Effects of Verbal vs Graphical Weather Information on a Pilots Decision-making during Preflight

by

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Abstract

Title: Effects of Verbal vs Graphical Weather Information on a Pilots Decision-making during Preflight

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Before a general aviation pilot conducts a flight, they obtain a preflight weather briefing that shares information on possible hazards along the intended route of flight. These preflight weather briefings are typically obtained either verbally, via a narrative delivered over a telephone, or visually, where graphical and textual information is presented on a computer or tablet display. This study compared verbal and graphical/textual weather briefings in a within-subjects study that altered the order in which participants received each format. Thirty-six participants were given a survey that contained two flight scenarios, each with specific weather scenarios and a specific briefing format. Measures of likelihood to make a decision, confidence in this decision, perception of risk, difficulty to interpret weather information, and ambiguity of weather information were collected along with four open-ended questions per each scenario. Overall, the order in which a pilot receives either a verbal or a graphical/textual briefing affects both decision and confidence depending on which briefing is received first as well as the type of weather to be encountered on each leg of a flight. Graphical/textual weather formats that were delivered first generally resulted in a higher likelihood to fly but with slightly lowered confidence, while a verbal briefing that contained
weather specific to precipitation resulted in the lowest likelihood with the highest confidence in that decision. Recommendations were made as to which briefing format should be received first based upon the type of weather to be encountered enroute. Consideration for the first weather briefing received on a multi-leg flight has shown to affect the decision and confidence on a subsequent leg if a second briefing with a different format is received.
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Lastly, I would like to thank all the FIT Aviation LLC students and instructors that participated in my survey. All 36 participants made the result of this thesis significant and contributable to the field of general aviation research.
Dedication

I would like to dedicate this thesis to my family, who has supported me throughout my college career since I arrived at Florida Tech in 2012. My father and mother, Matthew Pittorie and Donna Hayden, have always been supportive of new ventures and programs I have become involved in at college, including academics, Greek Life, service to the campus, and my aviation training.

I would also like to dedicate this thesis to my late grandfather, Morris Pittorie, who helped me become interested in aviation since I was very young. My grandfather was a model airplane builder and enthusiast and I enjoyed keeping him updated on my progress throughout my aviation training. I wish he could have been around to see me earn my M.S. Degree, but I am fortunate to have had him in my life as I graduated with my B.S. degree and earned multiple pilot certifications the past five years.
Chapter 1: Introduction

Problem Statement

The purpose of this study is to determine if a pilot’s likelihood to make a “go” or “no-go” decision during preflight is affected by the same weather information delivered in either a “verbal” or “graphical/textual” format. This study examined a pilot’s confidence in his or her decision and risk perception based upon weather that is presented in two different scenarios. The goal of this study is to make recommendations to Part 61, 91 and 141 pilots to determine which method for receiving preflight weather is more suitable for their learning style and ability to perceive risks.

Operational Definitions

For this research, operational definitions have been identified and are discussed in this section. A “go” or “no-go” decision can be defined as the binary decision for a pilot either to terminate or to conduct his flight after receiving and analyzing all preflight weather information. Pilot experience is defined as the total number of flight hours the pilot has at the time of the study.

Visual flight rules (VFR), for the purpose of this study, is defined as the minimum weather necessary to maintain orientation and control of an aircraft while referencing the horizon and having visual contact with the ground and obstacles.

Instrument flight rules (IFR) occurs when the weather falls below three statue miles of visibility and the pilot is unable to remain clear of clouds. When the weather falls under IFR, the pilot must be certified to fly while only referencing his
instruments and must be on a special flight plan. For the purpose of this study, all weather scenarios will use conditions that are close to IFR minimums, and therefore are highly ambiguous.

A verbal weather briefing is the sharing of weather information pertinent to a specific flight route and time of departure delivered over a phone by a flight service specialist (FSS).

A graphical/textual weather briefing is defined as the same weather information shared via a digital screen or paper printout that utilizes written raw weather data and graphics, such as aviation weather charts.

Perception of risk is defined as a pilot’s analysis of the severity and likelihood of hazards to occur during flight.

There are different terms used to describe pilots. A student pilot is a level of certification that enables a pilot in training to receive instruction. He or she does not act as pilot in command (PIC) unless it is a solo operation. Student pilots are not included in this study because they have not passed their practical exam to earn their private pilot’s license. Therefore, they can’t exhibit and use knowledge on preflight weather briefing analysis, risk assessment, and aeronautical decision-making (ADM). The private pilot and commercial pilot certification level will be included in this study. These levels of certification exhibit greater aeronautical knowledge respectively. The term student pilot should not be confused with college students who are currently pilots in training at a university. College students can hold any certification level such as a private pilot or commercial pilot
rating while still being enrolled at a university as a student. Pilots and flight students can also earn an instrument rating, which can be applied to a private or commercial license. This rating allows a pilot to fly under IFR on a special flight plan and into airspace where meteorological conditions are not favorable for VFR. As mentioned earlier, many general aviation accidents occur when a pilot continues flight from VFR into IFR without an instrument rating or without the knowledge and skill required to maintain control of an aircraft with no visual references outside of the cockpit.

Pilots can be certified to fly under specific “Parts” of the Code of Federal Regulations under Title 14 Chapter I: Federal Aviation Administration, Department of Transportation. The titles that are included within this study are Part 61, 91, 121, 135, and 141. Part 61 is the certification of pilots and flight instructors. Part 61 includes several flight hour and training requirement minimums set by the FAA that pilots must meet to be eligible to earn various certifications. Similar to understanding Part 61 is Part 141, which focuses on pilot schools that fall under Subchapter H: Schools and other certificated agencies. Pilots training under Part 141 must meet similar requirements as pilots training under Part 61, but their training curriculums have been approved in a different manner than the list of minimum requirements found under Part 61. Part 91 is the general operating and flight rules. This is the title that general aviation pilots operate under, which is separate from commercial operations. Parts 121 and 135 fall under Subchapter G:
Air carriers and operators for compensation or hire, which is inclusive of airline or charter pilots; both of which are out of scope for this study.

**Background**

In 1999, John F. Kennedy Jr. was conducting a flight in his private aircraft with two passengers (Pearce, 2000). This was a night VFR flight that was being flown to Martha’s Vineyard off the coast of Massachusetts. Kennedy was not an instrument-rated pilot and his aircraft entered hazy conditions, common to this area throughout the year. The flight never made it to its destination as the aircraft deviated from its flight route and impacted the ocean, killing all three people on board. The NTSB provided evidence that Kennedy had obtained a preflight weather briefing via WSI, an online weather briefing tool, which showed visibility between 4 to 10 miles along the intended flight route. During the flight, the aircraft began to perform a series of turns, climbs, and descents, with one descent exceeding 4,700 feet per minute. The NTSB also concluded that Kennedy suffered from spatial disorientation while in the cockpit, which led to a loss of control of the aircraft and eventual impact with the ocean. The pilot being unaware of the likelihood of encountering IFR conditions and the lack of an instrument rating were all cited as contributing factors to the deadly accident.

Adverse metrological conditions have contributed to 35% of general aviation accidents with 60% of these accidents occurring in instrument metrological conditions (Fultz & Ashley, 2016). Before conducting a flight, a pilot is legally responsible for being aware of weather conditions at his origin,
destination, and flight route between both airports. All pilots have varying levels of risk perception and assessment depending on their experience and level of aviation certification. Pilots also differ from one another with different learning styles that are best matched with presentations of the same weather information.

Traditionally, pilots have obtained a preflight weather briefing through a FSS via a telephone call. This phone call allows the pilot to receive all pertinent weather information verbally. The pilot is also able to receive a preflight advisory from the FSS to terminate the flight based upon the outlook of adverse weather along the intended flight route. This advisory is included in your briefing by the FSS stating, “VFR is not recommended,” which is triggered by current or forecasted weather conditions falling outside of set parameters for the duration of the flight.

