Impact of Computer Tablets on General Aviation Flight Training

By

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In

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Abstract

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Over the past two decades, Electronic Flight Bags (EFBs) and Personal Electronic Devices (PEDs) have developed from flight publication storage devices hosted on modified laptop computers into fully interactive near-avionics-quality navigation equipment based on consumer-grade tablet computers. Broadly speaking, the Code of Federal Regulation (CFR) 14 regulates the use of this type of equipment for commercial airlines, commuter operations, and fractional ownership operators, but have neglected the General Aviation (GA) sector. Due, in part, to this lack of governance, little has been known about EFB use in GA. After using an internet-based survey, this study was conducted to examine whether there is a strong impact of tablet EFB use among GA pilots’ performance. Further on, survey data helped in revealing which EFB capabilities are desired by GA pilots and their opinions of EFB usability compared to paper flight publications. Analysis of these results further lead on to recommendations for GA stakeholders, including the National Transportation Safety Board and tablet computer manufacturers.

Keywords: tablet computer, personal electronic device, electronic flight bag, EFB, general aviation
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The scholar shares his gratitude to his mother, father, sister, brother and brother-in-law for their encouragement and providing the author with inspiration.
Dedication

The author would like to dedicate this thesis to his beloved parents who are located in Kenya for their encouragement. This thesis is also dedicated to his sister, brother, brother-in-law and friends for all their love and motivation.
Chapter 1

Introduction

The purpose of this study was to examine the impact of using personal electronic devices on board an aircraft on the performance of a pilot during flight training. In the context of this study, this chapter illustrates sections of the study such as problem statement, purpose statement, operational definitions, research questions, null hypotheses and alternative hypotheses. Other significant sections consists of the significance of this study, delimitations and limitations.

Problem Statement

Technology has greatly increased its reach into the transportation system in the near past and little do we know on how far it can reach in the future. With it, comes less workload for human beings in the day to day way of life. Although this seems to be a positive sign, it may be a major concern in terms of safety in certain areas; for example, the use of personal electronic devices for flight training may tend to decrease the pilot’s situational awareness and attentional span. The aim of this study was to further research impact of computer tablets on flight training performance among GA flight student pilots. The use of hard copy maps with certain books and instruments that used to be carried by student pilots for better flight operations by observing the temperature, weather and terrain, has long been forgotten. Technology has extended its reach to enable a pilot to access all the necessary information for a flight procedure by the tap of a virtual button on a
personal electronic device. This study has sought to determine the absence, if any, of safety during the use of a computer tablet. In this case, the only human entities involved are the flight crew, specifically, pilots.

**Purpose Statement**

The purpose of this study was to examine the impact of computer tablets on flight students’ flight training performance. Moreover, it also determined the effect of demographic details such as: computer tablet usage experience, flight hours completed and language proficiency on flight training performance for those students that use computer tablets.

**Operational Definitions**

**Computer Tablet**

In the context of this study, personal electronic devices are defined as any piece of small, lightweight, both transmitting and non-transmitting devices such as smartphones, computer tablets, and e-readers, all of which may be operated under “Flight Mode” or “Airplane Mode”.

**Computer Tablet Users**

This term refers to the group of participants in the study who use a computer tablet for flight training operations. This group may or may not have previous experience in computer tablet usage.
Computer Tablet Non-Users

This term refers to the group of participants in the study who do not use a computer tablet for flight training operations. This group also may or may not have previous experience in computer tablet usage.

Computer Tablet Usage Experience

A commonly defined term of computer tablet usage experience is the amount of time a user has engaged oneself in operating a computer tablet for any specific reason. In the case of this study, computer tablet usage experience is referred to the experience a user has with a computer tablet to accomplish a flight training task as shown by the participants’ scores on the Likert-type scale of the survey. This survey mirrored the pilot’s performance from the scores obtained after the survey is filled out (as seen in Appendix A which is only meant for pilot participants who use computer tablets).

Language Proficiency

Language proficiency refers to the user’s discourse, grammatical and sociolinguistic knowledge of the language in question. One of the requirements in pilot training in the United States of America is that the pilot being trained needs to be highly proficient in English in order to read, interpret and communicate tasks during flight operations (FAA, c2017). In the analysis of this study, the pilot’s proficiency in English was referred to the participants’ scores on the Likert-type scale of the survey (see Appendix C).
Performance

Performance is mainly defined as the completion of a task as measured according to the completeness, cost, standards of accuracy and speed used to accomplish said task (Business Dictionary, c2016). For the analysis of this study, performance was referred to the completion of a flight training task as shown by the participants’ scores on the Likert-type scale of the survey (see Appendix A and B).

Flight Experience

Flight experience refers to the hours accumulated during flight, certificates/ratings held by the pilot, aircraft type or model flown, environment predominantly flown in, and years of operational experience (Sparks, 2008). For the purpose of this study, flight experience was referred to the participants’ scores on the Likert-type scale of the survey (see Appendix C).

Research Questions and Hypotheses

Research Question 1

What is the impact of computer tablets on flight students’ flight training performance?

Null Hypothesis 1

\( H_0: \) The use of computer tablets will not lead to a higher flight performance (as rated by the student) compared to the group that does not use computer tablets.
**Alternative Hypothesis 1**

$H_a$: The use of computer tablets will lead to a higher flight performance (as rated by the student) compared to the group that does not use computer tablets.

**Research Question 2**

What is the effect of computer tablet usage experience on flight training performance in the group that use computer tablets?

**Null Hypothesis 2**

$H_0$: The amount of computer tablet usage experience will not be associated with higher flight performance (as rated by the student).

**Alternative Hypothesis 2**

$H_a$: The amount of computer tablet usage experience will be associated with higher flight performance (as rated by the student).

**Research Question 3**

What is the effect of flight hours completed on flight training performance in the group that use computer tablets?
Null Hypothesis 3

H₀: Number of flight hours completed will not be associated with higher flight performance (as rated by the student) on those flight students using computer tablets.

Alternative Hypothesis 3

Hₐ: Number of flight hours completed will be associated with higher flight performance (as rated by the student) on those flight students using computer tablets.

Research Question 4

What is the effect of language proficiency on flight training performance in the group that use computer tablets?

Null Hypothesis 4

H₀: Students with English as their first language will not be associated to a higher flight performance (as rated by the student) compared to students in which English is not their first language on the flight students that use computer tablets.

Alternative Hypothesis 4

Hₐ: Students with English as their first language will be associated to a higher flight performance (as rated by the student) compared to students in
which English is not their first language on the flight students that use computer tablets.

**Significance of the Study**

The use of newly developed technological devices in flight operations being one of the new areas of research, has led to many potential paths of exploration. Previous studies done by various authors have led to different ways, focusing on many factors as such. Nonetheless, as to how the use of technology through personal electronic devices can cause distractions, this study consisted of a survey that determined the impact of computer tablets and other demographic variables on flight training performance among the students registered as GA pilots. Due to previous issues in studies related to the use of personal electronic devices, the experiment conducted in this study utilized Florida Institute of Technology GA pilots registered as flight students.

The rationale for this study pertains to the effect of a flight student’s performance when they are allowed to use personal electronic devices (PEDs) on board an aircraft. Even though there have been regulations set forth by the Federal Aviation Administration (FAA) on personal electronic devices to be considered as an electronic display system intended primarily for flight deck or cabin crew member use, this does determine the software installed inside. FAA have deemed
eligible devices which host and actively display certain type of software applications are permitted on board an aircraft (FAA, 2014).

However, the question pertaining to the ability of the crew member’s performance while also abiding to the safety standards remains unanswered. Strauss (2002) discusses on how PEDs causes interference to the avionics system of aircrafts by using the Aviation Safety Reporting System (ASRS) database and discovered 125 incident reports that led to interference occurrences (Strauss, 2002). Nonetheless, from these past occurrences, does the development of technology today enable a safer environment for flying? Therefore, with the FAA’s recent permission to use personal electronic devices such as phones, tablets and e-readers during flight operations, may lead to flight student pilots to misread the parameters measured by the avionics system and hence, reduce their performance during training.

However, if flight student pilots are able to install the necessary software applications and use their PEDs in an authorized manner and understand how to use their personal electronic devices with safety, it is more than likely to decrease aircraft accidents, increase the survival rate, and therefore, increase performance levels as well. However, if flight student pilots are allowed to use personal electronic devices in all aspects of flight operations, then it might result in a lower safety awareness by the crew member. This issue indicates that the new protocol of
the FAA allowing the use of personal electronic devices on board an aircraft should be evaluated.

Therefore, to ensure that flight student pilots are still aware of safety and are able to perform well in their training procedures when they are allowed to use personal electronic devices, conducting research on this issue is useful in terms of preparing a proactive plan for problems resulting from not paying attention to the standard flight operational procedures, which may be caused by personal electronic devices as a distraction. Moreover, the results of this study helped develop the understanding of the limitations on the ability of student pilots’ flight performance while using personal electronic devices.

Limitations and Delimitations

Limitations

While the objective of the study was to capture performance measures from Florida Institute of Technology flight students, they had not efficiently resemble the population being targeted. Pilot students in this department are of different educational levels – students enrolled in the undergraduate, graduate and doctoral degrees. Since some of these participants are likely to be higher educated and have higher maturity experience, the results may not be the same as the target population. Moreover, since there may be an older generation registered as flight students, it is possible that there may be people who have a negative bias view on the use of technology like personal electronic devices for flight operations. Finally,
due to the budget, the study was conducted as a survey as acquiring a flight simulator was too costly.

**Delimitations**

It is a fact that large amounts of information are provided by PEDs during various phases of flight operations. Additionally, the types of software applications required for PEDs to be used on board an aircraft are only limited to certain tasks performed by the pilot. Thus, the scope of the study needs to be focused on a specific type of task as to test the ability of the pilot’s performance. A suitable phase to test out if this motivates the pilot to perform at a better state is during aircraft maneuvering as the personal electronic device shall function in order to provide communications, navigation and surveillance. If this was to happen, the FAA would need to approve the design and installation.

In terms of the location for collecting data, it was difficult to collect data in an actual flight because the researcher had to collect data more than once. As a result, data shall be collected before and after a flight. Moreover, there was a challenge getting an instructor’s permission to collect data from the flight student prior to the training as time may be a factor.

Since most people are likely to carry a mobile phone or a computer tablet due to the portability feature, rather than other electronic devices, the study is focused on examining one electronic device (a computer tablet). One of the main delimitations of using a computer tablet in this experiment, was that, it had several
applications such as programs for playing games, reading novels, taking pictures, or watching movies that the researcher used to manipulate situations for evaluating participants' performance during flight operations.

In summary, this section presents the problem statement, background on the problem statement, purpose statement, and operation definition. Additional portions presented in this chapter contain research questions, which are two questions on the use of computer tablets during flight training. This chapter also includes the hypotheses, which were four null hypotheses and four alternative hypotheses. This chapter also presents the assumptions, limitations, and delimitations of this study. From these topics, it paves a way for a discussion of the theory of computer tablet usage as illustrated in the next chapter.
Chapter 2

Literature Review

Introduction

This section reviews the prevailing literature on the computer tablets’ impact towards flight training. Studies will be reviewed in this chapter to initiate the theoretical outline of the subject in question. Review will be conducted using the key words: computer tablet use, computer tablet usage duration, flight hours, English language competency and performance scores. Additional sections described in this chapter are the theories and studies supporting the research.

