & Gleim, G. W., 2011c). The fact that an aircraft may be stalled at any airspeed is an aerodynamic truth that is especially important for flight safety.

The second question from the private pilot research test (see Appendix C) investigates student comprehension of basic flight instrumentation. A basic understanding of the functionality of cockpit instruments commonly found in light general aviation (GA) aircraft is an essential skill for private pilots. Aircraft instrumentation is well represented in study guides designed to assist one in preparation for the FAA private pilot knowledge test (Gleim, I. N., & Gleim, G. W., 2011c). Aircraft instruments designed to provide essential flight data about airspeed, altitude, attitude, heading, rate of climb, and rate of turn have similarities and differences. Attitude

indicators, heading indicators, turn and bank indicators and turn coordinators are gyroscopic instruments while airspeed, altitude, and vertical speed are provided by instruments that make up part of the pitot-static system. Understanding what instruments are gyroscopic and how they are powered (pneumatically or electrically) along with what instruments rely on static pressure, pitot pressure or both is an essential aspect of possessing the necessary knowledge to be a safe aviator. While private pilots are not expected or required to have the same proficiency and understanding with aircraft instruments that an instrument rated pilot is required to have, private pilots must possess a basic understanding of the functionality of common instruments. Question two from the private pilot test associated with this research ascertains proficiency in common instruments' basic functionality. Selection of an incorrect response for this question would be indicative of a fundamental misunderstanding of the workings of basic flight instruments.

Question three from the private pilot research test (see Appendix C) checks for student awareness of potential flight hazards. Once a person becomes a private pilot, they are allowed to operate at almost any civilian airport in the United States. This means they will have the privilege of operating near large transport category aircraft. These aircraft generate vortices that could be very violent and hazardous to light single engine GA aircraft. Therefore, safety dictates that private pilots are cognizant of what wingtip vortices are, how they are formed, hazards associated with them and how to avoid them. Furthermore, there are nine questions associated with wake turbulence or wingtip vortices in the 2012 Gleim private pilot test prep literature (Gleim, I. N., & Gleim, G. W., 2011c).

The fourth question on the private pilot research test (see Appendix C) represents an investigation into student understanding of pertinent regulatory issues. Regulations dictate the way flights will be conducted and actions pilots will perform. Private pilots must understand the regulations relevant to the flying in which they participate. This question was constructed for its probative value into federal aviation regulation (FAR) comprehension. Instead of being unnecessarily confusing, this question poses a real world scenario in which regulations dictate proper behavior. An entire chapter of the 2012 Gleim private pilot knowledge test prep literature is dedicated to the subject of FAA regulations. There are nearly 200 questions in that chapter (Gleim, I. N., & Gleim, G. W., 2011c). An understanding of FAA regulations is essential for any pilot.

The fifth question from the private pilot research test (see Appendix C) also measures student awareness of regulations. Any airmen must understand the regulations that govern the aspect(s) of aviation they are privileged to participate with. This question appropriately measures understanding of regulations specifically governing private pilot privileges. As previously mentioned, regulations are a large part of the 2012 Gleim private pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011c). This is indicative of how large a percentage of the official FAA knowledge test is devoted to aviation regulations.

The sixth question from the private pilot research test (see Appendix C) measures understanding of aircraft performance and weather factors. Both subjects are represented in the Gleim 2012 private pilot knowledge test study guide. In fact, each of those subjects has an entire unit or chapter dedicated to their study (Gleim, I. N., & Gleim, G. W., 2011c). Subjects and concepts so well represented in common study guides and

therefore represented in official FAA knowledge test are appropriate for inclusion in this research.

The seventh question from the private pilot research test (see Appendix C) investigates how well aeromedical factors are understood by students. Aeromedical factors can enhance or diminish flight safety depending on what a flight crew knows about such factors and how such knowledge is implemented. Aeromedical factors along with decision making constitute an entire unit or chapter in the 2012 Gleim private pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011c). Subject inclusion in common study guides is indicative of subject inclusion on official FAA knowledge tests.

The eighth question from the private pilot research test (see Appendix C) measures student understanding of weather factors associated with thunderstorms. Aviation weather is well represented in the 2012 Gleim private pilot FAA knowledge test study guide. Thunderstorms present severe flight hazards and their avoidance is advisable (Gleim, I. N., & Gleim, G. W., 2011c). It is essential that all pilots understand thunderstorm development and appreciate the hazards they represent.

The ninth question from the private pilot research test (see Appendix C) is representative of a real world scenario dealing primarily with regulations. As previously mentioned, regulations are a large aspect of the 2012 Gleim private pilot knowledge test study guide making up an entire unit or chapter (Gleim, I. N., & Gleim, G. W., 2011c). This indicates that the official FAA private knowledge test will include questions which are regulatory in nature.

The tenth question from the private pilot research test (see Appendix C) measures student understanding of weight and balance issues. Weight and balance issues are very

important for flight safety. It is important that every pilot understand how to perform weight and balance computations. Pilots must appreciate the ramifications of locating an aircraft center of gravity outside of the manufacturer's specified range. Weight and balance is part of an entire chapter or unit in the 2012 Gleim private pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011c). This indicates a confidence within the FAA knowledge test prep industry that weight and balance issues are well represented within the databases used to generate official FAA private pilot knowledge tests. These reasons demonstrate the appropriateness that such a subject matter be addressed and represented within the private pilot test designed for this research.

The eleventh question from the private pilot research test (see Appendix C) investigates student comprehension associated with aircraft powerplant systems. Pilots must possess an understanding of the systems onboard their aircraft. An entire chapter is dedicated to instruments, engines and systems in the 2012 Gleim private pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011c). A basic understanding of aircraft magnetos and their function is essential for private pilot proficiency. This question is representative of powerplant knowledge appropriate for private pilot proficiency and skill level.

The twelfth question from the private pilot research test (see Appendix C) ascertains aerodynamic understanding. All pilots must possess an understanding of aerodynamic issues and principles. Airplanes and aerodynamics make up an entire chapter or unit in the 2012 Gleim private pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011c). The inclusion of aerodynamics-related questions in common

private pilot knowledge test study guides is indicative of their inclusion in official FAA private pilot knowledge tests.

Commercial questions.

You will find that some questions appear on more than one of the tests written for this research. This is deliberate and is representative of actual redundancy in flight training. More specifically, it is representative of actual redundancy in common training aids and test prep literature commercially available and is therefore likewise representative of redundancy in official FAA knowledge test database subject matter (Gleim, I. N., & Gleim, G. W., 2011a; Gleim, I. N., & Gleim, G. W., 2011c).

The first question from the commercial pilot research test (see Appendix D) explores student comprehension of aerodynamics. The study of aerodynamics is integral to flight training at many levels. All pilots must grasp and understand issues associated with lift, weight, thrust and drag. Therefore, aerodynamics is reviewed for commercial pilot applicants. Airplanes and aerodynamics makes up an entire chapter or unit in the 2012 Gleim commercial pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011a). The inclusion of aerodynamics related questions in common commercial pilot knowledge test study guides is indicative of their inclusion in official FAA private pilot knowledge tests.

The second question from the commercial pilot research test (see Appendix D) measures student comprehension of instrumentation and the function thereof. Unit two of the 2012 Gleim commercial pilot knowledge test study guide is titled “Airplane Instruments, Engines, and Systems” (Gleim, I. N., & Gleim, G. W., 2011a, p. v). The unit has 45 questions. Airspeed indicator along with turn coordinator issues and

functionality are explored (Gleim, I. N., & Gleim, G. W., 2011a). This is powerful evidence that aircraft instrumentation will be represented in the official FAA commercial pilot knowledge test.

The third question from the commercial pilot research test (see Appendix D) examines regulatory understanding in students. Explanation of this question was delivered above and is reproduced here for convenience. All pilots need to be aware of the regulations that govern their types of flying. Regulations are representative of a significant aspect of flying. Evidence that federal aviation regulations are a significant aspect of the official FAA commercial pilot knowledge test database is attained in the fact that an entire unit of the 2012 Gleim commercial pilot knowledge test study guide is dedicated to their investigation (Gleim, I. N., & Gleim, G. W., 2011a).

The fourth question from the commercial pilot research test (see Appendix D) deals with weather related issues and how they affect aircraft performance and longevity. Weather related factors, airplane engines and instruments are all represented in the Gleim 2012 commercial pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011a). Commercial pilots must know and understand the issues associated with winter preflight activities that are seasonally unique and represent activities not normally performed. Advanced pilots such as commercial pilot applicants need to understand the relationship proper engine care and maintenance has with powerplant reliability and longevity. The same is true for instruments.

The fifth question from the commercial pilot research test (see Appendix D) concerns itself with weight and balance, which contributes directly to flight safety. The importance of flight safety is amplified in the case of the commercial pilot while

exercising commercial privileges. Weight and balance issues represent a significant percentage of the study material found within the 2012 Gleim commercial pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011a). This question and one found in the private pilot research test are very similar. Weight and balance issues are represented in common study material for both the private and the commercial pilot knowledge tests (Gleim, I. N., & Gleim, G. W., 2011a; Gleim, I. N., & Gleim, G. W., 2011c). This is indicative of the importance of weight and balance to pilot study. This research question is an honest analysis of the weight and balance comprehension of the research participant.

The sixth question from the commercial pilot research test (see Appendix D) measures student understanding of aeromedical factors. Gleim devoted a significant amount of their 2012 commercial pilot knowledge test study guide to the study of medical issues as they relate to aviation. Study unit 6 is titled “Aeromedical Factors and Aeronautical Decision Making” (Gleim, I. N., & Gleim, G. W., 2011a, p. v). The inclusion of aeromedical subject matter in common commercially available knowledge test prep study guides is powerful evidence that some questions within the official FAA question database are representative of similar subject matter. As with all questions found within the research tests of this study, this question was constructed because it is representative of knowledge that is assessed within the official FAA test it represents. The question represents a straightforward assessment and is not deliberately confusing. Issues associated with nighttime vision acuity are directly relevant to flight safety.

The seventh question from the commercial pilot research test (see Appendix D) explores student understanding of weight and balance. All pilots must grasp weight and

balance issues. Weight and balance questions represent a significant aspect of the 2012 Gleim commercial pilot study guide and are therefore well represented in the FAA database used to generate official commercial pilot knowledge tests. Question seven from this research's commercial pilot test represents a straightforward assessment of one's understanding of weight and balance terminology, namely the datum.

The eighth question from the commercial pilot research test (see Appendix D) investigates student comprehension of aircraft terminology. Specifically, this question ascertains whether or not students understand what constitutes a high performance aircraft. This simple question is a straightforward assessment of basic aircraft terminology. Any commercial applicant should be able to define the qualities which constitute a high performance aircraft.

The ninth question from the commercial pilot research test (see Appendix D) assesses student familiarity with regulations. Regulations constitute an entire chapter or unit of the 2012 Gleim commercial pilot knowledge exam study guide. Over 125 questions are devoted to Federal Aviation Regulations within the Gleim 2012 commercial pilot study guide (Gleim, I. N., & Gleim, G. W., 2011a). This is indicative of how important regulation comprehension is for commercial pilot applicants. The fact that an entire chapter of a major commercially available knowledge test study guide is dedicated to this subject is highly indicative of its inclusion within the database used to generate official FAA commercial pilot knowledge tests.

The tenth question from the commercial pilot research test (see Appendix D) ascertains applicant understanding of aircraft performance issues. Commercial pilots, being likely to operate increasingly complex and powerful aircraft, must understand the

issues associated with such systems. Aircraft performance constitutes a significant portion of the 2012 Gleim commercial pilot knowledge exam guide (Gleim, I. N., & Gleim, G. W., 2011a). This is indicative of its inclusion within the database used to generate official FAA commercial pilot knowledge tests.

Instrument questions.

The first question from the instrument pilot research test (see Appendix E) simultaneously investigates applicant comprehension of weather related issues and aircraft instrumentation issues. These subjects are well represented in the Gleim 2012 instrument pilot knowledge study guide. Both airplane instruments and aviation weather have an entire chapter dedicated to their study (Gleim, I. N., & Gleim, G. W., 2011b). This is powerful evidence that these topics will be well represented on official FAA instrument knowledge tests.

The second question from the instrument pilot research test (see Appendix E) represents an investigation into applicant understanding of airplane instrumentation and the functionality thereof. The 2012 Gleim instrument pilot knowledge test study guide contains 73 questions pertaining to airplane instruments. In addition to that, an entire chapter is dedicated to the study of attitude instrument flying (Gleim, I. N., & Gleim, G. W., 2011b). Aircraft instrument functionality and use is very well represented within common commercially available knowledge test study guides. This is indicative of a consensus among test preparation literature providers that such subject matter is included within the database used to generate official FAA instrument knowledge tests.

The third question from the instrument pilot research test (see Appendix E) is representative of aircraft instrumentation and navigation. This question specifically

investigates applicant comprehension of specific navigational instrumentation; namely, distance measuring equipment (DME). To say that instrument pilot applicants must understand issues associated with navigation by reference to instrumentation is an understatement. This question represents a straightforward analysis of applicant comprehension of DME functionality. Navigation systems have an entire chapter or unit dedicated to their study within the 2012 Gleim instrument pilot knowledge study guide. The chapter is made up of more than 90 questions (Gleim, I. N., & Gleim, G. W., 2011b). The inclusion of such a question within the instrument knowledge research test is appropriate.