With the advancement of technology, pilots are now able to obtain preflight weather information textually and graphically over a computer, tablet, or smart phone. This newer method over the option of a verbal format cuts out the addition of a FSS providing a recommendation to the pilot to terminate his flight if hazardous weather is detected. Based upon the learning style and experience level of the pilot, the different delivery methods for a preflight weather briefing may influence the likelihood of a “go” or “no-go” decision being made.
Research Questions

RQ1: Is a pilot’s likelihood to make a “go” or “no-go” decision under VFR conditions affected by preflight weather given in a verbal or graphical/textual briefing?

RQ2: Is a pilot’s confidence for conducting a flight under VFR conditions different between preflight weather given in a verbal or graphical/textual briefing?

RQ3: Is a pilot’s perception of risk under VFR conditions different between preflight weather given in a verbal or graphical/textual briefing?

Hypotheses

The hypotheses for this study were nondirectional because the effects or possible interactions between variables were unknown based on the conflicting support provided in the literature findings. With two different but current methods for collecting preflight weather information being compared, it was deemed possible that different formats of information could benefit pilots. Therefore, structuring all hypotheses, as nondirectional did not point the research in any specific way, leaving the possibility for either method to prove useful in analyzing a part or all of the necessary preflight weather information.

H_0 – The delivery of preflight weather in verbal or graphical/textual formats will not have an effect on a pilot’s likelihood to make a “go” or “no-go” decision to conduct or terminate a flight.
H₁ – The delivery of preflight weather in verbal or graphical/textual formats will have an effect on a pilot’s likelihood to make a “go” or “no-go” decision to conduct or terminate a flight.

H₀ – The delivery of preflight weather in verbal or graphical/textual formats will not have an effect on a pilot’s confidence to make a “go” or “no-go” decision to conduct or terminate a flight.

H₁ – The delivery of preflight weather in verbal or graphical/textual formats will have an effect on a pilot’s confidence to make a “go” or “no-go” decision to conduct or terminate a flight.

H₀ – The delivery of preflight weather in verbal or graphical/textual formats will not have an effect on a pilot’s perception of risk for his or her particular flight.

H₁ – The delivery of preflight weather in verbal or graphical/textual formats will have an effect on a pilot’s perception of risk for his or her particular flight.

**Significance of Study**

As stated in 14 CFR Part 61.105, pilots are required to demonstrate areas of aeronautical knowledge that cover preflight weather analysis. Pilots must recognize critical weather situations from the ground and in-flight, wind shear avoidance, and the procurement and use of aeronautical weather reports and forecasts (FAA, 2017). Pilots are also required to be able to operate aircraft safely by using sound judgement and ADM. It is required for pilots to be instructed on how to obtain accurate weather pertinent to their route of flight before takeoff, but the format of this weather briefing is not standardized. Pilots are able to obtain
what they believe to be accurate weather from various types of sources, including the traditional phone call to a FSS or a digital briefing that contains weather in text and graphic formats. The research study findings provide recommendations on which format for preflight weather briefings has the largest impact on a pilot’s likelihood to “go” or “no-go” decision before takeoff.

**Generalizability**

The results of this study are generalized to the target population of all Part 61 and 141 schools within the country as well as pilots operating under Part 91. Commercial pilots under parts 121 and 135 were excluded from the study as these pilots can utilize dispatchers and other ground personal for preflight weather analysis before flight.

Although this study used a sample of pilots in training and flight instructors from the Florida Institute of Technology (FIT), the findings from this study can be generalized to all general aviation pilots because anyone receiving training for a pilot certificate operates under Part 61, unless working off a flight training curriculum approved under Part 141. Pilots at the FIT Aviation LLC, a Part 141 flight training school, must meet all requirements listed in Part 61 in addition to extra content provided through the approved training curriculum. Although this curriculum is proprietary to FIT Aviation LLC and can differ between other Part 141 flight schools, the topics of concern in this study, including preflight weather analysis, risk management, and ADM are all included in flight training curriculums for private and commercial pilots.
Limitations

Limitations are influences that the researcher cannot control such as shortcomings, conditions or influences that place restrictions on a study’s methodology and conclusions.

The first limitation of this study were the possible differences in past experiences with verbal or graphical/textual weather briefings between participants. Some pilots had little to no past usage of more technically advanced weather briefings, such as online programs or tablet applications.

The second limitation was the pilot knowledge and certification level relative to experience with hazardous aviation weather. Pilots ranging from a private pilot license through certified flight instructor certifications were included in the sample, providing a wide range of experience with hazardous weather. This can be linked to the demographics of the pilots in the sample, FIT Aviation LLC pilots, compared to those in the general aviation population.

A third limitation to this study was the low response rate customary to the distribution of a survey. In the case of this study, the researcher used convenience sampling to recruit initial participants and then snowball sampling through word of mouth identified the remaining participants needed to meet the required sample size.

The fourth limitation to this study was the snippet of information from a weather briefing that was provided for both scenarios on each survey. A full verbal weather briefing can provide several minutes of narrative while a full
graphical/textual briefing can contain multiple pages of information. A snippet of information from each briefing format in the survey for the study was utilized because of time and convenience considerations for the participants. This snipped was selected to act as a summary of each weather briefing and contained enough information for each Likert-type scale and open-ended question to be answered. However, the exclusion of all of the information typically available on a full briefing is a study limitation.

**Delimitations**

Delimitations are choices made by the researcher that describe study boundaries to include the study population studied.

The first delimitation is how the preflight weather briefing was displayed on the paper questionnaire used in this study. A verbal weather briefing, normally given through a phone call, and a graphical/textual weather briefing, normally displayed on a digital screen, were both depicted on the single-paged survey. This is not the most realistic depiction of both forms of weather briefings and therefore had low fidelity compared to the actual methods for delivering preflight weather.

Another delimitation for this study was the generalizability of the accessible population to the target population. FIT Aviation LLC has a unique training culture that may not be able to be easily applicable to all Part 141 or even all Part 61 flight schools. However, this accessible population recruited was part of the convenience sampling recruitment method used in this study.
Student pilots being eligible for random selection into the sample population was a delimitation for this study. Student pilots do not hold a private pilot’s license, making it unclear if they’ve received training on obtaining and interpreting preflight weather briefings, decision-making, and risk perception. Private pilots were the lowest certified participants due to their certification being earned based upon adequate performance in the areas previously listed.
Chapter 2: Review of Related Literature

Introduction

This study compared two formats of preflight weather information currently used by pilots, a verbal format and a graphical/textual format, in two realistic flight scenarios to measure possible differences in a pilot’s decision-making, confidence, and risk perception per each scenario. This topic was chosen due to preflight weather being a crucial step in flight planning and risk aversion, in addition to the current issue of adverse meteorological conditions on general aviation operations. Several past studies have been conducted to analyze the frequency of weather-related accidents and the impact on general aviation safety. A study by Fultz (2015) suggests that little is known about the overall characteristics of weather-related general aviation accidents even though they have been occurring since the early 1900’s. NTSB reports related to general aviation weather accidents from 1982 to 2013 were collected and concluded that overall, the number of these accidents has decreased over time. However, more than 100 weather-related general aviation accidents still occur every year. Fultz’s (2015) study shows that hazardous weather has a significant impact on the safety of a flight. The information a pilot receives before conducting a flight must be analyzed correctly in order for any hazards to be perceived as risks and correctly mitigated. The methods pilots use to gather weather information, known as preflight weather briefings were selected to be analyzed and tested to ensure they were providing pilots with the ability to make a sound decision to ensure the safety of their flight.
To address the issue of comparing a verbal preflight weather briefing to a briefing delivered in a graphical/textual format, there were a few topics in aviation that needed to be explored. These topics included the different formats of weather briefings a pilot can obtain before a flight and the strengths and weaknesses of these formats. Regardless of the format of a weather briefing, pilots are required to be aware of the weather at their origin, destination, and along their intended flight path.