Computer tablet

A computer tablet or sometimes known in reverse as a tablet computer, is commonly shortened to just ‘tablet’. It is a single mobile computer device contained in a touchscreen panel as its primary interface and consists of circuitry as well as a battery as a power source. The touchscreen feature uses stylus or finger recognition which replaces the use of a mouse and keyboard (Editors PC Magazine, c1981- 2016). An additional feature in most tablets is the ability of a virtual keyboard to pop-up once the use of typing is required. In terms of size, it is smaller in size than a laptop Personal Computer (PC) but bigger than a smartphone. Hence, it is letter-sized (Shelly, Gunter & Gunter, 2012). However, a tablet enables the user to access certain functionalities that can be found in both smartphones and laptop PCs. Nonetheless, a tablet enables productivity, time management and
creativity in the workplace. There are many examples in which this device has helped ease work by providing easy human-computer interaction. Lecturers and presenters of an audience have had their work load reduced due to the development of technology throughout the years, and Anderson et al. (2004) seconds this with a discussion that the capability to demonstrate materials in terms of a presentation and the ease of which to display it to a development environment during mid-presentation poses as an advantage (Anderson et al., 2004). In early childhood education, the tablet has been known to increase engagement between children with age due to significant differences in level of tablet use between sessions. Teachers have reported that they expected children to have had such high interest and drawings but not above the extent they expected (Couse & Chen, 2010).

Factors of a Tablet

Technology is complex. At first sight, it might not seem understandable, but after a user gets experienced with a certain device, the user tends to increase in expertise on the device’s use. There are a number of situations which can help a tablet user familiarize the device even further. Examples of such are the following.

Amount of usage time. Teachers may seem to be against the idea of technology ruling over the youth, some even having the strong belief that hands-on educational experiences are essential and any type of technological tool must be in tune with developmentally suitable practice and in such a way, children can discover and learn more about the world they live in (Shifflet, Toledo & Mattoon,
2012). In today’s world, children are exposed to progressive technology from a young age, as observed by many parents and teachers. Having such vast experience in devices such as tablets, e-readers and smartphones, paves the way for unprecedented learning opportunities (Mcmanis & Gunnewig, 2012). Couse and Chen (2010) explains that technology inclusion such as; tablet PCs, laptops, Palm Pilots and Alpha Smarts estimated an incline of 48% and a total of 72% in elementary students, who had online access (Couse & Chen, 2010; McLester, 2003 and Gray & Lewis, 2009). In an article done by Fourie and Fourie (2013), they talk about the issue in which high quality innovative work is to be completed on time, according to tight schedules caused mainly by short staffing events. Their intention is not to find an ultimate answer to the solution but to stand from a different view on the issues that might bring some answers (Fourie & Fourie, 2013). However, the early use of technology to gain better experience is still in question.

**English proficiency.** English is one of the top three most used languages in the world (Grimes, 1996). As such, the aviation world has internationally adopted the use of English as their main language in order to improve communication among personnel in terms of safety, reliability and validity issues; all thanks to the International Civil Aviation Organization (ICAO). In this manner, it avoids the subject of special problems in international operations due to language barriers (Yan, 2007). Such trends of aviation training institutes to adopt such a language started to illuminate as early as the beginning 2000s. By March 2008, the initial authorized institute located in the United Arab Emirates, known as
Emirates Aviation College, more specifically the Aerospace and Academic Studies wing, demonstrated a proficiency level of 4 in the English language (Operational) as directed by the ICAO (Al Bawaba, 2007).

However, smart devices in this century have exceeded the expectations of many with the ability to choose a preferred language by the user in order to operate more efficiently through the device’s virtual procedures. On 2\textsuperscript{nd} September 2004, ZiCorporation, a trendsetter of the intelligent interface solutions provision, declared the readiness of an updated version of the eZiTap Front End Processor (FEP) which is also advanced – text software that covers 38 unique language databases for smart devices. This software basically provides smarter ways of punctuation, messaging in various languages, and next word prediction. It gives the user a chance to personalize the device, therefore, there is leeway to simplify text entry. Glen Morgan, who holds the title of ZiCorporation Senior Vice President of Global Sales and Marketing explains that in the world market in coming years, smart phones are expected to be dominant and such innovations will enable Zi to place itself as the primary visionary in the predictive text department. Morgan continues to discuss how his predictions will come true by explaining that the company will install features in its technology which users will demand and need. Additionally, the company’s global reputation is built on its ability to answer quickly to the market and customization of devices to its user’s needs. This renewed product is an additional justification of that capability. (M2 Presswire, 2004). With such language barriers being overcome by technology, the use of tablets and other smart
devices could be operated by just anyone who could utter, write or speak any language on this planet.

**Flight Experience**

In a study done by Sparks (2008), a number of variables are said to define a pilot’s experience. Such variables may include – hours accumulated during flight, certificates/ratings held by the pilot, aircraft type or model in operation, environment predominantly operated in, and years of operational practices (Sparks, 2008). Although, one variable that clearly stands out in the determination of a pilot’s experience is the total amount of time logged during flight (Bell, 1995; Cain, 2001; Guilkey, 1997). As stated in the Federal Aviation Regulations, every registered pilot should materially document the hours of flight operation experience accomplished for the rationale of reaching the requirements set forth. Nonetheless, it is normal that numerous pilots diligently document all flight hours (as well as minutes if necessary) gathered for future progressive purposes. Pilots are therefore, judged according to the amount of flight time collected (Bell, 1995; Guilkey, 1997).

For years, pilots have earned such experience with the use of paper-based navigation aids which have been an integral part of safely operating an aircraft. As this has not altered the failure of pilots achieving their goals, technology has indeed come up with a solution of replacing them with a more productive and efficient device. One approach was achieved using Apple iPad equipped with ForeFlight
software. This showed a statistical significance as it increased every analyzed performance metric when pilots used the device in the stead of the paper-based method. The fact is that, in this day and age where there is information accessibility is at an increase, pilots have to go through colossal amounts of data while maintaining effective cockpit management during flight procedures. In the past, this has led to a bunch of hardcopy paper leaf pages and thus, disorganization in the tight confinements of the cockpit, which inevitably creates problems, such as clutter, especially when a pilot is in a high workload flight segment and needs to access an item (Haddock & Beckman, 2015).

Performance

Performance is commonly represented as the completion of a task as measured according to the completeness, cost, standards of accuracy and speed used to accomplish said task (Business Dictionary, c2016). With such a definition, performance is one of the major factors when it comes to the operation of an aircraft when airborne. Numerous books such as John Anderson’s Aircraft Performance and Design talk about how the design of the aircraft itself, from the exterior to the interior, affect how it performs during flight (Anderson, 1998). Nonetheless, considering the fact that the pilot undergoes all the necessary training needed to operate the aircraft, the perfection of the design of the plane itself will not assure good performance by the pilot.
Basically, the performance of an airplane mostly depends on the pilot’s ability to fly it through all stages of flight: take-off, climb, cruise, approach and landing. Other roles that play a part in the performance levels include: the pilot’s state of mind during flight operations, the pilot’s training, and the maintenance status of the plane; to name a few. As such, numerous criteria need to be taken into consideration during operation of an aircraft during flight to maintain perfect procedural execution in order to sustain safety of the people on board an aircraft.

**Research in the Use of Personal Electronic Devices**

Due to the vast increase and development of technology, gadgets like computer tablets, laptops, smartphones and even e-readers play a major role in people’s lives. Wajcman, Bittman, Jones, Johnstone, and Brown (2007) discuss that out of the many factors of human life, this is one that cannot be ignored (Wajcman et al., 2007). As such, the aviation industry needs to be modified in order to support technology use during flight operations. The Federal Aviation Administration, acting as a ruling organization in the aviation industry, became aware of the issue of technology and began re-analysis of its rules and regulations that were related to the use of personal electronic devices in the cockpit. In doing so, further review of the issue led to the expansion of the use of personal electronic devices under strict restrictions and prohibitions to certain types of technological devices that would not interfere with the aircraft’s communication and navigation systems as described in the Advisory Circular 120-76 (Federal Aviation Administration Advisory Circular, 2014).
Studies have shown that some theories have played a part in how
technology has and is still affecting the human way of life. One such theory is the
adaptive structuration theory. Adaptive Structuration Theory mainly focuses on the
interrelated dynamics implanted in the application and/or the creation of technology
that organizations use through a combination process of human interaction,
technology and organizational social structures. DeSanctis and Poole (1994)
originally advanced Adaptive Structuration Theory (AST) from Anthony Giddens’
structuration theory (1979; 1984) which consists of an incorporative change
process – basically meant as a practicable approach for detecting the role in
organization change that advanced information technologies possesses. Further
research illuminated that it was necessary as it led to the discovery that AST, over
time, opened up doors such as variations in the regulations, processes and
procedures that ultimately were used in group decision support systems. They
defined AST as a method for reviewing the part that advanced information
technologies plays in the organization change (DeSanctis & Poole, 1994).
However, the research mainly fixated on a meeting, which consisted of group
decision support systems used to signify the importance that interaction has at an
individual level of the organization. (DeSanctis & Poole, 1994; Griffith, 1999;
Lucas & Baroudi, 1994).

In a study done by Dündar and Akçayır (2013), they discuss how
technology devices such as the tablet PC have been spread globally for the use of
educational purposes and in doing so, has the potential to alter the educational
process from the unique characteristics that technology provides for the educational benefits to teachers and students (Dündar & Akçayir, 2012). Therefore, they conducted a study to investigate students’ attitudes and expectations of tablet PCs in the first year after an initial test run of tablet use in four pilot high schools. There are factors that were considered during the study, such as, previous use of tablet PCs by students in the past and the students’ experience with the internet in the past too. 206 student participants in the study proved to have a positive attitude towards the technology that, prior to the study, had been in use for 6 to 7 months. Additionally, they liked studying using the technological tool and this made them happy as, in the end, the students found this tool very useful and fun. The students recommended that tablet PCs should be used in schools to end the necessity of carrying books as the books can be accessed from the tablet PCs (Dündar & Akçayir, 2013). However, in an article by Rawat, Riddick and Moor (2008), incorporating mobile tablet PCs in addition with classroom management type of software in undergraduate electronic engineering technology courses proved to not adhere to the adaptive structuration theory. A survey was conducted at the final weeks of a semester to conclude the impact tablet PCs and supporting tools had in the classroom. As a result, 85% found the technological tool essential when it comes to note-taking, 78% found it great for learning, 89% deemed it useful for circuit analysis activities, while 78% discovered its importance when it came to lab experiments and all of them found it useful for keeping class work organized (Rawat, Riddick & Moor, 2008). Although the learning experience was enhanced,
the adaptive structuration theory is significant as the software improved the course delivery and it was beneficial in monitoring the group activities in class, which also included interaction between students. Therefore, it structured the class to provide a suitable systematic process for students’ learning.