The fourth question from the instrument pilot research test (see Appendix E) explores applicant understanding of issues associated with aviation weather services. It is essential that all pilots appreciate the risks associated with adverse weather and are knowledgeable about services designed to inform them of weather conditions. Aviation weather services represent an entire unit or chapter within the 2012 Gleim instrument pilot knowledge study guide. Within that chapter, there are more than 80 questions associated with weather services (Gleim, I. N., & Gleim, G. W., 2011b). Such emphasis on a subject in a commercially available FAA knowledge study guide is indicative of its inclusion within the database used to generate official FAA knowledge tests.

The fifth question from the instrument pilot research test (see Appendix E) inspects comprehension of both instrumentation function and regulatory procedure. This question represents a real world scenario in which pilots must understand their instruments, how they function, what data they present and what regulatory issues govern the phase of flight in which they find themselves. Such issues are represented in

commercially available instrument knowledge test study guides and are therefore appropriate for inclusion within this research's instrument pilot research test (Gleim, I. N., & Gleim, G. W., 2011b).

The sixth question from the instrument pilot research test (see Appendix E) investigates pilot understanding of aeromedical factors. More specifically, this question investigates understanding of visual illusions. Both wider than usual and down sloping runways may give an illusion that the pilot is approaching at a lower than normal altitude. Approaching a runway that is narrower than usual may create the opposite illusion; that the aircraft is higher than it truly is (Gleim, I. N., & Gleim, G. W., 2011b). Pilots who perceive their aircraft to be higher than normal may attempt to rectify the situation by reducing power. This situation could lead to slower than usual approach speeds. This question represents the least straightforward question of all three research tests associated with this research. It therefore has been identified as the weakest aspect of this research and the most likely basis for criticism. Nonetheless, visual illusion comprehension and recognition is represented in the Gleim 2012 instrument knowledge study guide (Gleim, I. N., & Gleim, G. W., 2011b). This inclusion of question subject matter within commercially available study guides provides justification for its inclusion within the research test.

The seventh question from the instrument pilot research test (see Appendix E) explores applicant comprehension of weather related phenomenon. Proper understanding of the driving forces behind changing weather is essential for the instrument rated pilot. Aviation weather constitutes an entire chapter or unit of the Gleim 2012 instrument pilot knowledge test study guide (Gleim, I. N., & Gleim, G. W., 2011b). Inclusion of aviation

weather related questions in common commercially available instrument knowledge test study guides constitutes their inclusion within this research's instrument pilot test.

The eighth question from the instrument pilot research test (see Appendix E) ascertains navigational systems comprehension and their functionality along with procedural requirements associated with their use. These issues are well represented in the Gleim 2012 instrument pilot knowledge test study guide. Navigation systems and regulations each have a chapter or unit dedicated to their study within the aforementioned guide (Gleim, I. N., & Gleim, G. W., 2011b). Inclusion of subject matter heavily represented within commercially available instrument knowledge test study guides in this research's instrument pilot research test is appropriate.

The ninth question from the instrument pilot research test (see Appendix E) examines applicant familiarity with aviation weather services. All pilots must be able to interpret aviation routine weather reports. Aviation weather services constitute an entire chapter or unit of the 2012 Gleim instrument pilot knowledge test study guide. Within this chapter there are over 80 questions (Gleim, I. N., & Gleim, G. W., 2011b). It is appropriate to represent subject matter in this research's instrument pilot written test that is heavily represented in common commercially available study guides.

The tenth question from the instrument pilot research test (see Appendix E) represents a real world scenario in which knowledge of regulations is needed to understand appropriate actions. This straightforward assessment investigates applicant knowledge of common aviation regulations. Aviation regulations make up a significant amount of common commercially available instrument knowledge test study guides

(Gleim, I. N., & Gleim, G. W., 2011b). Inclusion of such subject matter is appropriate for the instrument pilot research test.

Survey

The survey associated with this research (see Appendix F) represents an investigation into applicant study methods and techniques. Specifically, this survey determines if applicants attempted to memorize questions and answers from a commercially available study guide. The survey also determines if applicants felt as though they recognized questions and answers from their memorization sessions during their official FAA knowledge test. The survey solicits applicant opinion about the effectiveness of commercially available study guides at both preparing them to pass the associated FAA knowledge test and preparing them to be safe and effective aviators. Finally, the survey determines the amount of time applicants dedicated to their preparations for their official FAA knowledge test.

CHAPTER III - RESULTS

The data produced using the research tests and official FAA scores was ($n = 41$) analyzed using a t test. The sample was analyzed in aggregate ($n = 41$) and as individual subject groups: private ($n = 7$), commercial ($n = 15$) and instrument ($n = 19$). The aggregate analysis along with the instrument analysis was conducted with and without a particular question appearing on the instrument research test. The Likert scale survey ($n = 41$) was also quantified to facilitate the extraction of perspective from the data and to provide additional data associated with answering the primary research questions.

Written Tests

Private group.

To determine more about the role memorization plays with official scores on FAA knowledge tests, a t test was used to determine the significant difference, if any, between scores on official FAA knowledge tests and scores on an unpublished assessment of similar aeronautical knowledge. Scores on the unpublished test and official test from the private group were not significantly different $t(6) = .792, p < .05$. Although private applicants, on average, performed more poorly on an unpublished assessment of aeronautical knowledge ($M = 82.14, SD = 4.88$) than on the official FAA private pilot knowledge ($M = 87.71, SD = 14.77$), the average difference was not sufficiently great to be considered statistically significant. The raw results are posted in Table 1.

Table 1

Raw scores and means for private group

FAA Test	Research Test
83	100
88	83.33
83	100
83	83.33
92	75
90	58.33
95	75
Mean	Mean
87.71	82.14
Standard Deviation	Standard Deviation
14.77	4.88

Note: Microsoft Excel

Commercial group.

The t test was used to determine the statistically relevant difference, if any, between scores on official FAA commercial pilot knowledge tests and non-published assessments. Scores were not significantly different on the unpublished assessment, $t(14) = .744$, $p < .05$. Applicants did perform more poorly on the unpublished assessment ($M = 84.66$, $SD = 18.84$) than on the official FAA knowledge test ($M = 88.53$, $SD = 4.48$). However, the average difference between scores on the official FAA commercial pilot knowledge test and the commercial pilot research test associated with this research were not great enough to be considered statistically significant. Raw data is produced in Table 2.

Table 2

Raw scores and means for commercial group

FAA Test	Research Test
88	40
93	70
92	80
81	100
81	90
92	100
87	100
80	90
93	90

90	100
90	100
93	80
88	80
90	100
90	50
Mean	Mean
88.53	84.67
Standard Deviation	Standard Deviation
4.48	18.84

Note: Microsoft Excel

Instrument group.

The t test was again employed to determine the statistically relevant difference, if any, between scores on official FAA instrument knowledge tests and scores on an unpublished assessment of similar aeronautical knowledge. The instrument analysis was conducted twice, once with all questions appearing on the research instrument test, once with one question omitted. Question six was identified as the most likely source of criticism for this research. While visual illusions are associated with runways which are more wide or more narrow than normal, along with runways with unusual sloping characteristics, this question is the least straightforward. The researcher recognized this question as the most weak aspect of this research and analyzed data with and without its inclusion. For the analysis without question six, the research tests were graded and scored as a nine question test, omitting question six. Data from both analyses follows.

For the analysis with question six, research participants perform more poorly, in a statistically relevant way, on an unpublished assessment of instrument aeronautical knowledge than on their official FAA instrument knowledge test , $t(18) = 3.243, p < .05$. Average scores on official FAA instrument knowledge tests ($M = 80.53, SD = 7.23$) were greater than on that of an unpublished assessment ($M = 70, SD = 17.32$). This difference was sufficient to be considered statistically relevant. Raw data is provided in Table 3.

Table 3

Raw scores and means for instrument group

FAA Test	Research Test		
85	50	85	70
85	80	77	30
75	70	87	80
80	60	83	90
72	80	75	60
75	60	90	90
77	80	92	90
80	60	76	70
90	90	Mean	Mean
83	80	80.53	70
63	40	Standard Deviation	Standard Deviation
		7.23	17.32

Note: Microsoft Excel

When the analysis was conducted with question six omitted from the research instrument test, significance was lost. Research participants still performed more poorly on the research test ($M = 76.02, SD = 18.61$), than on their official FAA instrument knowledge test ($M = 80.53, SD = 7.23$), but not in a statistically significant way, $t(18) = 1.274, p < .05$. Raw data is provided in Table 4.

Table 4

Raw data and means for instrument group with question 6 omitted

FAA Test	Research Test		
85	55.55	85	77.77
85	88.88	77	33.33
75	77.77	87	88.88
80	66.66	83	88.88
72	88.88	75	66.66
75	55.55	90	88.88
77	88.88	92	100
80	66.66	76	77.77
90	100	Mean	Mean
83	88.88	80.53	76.02
63	44.44	Standard Deviation	Standard Deviation
		7.23	18.61

Note: Microsoft Excel

Aggregate.

The t test was used to analyze all data collected from private, commercial and instrument applicants in aggregate. This analysis was conducted both with and without question six from the research instrument test omitted. When question six from the research instrument test was included, participants performed more poorly on the research tests than on the official FAA knowledge tests in a statistically significant way $t(40) = 2.707, p < .05$. Research participants scored more poorly on the research test ($M = 84.68, SD = 7.04$) than on their official FAA knowledge test ($M = 77.44, SD = 18.48$). Raw data is provided in Table 5.

Table 5

Raw data and means for all groups with no question omissions

FAA Test	Research Test				
83	100	80	90	90	90
88	83.33	93	90	83	80
83	100	90	100	63	40
83	83.33	90	100	85	70
92	75	93	80	77	30
90	58.33	88	80	87	80
95	75	90	100	83	90
88	40	90	50	75	60
93	70	85	50	90	90
92	80	85	80	92	90
81	100	75	70	76	70
81	90	80	60	Mean	Mean
92	100	72	80	84.68	77.44
87	100	75	60	Standard Deviation	Standard Deviation
		77	80	7.04	18.48
		80	60		

Note: Microsoft Excel

Statistical significance was lost when the t test analysis was performed to the entire sample with question six from the instrument research test omitted $t(40) = 1.644$, $p < .05$. The entire sample's average scores were lower on an unpublished assessment (with the omission of question six from the instrument research test) ($M = 84.68$, $SD = 7.04$) than on their official FAA knowledge test ($M = 80.23$, $SD = 18.15$). However, this difference was not sufficient to be considered statistically significant. Raw data is produced in Table 6.

Table 6

Raw data and means for all groups with question 6 from instrument research test omitted

FAA Test	Research Test				
83	100	80	90	90	100
88	83.33	93	90	83	88.88
83	100	90	100	63	44.44
83	83.33	90	100	85	77.77
92	75	93	80	77	33.33
90	58.33	88	80	87	88.88
95	75	90	100	83	88.88
88	40	90	50	75	66.66
93	70	85	55.55	90	88.88
92	80	85	88.88	92	100
81	100	75	77.77	76	77.77
81	90	80	66.66	Mean	Mean
92	100	72	88.88	84.68	80.23
87	100	75	55.55	Standard Deviation	Standard Deviation
		77	88.88	7.04	18.15
		80	66.66		

Note: Microsoft Excel

Survey

The data produced using the Likert scale survey (see Appendix F) was compiled and graphed. The question responses are shown for the private, commercial and instrument groups individually and in aggregate. The response distributions for the private group are below in Figures 1-5. The response distributions for the commercial group are in Figures 6-10. The response distributions for the instrument group are in Figures 11-15. The response distributions for the entire sample are in Figures 16-20.

Private group.

It was found that 57% of participants from the private group indicated that they agree or strongly agree that they attempted to memorize questions and answers from test prep software or literature while studying for their FAA knowledge exam. Investigation

revealed that 100% of participants from the private group recognized 41% or more of the questions on their official FAA knowledge exam from their studies. It was found that 57% claim to have recognized 81% - 100% of the questions on their official FAA knowledge exam from their studies. Research discovered that 100% of research participants from the private group agreed that commercially available test prep material represented an effective way for them to prepare for their FAA knowledge exam. It was found that 86% of research participants from the private group agreed that commercially available test prep material prepared them to be safe and effective pilots. The total time private group research participants dedicated to preparing for their FAA knowledge test varied greatly. Responses concerning time studying and preparing are produced in Table 5. Raw data for the private group is produced in Figures 1-5.