Establishing an understanding of the current and forecasted weather will help a pilot maintain situational awareness while assessing potential risks to the safety of his or her flight. This will enable the pilot to make a “go” or “no-go” decision. Situational awareness is defined as the perception of critical elements in the environment, comprehension or their meaning, and the projection of their status into the future (Wickens, Hollands, Parasuraman, & Banbury, 2012). Situational awareness is commonly found within the aviation environment because many responsibilities that fall on a pilot are time-critical and occur within a dynamic environment. The ability for a pilot to maintain situational awareness of his weather all depends on the type of learning that the pilot finds most useful, whether this is verbal learning or visual learning. The first topic that was explored related to the usage of preflight weather briefings were the regulations and minimums set in place by the Federal Aviation Administration (FAA) for general aviation.
Aviation Weather Briefings

Regulations. General aviation pilots operate under Part 91 of the Federal Aviation Regulations under Title 14 of the Code of Federal Regulations. Part 91.103 titled Preflight action, and subsection (a) describes what a pilot must obtain before conducting a flight. “Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight. For a flight under IFR or a flight not in the vicinity of an airport, weather reports and forecasts…” (FAA, 2017, 91.103a). These regulations do not define the sources of weather information that the pilot must use to obtain a preflight weather briefing, they only state that the pilot must be aware of all the weather concerning his flight. The variety of the types of sources of weather information available to pilots means that the same weather information can be delivered through various mediums and could affect the pilot’s situational awareness or assessment of risk. Due to the literature findings not addressing a recommendation on the format of weather briefing pilots should obtain, this current study compared the two most widely used formats. The two formats are verbal and graphical/textual which were presented to participants in order to generate recommendations to general aviation pilots on the best format for weather briefings.

Types of weather sources. In AC 00-45, the FAA outlines their policy guidance on using aviation weather products, the types of weather information, and the categories of the sources of aviation weather. The advisory circular only describes those weather products that are distributed by the National Weather
Service (NWS) and states that pilots need to exercise caution when using unfamiliar weather products and to consult a FSS (FAA, 2016). It further describes that as new weather products are developed, older textual and graphical products are phased out, leading to confusion between regulatory requirements and the new products (FAA, 2016). The FAA (2016) addresses this issue by stating all flight related aviation weather decisions should be based on all available pertinent weather because every flight is unique and multiple products may be necessary to meet weather regulatory requirements. In order for the FAA to help translate regulations to recommended practices for general aviation pilots, they have published methods for obtaining a weather briefing that is relevant to the specific flight a pilot is conducting and how to properly analyze information to ensure all hazards are detected.

**Obtaining a good weather briefing.** The FAA released two Advisory Circulars to assist pilots in obtaining all relevant weather information during preflight. AC 00-6, Aviation Weather (FAA, 2016) provides pilots with weather theory and the types of weather and hazards a pilot could experience during flight. AC 00-45, Aviation Weather Services (FAA, 2016) lists the types of approved weather services and providers as well as a breakdown of the types of weather briefings used by weather specialists.

The FAA (2016) reminds pilots of the regulation requiring them to gather all weather information vital to the nature of their flight. They go further in detail, explaining that pilots should obtain this weather from an approved source via the
internet and/or a FSS (FAA, 2016). Therefore, the current research utilizes approved scenarios in that each participant will be giving a scenario from each of these two types of approved scenarios. The FAA also relates the information FSS specialists can provide with the pilot’s responsibility of developing strong situational awareness and risk assessment before the flight.

“The FSS’ purpose is to serve the aviation community. Pilots should not hesitate to ask questions and discuss factors they do not fully understand. The briefing should be considered complete only when the pilot has a clear picture of what weather to expect. Pilots should also make a final weather check immediately before departure, when possible.” (FAA, 2016, page 1-6).

The FAA released a publication entitled How to Obtain a Good Weather Briefing, designed to give pilots an overview of what makes up a good weather briefing, the available sources for weather information, and what leads to a “go” or “no-go” decision. The section in the publication entitled “The Go or No-Go Decision” is a list of resources the pilots should utilize during the steps in flight planning to make their final decision. During preliminary flight planning, pilots should get a big picture of the weather with media sources such as newspapers, TV and radio weather reports, and the internet (FAA, 2008). If these resources show favorable weather to fly VFR, the pilot should then obtain a standard weather briefing by utilizing the FSS, DUATS, and the internet (FAA, 2008). This section concludes by listing resources the pilot can use in-flight if he makes the “go”
decision (FAA, 2008). The study captured pilot’s decision-making to conduct a flight after receiving a verbal or graphical/textual weather briefing through use of a seven-point Likert-type scale which ranged from “no-go” to “go.” This was followed-up by an open-ended question that asked the pilot to describe how they reached this decision based upon the preflight weather information provided.

The FAA (2008) specifically lists several “Don’ts” that should assist pilots in making the “no-go” decision to terminate their plan to fly. Flying near thunderstorms, continuing into IFR conditions while under a VFR flight plan, forgetting that areas around airports reporting VFR can be under IFR conditions, proceeding to fly on top of the clouds and hoping to find a hole to descend into, and flying into areas of rain when the air temperature is near freezing are all reasons the FAA encourages pilots to make the “no-go” decision during preflight (FAA, 2008). The section on “go” or “no-go” decisions concludes with the FAA (2008) encouraging pilots to contact the FSS or air traffic control (ATC) if caught in adverse weather conditions for assistance. In addition to the regulations and best practices focused on preflight weather that the FAA provides to pilots, there are several theories that exist which play a role in how a pilot identifies and plans for risks that could be encountered on a flight.

Theories Related to Analyzing Preflight Weather

Situational awareness. Situational awareness is a versatile term that can be applied to almost any situation involving a pilot planning and reacting to events that could affect the safety of a flight. In addition to the definition provided by
Wickens, Hollands, Parasuraman, and Banbury (2012), the FAA defines situational awareness as “the accurate perception and understanding of all the factors and conditions within the four fundamental risk elements” (FAA, 2009, p. 5). These elements include the pilot, aircraft, environment, and type of operation (FAA, 2009). These factors are important when analyzing preflight weather. The pilot being instrument-rated and having past experience dealing with adverse weather conditions before or during a flight can all have an impact on his “go” or “no-go” decision. “Environment” is the most relatable element to preflight weather because this includes all atmospheric conditions that could change the weather to have a negative impact to safety of the flight. The environment will govern which type of operation the pilot chooses and/or is certified to operate under; either VFR or IFR. Both types of operations have varying levels of assured safety involved with responsibilities lying on the pilot and/or operator (FAA, 2009). In this study, situational awareness was captured through four open-ended questions per each of the two flight scenarios that focused on decision-making, risk perception, and confidence in a pilot’s decision. The process of reaching a final decision based upon pilots analyzing risks and identifying the affects on pilot’s confidence, identified the level of situational awareness each pilot had when analyzing a realistic weather briefing.

The FAA (2009) describes the “3-P” model, used to describe how a pilot maintains situational awareness and assesses possible risks during preflight. The 3-P model begins with “perceive,” which states that the pilot must recognize and
select all relevant pieces of weather information related to his flight (FAA, 2009). The second step is to “process” this information, which has the pilot evaluate the impact of the current and forecasted weather conditions on the safety of his flight (FAA, 2009). The third and final step is to “perform,” or to implement the best course of action (FAA, 2009). Regarding preflight action, performing means the pilot is choosing between a “go” or “no-go” decision to either continue or terminate the planned flight. If the pilot processes all weather information from sources then he or she is perceived to be relevant to his flight, the pilot must then perform by maintaining situational awareness during the time to reach a “go” or “no-go” decision. This “go” or “no-go” decision was explored further in the decision-theory that is provided by the FAA.