It is evident in today’s world that there is an increasing development of technology and this has led to the increase in mobile device popularity like smartphones, tablets and e-readers in educative institutions. According to Chou, Block and Jesness (2012), a state-issued report cards and data survey and led to a little bit over 88% of schools in the public districts in USA to possess written guidelines on suitable use of cell phones by students. Students in more than 2000 school districts located in the United States have implemented various electronic devices in the classroom and the numerical value keeps rising (Chou, Block & Jesness, 2012). As mentioned in the previous studies, human reliance on technology is increasing, this is evident in the medicine industry, as technology has led to the advancement of medicine and other aspects.

Turkestani (2015) conducted a field study to discover a way in which technology impacts various progressive phases of both normal and special needs children at the preschool level of education. The study mainly focused at discovering the iPad effect on or during school readiness amid schoolchildren with hearing impairments. A standardized survey test was conducted for children participants who were aged between 3 to 6 years and was individually administered
in a period of 20 minutes. This was used to discover a child’s developmental state in various vital sectors like locomotive, affective, cognitive, linguistic, and social skills; with the motive to find the level of readiness. The results showed that there was an upgraded sense of school readiness possessed by the children who were in the experimental group that had access to iPads. There were other bonus dissimilarities between the experimental group and control group, such that, the former outperformed the latter in linguistic, cognitive and social or affective sectors plus in the overall score. However, there was an improvement in performance from both groups in terms of the motor domain, but no statistically significant difference, hence, improvement was equal in both groups (Turkestani, 2015).

Computer Tablet Capabilities and Benefits

Brown (2010) discusses on the advantage that an iPad would possess when combined with the ForeFlight software application and how that would change GA operational activities when focusing on the features that ForeFlight provides and the in-flight weather as well as the paper replacement feature it additionally provides to Part 91 operators. Since then, an online aviation merchandise retailer by the name of Sporty’s Pilot Shop (2013), has introduced two types of generations of a product called Stratus™, which is mainly designed to collaborate with the ForeFlight software. The Second Generation Stratus™, conglomerates a Wide Area Augmentation System (WAAS) which has a capability with the GPS location system, traffic advisory, terrain warning, back-up attitude, Flight Information System Broadcast (FIS-B) receiver, with additional Wi-Fi capability; to convey
wireless location and weather information data towards ForeFlight in the aircraft’s system (Sporty’s, 2013). WingX version Pro7 combined using iLevil AW, deliver a similar and yet, added synthetic vision and pitot-static feedbacks aimed at roughly an additional $500 - hardware only (Levil Technology Corp., 2012). However, purchase and installation of the Garmin G500 would lead to $21,000 in expenditure and also, to possess the additional synthetic vision feature on the Garmin G500, would cost around $5000 (Sarasota Avionics International, 2013). Per the cost difference, being managed by the guidelines (McClellan, 2012), an individual is able to notice the reason as to why tablet-based technology as an Electronic Flight Bag (EFB) would appeal to GA pilots. The list of the abilities above does very little to illuminate the profits provided by these products.

WAAS and its GPS capability transmits a ground-based rectification signal to site data established from satellites in order to pin-point a very exact location to the component. From the aviation point of view, it leads to reason that a certified Wide Area Augmentation System is precise enough to direct an aircraft with a similar accuracy that a Category 1 Instrument Landing System (ILS) approach, to a minimum 200 feet level ceiling and one-half mile length of visibility. This additionally illuminates that the precise aircraft spot can be presented on the chart (ForeFlight, 2012). This accuracy level may also offer terrain warning once the terrain data is accessible, through a feature of highlighting in a variety of colors which represent the terrain on the two-dimensional charts to avoid controlled flight into terrain (CFIT) (ForeFlight, 2012).
iPad users can quickly access current information that involves the airport or any facility located in or around it while on any airfield along the route through the ForeFlight airport directory, which will of course include information such as runway information, frequencies, and figures (ForeFlight, 2012). On behalf of information in regards to Notices To Airmen (NOTAMs) and Temporary Flight Restriction (TFR), which are typically equipped among publication updates or in lieu of momentary circumstances, the Federal Aviation Administration Flight Information Services – Broadcast (FIS-B) (FAA, 2005) can be retrieved by Stratus™ (Sporty’s, 2013) or iLevil (Levil Technology Corp., 2012) toward safeguarding that pilots possess data to act in accordance per the utmost informed rules and techniques. Moreover, FIS-B offers weather information through the method of recent forecasts, surroundings and weather radar images (FAA, 2005).

Moving forward, both the stated Stratus™ as well as iLevil deliver an additional feature of Attitude and Heading Reference System (AHRS). Stratus™, combined with Stratus Horizon, has an ability of displaying a basic attitude gyroscope with heading (Sporty’s, 2013). Taking this notion further, a combination of WAAS and terrain data plus the AHRS info above, WingX Pro displays for the pilot a synthetic vision illustration of the physical appearance that the airplane visualizes right in front of it (Levil Technology Corp., 2012). Arthur et al. (2006) exposed a significant situational awareness surge which led to lesser CFIT narrow escapes in a study by means of the National Aeronautics and Space Administration’s Mission Rehearsal Tool (Arthur et al., 2006). Additionally, iLevil
can deliver the indicated airspeed and altitude data in the display by connecting the tool to the aircraft’s pitot-static system (Levil Technology Corp., 2012).

General aviation science will state that weight savings in the aircraft will lead to less consumption of fuel, therefore, it is cost effective, which is a benefit as mentioned by American Airlines as the corporation moves from paper publications during flight to the virtual iPad format (O’Grady, 2011). However, thirty-five pounds makes quite a variance respectively to common general aviation airliner than to a commercial airplane. A gallon of aviation gasoline in volume would weigh roughly six pounds (WhatToFly.com, 2013). For instance, an aircraft such as the Piper Cherokee 140 burns 5.9 gallons of fuel per hour (gph) at 55% power rating and 8.1 gph at 75% power rating (Plane and Pilot, 2006). Swapping paper comprising of a weight of 35 pounds for the same weight in fuel by switching to a tablet computer, would possibly lead to an increase of around 40 to 60 minutes of aircraft flight time. Otherwise, 35 more pounds of cargo might be another solution of what the aircraft could carry.

Of course, there are other benefits to reducing paper loads in aviation. At most times, publication updates can be automatically controlled via data push capability as programmed by the publishers of the app. For example, Jeppesen’s Mobile Flight Deck enables subscription authorization to both route and terminal charts (Jeppeson, n.d.). These publications and data concerning flight plans exist to be put away in a solid-state drive (SSD) located and contained by the tablet (Genesys, 2012). While at most times and/or always is numerous risks to data, one
thing is for sure, no power input is necessary to sustain any information inside the memory (Genesys, 2012). Mainly if presence of fire is avoided, data contained in an SSD might be crucial to avail information to GA aircraft investigators in the case of a crash or of the sorts. In addition, software developers could present a recoding feature for any necessary usage during flight operations. While it may not be exactly similar to the normal flight data recorders used in aircrafts, such a functionality has the possibility to deliver ample use to an investigator, rather than hardcopy paper publications, when necessary.

   Technology has been known to improve activities carried out by humans, and as such, tablet computers have the capability of refining pilot and aircraft records and with it, the compliance as well. For example, AvConnect from LisiSoft (2013) offers a pilot logbook functionality and aircraft maintenance tracking system, comprising of schedules and programmed downloading of service bulletins. A computer tablet can offer accessibility to materials used in training at more ease than a laptop or desktop computers will have, simply due to its portability criteria, if there is no need for special software or added hardware (LisiSoft, 2013).

**Framework of Guidance**

   One major important fact worth discussing about in regards to this study, is the absence of Electronic Flight Bag regulation under the Code of Federal Regulations 14 Part 91, General Operating and Flight Rules, without three exemptions from the prohibitions as mentioned above. The first is obviously the
situation that any EFB device does not substitute any vital system or main equipment. Secondly, large transport category aircraft operations under Part 91 Subpart F. The third and last, is the Fractional Ownership Operations administered by Part 91 Subpart K (FAA, 2014). In context to this discussion, General Aviation flight operations go according to Part 91, as such, the usage of PEDs as EFBs are in general, not regulated. Attaining the understanding of definitions and what effects the EFB sector is, nonetheless, of importance to comprehend in regards of this study. Advisory Circular 120-76C delivers a large chunk of guidelines in the usage of EFBs, which will include the EFB definition. AC 120-76C also illustrates three types of EFB hardware classes as well as three types of EFB software. From the list, the study will focus on EFB devices which will fall under Class 1 and Class 2 hardware devices - which are considered to be portable. Class 3 EFBs will not be relevant as they are readily installed and hence, are beyond the scope of this work. In terms of software, Type A and Type B are envisioned to swap paper flight documents, and meanwhile, Type C software undertakes airborne functions like communication and navigation. Software and other bonus add-ons can enable user computer tablets proficient in Type A, Type B, and some Type C functionality, then again, numerous tablets do not meet the essential requirements meant for certification, together with configuration control and rapid decompression testing (FAA, 2014).

On a particular note, Advisory Circular 120-76C (FAA, 2014) states a prohibition on own-ship position display during flight on Class 1 and Class 2 EFBs.
Regarding those pilot users who would require sanction to use EFBs; for example, Part 121, Part 91K, and Part 135; FAA Order 8900.1 (2012) carefully describes the procedure. On the other hand, to the processes that are essential to attain authorization for EFB practice, qualifications for each EFB hardware and software are located within Order 8900.1 as well (2012).

EFBs operational software projected for use through the vital phases of flight (Type B) in pressurized aircraft need rapid decompression testing in accordance with RTCA/DO-160, Environmental Conditions and Test Procedures for Airborne Equipment (FAA, 2012). It is doubtful that a user product manufacturer will at most times devote the essential finance to come across this standard. Jeppesen has met this goal with his software, in regards to the fourth generation Apple iPad and iPad Mini (Wilson, 2012). Obviously, to back the consent of Apple iPads using Jeppesen software, the company steered a rapid decompression testing to an altitude of 51,000 feet (Wilson, 2012). However, Wilson (2012) did not reference added tablet computers, suggesting that the iPad and iPad Mini devices are exceptional in their capability to ace this test. However, testing is not necessary for EFB practice in an unpressurized aircraft (FAA, 2012).

Commonly, a large sum of tablet computer devices are of a transmitting type as they as are expected to be of both transmitting and receiving radio signals (FAA, 2014). An aftermath, AC 120-76C entails tablet computer-based EFBs on Type B applications to reach the RTCA/DO-160 standards and guidelines as Order
8900.1 offers exhaustive testing procedures. A frequency evaluation test needs to be directed in clear accord with RTCA DO-294 which discusses the regulation on Portable Electronic Devices transmission allowance during aircraft operations. Following this, an electromagnetic interference test will be conducted by using isolated aircraft equipment as well as finally using the tablet-based EFB inside the aircraft (FAA, 2012; FAA, 2014).