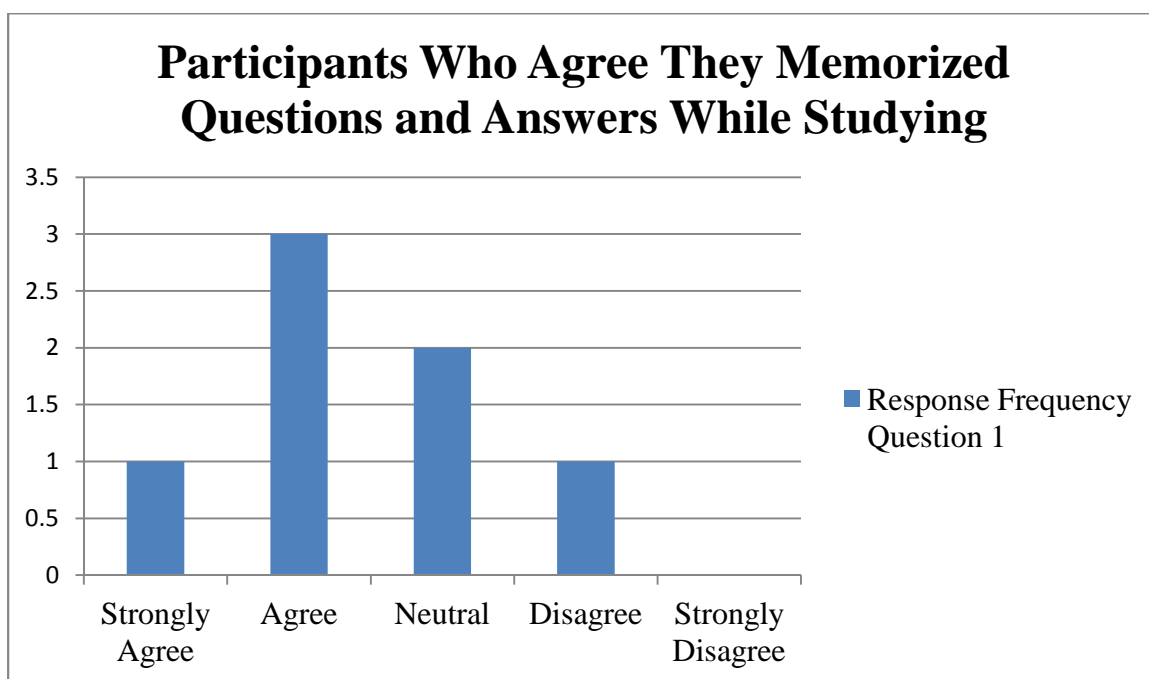


Figure 1: Participant response to survey question 1 indicating that participant attempted to memorize questions and answers from test prep software or literature while studying, private group

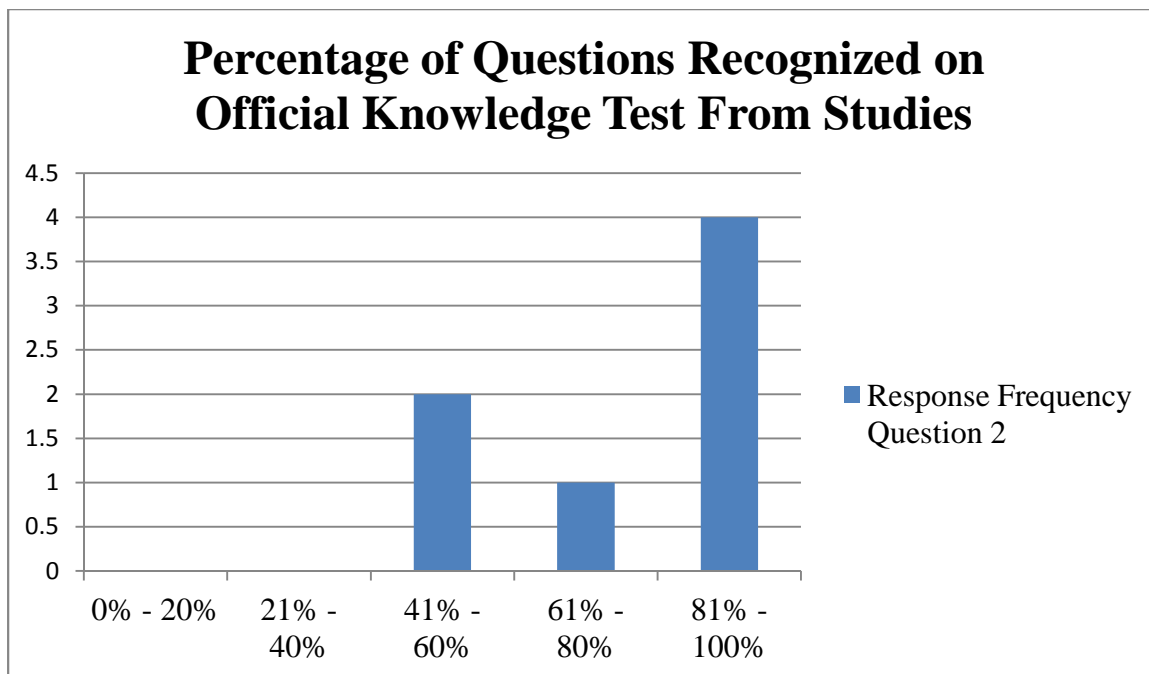


Figure 2: Percentage of questions participants reported recognizing on their FAA knowledge test from their studies, private group

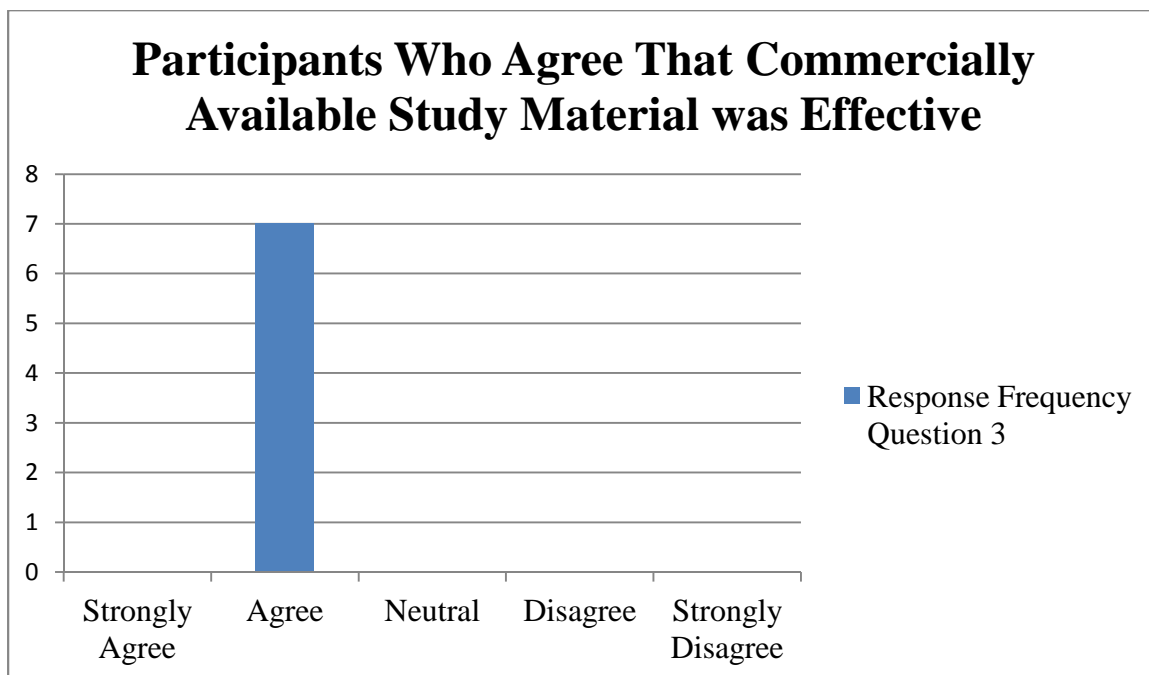


Figure 3: Participant response to survey question 3 regarding participant perception that commercially available test prep material was an effective means of studying for and passing their FAA knowledge exam, private group

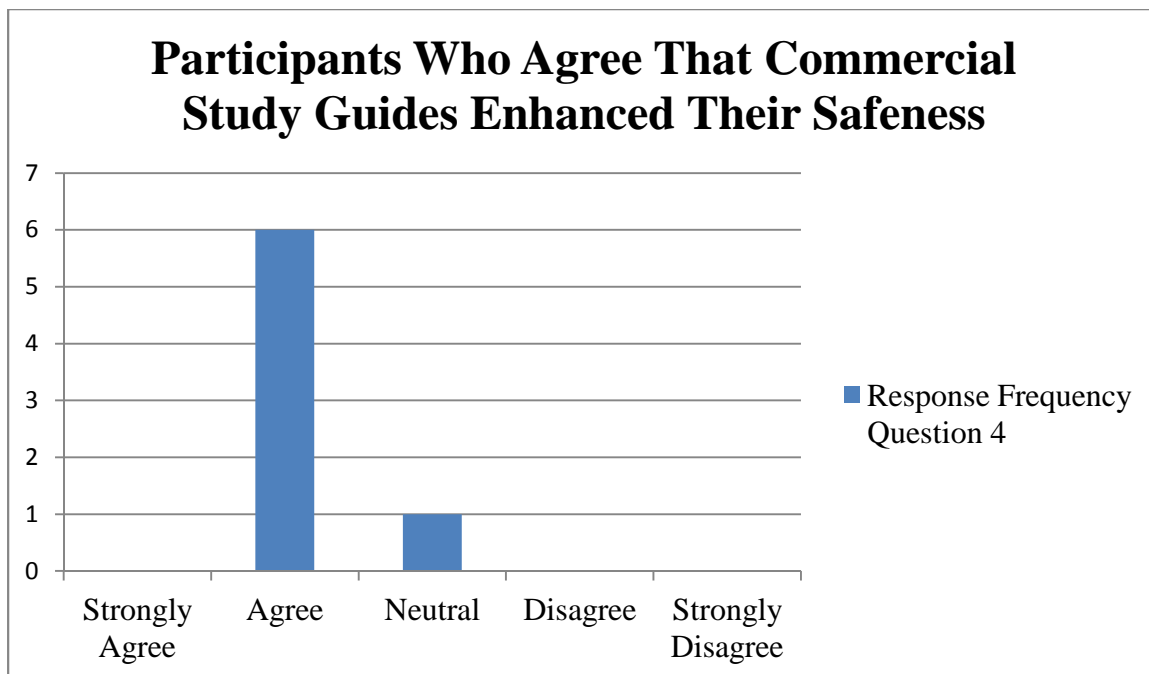


Figure 4: Participant response to survey question 4 regarding agreement that using commercially available test prep material prepared them to be a safe and effective pilot, private group

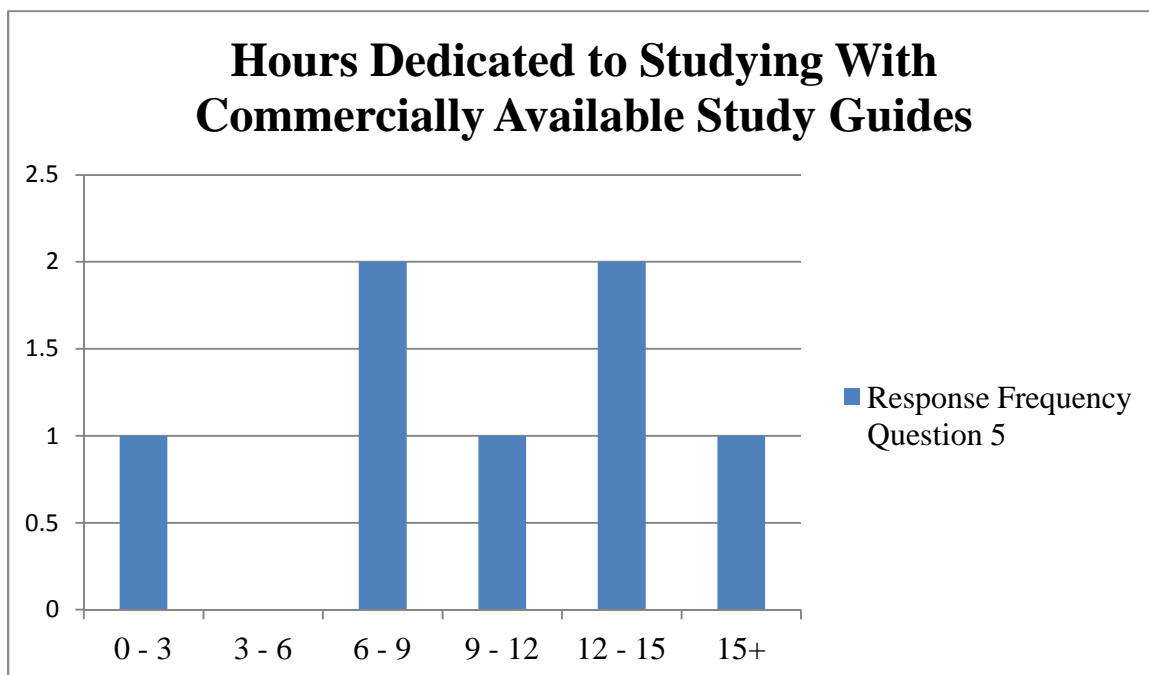


Figure 5: Participant response to survey question 5 regarding hours dedicated to studying for their FAA knowledge exam with commercially available test prep material, private group

Commercial group.

It was found that 93% of participants from the commercial group indicated that they agreed or strongly agreed that they attempted to memorize questions and answers from test prep software or literature while studying for their FAA knowledge exam. Research uncovered that 100% of participants from the commercial group recognized 61% or more of the questions on their official FAA knowledge exam from their studies. Additionally, 47% claimed to have recognized 81% - 100% of the questions on their official FAA knowledge exam from their studies. It was found that 93% of research participants from the commercial group agreed or strongly agreed that commercially available test prep material represented an effective way for them to prepare for their FAA knowledge exam. It was found that 47% of research participants from the commercial group agreed or strongly agreed that commercially available test prep material prepared them to be safe and effective pilots. The amount of time commercial group participants dedicated to preparing for their FAA knowledge test varied greatly with the most common response being between six and nine hours. Raw data for the commercial group is produced in Figures 6-10.