**Decision-making**

The FAA (2009) devotes a lot of attention on educating pilots on the different forms of decision-making, also known as ADM in the aviation domain. ADM is defined as the ability to take a structured and systematic approach to analyzing changes that occur during flight and how these changes could affect the safe outcome of the flight. Using ADM properly requires good judgement, something which the FAA (2009) states can be taught through instruction and is not always exclusively a byproduct of experience. To capture decision-making in this study, specific Likert-type scale and open-ended questions that focused on both a final decision reached by a pilot after analyzing a preflight weather briefing and how confident they were in their decision were included in the final instrument.
One form of ADM that most closely relates to the analysis of a preflight weather briefing is analytical ADM (FAA, 2009). This follows the DECIDE model, which has pilots detecting a change or hazard, estimating the need to counter this change, choose a desirable outcome, identify actions that can successfully control change, do the necessary action, and evaluate the effect of the action. Analyzing all parts of a preflight weather briefing encompasses the DECIDE model as pilots already have a desired outcome for their flight and must weigh the changes detected in the weather briefing against this safe outcome.

The FAA (2009) concludes their education on ADM by listing several operational pitfalls pilots can fall under during both preflight and inflight, all of which directly relate to a flight from VMC into IMC. Pilots can experience a phenomenon called “get-there-itis” which occurs when personal or external pressures can cloud or impair a pilot’s judgement by causing the pilot to fixate on the original goal or destination with total disregard for alternative action. To capture “get-there-itis” in this study, each scenario presented to the pilot participants were portrayed as a flight lesson provided through a flight school. Whether a flight student or a flight instructor was analyzing preflight weather for a simulated flight scenario, this flight lesson was viewed as either costing money for a flight student or a paid opportunity for a flight instructor. This was intended to motivate participants to want to fly, instead of portraying each scenario as a casual flight with no consequences if it had to be cancelled. During the get-there-itis, a pilot could end up scud-running, which is flying close to VFR minimums and
potentially close to surface objects or terrain and flying at the edge of the envelope for the aircraft and their own personal performance. This topic needs further investigation and therefore is part of the future research section.

**Related studies.** Several studies have been performed to measure decision-making ability against various conditions including verbal information and graphical information. Furthermore, some studies have been performed that compare both methods to each other. Most of these studies have occurred outside of the aviation domain, including a study that investigated guiding visual attention using verbal or graphical instructions. Cañal-Bruland (2009) conducted a study that investigated how perceptual-cognitive process play an important role in open, fast-paced, and interceptive sports. Although previous studies showed that athletes require specific visual cues to anticipate and perform tasks, it was unclear whether verbal or visual information had a more beneficial impact on their decision-making. Cañal-Bruland’s (2009) study involved athletes randomly assigned to two separate groups: one which would receive verbal instructions and the other group would receive visual instructions. Both instructional methods guided participants through 10 steps with multiple videos or verbal recordings per participant presented in random order. Response time was measured starting at the beginning of each instruction with 2 seconds added if a participant did not respond. Two separate ANOVA’s were used to compare responses for correct responses only with all outliers at 3 standard deviations removed from the dataset. A difference between the verbal and visual instruction methods was detected $F(1, 48) = 4.26, p < 0.5, n_p^2$
= .08. The mean response time for the visual instruction was $M = 1.438$ ms and the response time for verbal instruction was $M = 1.648$ ms. During the discussion, it was concluded that verbal instructions can have a negative impact on decision-making performance compared to visual instruction. This was due to significant deterioration in decision-making times during verbal instruction. The conclusion of this study stated that visual information does not necessarily facilitate instruction in a more beneficial way than verbal instruction, but the slower response times after receiving verbal instruction is the cause for a difference in performance between the two methods. The guidance of visual attention will be more efficient if the information received is visually presented rather than presented over a set of verbal instructions. Although this experiment could have acted as a hypothesis for the current study, the verbal scenario used in the current study is a written narrative providing pieces of weather information and not a set of verbal directions. In this experiment, receiving verbal instructions caused slower reaction times, and this was pertinent to the current study as verbal and graphical/textual weather briefings were tested to measure a pilot’s decision-making, confidence, and risk perception.

A study on decision-making found within the aviation domain also focuses on cognitive ability in decision-making when a pilot is analyzing weather information visually. Walmsley and Gilbey (2016) investigated three common cognitive heuristics (anchoring and adjustment, confirmation, and outcome) which could lead to cognitive biases that might affect their weather-related decision-making. The research was split into three small studies, each investigating the
cognitive heuristics. Anchoring and adjustment is when someone fails to reassess their initial judgement, leaving their final judgement biased towards the initial value (Epley & Gilovich, 2006). This relates to pilots keeping their initial judgement from a preflight weather briefing despite changing weather conditions that could be occurring during flight. The first study by Walmsley and Gilbey (2006) involved pilots being told to imagine they were conducting a flight, which was chosen from five possible scenarios, each providing the pilot with a static image of clouds outside of the cockpit windshield. The weather conditions were set at 16 km visibility and a cloud layer at 2500 feet above ground level, which places the meteorological conditions between good and poor flying conditions for VFR. Half of the participants received a “good” weather forecast while the other half received a “poor” weather forecast. This initial forecast acted as the cognitive anchor while the static image of the clouds was the adjustment, and the participants were asked to make a comparative judgement between the two. Finally, the participants were asked to rate how confident they felt about continuing to their destination. The Likert-type scale was ranked from 1 to 9, with 1 being not confident and 9 being very confident. This confidence measure, developed by Walmsley and Gilbey (2016) was tailored for use in the current study on verbal and graphical/textual weather briefings. This scale was modified and used in the current study and specifically captured a pilot’s confidence in their final decision to “go” or “no-go” after reading through the simulated preflight weather briefing.
Walmsley and Gilbey (2016) analyzed their findings with a mixed-model ANOVA, which compared the high-anchor and the low-anchor to the participant’s experience: novice or expert. In terms of both cloud height, both experience levels reported that the higher anchor caused a higher assessment of the weather conditions with no interaction between low or high anchor and experience level. Again, anchoring in this study refers to someone failing to reassess initial judgement and their only judgement is bias towards the initial value. For visibility, both experience groups reported a higher assessment of weather conditions when exposed to the high anchor. Higher assessment in this part of the study refers to pilots putting emphasis or value on a certain weather condition and if it will impact the safety of their flight. However, there was an interaction between high or low anchor and experience level, with experts reporting a higher difference in assessment of weather after receiving the high anchor compared to the novice group. In terms of a safety assessment, both novices and experts showed that receiving the high anchor would increase the likelihood of them reassessing the conditions of the weather compared to receiving the low anchor. Another way to look at it would be that the more a pilot can compare his or her initial value on weather information compared to a changing or current condition, the more likely a pilot will put high emphasis on the weather being a safety concern to his or her flight or if it will not be a factor at all. This was important to the current study as consideration had to be taken for participants putting value in the initial reaction to the first scenario and its weather briefing. It was possible that the decision made in
the first scenario could have had effects on the decision made in the second scenario.