Imperatively, to reach and stay in compliance with the criterions set forth in FAA Order 8900.1 (2012), the Class I and Class II EFBs, which are the emphasis of this study, should be configuration controlled. Main mechanisms need to be analyzed and additional alterations will lead to re-evaluation for non-interference confirmation, functionality, and reliability is at satisfactory ranges (FAA, 2012). Additionally, configuration control is likewise compulsory for EFB software (FAA, 2012). Standard structural hardware or software should essentially be recognized, along with procedures to retain control and update databases (FAA, 2012). The nature of user tablet computers plus its operations by numerous users takes the necessary control measure to impractical levels. Alteration of apps by the typical user, which includes the addition or removal of the apps, to contain general aviation pilots, fluctuates the software configuration.

To this point, regulations taken into account in governing the airworthiness and certification of EFBs, are only from one FAA Order, one Advisory Circular, and one TSO. Each of the reference standards as well as the requirements from added documents, including Code of Federal Regulations (CFR), other TSOs, other
ACs, and Directive Orders. AC 91-78 (FAA, 2007) controls the definite use of the Class 1 and Class 2 devices and certifies the practice of these devices in all phases of flight that provide:

- No replacement of necessary equipment or systems
- Display is restricted to only pre-composed or interactive information which is functionally similar to the paper in substitution
- Updated information
- No interference with vital equipment or systems.

Keep in mind, the tablet-based Electronic Flight Bag capabilities mentioned before surpass the information display confines listed above. Certifying avionics capable of those necessary additional functions is difficult, Amazon.com (2013) carries a book of 244 pages to direct potential designers and/or manufacturers via the procedure of reaching DO-178 airborne systems and equipment authorization software considerations and DO-254 standards in design assurance guidance allowance for airborne electronic hardware. In addition to supplementary standards, which include TSO-C165 Electronic Map Display Equipment for Graphical Depiction of Aircraft Position, TSO-C2D Airspeed Instruments, and TSO-C47A Fuel, Oil, and Hydraulic Pressure Instruments. These high priced driven protocols are the type McClellan (2012) refers to when lamenting the high cost of certified avionics (Amazon, 2013; McClellan, 2012).
Summary

From the information given above, the Federal Aviation Authority has set forth a number of regulations that allow tablets with certain types of requirements in relation to their specifications: software and hardware. However, further research on the use of these devices during flight operations have not determined whether the performance levels of the pilot will indeed increase or decrease for the matter.

In summary, from the above discussion of the theoretical point of view on the use of computer tablets in performance-related areas, it paves the way into how the research study is to be conducted as shown in the following chapter, which will illustrate the methodology that was used in the study.
Chapter 3

Introduction

The purpose of this chapter is the discussion of the procedure and organization of the study to determine the impact of personal electronic devices on flight students’ flight training performance. Additionally, it will determine the effect of demographic details such as: computer tablet usage experience, flight hours gathered and language proficiency on flight training performance in the group that use personal electronic devices as compared to those to who do not use the devices. This section will also contain a descriptive step by step process of the measures taken to construct the study such as the research design and the methods. Additionally, the target population and the sample will be described in terms of sample size, sampling technique, as well as the participants’ criteria and the required instrument to collect the data.

Methodology

To study the impact that personal electronic devices on board an aircraft have on a flight student’s training performance, a quantitative research methodology was used in this study. This methodology was appropriate to conduct the research because the data collected in this study relied on numerical data. As the experiment is a scientific investigation, the researcher conducted a survey which quantitatively assessed flight students’ performance. This enabled collection of data which was used to evaluate each of my hypotheses. A survey study was
selected as it is easy to collect data and helped the researcher to achieve accurate data.

**Research Setting and Sampling**

**Population**

The target population of my study was all flight students in the state of Florida, USA. The accessible population for my study was all flight students enrolled at Florida Institute of Technology. The issues being researched are universal to every nation’s aviation industry, and therefore this study had the aim to better understand flight students’ performance training. Aviation is a worldwide industry, and any further understanding of the relationship between pilots and technology will be helpful.

**Sample**

The study used a convenience sampling method to find the suitable sample for the study as both the researcher and the flight students were registered members of Florida Institute of Technology. Therefore, the sample was easy to reach.

I used G*power software to find an appropriate sample size. G*power is a free-to-use computational software that can be used to calculate statistical power in a wide variety of tests such as: t tests, F tests, z tests, chi-square tests and some exact tests (Universität Düsseldorf, c2016). In terms of the logistic regression and correlation tests, a bivariate normal model statistical test was used and involved a one tail with a medium effect size of 0.3, α of 0.05 and power of 0.95. This led to a
total sample size of 111. In relation to the t-test, a medium effect size of 0.5 was used, \( \alpha \) of 0.05 and power of 0.95. This led to each sample size group to be 88 and hence, a total sample size of 176. Therefore, the group of tablet users were made up of 88 participants and the group of participants that did not use tablets were made up of 88 participants as well. From the calculations made above, as the software brought up a higher sample group in the t-test calculation, each group in the study to be conducted consisted of 90 participants, for a total \( N = 180 \).

However, this study also used the snowball sampling method to find an additional suitable sample.

**Instrument**

The instrumentation used in this study primarily consisted of a survey questionnaire in order to collect data. The survey was created using SurveyMonkey®, a widely known and recognized online survey collection and administration tool. The survey was in the form of a semantic scale type. This ensured efficient data gathering from the participants as they were all subject to the same scenario and through the same medium. All prospective participants received an invitational email or text which explained the nature of the study and a general link (which had no user tracking information) to the online survey.

There were two sections of the questionnaire: a section for computer tablet usage situations in training and another section for non-usage of computer tablet
situations in training. The first scenario is the computer tablet usage condition, where the participants are presented with the following information:

“Imagine that you are flying on a cross-country flight with your CFI, from one major city to another. During a number of times during the flight, the instructor asks for the parameters as shown on your computer tablet.”

The participants, following this, were asked three questions to rate their feelings towards the situation based scenario. The questions were on a five-point Likert type scale stating extremely negative (-2) to extremely positive (+2); extremely unfavorable (-2) to extremely favorable (+2); and extremely uncomfortable (-2) to extremely comfortable (+2). Each scale has a neutral position scored by zero (0). Using a five-point Likert-type scale within the survey tool, the study was able to measure the variables and gather data in a numerical value. By doing so, the study allowed for more precise data analysis. Murray (2013) describes in one of his studies that the Likert scale is deemed most appropriate by a researcher of several fields when attempting to measure characteristics of either individuals or groups. A traditional Likert scale is a five-point scale that ranges from strongly agree to strongly disagree using corresponding numerical values that usually range from -2 to 2 (Royeen, 1985). This study utilized a modified Likert type scale based on a study created by Rempel, Holmes, and Zanna, (1985). The study would make use of Cronbach’s alpha test as a measure of internal consistency. Cronbach’s alpha is defined as coefficient of internal consistency.
(Schweizer, 2011). The three questions of ratings of tablet usage would be put through a Cronbach’s alpha test. This was done to be able to generate a single value attributing to the person’s overall feelings towards the situation. Once the participant had answered the above mentioned questions, the survey would ask them to rate their feelings of the use of tablets in the cockpit to alter human performance. The survey had once again employ a five-point Likert type scale that will ask the participant to rate their feelings of trust from extremely distrust (-2) to extremely trust (+2) with a neutral position of zero. They were asked to answer questions for the following items: amount of time on previous computer tablet usage, number of flight hours achieved and English language usage. Once this was completed, the participants were asked to provide demographic information. All of the collected information remained private. Once all items were completed, the participants were dismissed.

In the second situation, a similar procedure was applied as the previous one. In this situation, which consists of the non-computer usage condition, the participants were presented with the following situation:

“Imagine that you are flying on a cross-country flight with your CFI, from one major city to another. During a number of times during the flight, the instructor asks for the parameters as experienced by the plane’s current status and by your observance.”
The participants were asked the same questions as the first condition to gauge their overall attitude towards the situation. In a similar manner, the participants were asked to provide their ratings towards the use of tablets in the cockpit to alter human performance. They were as well be asked to provide demographic information and then be dismissed.

By conducting this research in the stated manner, it allowed us to employ a between participants analysis. The second condition acted as a baseline control, and was a benchmark to analyze the differences observed when flight trainees are presented with the use of a computer tablet.

**Variables**

**Independent Variable**

The independent variables for this study consisted of: groups that use computer tablets for flight training as well as those who do not; the amount of computer tablet usage; number of flight hours; and English language usage. The first independent variable were the groups of people, which were in two sub-groups - those who use and those who do not use computer tablets during flight training. The second independent variable were the amount of computer tablet usage which entails the flight student’s prior experience with computer tablets. The third independent variable is the amount of flight hours – this consisted of the total numerical value of hours that the flight student had obtained in flying an aircraft prior to participating in the study. The fourth and last independent variable is
English language usage – this entailed how proficient the pilot’s use of the English language is prior to participating in the study.

**Dependent Variable**

The dependent variable for this research study consisted of the scores received from the survey questions that asked participants to rate their flight performance. Performance is measured as the participants’ scores on the Likert-type scale of the survey (see Appendix A). The performance questions were measured for internal consistency. This was measured from the average of the scores from the performance questions. Internal consistency is said to exist if the Cronbach Alpha’s metric is greater than 0.7. The scale used to measure the DV were ordinal, but the data achieved was treated as an interval scale of measurement. This assumption can be made as values of equal magnitude difference are assigned to each response of the Likert type scale (Göb, McCollin, & Ramalhoto, 2007).

**Data Analysis**

This research sought to perform a t-test, logistic regression and Pearson correlation as the statistical tools of analysis. The alpha-level of significance is set to \( \alpha .05 \). All the results were displayed and based on the findings of the statistical analyses. Once these results had been obtained, interpretations and inferences were made on the findings, so as to determine their relevance to the research question. Additionally, the results of the statistical analyses allowed the researchers to test
the hypotheses and determined whether the predictions were found to be present or not.

The purpose of the data analysis was to determine whether the independent variables stated could be shown to have differences between the group that use computer tablets for flight training and for those who do not. Additionally, a logistic regression would also be used to compare English language usage (English as first language vs English not as first language) as well as tablet experience (prior tablet experience vs non-prior tablet experience) to flight performance among students in the group who use computer tablets for flight training. However, a Pearson correlation was used to determine the impact of the amounts of flight hours achieved and flight performance.

In summary, an independent t-test was conducted on my first research question as they involved participants that are unique to each group being tested while a logistic regression test was conducted for research question 2 and 4 (tablet experience as well as English proficiency) then finally, a correlation test was conducted for research question 3 (flight hours). The data collected for the research was analyzed using SPSS® software.

Participants’ Eligibility Requirement

The study being conducted provided no harm to the participants in any physical, mental or psychological way. Despite this, it required all participants to be at least 18 years of age.
Participants’ Protection

The research study utilized an online tool for surveying, SurveyMonkey®, which did not require any confidential information from the participant. It therefore kept the participant completely anonymous. Participant responses were completely anonymous and confidential, thereby ensuring the protection of the participant. Participant protection is extremely important to the researchers. Every effort and measure was taken to ensure this is performed to this highest degree possible.