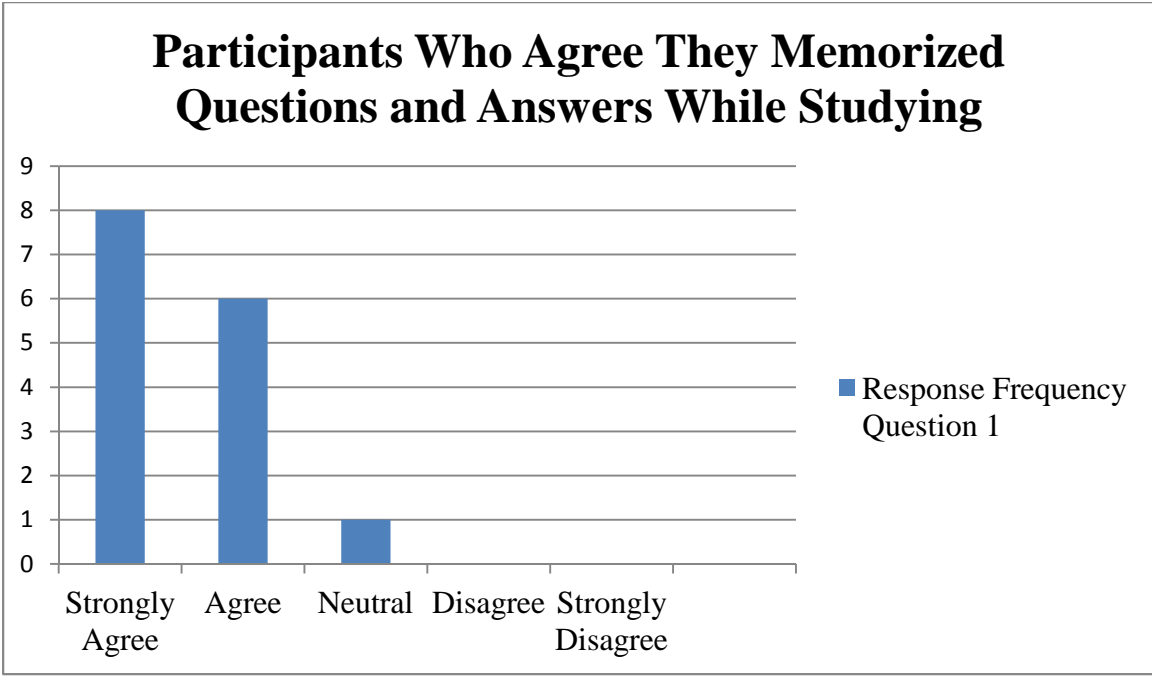


Figure 6: Participant response to survey question 1 indicating that participant attempted to memorize questions and answers from test prep software or literature while studying, commercial group

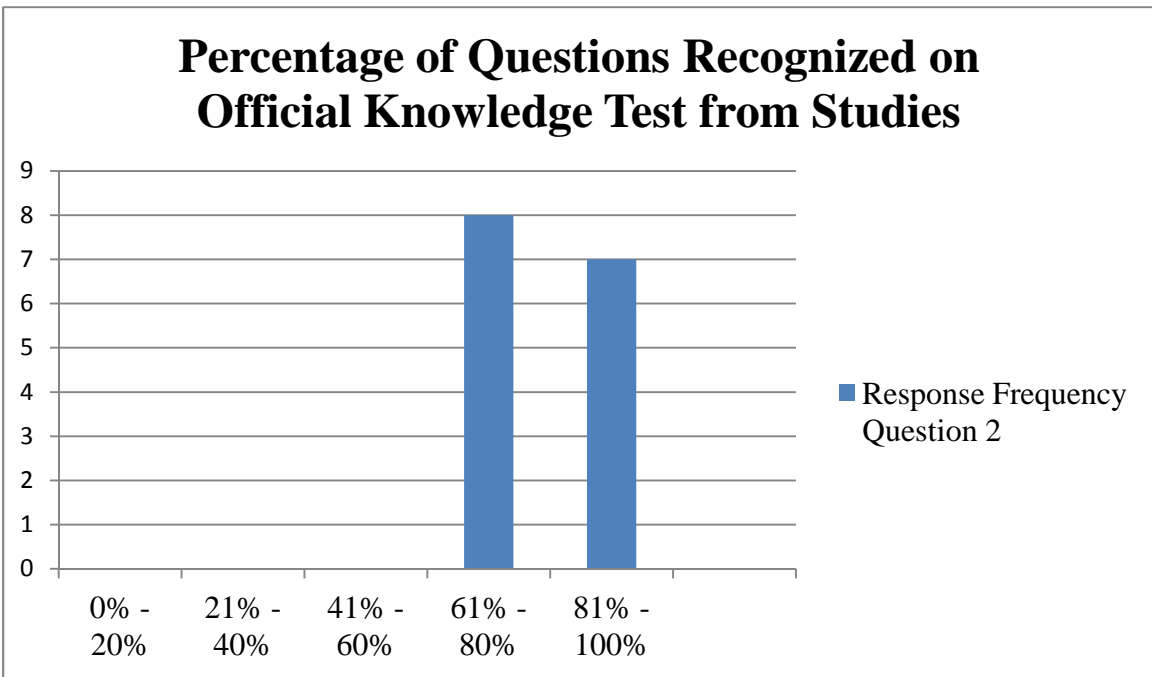


Figure 7: Percentage of questions participants reported recognizing on their FAA knowledge test from their studies, commercial group

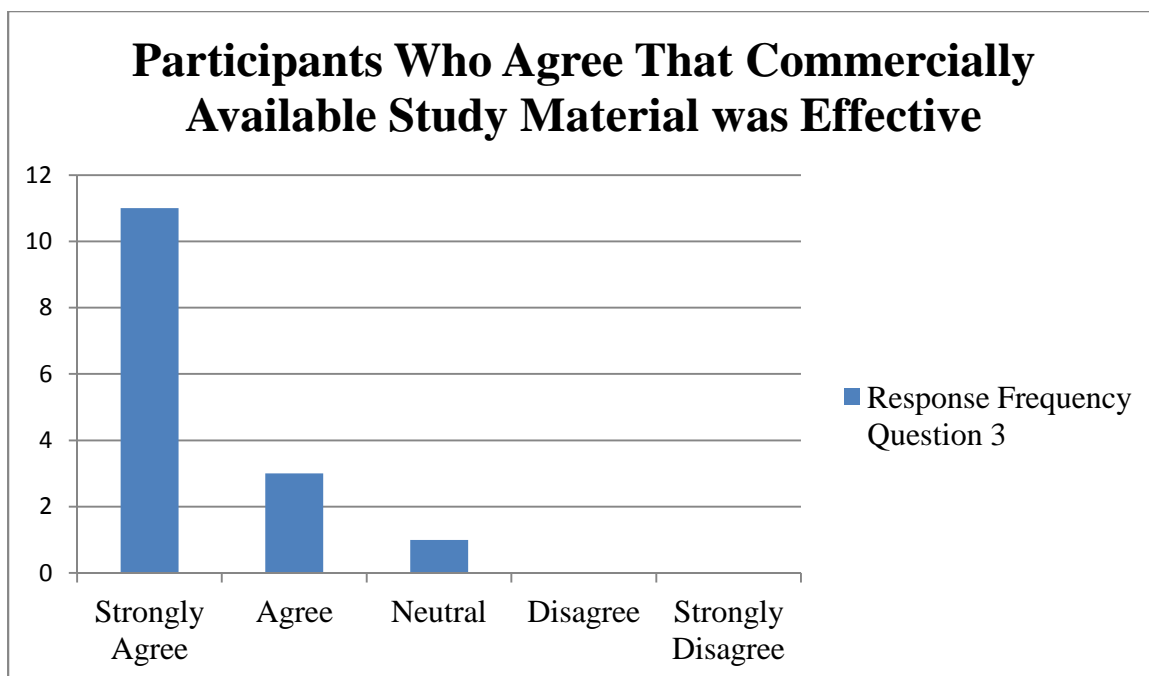


Figure 8: Participant response to survey question 3 regarding participant perception that commercially available test prep material was an effective means of studying for and passing their FAA knowledge exam, commercial group

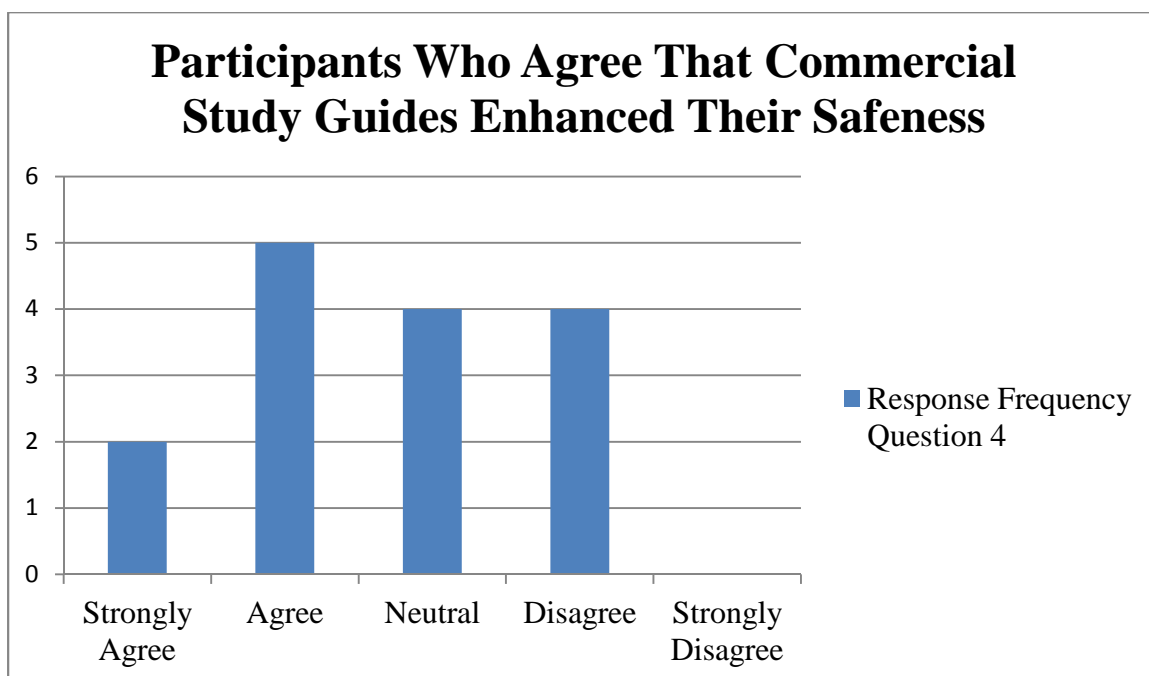


Figure 9: Participant response to survey question 4 regarding agreement that using commercially available test prep material prepared them to be a safe and effective pilot, commercial group

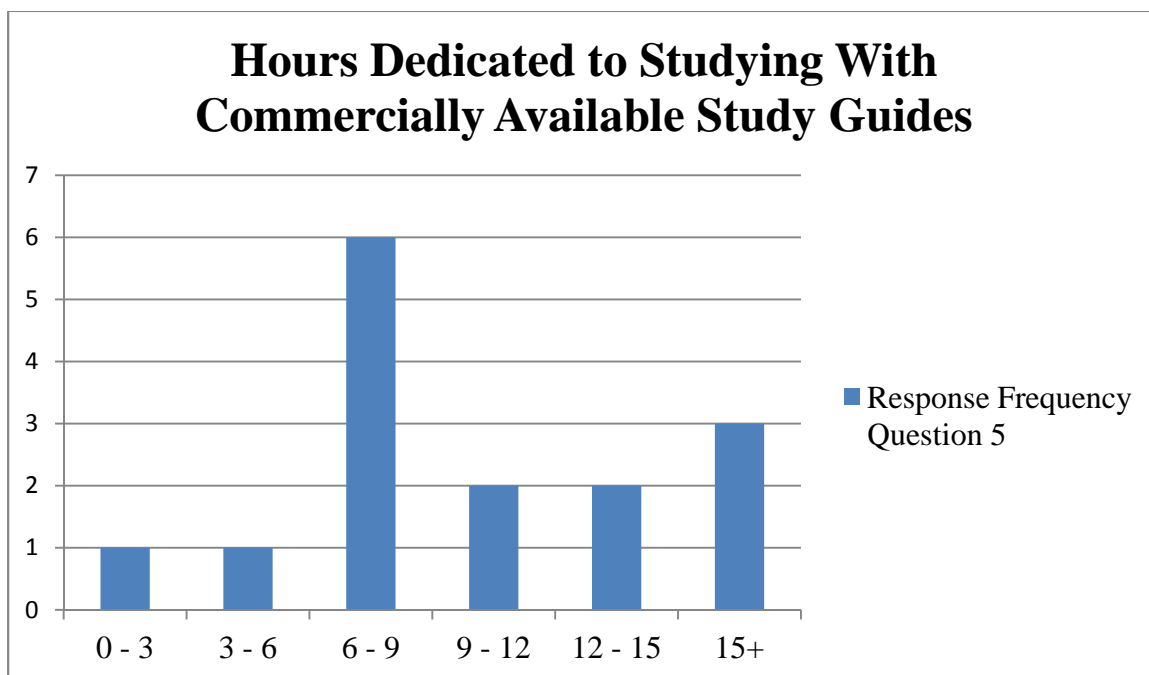


Figure 10: Participant response to survey question 5 regarding hours dedicated to studying for their FAA knowledge exam with commercially available test prep material, commercial group

Instrument group.