**Confirmation bias.** A cognitive heuristic explored in this study was confirmation bias. Confirmation bias is the tendency to seek out or interpret evidence in a way that favors an existing belief, expectation, or hypothesis (Gilbey & Hill, 2012). This type of bias could cause a pilot to believe weather conditions are better than they actually are based upon confirmatory information. Participants in the second study by Walmsley and Gilbey (2016) were again split into two groups, novice if they had below 1,000 total flight hours and expert if they had more than 1,000 flight hours, and were asked to select one out of three statements of weather that they believe to be most informative. Two out of the three weather statements said that a pilot could safely proceed to the nearest airport in the event of an emergency, while the third statement showed entering below VFR conditions if the pilot proceeded to this airport, which was contrary to the pilot’s hypothesis that the flight could be conducted safely. Results of an independent-sample $t$ test showed that the novice pilots chose the disconfirmatory statement more often than the expert pilots, again, based upon total flight hours; either below or above 1,000 total flight hours respectively. A second independent $t$ test compared pilots who had previously flown from VMC into IMC and their selection of the disconfirmatory statement to those who had never flown from VMC into IMC. The test showed that pilots who had not flown from VMC into IMC chose the disconfirmatory statement more frequently than those who had flown from VMC.
into IMC. In the current study, confirmation bias, which is rooted in past experiences and beliefs, will be captured via aviation experience questions and a Likert-type scale on confidence. All participants will be asked to list the amount of total flight hours they have in addition to total instrument time in order to quantify total aviation experience and experience with flying under simulated or actual IFR conditions.

A second cognitive heuristic explored in this study is outcome bias, defined as a tendency for the pilot to judge the quality of a decision by its eventual outcome, instead of judging it based on the quality of the decision at the time it was made (Baron & Hershey, 1988). Walmsley and Gilbey (2016) explored this heuristic by creating five flight scenarios, each with graphical/textual weather conditions at the departure and destination airports along with a route map. Two possible outcomes were available: a positive outcome and a negative outcome. There is a third group, acting as the control, with no additional information or outcome following the weather conditions for the flight. All participants were then asked three Likert-type questions regarding their respective scenario: “How would you rate the pilot’s decision to conduct the VFR flight?,” “How much risk did the pilot take in conducting this flight?” and “Indicate your level of agreement that you could have safely conducted a flight under the same conditions.” For decision judgement, participants rated the scenario with the negative outcome as having worse judgement than the scenario with the positive outcome, with no interaction between experience levels. For risk assessment, the participants rated the scenario
with the negative outcome as having a higher level of risk with no interaction between experience groups. Lastly, when asked to rate if it was safe to conduct a flight under the same conditions, there was significant difference between the three groups: negative outcome, positive outcome, and the control group. There was also an interaction between experience level and the outcome of the flight, with the expert pilots being more likely to conclude it is safe to conduct the flight under the same conditions than the novice pilots. The current study instrument examined experience and confidence in decision-making by collecting flight hours in the demographics section. Furthermore, the instrument also had a Likert-type scale question for each scenario that asked participants to gauge their confidence in the decision they made to continue or terminate their flight. This directly influenced the current study in the instrument design because after the Likert-type scale measure on likelihood to make a decision, participants were asked to rank their confidence in their decision. The interaction of the formats of the weather briefings on both decision and confidence generated more useful data than just the measure of the likelihood to “go” or “no-go” alone. The next subject that was explored and incorporated into the instrument for this study was risk management and assessment.

**Risk Management**

The current study takes the topic of risk into consideration through asking participants to identify their perception of risk in two different flight scenarios. This section discusses the topic of risk as it relates to pilots based on literature
findings. The FAA (2009) identifies and differentiates between two common terms used to describe the safety of a flight: hazard and risk. The FAA (2009) defines a hazard as a present condition, event, object, or circumstance that can contribute or lead to an unplanned event, ranging from minor incident to accident. The FAA (2009) identifies that the usage of unapproved or unreliable hardware is an example of a hazard, and this is directly relatable to pilots using certain proprietary commercial products as their sole-source for preflight weather. Pilots that do not check the source of the weather information that the commercial product is showing may fail to identify the hazard in potential inaccurate observations, analyses, and forecasts.

The FAA (2009) defines a risk as the future impact of a hazard that is not controlled or eliminated. A pilot relying on inaccurate weather information is assuming risk before conducting a flight due to the possibility of encountering hazardous weather during flight where the pilot is unaware. When pilots utilize the proper tools during preflight for analyzing the weather, risks can be managed and assessed. Pilots should utilize a risk assessment tool during preflight to help guide them to their “go” or “no-go” decision. The FAA (2009) outlines a basic risk assessment matrix by comparing the likelihood of a risk occurring to the severity of the risk if it occurs. Due to the importance of risk perception for pilots, risk is measured in the current study in the form of a survey item for each of the two flight scenarios.
**Risk assessment.** The FAA’s (2009) risk assessment matrix “risk likelihood” categories are improbable to remote, occasional, and probable. The “risk severity” categories are negligible, marginal, critical, and catastrophic. Pilots must consider all risks and their respective likelihood and severity, especially if the risk falls into the “high likelihood” and “high severity” region of the assessment matrix. Assessing risks associated with weather is unique in that pilots can be provided with approved analyses, observations, and forecasts that describe the severity of hazardous weather. Weather forecasts, in particular, also give the pilot the ability to analyze both risks severity and risk likelihood. Pilots utilizing the FSS can also receive a dynamic analysis of their preflight weather when working with another human being who is disseminating the weather information relevant to the particular flight. In order to capture pilots perception of risks during a preflight weather briefing, there was a Likert-type scale question for each scenario that asked participants to rank the severity of risks they perceived. This was also captured via two open-ended questions after each scenario that asked participants to describe the risks they perceived and how these impacted their decision to “go” or “no-go.”

The FAA (2007) released an Information for Operators (InFO) which is a complex risk assessment tool that can be used within the safety management system for a flight operation. This risk assessment tool is based upon the risk assessment matrix, but also lists specific hazards pilots can encounter during preflight. The weather section of the InFO risk assessment tool lists a wet runway, winter operation, no weather reporting at destination, location of thunderstorms,
severe turbulence, destination ceiling and visibility below two statute miles and
five-hundred feet, heavy rain, frozen precipitation, icing, surface winds above thirty
knots, and crosswinds above fifteen knots as hazards pilots must consider during
preflight. If these conditions exist, the pilots must include this in their final
assessment of the total risk for conducting their flight. Each hazard has a numerical
value associated with it, and the sum of all hazards will produce the “total risk” for
the flight. Some operators that utilize a similar risk assessment tool set an
allowable total for certain operations. If the sum of the hazards goes above this
total, the flight may not be allowed to be dispatched. Although the InFO tool was
not used in the instrument for the current study, a numerical value to rate
perception on the total risk perceived from each flight scenario was included. This
is also an area for future research, based upon the results from this study and the
inclusion of a FAA-approved risk measurement tool.

This InFO risk assessment tool sets specific values for wind speeds, levels
of turbulence, etc. These numbers can be tailored for small general aviation
operations or larger commercial airline operations. The numbers operate in the
same manner: to give the pilot a breakdown of each hazard and the impact on the
safety of the flight when all risks are considered together. Single-pilot operations
who utilize a similar risk assessment tool are the only authority on the dispatch of
their flight while multi-crew operations or commercial operations rely on multiple
levels of authority for a flight to be dispatched after preflight analysis of relevant
weather. The final topic that was analyzed for inclusion into the instrument of the
current study was learning theories and the major differences between verbal and visual learning.

**Learning Theories**

**Verbal learning & memory.** The analysis of literature on learning theories began with information the FAA provides to pilots on visual and verbal learning. This information also includes how it pertains to flight training and operations. This section also summarizes a review of academic articles for similar studies on the subject and instruments used to measure these constructs. The FAA (2008) identified three types of learning that are common in the flight-training environment for flight instructors to efficiently train students with varying types of learning traits. The FAA first identified verbal learning and defined it as learners who gain knowledge through speaking and hearing and can be excellent at repeating instructions but lack strength in note-taking or writing down what has been spoken to them. Allen, Reber, and Reber (2009) define verbal learning as the type of learning that uses verbal stimulus materials and verbal responses. Procedures that are often associated with verbal learning include paired-associate learning, serial learning, and verbal problem-solving (Allen, Reber, & Reber, 2009). In the current study, a one-item measure was used which was adapted from Mayer and Massa (2003) to differentiate between verbal and visual learners. At the end of the instrument for the current study, this one-item measure was included as a covariate and asked to each participant to identify what type of learning style they
prefer, ranging from visual to verbal, with a “combination of both methods” as the middle measurement.