Legal and Ethical Consideration

There were no known or expected risks to the human subjects participating in this study. Participants’ responses through the SurveyMonkey® tool did not expose them to any legal, physical, psychological, or social risks. The study did not include any minors, as the participants were required to be 18 years or older.

Conclusion

The general purpose of this chapter is to give an understanding into the methodology of the research. It additionally gives an insight and a broad awareness of the research design and approach, the defining population and samples, as well as the instrument utilized in the study. This chapter sets up the research study with the data analysis tools. Its supplemental purpose is to prepare for chapter 4 which will foremost deal with the results provided from the statistical analyses performed on the collected data.
Chapter 4

Introduction

In this chapter, the researcher analyzed the data that had been collected from conducting the current study. This section displays the results of the data analysis in both textual and graphical formats. Additionally, both descriptive and inferential statistics will be presented from the statistical analysis software tool known as Statistical Package for the Social Sciences (SPSS®) by IBM.

General Design

In this study, to discover the impact that personal electronic devices have on board an aircraft on a flight student’s training performance, a quantitative research methodology was utilized. The independent variables were the groups that use computer tablets for flight training as well as those who do not; the amount of computer tablet usage; number of flight hours; and English language usage. The dependent variable for this research study consisted of the scores received from the survey questions that asked participants to rate their flight performance. The two groups, amount of computer tablet usage, and English language proficiency were nominal variables; number of flight hours was a ratio scale variable.

As stated in chapter 3, an independent t-test, a logistic regression test and a Pearson correlation test were performed in order to determine whether the independent variables stated can be shown to have differences between the group that use computer tablets for flight training and for those who do not. Additionally,
a logistic regression analysis was used to compare English language usage (English as a first language versus English not as a first language) and tablet experience (prior tablet experience versus non-prior tablet experience) to flight performance among students in the group who use computer tablets for flight training. The correlation analysis was used to determine the relationship between the amount of prior flight hours achieved and flight performance.

**Research Tool**

The research tool used to collect data is a survey questionnaire. As stated earlier, the survey was created by use of SurveyMonkey® and participants were registered Florida Institute of Technology flight students. The questionnaire was divided into three sections: the first section was designed only for computer tablet users and consisted of a scenario and follow up questions for the scenario; the second section was administered only to the group of flight students who do not use computer tablets and consisted of a similar scenario and follow up questions for the scenario; lastly, the final section consisted of questions basically to collect the demographic details. The questions asked were on a five point Likert-type scale.

**Data Analysis**

**Descriptive Statistics**

The target population of this study was all flight students in the state of Florida in the USA. The accessible population was Florida Institute of Technology students who exercise their flight training at Florida Institute of Technology
Aviation. The researcher of this study solicited 28 participants for the study. There were (N=19) tablet users and (N=9) non-tablet users in this study. These participants were approximately 67.9% tablet users and 32.1% non-tablet users. Participants ranged in various levels of education completed prior to the study: three completed a high school diploma, fourteen completed an undergraduate degree and eleven completed a graduate degree.

Participants’ ages resulted with a mean of 24.7 years of age (SD=.943). The average age of tablet users was 23.7 (SD=.970). The average age of non-tablet users was 25.8 (SD=.928). Table 1 shows the participants’ ages and flight hours by group (tablet user vs non-tablet user).

Table 1

<table>
<thead>
<tr>
<th>Performance Factors Descriptive Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
</tr>
<tr>
<td>Tablet User</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Tablet Non-User</td>
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<td></td>
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<td></td>
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<tr>
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<tr>
<td>Total</td>
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</tbody>
</table>
Participants’ number of flight hours achieved resulted with a mean of 114.8 hours of flight experience (SD=107.727). The average flight hours of tablet users was 139.53 hours (SD=110.995). The average flight hours of non-tablet users was 90 hours (SD=97.852).

Table 2
*Proficiency in English Descriptive Analysis*

<table>
<thead>
<tr>
<th>Proficiency in English</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24</td>
<td>85.7</td>
<td>85.7</td>
<td>85.7</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>14.3</td>
<td>14.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

In terms of participants’ score of proficiency in English, participants were asked to choose between two answers: ‘Yes’ and ‘No’. These two choices were available to the participants to answer the following question, ‘Are you proficient in English?’ Participants’ score of proficiency in English achieved resulted in four participants mentioning that English is not their first language (14.3% of the total). This depicted two English Second Language users from both groups of tablet users and non-tablet users, respectively. As such, this led to 24 users mentioning that they were proficient in English (85.7% of the total) – seven participants from the non-tablet users group and 17 participants from the tablet users group.
Table 3
*Tablet Experience Descriptive Analysis*

<table>
<thead>
<tr>
<th>Tablet Experience</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid Yes</td>
<td>23</td>
<td>82.1</td>
<td>82.1</td>
<td>82.1</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>17.9</td>
<td>17.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>100.0</td>
<td>100.0</td>
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</tr>
</tbody>
</table>

Again, in terms of participants’ tablet experience, participants were told to choose between two answers: ‘Yes’ and ‘No’. Participants’ score of tablet experience prior to volunteering to the study resulted in five participants from the tablet users group mentioning that they did not have any experience prior to the study (26.3% of the tablet users group). While all members of the tablet non-users had prior experience with tablets.

**Independent T-Test**

The researcher of this study conducted an independent T-test in order to test the first research question of the study: What is the impact of computer tablets on flight students’ flight training performance? As such, the following hypotheses were in question:

**Hₐ:** The use of computer tablets will lead to a higher flight performance (as rated by the student) compared to the group that does not use computer tablets.

**H₀:** The use of computer tablets will not lead to a higher flight performance (as rated by the student) compared to the group that does not use computer tablets.
The study was conducted by laying out a scenario then a series of five questions to both tablet users and tablet non-users. The scenario and questions were similar in both groups in order to ensure similarity in situations. The scores were collected and with the use of SPSS, an independent samples t-test was calculated and shown in Tables 4 and 5.

Table 4
*Independent Samples T-Test Descriptive Statistics*

<table>
<thead>
<tr>
<th>Performance</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 Tablet User</td>
<td>19</td>
<td>2.11</td>
<td>.658</td>
</tr>
<tr>
<td>Tablet Non-User</td>
<td>9</td>
<td>1.67</td>
<td>.500</td>
</tr>
<tr>
<td>Q2 Tablet User</td>
<td>19</td>
<td>2.26</td>
<td>.806</td>
</tr>
<tr>
<td>Tablet Non-User</td>
<td>9</td>
<td>2.00</td>
<td>1.323</td>
</tr>
<tr>
<td>Q3 Tablet User</td>
<td>19</td>
<td>1.84</td>
<td>.688</td>
</tr>
<tr>
<td>Tablet Non-User</td>
<td>9</td>
<td>1.44</td>
<td>.527</td>
</tr>
<tr>
<td>Q4 Tablet User</td>
<td>19</td>
<td>2.05</td>
<td>.848</td>
</tr>
<tr>
<td>Tablet Non-User</td>
<td>9</td>
<td>1.78</td>
<td>.667</td>
</tr>
<tr>
<td>Q5 Tablet User</td>
<td>19</td>
<td>2.11</td>
<td>.567</td>
</tr>
<tr>
<td>Tablet Non-User</td>
<td>9</td>
<td>2.11</td>
<td>1.269</td>
</tr>
</tbody>
</table>

In this analysis, the questions were listed with five choices formatted as a Likert scale. In order to statistically analyze the results, the choices were entered with a key as follows:

1 – Strongly agree
2 - Agree
3 - Neutral
4 - Disagree
5 – Strongly disagree
With the key, Table 4 was analyzed and the mean for each question as answered by participants represented the average score by each group used for this study. In this way, the average score also represented the performance as rated by the flight student. Additionally, the key also led to the results in Table 5.

Table 5
Independent Samples t-Test Analysis

<table>
<thead>
<tr>
<th>Independent Samples Test</th>
<th>Levene's Test for Equality of Variances</th>
<th>t-Test for Equality of Means</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig</td>
<td>df</td>
</tr>
<tr>
<td>Q1 Equal variance assumed</td>
<td>.029</td>
<td>.565</td>
<td>1.798</td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td>1.951</td>
<td>.065</td>
<td>20.402</td>
</tr>
<tr>
<td>Q2 Equal variance assumed</td>
<td>.869</td>
<td>.360</td>
<td>1.54</td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td>1.550</td>
<td>.199</td>
<td>10.909</td>
</tr>
<tr>
<td>Q3 Equal variance assumed</td>
<td>.072</td>
<td>.790</td>
<td>1.528</td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td>1.684</td>
<td>.098</td>
<td>20.267</td>
</tr>
<tr>
<td>Q4 Equal variance assumed</td>
<td>.162</td>
<td>.691</td>
<td>1.853</td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td>.931</td>
<td>19.797</td>
<td>1.953</td>
</tr>
<tr>
<td>Q5 Equal variance assumed</td>
<td>3.528</td>
<td>.032</td>
<td>1.917</td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td>9.547</td>
<td>.956</td>
<td>9.006</td>
</tr>
</tbody>
</table>
Assumption Testing

The assumptions for an independent t-test included the following:

- The data scores are independent of each other.
- The dependent variable is normally distributed within each of the two populations.
- The variances of the dependent variable in the two populations are equal (Huck, 2004).

According to Table 5, a two-tailed t-test was conducted on the data received from flight students’ participants who filled out a survey as either a tablet user or a tablet non-user. Each question score showed that they have equality of variances as listed in the first column, if Levene’s Test for Equality of Variances is not significant, then equal variances are assumed. Levene’s test is not significant only if (p > .05). As such, the scores resulted in numerical outputs of above .05 as seen in Table 5. Therefore, equal variances are assumed. Additionally, with both the lower and upper output values of the 95% confidence interval of the difference both crossing 0, assumption is made of no difference. Hence, with these values, the means are not statistically significantly different. In conclusion, the tablet user group was not significantly different in performance than the tablet non-user group.

To determine another assumption of the testing, the data were run for normality in two tests – the Kolmogorov-Smirnov test and the Shapiro-Wilk test. For data set smaller than 2000 elements, we use the Shapiro-Wilk test, otherwise, the researcher would have used the Kolmogorov-Smirnov test. In the case of the data collected in this study, the Shapiro-Wilk test was used.
The null hypothesis is that the data are normally distributed and the alternative hypothesis is that the data are not normally distributed. As seen in the Shapiro-Wilk section of Table 6, the p value of each question are as follows respectively: .000, .002, .000, .001 and .000. As each question possessed a p value less than .05, the null hypothesis is rejected and conclude that the data are not normally distributed.

With one assumption of the independent samples t-test not satisfied, a Mann-Whitney test was then conducted as an alternative.

**Mann-Whitney U Test Analysis**

The Mann-Whitney U test is a non-parametric test of the null hypothesis that is equally likely that a randomly selected value from one sample will be less than or greater than a randomly selected value from a second sample. In this study,
this test is used as it is as efficient as the t-test conducted on normal distributions
but unlike it, does not require the assumption of normal distributions.