Research showed that 95% of participants from the instrument group indicated that they agreed or strongly agreed that they attempted to memorize questions and answers from test prep software or literature while studying for their FAA knowledge exam. Research indicated that 84% of participants from the instrument group recognized 61% or more of the questions on their official FAA knowledge exam from their studies. Only 26% claimed to have recognized 81% - 100% of the questions on their official FAA knowledge test from their studies. Investigation indicated that 95% of research participants from the instrument group agreed or strongly agreed that commercially available test prep material represented an effective way for them to prepare for their

FAA knowledge exam. Research indicated that 53% of research participants from the instrument group agreed or strongly agreed that commercially available test prep material prepared them to be safe and effective pilots. The amount of time instrument group participants dedicated to preparing for their FAA knowledge test varied greatly with the most common response being fifteen or more hours. Raw data for the instrument group is produced in Figures 11-15.

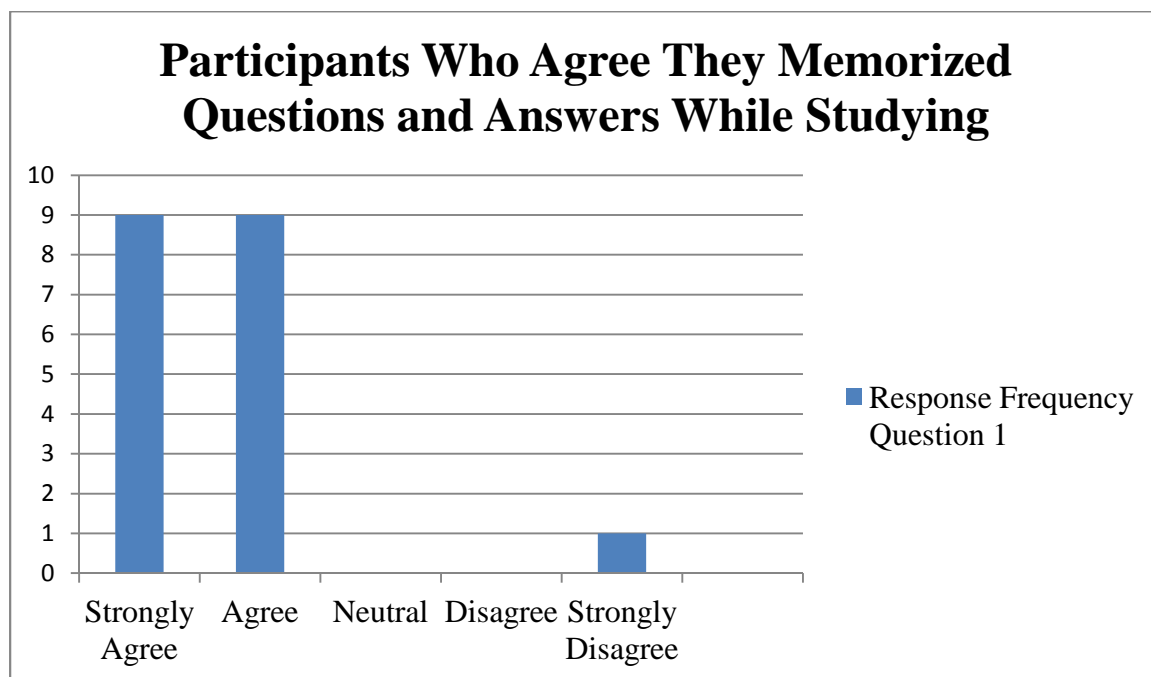


Figure 11: Participant response to survey question 1 indicating that participant attempted to memorize questions and answers from test prep software or literature while studying, instrument group

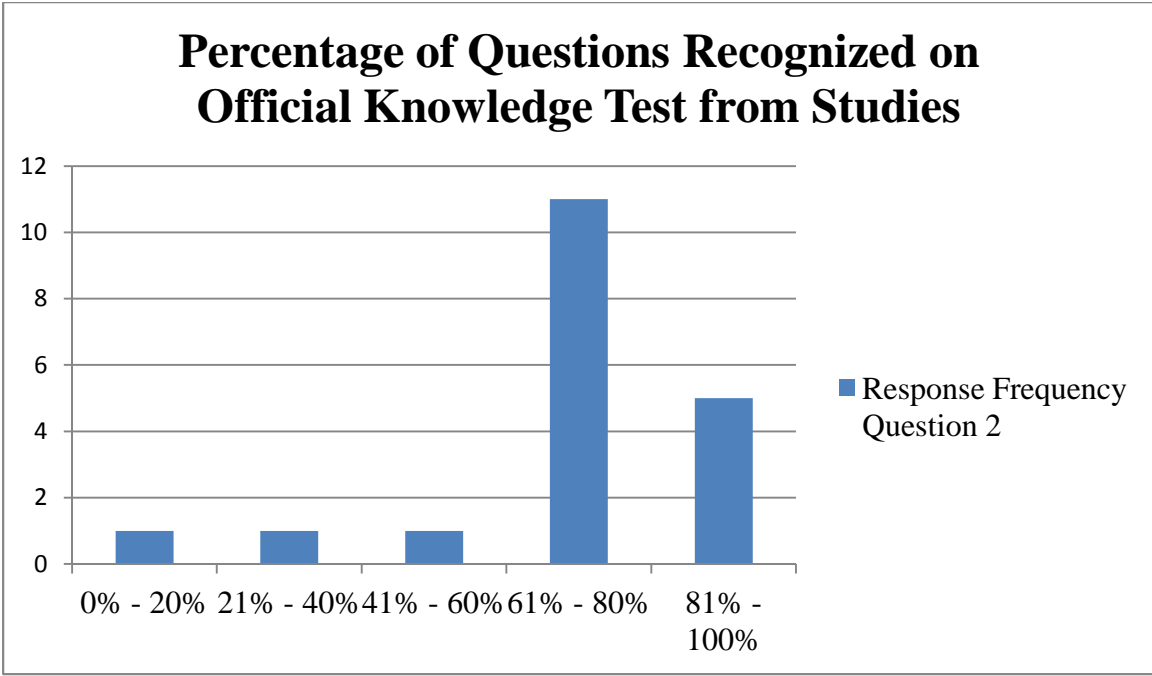


Figure 12: Percentage of questions participants reported recognizing on their FAA knowledge test from their studies, instrument group

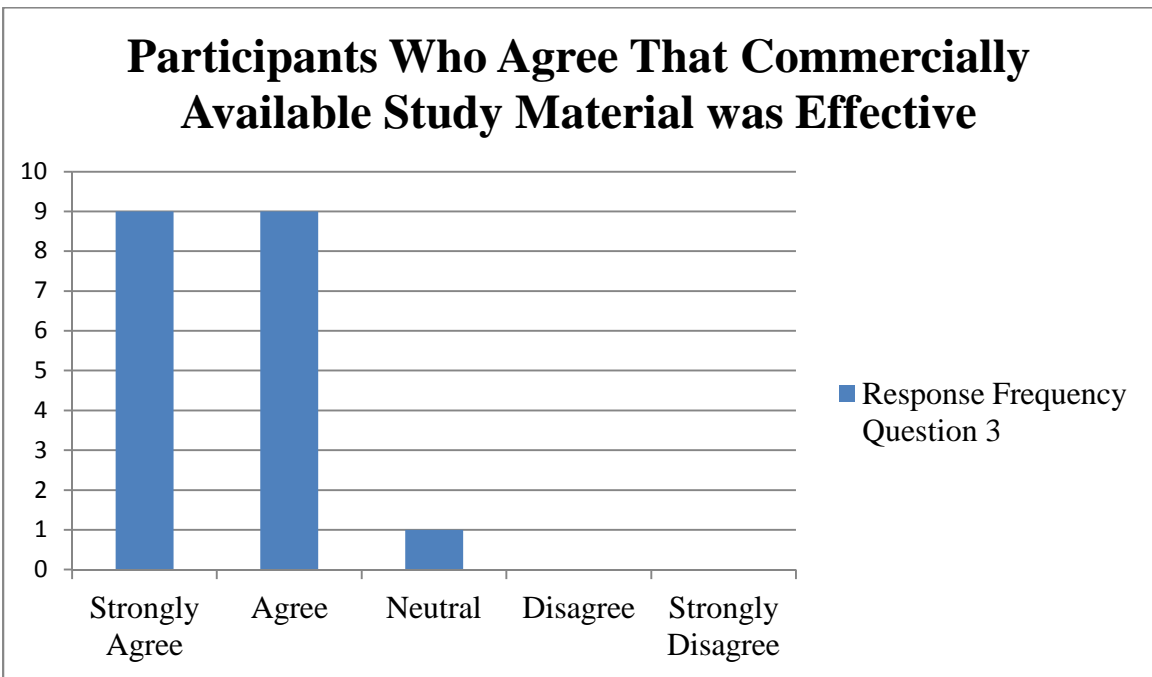


Figure 13: Participant response to survey question 3 regarding participant perception that commercially available test prep material was an effective means of studying for and passing their FAA knowledge exam, instrument group

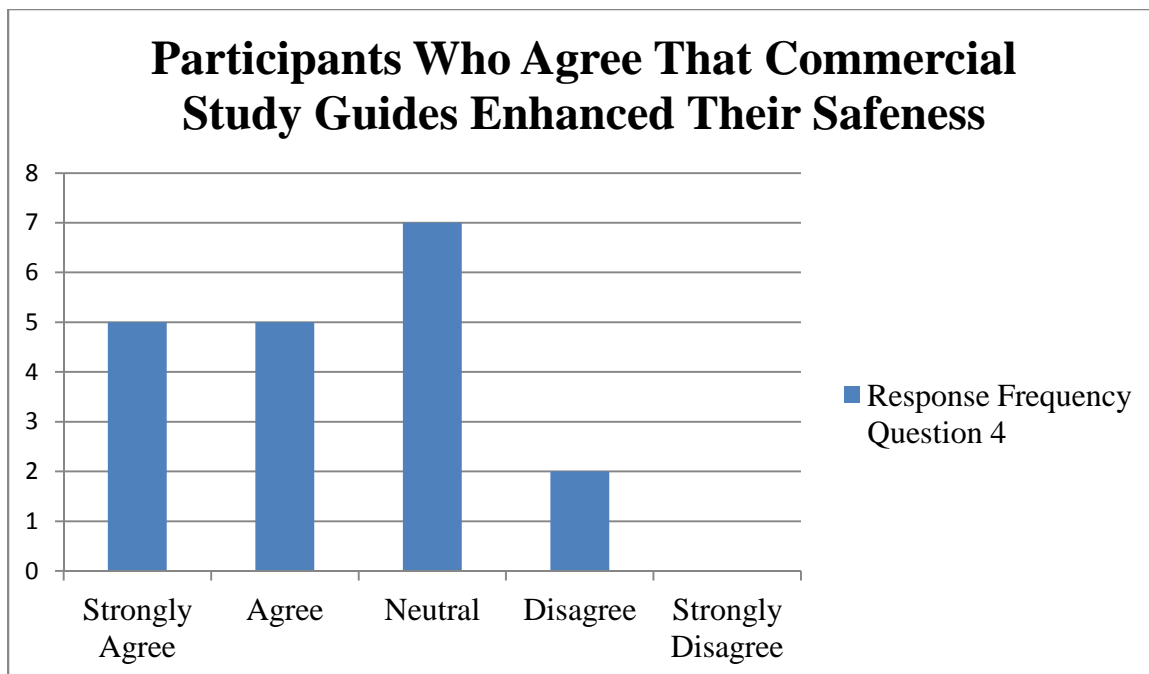


Figure 14: Participant response to survey question 4 regarding agreement that using commercially available test prep material prepared them to be a safe and effective pilot, instrument group

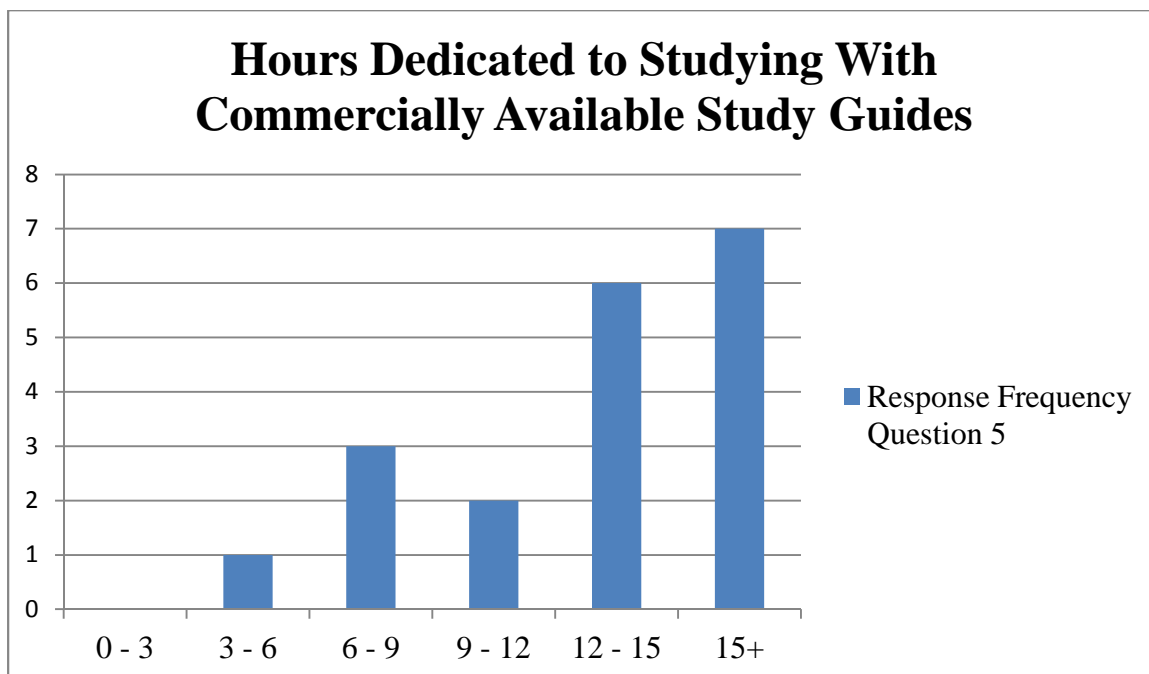


Figure 15: Participant response to survey question 5 regarding hours dedicated to studying for their FAA knowledge exam with commercially available test prep material, instrument group

Aggregate.