After analyzing FAA material on learning theories, research that focused on verbal learning and memory were analyzed to support the research direction of the current study. A study by Blachstein and Vakil (2015) was conducted, examining the performance between a child sample and an adult sample with respect to their performances on various verbal recall tests. The child sample included 943 children with ages ranging from eight to 17 selected and tested against a sample of 528 adults with ages ranging from 21 to 91 (Blachstein & Vakil, 2015). The study used trial summary scores and tested trial-by-trial single-word recalls that included omissions, additions, and touched words (first recall time only) (Blachstein & Vakil, 2015). The results displayed an inverted “U” that showed a symmetrical increase in words recalled as childhood age increased and a decrease in words recalled as adult age increased (Blachstein & Vakil, 2015). The study concluded that older adults showed the lowest rates of touched words and the highest rates of additions and omissions (Blachstein & Vakil, 2015). The poor performance on verbal recall for older adults can be connected to an associative deficit of decreased binding ability, or the ability to associate two items to one another in the working memory (Naveh-Benjamin, 2000) and less-effective strategy application (Blachstein & Vakil, 2015). Memory recall is a potential topic for future research on preflight and inflight weather analysis that can be conducted based upon the outcomes of this current study.
**Visual learning & memory.** Similar to verbal learning, the FAA (2008) identified visual learning as another common learning theory found in the flight-instruction environment. Visual learners gain a transfer of knowledge through graphic and printed materials that include diagrams, charts, and illustrations. Not only is seeing one of their main learning traits but also reading textual material is a major strength of visual learners.

To perform a cognitive task after experiencing a visual stimulus, working memory is used to hold and manipulate the necessary information (Baddeley, 1986, 2000). This past research defined working memory as the temporary storage of information necessary to perform learning, reasoning, and comprehension tasks. This research relates to the current study because of the amount of information stored in the pilot’s working memory during their assessment in making a “go” or “no-go” decision. Baddeley (1986, 2000) explores two hypothetical systems: The Articulatory Loop, which stores verbal material, and the Visio-Spatial Sketchpad which stores and manipulates images. These two systems can be used to describe a pilot’s memory process as he or she analyzes textual or graphical weather data during preflight. Past studies by Baddeley (1986, 2000) have justified both systems and indicated that the concept of working memory is a replacement for the older, short-term memory concept.

Baddeley (2000) proposed a new component to working memory, the episodic buffer. It was proposed that this buffer is comprised of a limited capacity system that provides temporary storage of information. This coded information is
held in the limited capacity system, capable of binding information from subsidiary systems and from the long-term memory into episodic representations. It was also proposed that conscious awareness is the primary retrieval method for recalling information from the buffer. Pilots recalling weather information when they are analyzing various parts of the preflight weather briefing, whether verbal or textual/visual, use this process of memory recall from the episodic buffer when it comes time to make their “go” or “no-go” decision after the briefing is complete. Although not directly referenced in the instrument for the current study, the episodic buffer and this specific type of memory recall is important to keep in mind when analyzing the effects of different weather formats on how likely a pilot is to make a “go” or “no-go” decision. This has also been identified as an area for future research as memory recall can be tied into the results of the current study if the weather scenarios are presented differently. The current study used written statements for the weather briefings that could be referenced again if the pilot forgot a piece of information. A future study could use a briefing format that the pilot is unable to reference again, and therefore must rely on memory recall; which can then be measured.

A study by Alloway and Alloway (2010) has focused on visual memory capacity due to it being one of the main hallmarks of working memory. Differences between individuals’ measure of working memory capacity can be correlated with differences in fluid intelligence, reading comprehension, and academic achievement. The study involved 98 children that were tested at two
points: when the children were attending kindergarten and a second test six years later. The children were tested with a verbal short-term memory test and a verbal working memory test. The findings of the study indicated that the working memory skills of the children during the first test were the best predictor of literacy and numeracy on the second test six years later. The study concluded that working memory is not a proxy for IQ but can represent a cognitive skill with a link to academic attainment. A strong working memory can be a predictor of subsequent academic success. Pilots with strong working memories will be able to more quickly comprehend the various pieces of information presented during a preflight weather briefing. The outcome of their decision to continue their flight may be linked to how well their working memory relates to using a verbal or graphical/textual weather briefing. It is important to keep working memory in mind during the current study as pilots must have strong working memories due to the complex and dynamic environment of the cockpit and potential hazardous conditions outlined in preflight weather briefings. Items involving memory, including memory recall and working memory or short-term memory were identified as topics for potential future research.

Graphical weather briefings often incorporate colored charts or diagrams to illustrate current or forecasted weather conditions. A study by Alvarez and Cavanagh (2004), who conducted a study on the limited capacity of visual working memory, was analyzed to better understand the impact of color on this measure. They stated that past research showed a visual memory capacity of about four
images. The study used five classes of participants with each class receiving a
different set of visual stimuli based on shape and color. The stimuli ranged from a
set of various-shaded squares to a set of squares with varying colors. The
information load per item in each class was estimated, using visual search rate.
The results showed a mirrored but inverse relationship between memory capacity
and visual search rate, with $r^2 = 0.992$. The research suggests that the higher the
work load for a set of stimuli, there was a higher capacity in visual memory. This
example of working memory as the focus of a graphical study was identified as an
area for potential future research, stemming off the already identified topic on
working memory and memory recall.

Zhang and Luck (2008) performed research that defined the capacity of
working memory. The researchers stated that working memory significantly
affects cognitive abilities in a wide range of domains, but the nature of these
capacity limits has been elusive. There have been two theories on the capacity of
working memory. The first is a storage of discrete, fixed-resolution representations
while the second is a pool of resources that can be allocated flexibly to provide a
lot of small-resolution or a few high-resolution representations. Zhang and Luck
(2008) presented participants with several simple objects and found that the
participants recalled high-resolution information about a few of the objects, but
nothing was retained about the remaining objects. They concluded that because the
memory retrieval varied across a narrow range, this was not explainable by a
general resource pool but by a small set of discrete, fixed-resolution
representations. Capacity for working memory is another topic for future research based off of this current study with a focus on preflight and inflight weather analysis. The final topic analyzed within visual and verbal learning is attribution theory and the potential role it played in the current study.

**Attribution theory.** Attribution theory was the final topic related to visual and verbal learning. Although it is not directly addressed within the instrument of the current study, it was deemed important to consider when analyzing the “why” or open-ended responses from all participants. Attribution theory is defined as by what mechanisms individuals assess the motives and behaviors of others. The judgements of others are created by combining available information about both the actor and their behavior, context of their behavior, and previous history with the actor or behavior (Weiner, 2000). Recent research in attribution theory links causal thinking to learning and motivational outcomes. Fishman and Husman (2017) decided to compare attribution-related beliefs to the influence of their casual thought process. The perceived control of attributions model (PCAP) was used to model the motivational impact of students’ beliefs. There are two subconstructs that make up PCAP, and they are the perceived control of attributions (PCA) and awareness of motivational consequences of attributions (AMC). Both of these subconstructs were identified as areas for potential future research in addition to the findings of the current study. PCA is a person’s capability to influence attributional thought. AMC is a person’s understanding that attributions have behavioral and psychological consequences. Fishman and Husman (2017)
developed four research goals and set out to provide evidence that supported these goals with a sample of 800 students. The second and third goals established by Fishman and Husman (2017) can be directly related to a pilot making a decision based upon information from a preflight weather briefing. The second goal states that PCA and AMC are two distinct constructs, which was supported by the evidence stating that both are structurally independent beliefs. It’s important to understand that a pilot is capable of influencing their attributional thought when making connections between potential hazards listed in a preflight weather briefing and the outcome these can have on the safety of their flight. Depending on the pilot’s ability to make sound attributions between new information received through a weather briefing and the established knowledge they’ve used when planning their flight, the behavioral or psychological outcome will be the pilot’s ability to perceive and assess risk while making a decision to conduct or terminate his flight. The third goal states that levels of PCA and AMC differ significantly between controllable and uncontrollable events. The results of this study showed that levels of PCA and AMC were significantly higher for subjectively controllable events. The participants perceived capability to explain what caused said event was tied to whether or not they felt capable of controlling the event. Also, the participant’s awareness of the motivational consequences of such explanations was linked to how controllable was the event. This relates to the current study in that a pilot experiences an event that is out of his control, may cause him or her to feel incapable of determining the cause of the event as well as being unaware of how
casual thinking could affect the safety of the flight. Technically, the safety of a flight related to meteorological conditions is initially controllable if the pilot is made aware of possible hazards to his or her flight during the preflight briefing or if the pilot is able to avoid any weather hazard by diverting his flight path while enroute.