Table 7
Mann-Whitney U Test Statistics

<table>
<thead>
<tr>
<th>Test Statistics</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann-Whitney U</td>
<td>55.50</td>
<td>62.50</td>
<td>59.00</td>
<td>71.00</td>
<td>73.00</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.091</td>
<td>.231</td>
<td>.149</td>
<td>.438</td>
<td>.482</td>
</tr>
<tr>
<td>Exact Sig. [2*(1-tailed Sig.)]</td>
<td>.142^b</td>
<td>.263^b</td>
<td>.205^b</td>
<td>.498^b</td>
<td>.562^b</td>
</tr>
</tbody>
</table>

a. Grouping Variable: Performance
b. Not corrected for ties.

Table 7 shows the actual significance value of the test conducted.
Specifically, the test statistic, U statistic and the asymptotic significance (2-tailed) p-value for each answered question collected from the participants. In this test analysis, the Mann-Whitney U are the test statistics which summarize the difference in mean rank numbers in a single number. The preferable reporting p-value for the data collected would be that of the Exact Sig. [2*(1-tailed Sig.)] which is the exact p-value, otherwise, if a larger sum of data were collected, an Asymptotic Sig. (2 tailed) would have been used as the critical value. The hypotheses in this testing would be as follows:

**H₀:** The mean ratings of both tablet users’ and non-tablet users’ performance scores are equal

**H₁:** The mean ratings of tablet users’ and non-tablet users’ performance scores are not equal
Going back to the Exact Sig. \([2^* (1\text{-tailed Sig.})]\) row of values, each question presented a value greater than .05, which concluded that \(p > .05\). Hence, the null hypothesis was accepted and thus, the mean ratings of tablet users’ and non-tablet users’ performance scores were equal.

**Correlation Analysis**

The researcher of this study continued to test out research questions 2, 3 and 4 as shown in chapter 1 by conducting a correlation test in order to determine which hypotheses are true or false.

The researcher conducted this correlation test in order to test the second research question of the study, which is: What is the effect of demographic details such as; computer tablet usage experience, flight hours gathered and language proficiency on flight training performance in the group that use computer tablets? As such, the following hypotheses were in question:

\[ H_a: \] The amount of computer tablet usage experience will be associated with higher flight performance (as rated by the student).

\[ H_0: \] The amount of computer tablet usage experience will not be associated with higher flight performance (as rated by the student).
**Hₐ:** Students with English as their first language will lead to a higher flight performance (as rated by the student) compared to students in which English is not their first language on the flight students that use computer tablets.

**H₀:** Students with English as their first language will not lead to a higher flight performance (as rated by the student) compared to students in which English is not their first language on the flight students that use computer tablets.

**Hₐ:** Number of flight hours completed will be associated with higher flight performance (as rated by the student) on those flight students using computer tablets.

**H₀:** Number of flight hours completed will not be associated with higher flight performance (as rated by the student) on those flight students using computer tablets.

**Logistic Regression**

In order to test out the hypotheses that determine the relationships between performance and tablet experience as well as performance and proficiency in English, all types of variables were taken into consideration. In this section, performance scores were rated in the form of a five type Likert scale, the performance variable in this situation was determined to be a continuous variable. However, both proficiency in English and tablet experience were determined to be discrete variables as the data collected from the participants were in Yes or No
A logistic regression predicts the probability that there is a relationship on one of two categories of a dichotomous dependent variable based on one or more independent variables that can be either continuous or categorical. In this case, both proficiency in English and tablet experience variables are dichotomous (discrete) while Performance is a continuous variable. This led to the use of a logistic regression test to be used (Menard, 2002).

Assumption Testing

The assumptions for a logistic regression test included the following:

- The dependent variable should be on a dichotomous scale measurement.
- One or more of the independent variables could be either a dichotomous or continuous variable.
- There should be an independence of observations and the dependent variable should have mutually exclusive and exhaustive categories (Menard, 2002).

To determine the first and second assumptions, as mentioned earlier, two variables (proficiency in English and tablet experience) are discrete, another reference for dichotomous, while performance is continuous. Therefore, the first two assumptions were met. An independence of observations were met as the
ratings of the performance scores by the flight student’s operations were unrelated to the flight students’ previous experience in using a tablet as well as the proficiency level of the English language they possess. Lastly, the categories that existed to define the variables as dichotomous were exclusive and exhaustive as the choices to be made by the participant were one or the other – there was no in-between.

**Performance vs Tablet Experience Logistic Regression Analysis**

Table 8

*Model Summary of Performance vs Tablet Experience*

<table>
<thead>
<tr>
<th>Step</th>
<th>-2 Log likelihood</th>
<th>Cox &amp; Snell R Square</th>
<th>Nagelkerke R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25.905a</td>
<td>.013</td>
<td>.022</td>
</tr>
</tbody>
</table>

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 8 contains the Cox & Snell R Square and Nagelkerke R Square values which were both methods used in calculating the described variation. At times, these values are known as pseudo $R^2$ values and will tend to have lower values than in a multiple regression scenario. Nonetheless, they are interpreted in the same way, however, with more caution in interpretation. As a result, the explained variation in the dependent variable (DV), in this circumstance, based on the model ranges from 13% to 22% depending on whether the Cox & Snell $R^2$ or Nagelkerke $R^2$ method columns are stated, respectively. Nagelkerke $R^2$ is an alteration of Cox
& Snell $R^2$, in which, Cox & Snell $R^2$ cannot attain a value of 1. Therefore, it was preferable to report the Nagelkerke $R^2$ value (Laerd Statistics, c2013).

Table 9

*Classification Table of Performance vs Tablet Experience*

<table>
<thead>
<tr>
<th>Observed Tablet Experience</th>
<th>Predicted Tablet Experience</th>
<th>Percentage Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 Table</td>
<td>Yes</td>
<td>14</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Overall Percentage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. The cut value is .500

The binomial logistic regression test being conducted assessed the probability of an event occurring – in this case, tablet experience. If the predicted probability of the event occurring is greater than or equal to 0.5, SPSS classifies the event as one that has occurred. This type of regression is common to foresee whether cases can be correctly predicted from the independent variables. Thus, it is necessary to have a means to assess the effectiveness of the predicted classification against the actual classification. Table 9 presents the observed and predicted classifications.

It is important to note that underneath Table 9, there is “The cut value is .500” which means that if the probability of a case being classified into the “Yes” category is greater than .500, then that particular case is classified into the “Yes” category. If not, it will be in the “No” category, as mentioned earlier.
Again, in Table 9, additional important information is provided - the percentage accuracy in classification (PAC), which represents the percentage of cases that can be correctly classified. In table 9 above, the model correctly predicts 73.7% of the cases (Laerd Statistics, c2013).

Table 10  
*Variables in the Equation of Performance vs Tablet Experience*

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1* Performance</td>
<td>.523</td>
<td>.867</td>
<td>.363</td>
<td>1</td>
<td>.547</td>
<td>1.687</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.526</td>
<td>1.777</td>
<td>2.021</td>
<td>1</td>
<td>.155</td>
<td>.080</td>
</tr>
</tbody>
</table>

a. Variable(s) entered on step 1: Performance.

According to Table 10, the Wald column represents the Wald test, which is used to determine the statistical significance for the independent variable. This statistical significance is located in the significance column with a “Sig.” label.

From the results in Table 10, performance has a p-value of .547 which did not add significantly to the expectation that tablet experience helped in improving performance. As such, Table 10 predicts the probability of an event occurring based on an independent variable one unit change when the dependent variables are at a constant. In this case, the likelihood of tablet experience being related to participants’ performance is 1.687 times greater for the group of tablet users. As the value is positive, that represents an increase in the probability of tablet experience being related towards performance, whereas if it was a negative value, it would resemble a decrease in the probability. Hence, with a p-value of .547 (p>.05), then
the null hypothesis is accepted and this led to a conclusion that there is no significant relationship between performance scores and tablet experience.

Performance vs English Proficiency Logistic Regression Analysis

Table 11
Model Summary of Performance vs English Proficiency

<table>
<thead>
<tr>
<th>Step</th>
<th>-2 Log likelihood</th>
<th>Cox &amp; Snell R Square</th>
<th>Nagelkerke R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22.807(^a)</td>
<td>.006</td>
<td>.010</td>
</tr>
</tbody>
</table>

\(^a\) Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Again, in Table 11, the Cox & Snell R Square and Nagelkerke R Square values are observed. As explained earlier, these values are interpreted with more caution. Therefore, the explained variation in the dependent variable, in this case, based on the model ranges from 6% to 10% depending on whether the Cox & Snell R\(^2\) or Nagelkerke R\(^2\) methods are stated, respectively. Nagelkerke R\(^2\) is a modification of Cox & Snell R\(^2\), the latter of which cannot reach a value of 1. As a result, it was preferable to report the Nagelkerke R\(^2\) value (Laerd Statistics, c2013).
Table 12
Classification Table of Performance vs English Proficiency

<table>
<thead>
<tr>
<th>Observed</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proficiency in English</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Step 1</td>
<td>Proficiency in English</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Overall Percentage</td>
<td></td>
</tr>
</tbody>
</table>

a. The cut value is .500

It is important to note again, that underneath Table 12, there is “The cut value is .500” which means that if the probability of a case being classified into the “Yes” category is greater than .500, then that particular case is classified into the “Yes” category. If not, it will be in the “No” category.

Similar to Table 9, in Table 12, additional important information is observed. The classification table is another method to define the predictive accuracy of the logistic regression model. In this case, the “overall percentage” observed as 89.5% in the table, is the cross-classification of dependent outcome and the predicted values. Hence, the model correctly predicts 89.5% of the cases (Laerd Statistics, c2013).

Table 13
Variables in the Equation of Performance vs English Proficiency

<table>
<thead>
<tr>
<th>Variables in the Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Step 1a</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

a. Variable(s) entered on step 1: Performance.
According to Table 13, the Wald column represents the Wald test, which is used to determine the statistical significance for the independent variable. This statistical significance is located in the “Sig.” column. From the results in Table 10, performance has a p-value of .691 which did not add significantly to the prediction that proficiency in English helped in improving performance as it is greater than .05. As such, Table 13 predicts the probability of an event occurring based on a one unit change in an independent variable when any other independent variables are at a constant. In this case, the odds of proficiency in English being related to participants’ performance is .688 times greater for the group of tablet users. As the value is positive, that represents an increase in the odds of proficiency in English towards performance, whereas if it was a negative value, it would resemble a decrease in the probability. Hence, with a p-value of .691 (p>.05), then the null hypothesis is accepted and this led to a conclusion that there is no significant relationship between performance scores and proficiency in English.

**Pearson Correlation**

At this point of the study, there was only one last set of hypotheses to test out, to determine the relationship between performance scores and flight hours. As previously stated, performance scores were rated in the form of a five type Likert scale, the performance variable in this situation was determined to be a continuous variable. In regard to flight hours, the data collected were in terms of number of hours achieved by the participant prior to participating in the study, therefore, this
data were also determined to be a continuous variable. In conclusion, the test required to determine the relationship between these two variables resulted in a Pearson correlation test.