Research showed that 88% of participants from the entire sample indicated that they agreed or strongly agreed that they attempted to memorize questions and answers from test prep software or literature while studying for their FAA knowledge exam. It was found that 88% of participants from the entire sample recognized 61% or more of the questions on their official FAA knowledge exam from their studies. Furthermore, 39% claimed to have recognized 81% - 100% of the questions on their official FAA knowledge test from their studies. Research found that 95% of research participants from the entire sample agreed or strongly agreed that commercially available test prep material represented an effective way for them to prepare for their FAA knowledge exam. Only 56% of research participants from the entire sample agreed or strongly agreed that commercially available test prep material prepared them to be safe and effective pilots. The amount of time all participants dedicated to preparing for their FAA knowledge test varied greatly. Raw data for the sample aggregate is produced in Figures 16-20.

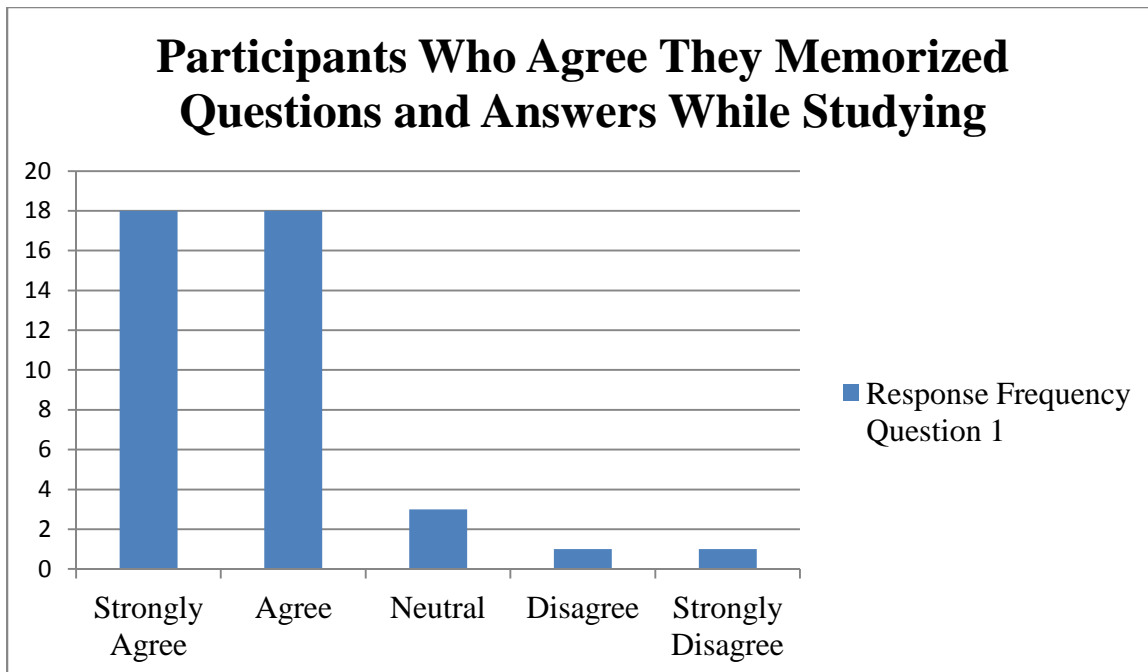


Figure 16: Participant response to survey question 1 indicating that participant attempted to memorize questions and answers from test prep software or literature while studying, sample aggregate

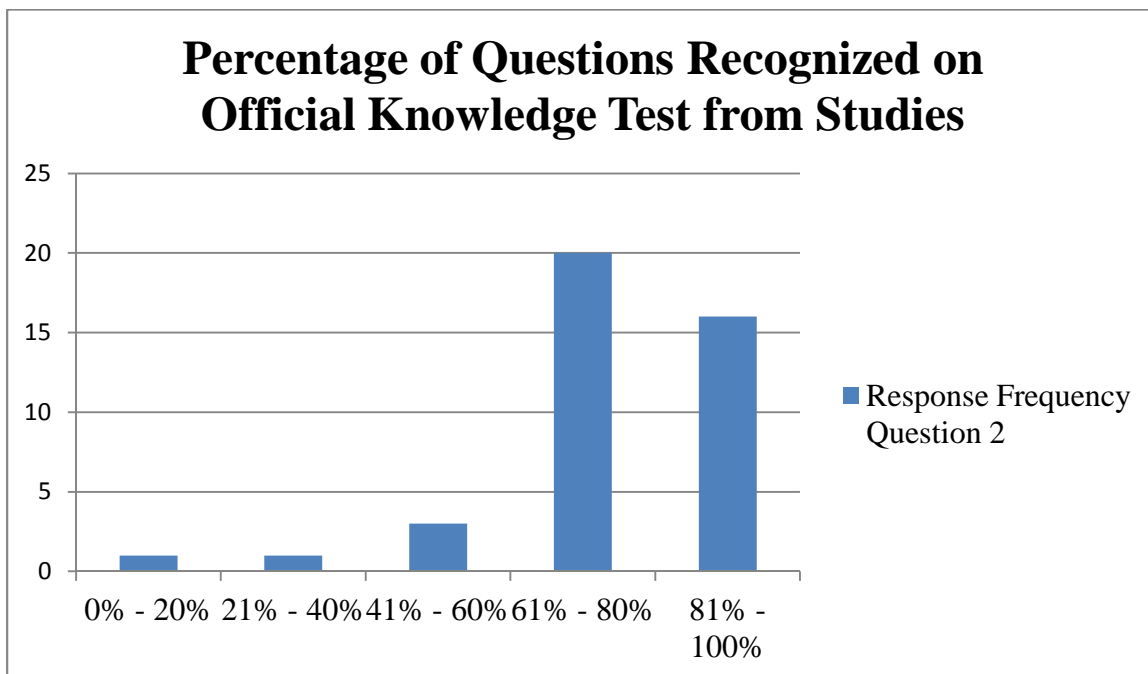


Figure 17: Percentage of questions participants reported recognizing on their FAA knowledge test from their studies, sample aggregate

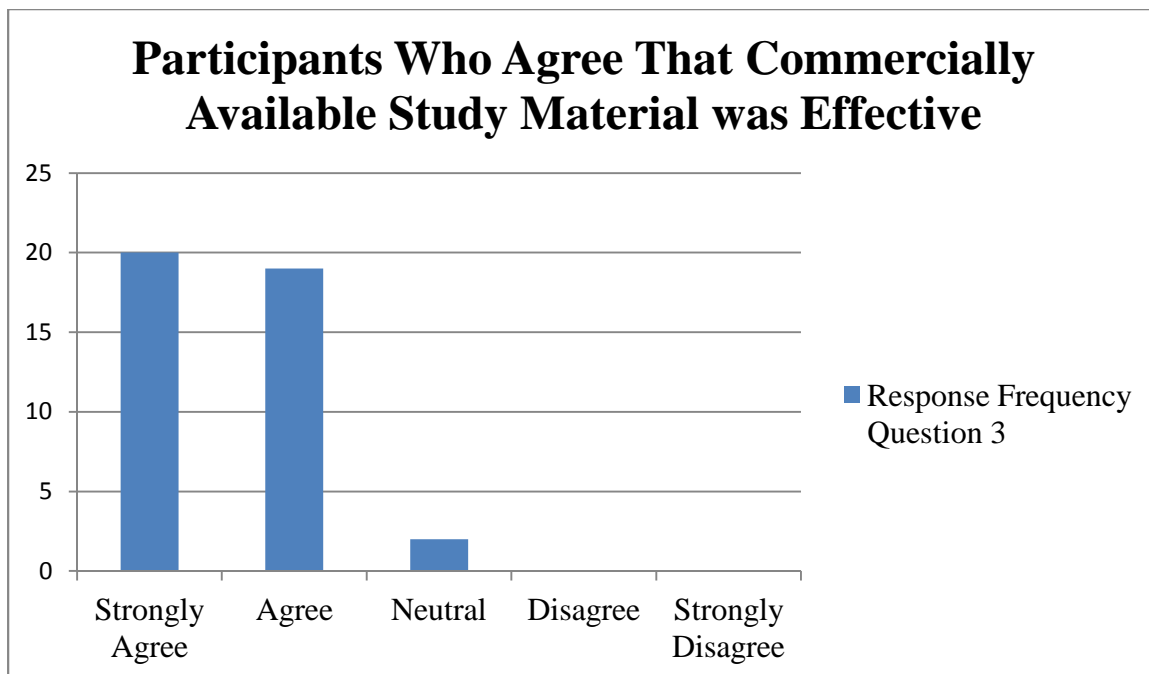


Figure 18: Participant response to survey question 3 regarding participant perception that commercially available test prep material was an effective means of studying for and passing their FAA knowledge exam, sample aggregate

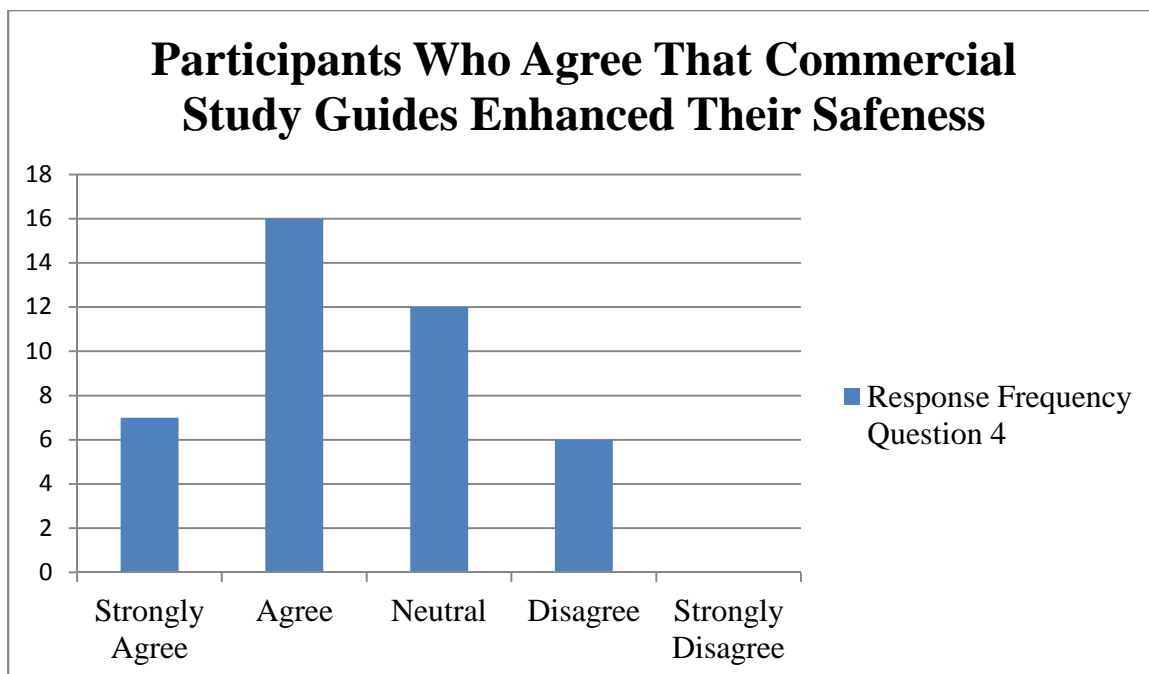


Figure 19: Participant response to survey question 4 regarding agreement that using commercially available test prep material prepared them to be a safe and effective pilot, sample aggregate