In order to incorporate attribution theory into the current study, clear motivation for why the scenarios are being conducted were given to each participant as well as opportunities to explain their “go” or “no-go” decision and what impacted it. PCA and AMC, which revealed that controllable and uncontrollable events can affect the reactions of pilots, influenced the survey instrument of the current study by making events that could be perceived as risks to the safety of the flight be portrayed as weather conditions; outside of the pilot’s control. The analysis of attribution theory was the final section reviewed for learning theories. The last area of literature that was analyzed for this current study were related studies in aviation. Several studies that incorporated analysis of aviation weather in different formats and their effect on decision-making and risk management with a possible experience covariate were analyzed for similarities that could have influenced the current study.

Related Studies in Aviation

The first related aviation study that was analyzed was by Melendez et al. (2017), who conducted a study that tested a pilot’s interpretation and decision-making between graphical or textual weather information. The study consisted of
21 participants who were given a cross-country flight scenario with either textual or graphical weather information. The researcher used METARs (aviation routine weather report) for both textual and graphical information. The METARs in their raw form was used for the textual format while a chart that displayed flight category, location over an airport, and a few other pieces of pertinent information was used for the graphical weather format. The researcher hypothesized that pilots would prefer the graphical weather format over the textual weather format. A second hypothesis was that pilots who are stronger visual learners would prefer to use weather charts and maps over textual weather data.

This study by Melendez et al. (2017) utilized the situational present assessment method (SPAM) used by Durso and Dattel (2004) to measure situational awareness with respect to meteorology. The survey collected additional information from the participants, such as demographics, preferred learning styles, and feedback about the cross-country scenarios. The experimental design for Melendez et al. (2017) was a two by two factorial, with the stimuli (graphical weather information or textual weather information) being the first independent variable and the “go” or “no-go” decision being the second independent variable. The number of pilots that made their decision based on the type of weather information they received was the dependent variable. Melendez et al. (2017) used a chi square test for independence: \( \chi^2 (1) = 0.102, p = 0.749 \). The study also tested the accuracy of their situational awareness responses by using a two-tailed \( t \) test, with the difference between the textual weather information group (\( M = 3.25, SD = \))
1.54) and the graphical weather information group (M = 4.70, SD = 1.72), and significance: significant, t(19) = -2.33, p = 0.03), Cohen’s d = 0.52. A related-samples t test was also performed to test whether there was a difference in the SPAM reaction times when using the two types of weather information. “The mean reaction time for TWI (M = 2.56, SD = 1.39) was not statistically different from the mean reaction time for GWI (M = 3.05, SD = 1.90); t(19) = -0.76, p = 0.46.” (Melendez et al., 2017, p. 32). Finally, Melendez et al. (2017) ran a correlation between learning styles and SPAM scores and found that the data points were reasonably well distributed along the regression line which indicated a linear relationship and homoscedasticity. This study was important to the development of the current study based upon the clear similarities of comparing graphical to verbal weather briefings. The study by Melendez et al. (2017) focused on which method of receiving a weather briefing pilots preferred, while the current study gave each participant both formats of weather briefings and measures some of the same constructs, such as decision-making and certain areas of situational awareness. Melendez et al. (2017) prompted the inclusion of a measure that asks what type of learner (visual or verbal) each participant is to see if there is a significant effect of the type of learner someone is perceived to be and their reaction to a preferred and not-preferred format for weather information. Much like the study by Melendez et al. (2017), the current study incorporated a measure to obtain data on what type of learner each participant is through presenting both a verbal and graphical/textual scenario for each participant.
A second related study to weather information and pilot decision-making was conducted by Little (2016) which distributed surveys that polled pilots on the same weather information presented textually and graphically. Little (2016) hypothesized that there would be a change in perception of risk between weather information formats, the “go” or “no-go” decision made by the pilot, and a change of perception of risk with experience. The sample used in this study were college aviation students enrolled in ground courses for their private pilot certificate, instrument rating, and commercial pilot certificate. The results suggest an average increase of perception of risk and an increase in “no-go” decisions when using the textual weather format (Little, 2016). There was also an average decrease in perception of risk as pilot experience increased from the private course to the commercial course respectfully (Little, 2016). Much like the study by Little (2016), the current study also incorporated measures for perception of risk and likelihood to “go” or “no-go” analyzed via a quantitative method.

A third study related to aviation weather was conducted by O’Hare and Waite (2012). This study focused on a pilot’s ability to recall information after it has been reviewed during a preflight briefing. In this study, a group of pilot participants were given four hypothetical cross-country scenarios. The weather for each scenario was represented in a different way: textually in raw code form, textually in plain English, graphically, and a combination of graphically and in plain English. Each participant was then asked to recall as much information as they could from the weather briefing they had just received. The results showed
that the participants who could recall the most information were the ones who receive the plain English and the combination of a graphical display and plain English. The research results suggest that this is likely due to these pilots requiring more time to analyze and interpret these briefings and therefore had more time to commit this information to memory. Another finding showed that experienced pilots were able to interpret more information from the raw code weather information than inexperienced pilots could even though all four weather formats were rated equally in the ability to be comprehended. The focus of Little’s study, which was memory recall, was not incorporated into the current study, but has been identified as an area of potential future research based upon the results of this study. This was the only study identified which was not enough for the current hypotheses to be directional.

**Conclusion**

The various types of formats for aviation weather information allows pilots to retrieve the same information in either a verbal or graphical format. Various sources of literature were analyzed on multiple topics for inclusion into the current study to identify research gaps that could become areas of future research following the conclusion of this study. Related literature that was analyzed began with background information on current methods pilots use to obtain preflight weather briefings and the practices that are recommended by the FAA. Next, topics on decision-making, risk, and situational awareness and their subtopics were analyzed in depth for their inclusion on the instrument of the current study. Several Likert-
type scale and open-ended questions developed in the current instrument capture these constructs both in a quantitative and qualitative format. Learning theories, specifically the differences between verbal and visual learning were analyzed, as well as related subtopics of learning and memory, were analyzed in order to incorporate a measure on a participant’s preferred learning style into the current instrument. The FAA (2008) also lists these different types of learning styles to inform flight instructors and educators of the need to change teaching styles to accommodate varying styles of learning amongst students. Lastly, related studies from both the educational and aviation domains were analyzed and suggested how there are differences in perception and the outcome of decision-making when presented with the same data in a textual format, broken down between pictures or raw text, and verbal information. With the information collected from the various domains covered in this review, a thorough instrument was developed to measure topics and constructs outlined for this current study as well as the identification of areas for potential future research.
Chapter 3: Methods

Introduction

This study compared a pilot’s likelihood to make a “go” or “no-go” decision to conduct or terminate a flight based upon meteorological information presented in either a verbal format or a combined textual and graphical format. Past research has measured a pilot’s preflight decision based upon either textual or graphical information, but verbal methods were never analyzed for its effect on a pilot’s situational awareness and decision-making during preflight. This study focused on the older technology of a verbal preflight weather briefing compared with the newer and emerging technology of digital textual and graphical weather pertinent to the flight route the pilot has chosen.