A Pearson correlation test, as stated by Kent State University Libraries (c2018), “produces a sample correlation coefficient which measures the strength and direction of linear relationships between pairs of continuous variables” (Kent State University Libraries, c2018). In order to discover if this test is a right fit, an assumptions testing was first conducted.

Assumption Testing

The assumptions for a Pearson correlation test included the following:

- The two variables should be continuous.
- There is a linear relationship between your two variables.
- There should be no significant outliers.
- The variables should be approximately normally distributed (Huck, 2004).

To test out if the above assumptions are met, the below scatter plot graph was created on SPSS by correlating the performance scores to the flight hours data.
Figure 1. Performance against flight hours

In figure 1, the data were plotted out on a scatter plot graph with the performance scores on the Y axis and Flight Hours data on the X axis. In this case, performance scores in the Y axis were measured by the answer choices as rated by the participant in the survey and flight hours in the X axis were measured by the demographic detail section of the survey as answered by the participant. Figure 1 was used to test out the last set of hypotheses. To cancel out the first assumption, it was earlier stated that both variables were measured and discovered to be continuous.

With the help of the Chart Editor in the SPSS program, the researcher was able to fit a line in the graph to show what type of flow the data possessed. The line
symbolizes that there is a linear relationship between the two variables as the dots in the figure tend to follow the straight line, hence, the second assumption is met.

To test out whether the variables were approximately normally distributed, a normality test was conducted. The data were run for normality in two tests – the Kolmogorov-Smirnov test and the Shapiro-Wilk test. For data set smaller than 2000 elements, we use the Shapiro-Wilk test, otherwise, the researcher would have used the Kolmogorov-Smirnov test. In the case of the data collected in this study, the Shapiro-Wilk test was used.

Table 14
Test of Normality Data

<table>
<thead>
<tr>
<th>Tests of Normality</th>
<th>Kolmogorov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>df</td>
</tr>
<tr>
<td>Flight Hours</td>
<td>.286</td>
<td>19</td>
</tr>
<tr>
<td>Performance</td>
<td>.346</td>
<td>19</td>
</tr>
</tbody>
</table>

a. Lilliefors Significance Correction

The null hypothesis is that the data are normally distributed and the alternative hypothesis is that the data are not normally distributed. As seen in the Shapiro-Wilk section of Table 14 above, the p-values observed are all .000. As each variable possessed a p-value less than .05, the null hypothesis is rejected and conclude that the data are not normally distributed. With one assumption of the Pearson correlation test not satisfied, a Spearman correlation test was then conducted as an alternative.
Spearman Correlation

A Spearman correlation test was conducted as an alternative to the Pearson correlation test above as the assumption was not met. This Spearman correlation test was essential as not only is it used to measure the degree of relationship between two variables, but it also does not carry any assumptions about the distribution of data (Statistics Solutions, c2018). As there were no assumptions, the following table was resulted from running the Spearman test on SPSS.

Table 15
Spearman Correlation Test Statistics

<table>
<thead>
<tr>
<th></th>
<th>Flight Hours</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spearman's rho</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flight Hours</td>
<td>Correlation Coefficient</td>
<td>1.000</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.</td>
<td>.777</td>
</tr>
<tr>
<td>N</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Performance</td>
<td>Correlation Coefficient</td>
<td>.070</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.777</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>19</td>
<td>19</td>
</tr>
</tbody>
</table>

In Table 15 above, there is the “correlation coefficient”, which is the actual correlation value that denotes magnitude and direction. In this case, the correlation coefficient is represented as .70. There is also the “sig. (2-tailed)” row, which interprets the p-value of the test and is represented by .777. Lastly, there is the “N” row, which is the number of participants or observations that were correlated and is represented by the value 19.
In order to analyze the table, the correlation coefficient was first taken into consideration by the researcher. With a positive value of .70, it led to the conclusion that both performance scores and flight hours possessed a positive correlation. In regard to the test resulting in a p-value, a p-value of .777 signifies that it had a value higher than .05. Therefore, the researcher finally concluded that the null hypothesis was accepted and this was evidence that there was no statistically significant relationship between the two variables.

Summary

As stated previously, the purpose of this study was to determine the impact that computer tablets have on flight students. Moreover, the study took into account other factors that may have played a part in determining the impact of computer tablets on performance, such factors included the following: English proficiency, prior tablet experience and number of flight hours achieved to the date of participating for the study. An independent t-test was conducted. However, the test did not satisfy all the assumptions. Therefore, it led to a Mann-Whitney U Test to be conducted and the following null hypothesis was accepted: The mean ratings of both tablet users’ and non-tablet users’ performance scores are equal. This demonstrated that the tablet user group was not significantly different in performance than the tablet non-user group. Furthermore, the outcome of the correlation analyses on the three factors of computer tablet usage showed that there was no statistically significant difference in the group that uses computer tablets in terms of English proficiency, prior tablet experience nor flight hours. Thus, the
results failed to reject the null hypotheses. Chapter 5 will present a summary and discussion of these findings.
Chapter 5

Conclusion

The purpose of this study was to examine the impact of computer tablets on flight students’ flight training performance. Moreover, it also determined the effect of demographic details such as: computer tablet usage experience, flight hours completed and language proficiency on flight training performance for those students that use computer tablets.

To study the impact that personal electronic devices on board an aircraft have on a flight student’s training performance, a quantitative research methodology was used in this study. This methodology was appropriate to conduct the research because the data collected in this study relied on numerical data. As the experiment is a scientific investigation, the researcher conducted a survey which quantitatively assessed flight students’ performance. The independent variables for this study consisted of: groups that use computer tablets for flight training as well as those who do not; the amount of computer tablet usage; number of flight hours; and English language usage. The dependent variable for this research study consisted of the scores received from the survey questions that asked participants to rate their flight performance. An independent samples t-test and correlations test were initially set as the two main tools of analysis. However, after analyzing the results achieved from the t-test, the data were found not to be normally distributed and the t-test assumptions were not all met and hence, a
Mann-Whitney U test was conducted. In this study, the Mann-Whitney U test is used as it is as efficient as the t-test on normal distributions but unlike it, does not require the assumption of normal distributions. The study has answered the following research questions and hypotheses:

RQ1: What is the impact of computer tablets on flight students’ flight training performance?

H₀₁: The use of computer tablets will not lead to a higher flight performance (as rated by the student) compared to the group that does not use computer tablets.

Hₐ₁: The use of computer tablets will lead to a higher flight performance (as rated by the student) compared to the group that does not use computer tablets.

RQ2: What is the effect of computer tablet usage experience on flight training performance in the group that use computer tablets?

H₀₂: The amount of computer tablet usage experience will not be associated with higher flight performance (as rated by the student).

Hₐ₂: The amount of computer tablet usage experience will be associated with higher flight performance (as rated by the student).

RQ3: What is the effect of flight hours completed on flight training performance in the group that use computer tablets?
H₀₃: Number of flight hours completed will not be associated with higher flight performance (as rated by the student) on those flight students using computer tablets.

Hₐ₃: Number of flight hours completed will be associated with higher flight performance (as rated by the student) on those flight students using computer tablets.

RQ₄: What is the effect of language proficiency on flight training performance in the group that use computer tablets?

H₀₄: Students with English as their first language will not be associated to a higher flight performance (as rated by the student) compared to students in which English is not their first language on the flight students that use computer tablets.

Hₐ₄: Students with English as their first language will be associated to a higher flight performance (as rated by the student) compared to students in which English is not their first language on the flight students that use computer tablets.

Summary of Findings

The aim of this study was to find out the impact performance had during flight training in general aviation with the use of a computer tablet. In doing so, the researcher sought an eligible instrumentation tool. In this study, the instrumentation used primarily consisted of a survey questionnaire in order to collect data. The
survey was created using SurveyMonkey ® and distributed to flight students undergoing their training at Florida Institute of Technology Aviation.

After analyzing the data, the Mann-Whitney U test results were used to show whether there was a significant difference between the group that uses tablets and the group that does not. In regard to the three factors that hinder performance, a logistic regression test was used to determine whether there was a significant relationship related to performance and tablet experience as well as performance and English proficiency. Additionally, a Spearman’s correlation test was used to determine whether there was a statistically significant relationship between performance and flight hours.

Discussion

While the results have been reported, it is necessary to understand the interpretation of the findings previously illustrated. The study has answered four questions with their null and alternative hypotheses. The first question was, “What is the impact of computer tablets on flight students’ flight training performance?” The null hypothesis that is related to this question is that there is no significant difference in the use of computer tablets leading to a higher flight performance (as rated by the student) compared to the group that does not use computer tablets. The alternate hypothesis that is related to the first question is that there is a significant difference in the use of computer tablets leading to a higher flight performance (as rated by the student) compared to the group that does not use computer tablets. The
outcome from the Mann-Whitney U test showed that there is no significant difference in the two groups’ flight performance during training. Therefore, the outcome of this test explained that whether a flight student used a table device during flight training or not, the performance would be the same. Certain research additionally disagreed with this result as Haddock and Beckman (2015) conducted a study on the effect of electronic flight bags (EFBs) on pilot performance during an instrument approach and discussed that when using an EFB, the average time by participants during completion of a task increased by one minute and 29 seconds. They argue that the reasoning for this was that the participants had made wrong decisions when digitally choosing the approach chart as compared to paper based materials. This resulted in the use of EFB reducing the performance levels and hence, safety was decreased. Although the current study managed to attain 14 participants (all traditional college age), the two studies differ as Haddock and Beckman (2015) were mainly aiming on instrument rating specifically, which, in terms of flight training, is a complex section of learning (Haddock & Beckman, 2015).

The second research question that guided this study was, “What is the effect of computer tablet usage experience on flight training performance in the group that use computer tablets?” The null hypothesis that is related to the second question is that the amount of computer tablet usage experience will not be associated with a higher flight performance (as rated by the student). The alternate hypothesis that is related to the second question is that the amount of computer tablet usage
experience will be associated with a higher flight performance (as rated by the student). The outcome from the logistic regression test showed that there is no significant relationship between performance (as rated by the student) and the amount of tablet usage experience.