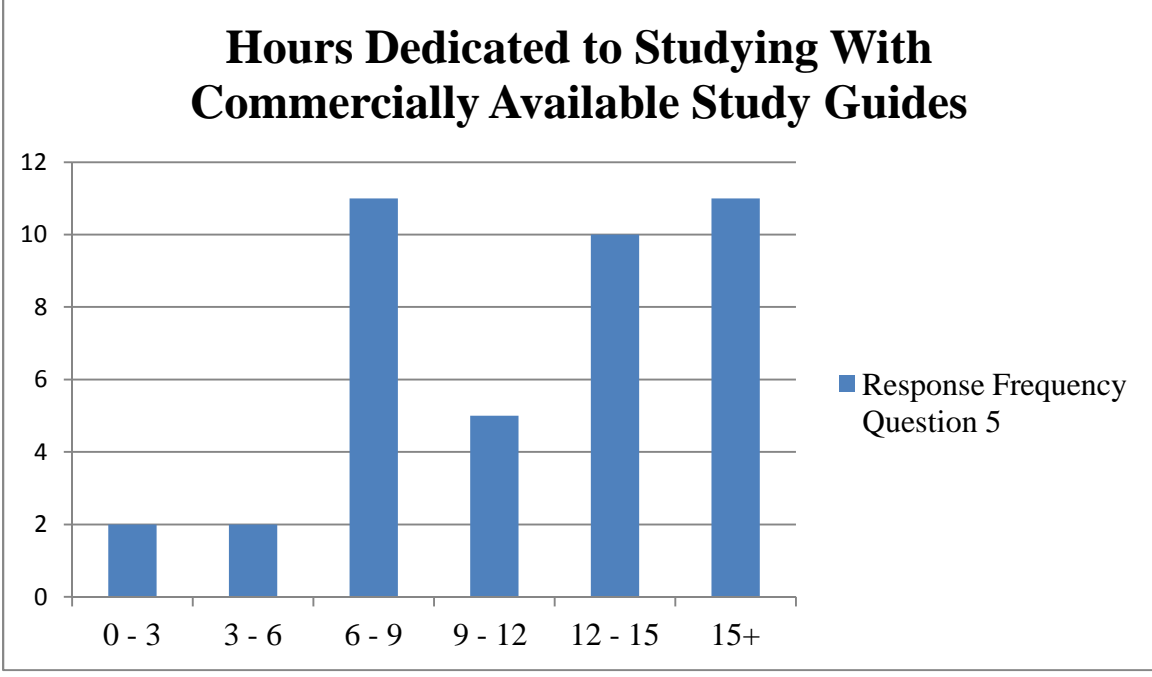


Figure 20: Participant response to survey question 5 regarding hours dedicated to studying for their FAA knowledge exam with commercially available test prep material, sample aggregate

CHAPTER IV – DISCUSSION

The first research question, “Is memorization of questions and answers from a commercial source a common study method?” can be answered by evaluating Tables 1, 6, 11 and 16. Table 16 demonstrates in an overwhelming way that most research participants endeavored to memorize questions and answers from a commercially available study guide while preparing for their official FAA knowledge test. It was found that 88% of research participants agreed or strongly agreed that they attempted to memorize questions and answers from commercially available test prep literature or software. The instrument group was most prone to memorizing questions and answers, followed by the commercial group and finally the private group. The percentage of research participants within the instrument, commercial and private group who attempted to memorize questions and answers from a commercially available source was 95%, 93% and 57%, respectively.

The answer to the second research question, “Is there a positive correlation between memorization of test questions and answers and official FAA test scores?” was answered by performing matched t test analysis of research participants’ scores on their official FAA knowledge test and an unpublished assessment of similar aeronautical knowledge. As previously mentioned, scores were lower on an unpublished assessment of similar aeronautical knowledge than on official FAA written knowledge exams. The average difference was great enough within the entire sample and within the instrument group to be considered statistically relevant. In other words, research participants’ average performance was lower on the research test than on their official FAA

knowledge test. It was so much lower that a statistically relevant difference was produced.

This statistical significance comes with a caveat. As mentioned in chapters II and III, one question on the instrument written research test was identified as the weakest aspect of this research. The researcher, identifying this question as the most likely source of criticism for this research, analyzed data with and without the selected question. When the research is conducted with question six from the instrument written research test omitted this statistical significance is lost from both the instrument and aggregate groups. It should be noted that only the instrument and aggregate groups have statistical significance. This significance is only retained when all questions from the instrument written research test are retained.

The third research question, “Is there a difference between FAA knowledge test scores and test scores on an unpublished assessment of similar aeronautical knowledge?” is answered in similar fashion to the second research question. Results determine that there is a difference between FAA knowledge test scores and test scores on an unpublished assessment of similar aeronautical knowledge. On average, research participants performed more poorly on an unpublished assessment than they did on official FAA knowledge tests. This average difference was only statistically significant in certain previously elaborated upon circumstances.

This research can be used to demonstrate that deliberate memorization was a common study method of those pilot applicants who were sampled. Although this research does not clearly demonstrate it, this study can be used to support claims that memorization of questions and answers, instead of fundamental understanding of

aeronautical knowledge, is a factor in positive scores of FAA knowledge tests. Research participants, like all FAA airmen knowledge test applicants, had advance knowledge of the questions and answers within the database used to generate the FAA knowledge test they took. Additional investigation is needed to determine with more confidence if the availability of this advance notice is positively correlated with FAA knowledge test scores.

Recommendations

In order to ensure that applicants for FAA credentials have not memorized questions and answers from commercially available sources so as to enhance their performance on FAA knowledge tests, regulators must take simple but effective measures. First, those measures must include removing sample questions and answers from the public domain. Secondly, the databases used to generate FAA knowledge tests must be updated on an ongoing and frequent basis. This will ensure that commercially available sources of near facsimile representation of official question and answer databases will be too difficult and costly to commercially produce.

As previously described, test prep companies may employ individuals to take various FAA knowledge tests. These professional test takers endeavor to memorize the questions and answers presented to them during their official knowledge test. Later, these individuals document as much of their test's questions and answers as they can remember. While this process would be difficult to prohibit, it would be easy to make the fruits of such labor nearly useless. Provided the databases used to generate official knowledge tests are updated rapidly enough and old questions are expunged rapidly enough, test prep providers would not be able to maintain sufficiently accurate and

complete compilations of test questions for those compilations to be commercially viable. A team of additional FAA employees dedicated exclusively to the task of airmen test database updating would be required. Additionally, it is recommended that regulators add two additional distractor answers to each question. Provided FAA airmen knowledge tests consisted of multiple choice questions with five answer choices instead of three, the possibility of test applicants guessing correctly without possessing a sufficient understanding of the issues presented within the question will be greatly diminished.

Such policy changes will help ensure that honest scholarship and deliberate study are necessary to achieve high scores on FAA knowledge tests instead of simple rote memorization. Such policy changes will shift FAA knowledge testing from an exercise in rote memorization to one that is representative of a thoughtful effort to understand aeronautical issues. Such policy changes will allow FAA knowledge tests to evaluate aeronautical knowledge instead of memorization prowess.

Limitations and Future Research

Future research faces significant challenges associated with the development of the research tests associated with the study. Questions developed for inclusion within the research tests of similar future research must meet demanding criteria. Such questions must evaluate similar aeronautical knowledge as that which is evaluated on the official FAA knowledge test being represented. Research questions must be presented in a format identical to that of official FAA knowledge tests; they must be of a difficulty level and confusion level commensurate with that of the official knowledge test being represented. Research questions must not only meet the aforementioned criteria of similar difficulty, identical format, and similar knowledge being assessed; but must also

be sufficiently different from those found on official knowledge tests to be viable for inclusion in similar research.

This research was skewed by the source of its sample. The entire sample used in this research was made up of collegiate students in a professional pilot program at Middle Tennessee State University. In order to make less biased inferences about the entire population of United States FAA airmen knowledge test applicants, a larger and more diverse sample is needed. Future research of a similar nature must involve a sample of collegiate and non-collegiate airmen knowledge test applicants. Efforts must be made to ensure that multiple collegiate programs are represented within the portion of the sample derived from collegiate programs. Efforts must also be made to ensure that the sample includes non-collegiate applicants from many regions of the nation. Future research must use a sample whose diversity resembles that of the entire population of FAA airmen knowledge test applicants. Future research would also benefit greatly by increasing the number of questions making up each of the research tests it contains to coincide with the number of questions found within each official knowledge test being represented.

References

- A report from the airman testing standards and training aviation rulemaking committee to the Federal Aviation Administration. (n.d.). Retrieved from http://www.faa.gov/aircraft/draft_docs/media/airman_test_arc_final_rpt.pdf
- Airman knowledge test questions. (n.d.). Retrieved from http://www.faa.gov/training_testing/testing/airmen/test_questions/
- Appropriate use of high-stakes testing in our nation's schools. (n.d.). Retrieved from <http://www.apa.org/pubs/info/brochures/testing.aspx>
- ASA: test prep series. (n.d.). Retrieved from http://www.asa2fly.com/Test-Prep-Series-C22_category.aspx
- Aviation rulemaking committee (ARC) reports. (n.d.). Retrieved from http://www.faa.gov/aircraft/draft_docs/arc/
- Changes to FAA knowledge test question banks affecting testing scores. (2011, March 3). Retrieved from <http://www.nafinet.org/news.aspx?id=539>
- Evers, A., Sijtsma, K., Lucassen, W., & Meijer, R. R. (2010). The Dutch review process for evaluating the quality of psychological tests: history, procedure, and results. *International Journal of Testing*, 10(4), 295-317.
- Fanjoy, R., Young, J., & Dillman, B. (2005). Exit Exams for College Flight Programs: Redundant Activity or Certification of Competency? *Collegiate Aviation Review*, 23(1), 24-31.
- Finn, G. (2004). *Examining GRE validity with and without restricted sample range*. (Doctoral dissertation). Retrieved from EBSCOhost. (UMI No. 3147404)

Gleim, I. N., & Gleim, G. W. (2011a). *Commercial pilot FAA knowledge test for the FAA computer-based pilot knowledge test* (2012 ed.). Gainesville, FL.: Gleim Publications.

Gleim, I. N., & Gleim, G. W. (2011b). *Instrument Pilot FAA Knowledge Test for the FAA computer-based pilot knowledge test* (2012 ed.). Gainesville, FL.: Gleim Publications.

Gleim, I. N., & Gleim, G. W. (2011c). *Private pilot and recreational pilot: FAA knowledge test for the FAA computer-based pilot knowledge test* (2012 ed.). Gainesville, FL.: Gleim Publications.

Gleim products: private pilot FAA knowledge test. (n.d.). Retrieved from http://www.gleim.com/products/productdetails.php/PPKT_-_Private-Pilot-FAA-Knowledge-Test

How standardized testing damages education. (2007) Retrieved from <http://www.fairtest.org/facts/howharm.htm>

Kontovourki, S., & Campis, C. (2011). Meaningful Practice: Test Prep in a Third Grade Public School Classroom. *The Reading Teacher*, 64(4), 236-245.

Namowitz, D. (n.d.a). Industry, FAA seek fix for knowledge tests. Retrieved from http://www.aopa.org/advocacy/articles/2011/110421industry_faa_seek_fix_for_knowledge_tests.html

Namowitz, D. (n.d.b). FAA accepts knowledge-test reform plan. Retrieved from <http://www.aopa.org/advocacy/articles/2012/120621faa-accepts-knowledge-test-reform-plan.html>

Norcini, J. J., & Shea, J. A. (1997). The credibility and comparability of standards.

Applied Measurement in Education, 10(1), 39. Retrieved from EBSCOhost.

Sample airmen knowledge test questions. (n.d.). Retrieved from

http://www.faa.gov/training_testing/testing/airmen/test_questions/

Statement regarding recent FAA test question changes. (n.d.). Retrieved from

<http://www.dauntless-soft.com/products/groundschool/news/>

Summey, J., Schultz, M. C., & Schultz, J. T. (2004). Are four-year universities better than two-year colleges at preparing students to pass the FAA aircraft mechanic certification written examinations? *Journal Of Air Transportation*, 9(1), 3-15.

Appendices

Appendix A: IRB Approval

November 21, 2012

Michael Counts, Dr. Wendy Beckman
Department of Aerospace
mac3v@mtmail.mtsu.edu, Wendy.Beckman@mtsu.edu



Protocol Title: "Airmen Written Testing, an Investigation in Test Legitimacy"
Protocol Number: 13-128

Dear Investigator(s),

The exemption is pursuant to 45 CFR 46.101(b) (2). This is because the research being conducted involves the use of educational tests, survey procedures, interview procedures or public behavior.

You will need to submit an end-of-project report to the Office of Compliance 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 **November 21, 2015**.

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

Appendix B: IRB Consent Form

Middle Tennessee State University Institutional Review Board Informed Consent Document for Research	MTSU IRB Approved Date: 11/21/2012
<p>Principal Investigator: Michael Aaron Counts Study Title: Airmen Written Testing, an Investigation in Test Legitimacy Institution: Middle Tennessee State University</p>	
<p>Name of participant: _____ Age: _____</p>	
<p>The following information is provided to inform you about the research project and your participation in it. Please read this form carefully and feel free to ask any questions you may have about this study and the information given below. You will be given an opportunity to ask questions, and your questions will be answered. Also, you will be given a copy of this consent form.</p>	
<p>Your participation in this research study is voluntary. You are also free to withdraw from this study at any time. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.</p>	
<p>For additional information about giving consent or your rights as a participant in this study, please feel free to contact the MTSU Office of Compliance at (615) 494-8918.</p>	
<ol style="list-style-type: none"> 1. Purpose of the study: You are being asked to participate in a research study designed to collect data about Federal Aviation Administration (FAA) airmen written tests and how effective they are at ascertaining aeronautical knowledge. 2. Description of procedures to be followed and approximate duration of the study: If you agree to be in this study, you must have recently taken either the private, instrument, or commercial FAA written test. You will provide the researcher with the score you achieved on your FAA test. You also will be asked to complete a brief (between 10-12 question) multiple choice test pertaining to aeronautical knowledge. Finally, you will be asked to complete a brief 5 question survey. It should require no more than fifteen minutes of your time to complete all aspects of this research study. 3. Expected costs: Participation will not cost you anything except your time. 4. Description of the discomforts, inconveniences, and/or risks that can be reasonably expected as a result of participation in this study: I do not anticipate any risks to you participating in this study other than those encountered in day-to-day life. 5. Compensation in case of study-related injury: MTSU will not provide compensation in the case of study related injury. 6. Anticipated benefits from this study: <ol style="list-style-type: none"> a) The potential benefits to science and humankind that may result from this study are a greater understanding of issues associated with FAA airmen written tests. b) There are no personal benefits you should expect from participating in this survey. 7. Alternative treatments available: There is no alternative means of participating in this study. 8. Compensation for participation: There is no compensation for participating in this study. 9. Circumstances under which the Principal Investigator may withdraw you from study participation: 	

Appendix B: IRB Consent Form (continued)

Should the principal investigator believe you are cheating in some way, your data will be withdrawn from the study.

10. What happens if you choose to withdraw from study participation:

Should you choose to withdraw from the study you will be thanked for your time. No further correspondence will occur.

11. Contact Information. If you should have any questions about this research study or possible injury, please feel free to contact **Michael Aaron Counts** at (864) 554-0159 or my Faculty Advisor, **Dr. Wendy S. Beckman** at (615) 494-8755

12. Confidentiality. All efforts, within reason, will be made to keep the personal information in your research record private but total privacy cannot be promised. Your information may be shared with MTSU or the government, such as the Middle Tennessee State University Institutional Review Board, Federal Government Office for Human Research Protections, if you or someone else is in danger or if we are required to do so by law.

13. STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY.

I have read this informed consent document and the material contained in it has been explained to me verbally. I understand each part of the document, all my questions have been answered, and I freely and voluntarily choose to participate in this study.

Date

Signature of patient/volunteer

Consent obtained by:

Date

Signature

Printed Name and Title

Appendix C: Private Pilot Questions

These questions are intended for Private pilot applicants:

1. Select the true statement with regard to aircraft.
 - A. Aircraft may stall at any airspeed.
 - B. Aircraft must be operating near V_{so} in order to stall.
 - C. Aircraft may not be stalled while operating at speeds 10% greater than V_{so} .

2. Pitot-static systems are necessary for some aircraft instruments. Regarding these systems, select the true statement.
 - A. Pitot pressure usually drives two gyroscopic instruments and one or more gyroscopic instruments are usually electrically driven. This is for redundancy
 - B. Pitot static systems typically drive three instruments, the airspeed indicator, altimeter and turn and bank indicator.
 - C. One instrument typically relies on both pitot and static pressure to operate.

3. Wake turbulence or wingtip vortices are a phenomenon resulting in temporary changes to the air near operating aircraft. Which statement most correctly describes wake turbulence?
 - A. Wing tip vortices do not affect light twin aircraft because the two propeller slipstreams destroy the vortices before they interact with the wings.
 - B. One option for avoiding wingtip vortices generated by large aircraft is to delay departure.
 - C. One option for avoiding wingtip vortices generated by large aircraft is to stay below the flight path of a preceding aircraft.

4. What expenses associated with a flight may a Private pilot allow their passengers to pay?
 - A. Private pilots may allow their passengers to pay all costs associated with a given flight in which they act as Pilot in command.
 - B. Private Pilots must pay all costs associated with a flight in which they act as Pilot in command.
 - C. Private Pilots and their passengers must pay equal share of fuel, oil, rental fees, and airport fees.

Appendix C: Private Pilot Questions (continued)

5. Special VFR allows pilots to fly with reduced weather requirements. Select the true statement.
 - A. Only while on a special VFR clearance may a private pilot operate above 18,000 Feet MSL.
 - B. Private pilots must have an instrument rating and instrument rated aircraft to operate Special VFR during the day.
 - C. Private pilots must have an instrument rating and instrument rated aircraft to operate Special VFR at night.

6. Select the true statement with regard to aircraft performance.
 - A. At high altitude true airspeed increases. Pilots landing at high altitude airports should approach at a 10% slower indicated airspeed than normal to avoid landing long.
 - B. Density altitude is higher when temperatures are above standard and humidity is high.
 - C. High density altitude is desirable because aircraft performance is augmented in such conditions.

7. Select the true statement with regard to hypoxia.
 - A. Hypoxia is alleviated during high altitude unpressurized flight without oxygen by climbing.
 - B. Hypoxia is prevented by requiring flight crew use supplemental oxygen all times above 14,000 feet MSL when pressurization is not available.
 - C. Hypoxia can be described as overutilization of oxygen by the body for varying reasons and actually enhances night vision acuity in pilots.

8. Thunderstorms have distinct stages of development. Select the true statement.
 - A. The incipient stage of a thunderstorm is the first stage and is characterized by severe wind shear and turbulence.
 - B. The cumulus stage of a thunderstorm is the first stage and is characterized by mostly downdrafts and severe wind shear and turbulence.
 - C. The mature phase of development is the time of greatest intensity and is characterized by updrafts and downdrafts.

Appendix C: Private Pilot Questions (continued)

9. Who is responsible for determining that an aircraft is safe for a proposed flight?
- A. The owner is responsible for determining an aircraft is safe for each flight.
 - B. The pilot in command is responsible for determining an airplane is safe for flight.
 - C. Aircraft owners are required by law to always maintain their aircraft in airworthy condition.
10. Select the true statement with regard to weight and balance.
- A. Weight and balance will shift as fuel is burned in flight. Therefore, a calculation should be made for before flight conditions, inflight conditions, and landing conditions.
 - B. If weight and balance calculations show that an aircraft is under gross weight and within C.G. limits before flight, it is impossible for fuel burn to result in an out of balance condition during flight.
 - C. Weight and balance does not change during flight.
11. Select the true statement with regard to aircraft magnetos.
- A. If the charging system fails on an aircraft, the magnetos will no longer function once the battery is dead.
 - B. Magnetos operate independent of the main aircraft electrical system.
 - C. Magnetos require bi-annual recharging for continued operation.
12. Aircraft wings stall when certain conditions are met. Select the true statement.
- A. The critical angle of attack is affected by the airplane's weight, load factor and power setting.
 - B. The critical angle of attack for a given airfoil remains constant.
 - C. Aircraft in descent are impossible to stall.
- (Gleim, I. N., & Gleim, G. W. 2011c).

Appendix D: Commercial Pilot Questions

These questions are intended for Commercial applicants:

1. Aircraft wings stall when certain conditions are met. Select the true statement
 - A. The angle of attack at which the wing stalls is affected by the airplane's weight, load factor and power setting.
 - B. The critical angle of attack for a given airfoil remains constant.
 - C. Aircraft in descent are impossible to stall.

2. Pitot-static systems are necessary for some aircraft instruments. Regarding these systems, select the true statement.
 - A. Pitot pressure usually drives two gyroscopic instruments and one or more gyroscopic instruments are usually electrically driven. This is for redundancy.
 - B. Pitot static systems typically drive three instruments, the airspeed indicator, altimeter and turn and bank indicator.
 - C. One instrument typically relies on both pitot and static pressure to operate.

3. Special VFR allows pilots to fly with reduced weather requirements. Select the true statement.
 - A. Only while on a special VFR clearance may a private pilot operate above 18,000 Feet MSL.
 - B. Private pilots must have an instrument rating and instrument rated aircraft to operate Special VFR during the day.
 - C. Private pilots must have an instrument rating and instrument rated aircraft to operate Special VFR at night.

4. Cold weather operations bring with it new preflight duties. Select the true statement.
 - A. Only the powerplant will benefit from preheating. Therefore it is only necessary to preheat the powerplant.
 - B. Preheating the cabin provides crew and passengers with additional comfort until the aircraft can heat itself but this is the only benefit.
 - C. The aircraft's instruments and powerplant will benefit from preheating.

Appendix D: Commercial Pilot Questions (continued)

5. Select the true statement regarding weight and balance calculations.
 - A. Weight and balance will shift as fuel is burned in flight. Therefore, a calculation should be made for before flight conditions, inflight conditions and landing conditions.
 - B. If weight and balance calculations show that an aircraft is under gross weight and within C.G. limits before flight, it is impossible for fuel burn to result in an out of balance condition during flight.
 - C. Weight and balance does not change during flight.

6. Night flight is most safely conducted when vision has adjusted to the low light conditions. Select the true statement.
 - A. This takes approximately 15 minutes.
 - B. This takes approximately 30 minutes.
 - C. This takes approximately 45 minutes.

7. The datum is a reference used for weight and balance computations. Where is it located?
 - A. Anywhere the manufacturer designates.
 - B. Anywhere the manufacturer designates forward of the firewall.
 - C. Anywhere the manufacturer designates aft of the firewall.

8. Select the true statement regarding high performance aircraft.
 - A. High performance aircraft must have flaps and a constant speed propeller.
 - B. High performance aircraft must have flaps, retractable landing gear, and a constant speed propeller.
 - C. High performance aircraft are equipped with a powerplant that produces more than 200hp.

9. Select the true statement regarding commercial pilot privileges.
 - A. A commercial pilot certificate is one requirement for flying persons or property for hire.
 - B. Commercial pilot certificate privileges are not required to accept compensation for banner tow operations.
 - C. Commercial pilot certificates expire every 24 calendar months.

Appendix D: Commercial Pilot Questions (continued)

10. Select the true statement with regard to high performance aircraft.
- A. High performance aircraft powerplants are generally more forgiving with regard to engine power management and less susceptible to damage from improper operation.
 - B. High performance aircraft powerplants are more susceptible to damage due to improper management of power.
 - C. High performance aircraft powerplants require rapid throttle movement in order to respond properly to pilot demands for power. (Gleim, I. N., & Gleim, G. W. 2011a).

Appendix E: Instrument Pilot Questions

These questions are intended for Instrument applicants:

1. When atmospheric pressure is 29.92" Hg, the temperature is 15°C, the aircraft is level and the altimeter is set correctly, what altitude(s) is/are indicated on the altimeter face?
 - A. Only density altitude and pressure altitude.
 - B. Density altitude, pressure altitude and indicated altitude.
 - C. Only indicated altitude and pressure altitude.

2. Prior to IFR flight taxi turns should be initiated in order to check the operation of gyroscopes. Which gyroscopes may be checked for proper operation during taxi turns?
 - A. Artificial horizon or attitude indicator, directional gyro and turn coordinator.
 - B. Artificial horizon or attitude indicator and directional gyro.
 - C. Directional gyro and turn coordinator.

3. Distance Measuring Equipment (DME) measures slant range distance to the station. Which scenario will provide the greatest slant range error?
 - A. Distances greater than 100 NM from the station at 10,000 ft. AGL.
 - B. Distances between 5 NM and 10 NM from the station and 500 ft. AGL.
 - C. Directly above the station at 18,000 ft. AGL.

4. While listening to the automated terminal information service (ATIS) you note that the sky condition and visibility are not reported. Select the true statement.
 - A. This indicates an equipment failure. Sky condition and visibility will be reported by ATC.
 - B. This implies that the ceiling is in excess of 5,000ft. and the visibility is greater than 5 SM.
 - C. This implies that the ceiling is in excess of 10,000ft. and the visibility is greater than 6SM.

Appendix E: Instrument Pilot Questions (continued)

5. While on an instrument landing system ILS approach with the localizer and glideslope needles centered, the ILS fails. You have the VASI in sight. Select the appropriate action.
 - A. The approach should be completed as long as the VASI continues to be visible.
 - B. The approach should be terminated and the missed approach procedure should be flown.
 - C. The pilot should request radar vectors to the threshold.

6. Select the situation leading to a visual illusion which may cause a pilot to approach at a speed slower than usual.
 - A. Approaching a runway that is more narrow than usual.
 - B. Approaching a runway that is more wide than usual.
 - C. Approaching a runway that slopes downward.

7. In Florida at winter, a mass of warm moist air has been blown inland from the ocean and condenses. What type of fog has occurred?
 - A. Advection fog.
 - B. Radiation fog.
 - C. Precipitation-induced fog.

8. The minimum obstruction clearance altitude or MOCA will ensure navigation reception at what distance?
 - A. Within 50 NM of the VOR.
 - B. Within 25 NM of the VOR.
 - C. Within 22 NM of the VOR.

9. Select the true statement regarding the following METAR: **KBNA 031253Z 20007KT 10SM BKN008 BKN014 OVC037 23/22 A2989 RMK AO2 SLP115 T02330217.**
 - A. The ceiling is broken at 800ft. AGL.
 - B. The ceiling is broken at 800 ft. MSL.
 - C. The ceiling is broken at 80ft. MSL.

Appendix E: Instrument Pilot Questions (continued)

10. If you must deviate from an air traffic control (ATC) clearance during an emergency, at what time must you notify ATC of your deviation?
- A. ATC must be notified prior to any deviations.
 - B. ATC must be notified within 2 minutes of deviating from their clearance.
 - C. ATC must be notified as soon as is possible after deviating from their clearance.
- (Gleim, I. N., & Gleim, G. W. 2011b).

Appendix F: Survey

Circle the answer which is most accurate for you.

1. I attempted to memorize questions and answers from test prep software or literature while studying for my FAA knowledge exam.

Strongly Agree Agree Neutral Disagree Strongly Disagree

2. On my FAA knowledge exam, the percentage of questions I recognized from my studying was:

0%-20% 21%-40% 41%-60% 61%-80% 81%-100%

3. I feel as though using commercially available test prep material was a very effective method for studying for and passing my FAA knowledge exam.

Strongly Agree Agree Neutral Disagree Strongly Disagree Not Applicable

4. I feel as though using commercially available test prep material has prepared me to be a safe and effective pilot.

Strongly Agree Agree Neutral Disagree Strongly Disagree Not Applicable

5. The amount of time I dedicated to studying for my FAA knowledge exam with commercially available test prep material was:

0-3 Hours 3-6 Hours 6-9 Hours 9-12 Hours 12-15 Hours 15+ Hours