In previous literary works, studies have been done on the issues and concerns that pilots have faced when commercial airplanes switched from analogue to glass flight deck (GFD) displays. A GFD display is basically a screen that replaced the old fashioned dials and gauges in the cockpit to enable the pilot to fly the plane more efficiently. Hanh (2010) and Casner (2008, 2009) pointed out that there were numerous difficulties in pilots learning how to operate the complex GFD displays. Nonetheless, other numerous studies have indicated that pilots, who were interviewed, were happy and excited to have improvements in situational awareness, information and flight operational capabilities that were in reach with the help of the GFD system while in-flight – even given the previously stated usability issues (Casner, 2008, 2009; Hanh, 2010; Kearns, 2007; Mitchell et al., 2009, 2010). In a study conducted by Cino (2016) to determine the usability and learnability of GFD on pilots through scenario-based situations, he concluded that a majority of the participants acknowledged the learnability and user satisfaction issues, but mentioned that the scenario-based training helped better learn the GFD system (Cino, 2016). As explained, Cino (2016) does prove that with the scenario-based training, the participants attained more experience with GFD display usage and later felt more comfortable using the new technology in flight operations.
Hence, as the participants achieved more experience with the technology, it brought a positive outcome on their flight performance respectively. However, in comparison to the results received from testing the second research question, a tablet and GFD displays may be similar as both are basically all-screen technology displays that are used in airplane operations, but, GFD systems are mainly used in commercial aviation. Whereas, this present study focused more on the GA section of aviation. The former consisting of more complex airplanes than the latter. Additionally, the use of a flight simulator to provide scenario-based situations helped in providing more objective measured results. Therefore, these two factors had played a part in Cino (2016) concluding that experience with technological displays caused a positive impact on flight operations (Cino, 2016).

The third research question that steered this study was, “What is the effect of flight hours completed on flight training performance in the group that use computer tablets?” The null hypothesis that is related to the third question is that the number of flight hours will not be associated with a higher flight performance (as rated by the student) on the flight students that use computer tablets. The alternate hypothesis that is related to the third question is that the number of flight hours will be associated with a higher flight performance (as rated by the student) on the flight students that use computer tablets. The outcome from the Spearman correlations test once again showed that there is no significant relationship between performance (as rated by the student) and the number of flight hours on the flight students that use computer tablets.
In a study conducted by Adamson et al. (2010), the issue of brain size was in question on whether it impacted pilots’ performance in variation to aviation training and years of education. A total of 51 general aviation pilots were studied and classified into three levels of expertise: least expertise, moderate expertise and most expertise. Each participant had six practice flights by a flight simulator and the performance was objectively measured. The authors concluded that the results from the study strongly suggested that both expertise and/or education may influence performance of a domain-specific task by interaction with the brain. Therefore, the amount of training achieved by a participant highly enabled the participant to perform better. In comparison, to the third research question in this present study, the main factor that influenced this result was the age. Adamson et al. (2010) had participants that were 50 years and older whereas, this present study had flight students that averaged 24.7 years old. An assumption is the amount of time difference between the two sets of participants, in which, the former attained a vast range of information through training and education. Nonetheless, in due time, flight hours achieved might end up being a major factor in helping flight students become pilots who perform at a higher level (Adamson et al., 2010).

The fourth research question that guided this study was, “What is the effect of language proficiency on flight training performance in the group that use computer tablets?” The null hypothesis that is related to the fourth question is that the students with English as their first language will not be associated with a higher flight performance (as rated by the student) compared to students whose English is
not their first language on the flight students that use computer tablets. The alternate hypothesis that is related to the fourth question is that the students with English as their first language will be associated with a higher flight performance (as rated by the student) compared to students whose English is not their first language on the flight students that use computer tablets. The outcome from the logistics regression test showed that there is no significant relationship between students with English as their first language performance (as rated by the student) and students whose English is not their first language on the flight students that use computer tablets. While past research showed evidence that there were differences between paper and electronic media, in terms of reading speed, comprehension and accuracy (Bevan, 1981; and Gould & Grischkowsky, 1986), more current research showed that there were less consistent differences when it came to memory for text (Huang, 2006).

However, in a study by Margolin et al (2013), the authors mention that their study was consistent with the recent research conducted. The study consisted of an investigation to determine the connection between technology (an e-reader) and reading comprehension. An e-reader’s singular purpose is of reading, rather than searching the World Wide Web for information. As such, they compared this to paper based literature and concluded that there were no differences in both situations (Margolin et. al, 2013). In comparison to the flight students, both studies conducted agree that the proficiency in the language did not play a part. Therefore, the use of technology did not influence the students’ performances. However, it
should be noted that in the study by Margolin et al (2013), the students were not under as much pressure as the flight students since flight operations requires the participant to be fully committed and attentive into performing the tasks set forth.

**Practical Implications**

Based on the findings of this study, the application of computer tablets in developing flight students’ training does not seem to impact performance levels as compared to those flight students who do not use it. However, similar to what Majid (2014) mentioned in regard to American Airlines, there may be significant cost savings realized by an airline once the permanent removal of paper-based material is accomplished and computer tablets are installed instead. Nonetheless, the complexity of commercial airlines as compared to general aviation aircrafts needs to be taken into consideration. Although the result of the study led to a tablet not impacting the performance levels of students in GA aircraft, it may be of great use to commercial aircraft that have a higher level of technology to operate.

Additionally, for airlines to install such technology in their airplanes, they may have to be sure that these devices fall under the right specifications as stated by the Federal Aviation Administration (FAA) as they are the governing body of the skies in the USA.

In terms of software implications, being in possession of a tablet during flight training can be of great use. A majority of pilots in the general aviation sector are either renters or flying club members, which leads to the fact that they do not
control the avionics side of the airplanes they end up getting. Therefore, if there was a new update feature to be installed into GA airplanes, not all of them would have it. This might end up to be costly for the airplane owners. However, if all the pilots used a tablet for flight operations, the new update features can easily be offered to all users and sometimes for free (Zimmerman, 2016).

**Limitations**

One limitation for this study includes the limited number of participants. The study was aimed in soliciting participants from the Florida Institute of Technology who were currently registered in the flight training program. As the students registered were of a low number, the sufficient amount of participants were not found by the researcher to take part in the study. Additionally, the use of the snowball method to collect data did increase the number of participants, but not to the required number based on the power analysis. As stated previously, the power analysis generated a required 88 participants per group (176 in total) but the study was underpowered to be able to pick up any significant effects if they existed as it produced 19 participants for the group of tablet users and 9 participants for the group of non-tablet users (28 participants in total).

Another limitation is the method used to collect performance scores. In this study, participants were solicited to self-report their performance during flight training by filling up a five scale Likert set of questions. As they answered according to their opinion on how they did during the operations, this led to it being
a subjective measure as this may have brought forth a bias towards their responses on their performance assessment. Whereas, if a flight simulator or similar device was used instead to automatically record specific performance parameters of the flight student, a more objective measure would have been available. Hence, perhaps more accurate performance scores would have been recorded.

**Recommendation for Future Research**

This study provides issues to consider for government and private entities to ensure the safe and effective use of tablet computers. As such, a number of recommendations for certain organizations are provided.

First, the FAA need to develop regulations allowing the use of computer tablets in the cockpit and since they are the main governing body for the USA, they need to put into consideration the development of technology today and base their rules according to such. Secondly, the Department of Transportation needs to update any of their technological regulations in order to provide information on new capabilities with the development of technology.

To the National Transportation Safety Board (NTSB), they need to recommend to the FAA to set up regulations for the use of computer tablets for the purpose of providing flight recording capabilities to the pilot, such capabilities may include: GPS location, ground speed, weather, etc. To the software developers, applications used in computer tablet devices for flight training are required to be more reliable and efficient than the previous versions. To the tablet manufacturers
and creators, the tablets processed need to be more reliable as hardware and software both matter; the display screen needs to possess better glare reduction options; the outer material needs to withstand various types of shock and temperature and also, the screen brightness levels need to be more efficient in the case of daylight tablet usage. Lastly, for future researchers, it should be noted that this study was conducted with an underpowered population sample and that a large sample size should be in access prior to conducting any future research for more accurate results and conclusions.

**Summary**

The purpose of this study was used to determine the impact that computer tablets had on the performance of flight students’ training. Additionally, the study was used to discover the effect of demographic details such as; computer tablet usage experience, flight hours gathered and English language proficiency on flight training performance in the group that use computer tablets.

With the use of a Mann-Whitney U test, there was no significant difference in the performance (as rated by the student) by both the group that use computer tablets as compared to the group that did not use computer tablets. Also, with the use of a logistic regression test, there was no significant relationship found between the performance (as rated by the student) as compared to either computer tablet usage experience and English language proficiency. Lastly, with the use of a Spearman’s correlation test, there was no significant relationship found between the performance (as rated by the student) as compared to the flight hours gathered.
Technology development today has delivered pilots the capability to further their range or payload, save money, and improve their situational awareness during flight operations in the form of computer tablets. Consumer-grade electronics and the availability of data have extended this capability to General Aviation. Perhaps because the use of computer tablets is not fully regulated and up-to-date by the FAA, little is known about the uses by and challenges of the pilots in this segment. This study has shed light on topics of interest to the Federal Aviation Administration, Department of Transportation, National Transportation Safety Board, hardware manufacturers, software developers, and General Aviation pilots.
References


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Appendix A

Dear participants, Thank you so much for joining in this research “The impact of computer tablets on flight training among FIT GA pilots.” During this study, no human will be subjected to any physical test procedure. You have the right to withdraw from the study at any time you want. You have the right to decline participation in the experiment study if you want. Please do not hesitate to email Dr. John Deaton if you have any questions regarding this study at jdeaton@fit.edu or email Mr. Anthony Lolchoki at alolchoki2014@my.fit.edu.

In this section, imagine that you are flying on a cross-country flight with your CFI, from one major city to another. During a number of times during cruise control flight, the instructor asks for the parameters as shown on your computer tablet.

Please answer all questions below from the information provided.

1. The procedure helped me understand the safety procedures during flight operations.
   a) Strongly agree
   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree

2. From the information given, I was not distracted from my flight tasks.
3. I can easily explain to the instructor the current location during the flight.
   a) Strongly agree
   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree

4. The source of the aircraft’s location was easily designed to help me operate it better.
   a) Strongly agree
   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree

5. It was clear for me to comprehend and easily accomplish flight tasks.
   a) Strongly agree
   b) Agree
   c) Neutral
d) Disagree

e) Strongly disagree
Appendix B

In this section, imagine that you are flying on a cross-country flight with your CFI, from one major city to another. During a number of times during cruise control flight, the instructor asks for the parameters as experienced by the plane’s current status and by your observance.

Please answer all questions below from the information provided.

1. The procedure helped me understand the safety procedures during flight operations.
   a) Strongly agree
   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree

2. From the information given, I was **not** distracted from my flight tasks.
   a) Strongly agree
   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree

3. I can easily explain to the instructor the current location during the flight
   a) Strongly agree
4. The source of the aircraft’s location was easily designed to help me operate it better.
   a) Strongly agree
   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree
5. It was clear for me to comprehend and easily accomplish flight tasks.
   a) Strongly agree
   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree
Appendix C

Demographic data. Please answer the following questions:

Are you proficient in English?

a) Yes
b) No

Age:

a) 15-20
b) 21-25
c) 26-30
d) 31-35
e) 36-40
f) 41+

Gender:

a) Male
b) Female

Level of education:

a) High school
b) Associate degree
c) Undergraduate
d) Graduate
Number of flight hours currently achieved: ________

Are you experienced in using a computer tablet prior to your flight training?

a) Yes
b) No

Ethnicity:

a) White
b) Asian
c) Black or African American
d) American Indian or Alaska Native
e) Native Hawaiian or Other Pacific Islander
f) Hispanic or Latino
g) Other