Population and Sample

Target population. The target population for this study were aviation students and instructors at Part 61 and 141 flight schools across the country. The main reason students and instructors at flight schools were the target population is because this was the level of experience and certification directly related to this research. Regardless of the curriculum or proprietary lesson plans, all flight instruction must include obtaining and analyzing preflight weather. General aviation pilots outside of the flight training environment can have a multitude of certifications and a wide range of experience, typically measured by total flight hours.
**Accessible population.** The accessible population for this study was FIT flight students that had at least a private pilot’s license up through flight instructors from FIT Aviation LLC. These potential participants were located on or near the college campus that was easily accessible logistically to participants. Participants were required to have held at least a private pilot’s license to establish that they had initial training on obtaining and analyzing a preflight weather briefing. Pilots undergoing flight training at FIT Aviation LLC hold anywhere from a Student Pilot Certificate to a commercial pilot’s license. Flight instructors who are employed at FIT Aviation LLC hold a Certified Flight Instructor rating as well as the possibility of a Certified Flight Instructor Instrument rating and an Airline Transport Pilot (ATP) certificate. All of these pilots were part of the sample for this study except for Student Pilots. The reasoning behind excluding Student Pilots was to establish a level of knowledge on aviation weather analysis, preflight planning, and risk management which are all items that any pilot must be proficient in to earn their first and subsequent pilot certificates.

**Sample.** The sample that was used in this study was not selected based upon gender, age, and experience (with the exclusion of pilots without a private pilot certificate). The participants were selected from the accessible population based upon their availability and willingness to participate in the study.

The average age of general aviation private and commercial pilots is 48.4 and 48.0 years respectively using data from Gama Aviation (GAMA) (GAMA, 2016). The total number of certified private pilots in the general aviation
population is 162,313 with 10,009 of these pilots being female. The total number of certified commercial pilots in the general aviation population is 96,081 with 6,081 of these pilots being female (FAA, 2016). The age of college students enrolled in a four-year institution ranges from 18-24 years old (NCES, 2015). At FIT, there were 315 undergraduate students enrolled in a four-year aviation program (Florida Institute of Technology, 2016) with the university’s male to female ratio being 70:30 as reported by U.S. News (2018). Due to these statistics, generalizability based upon male to female ratio was easily translated from the study to the real world. However, the age demographics did not as easily translate. The results of this study mostly translated to younger general aviation pilots outside of the research site. Furthermore, the younger generation of general aviation pilots may be earlier adopters of aviation technology, such as the programs used to obtain graphical/textual weather briefings.

**Sampling Strategy.** This study drew upon pilots or flight instructors at FIT because students were not different from those at other aviation schools. Participants for the study were recruited via email inviting them to take the online survey as part of an aviation research thesis.

**Statistical Analysis**

**Assumptions.** A repeated measures, within-factors MANOVA was used to statistically analyze the data collected from the survey used in this study. The assumptions met in order to use the MANOVA include that all observations were randomly and independently sampled from the population, each dependent variable
had an interval measurement, dependent variables are multivariate normally distributed within each group of the categorical independent variables, and the population covariance matrices for each group were equal.

**Statistical test.** This study used a one-way MANOVA to analyze data collected from the survey instrument. The MANOVA met ten assumptions, which was mandatory in order to use this statistical test to analyze the instrument data.

1. Two or more dependent variables: This study incorporated five dependent variables measured with Likert-type scale questions on an ordinal scale.

2. One independent variable that includes two or more categorical, independent groups: This study had one independent variable (IV). This was the format of the weather briefing per scenario; one verbal and one graphical/textual, both of which were presented to each participant in a within-subjects design.

3. Independence of observations: All four groups in this study were assigned via a numbered list of participants (1 – 36) with the first person assigned via a random roll of a six-sided dice and all remaining participants assigned chronologically. No relationship between any of the four groups were observed.
4. No univariate or multivariate outliers: All data was organized onto scatter plots to be visually analyzed for outliers. No outliers were observed.

5. Multivariate normality: All ten quantitative measures were analyzed independently for a normal distribution. All histograms were observed to be normal with no skewness or kurtosis.

6. No multicollinearity: There were no multicollinearity observed between any of the DVs.

7. Linear relationship between DVs for each group of the IV: All DVs were analyzed for linearity against the IV via scatterplots.

8. Adequate sample size: Sample size was calculated with a power analysis, described in the proceeding section.

9. Homogeneity of variance-covariance matrices: Box’s Test of Equality of Covariance Matrices was unable to be calculated because there are fewer than two nonsingular cell covariance matrices. However, all four groups within the study are of equal size.

10. Homogeneity of variances: There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance ($p > .05$).
Power analysis. A power analysis was conducted for a repeated measures, within factors MANOVA to determine the sample size required for this study. Using an effect size ($f = 0.3$), an alpha ($\alpha = 0.05$), and a total of four groups with five measurements, the sample size was determined to be 36 participants.

**Instrument**

Two weather scenarios were selected for the trials in this study. The scenarios were in two formats of preflight weather, verbal format and graphical/textual format, and were presented in this study via an online questionnaire. The two scenarios used in this survey both had high-ambiguity of falling between the parameters for VFR and IFR weather minimums. This survey was counterbalanced with each participant assigned to one of four groups based on the order of the two different formats of the two different scenarios. The verbal weather briefing for both the scenarios were summarized on the questionnaire by selecting a few lines of transcript from an actual preflight briefing. The lines of transcript specifically included the current visibility and cloud coverage for the flight.

**Manipulated variables.** After creating the verbal weather briefings for both weather scenarios, a graphical/textual briefing was created for both scenarios through the ForeFlight™ application on an iPad, which utilized the FAA approved DUATS program. A line of textual weather data as well as one graphic, in the form of a weather chart, was selected that showed visibility and cloud conditions for the flight.
All weather scenarios were checked by one faculty member in the College of Aeronautics at FIT, one senior flight instructor at FIT Aviation LLC, and one currently employed regional airline pilot for face and content validity. All participants in the pilot study were experts in the domain of this study.

In addition to the likelihood of a “go” or “no-go,” made by each participant for each of the two scenarios, each participant was asked to rate his or her confidence of their decision on a Likert-type scale from 0 (not confident) to 10 (very confident), and perceived risk ranging from 0 (low risk) to 10 (high risk).

Procedures

Research design/methodology. The design of this study was chosen to compare varying weather conditions with the verbal and graphical/textual delivery of the preflight briefing. Each of the 36 participants were shown two weather briefings, one in a graphical format and one in a verbal format. The IV was that each participant would receive a verbal and a graphical/textual briefing using a within-subjects research design because each participants received a scenario in both formats. To control for order effects, counterbalancing occurred by each participant being assigned to one of four groups. Group A consisted of scenario one in verbal format followed by scenario two in graphical/textual format. Group B consisted of scenario one in graphical/textual format followed by scenario two in verbal format. Group C consisted of scenario two in verbal format followed by scenario one in graphical/textual format. Group D consisted of scenario two in graphical/textual format and scenario one in verbal format. For analysis purposes,
these two counterbalancing methods were treated as between-subjects IVs. Participant one was assigned one of the four groups based upon the role of a dice.

The four scenarios were arranged in a different order to minimize the internal validity threat of the testing effect, or the participant becoming aware of what was trying to be measured. This allowed the research design to utilize counterbalancing to limit the testing effect. Participants were evenly distributed and randomly assigned to one of four groups based on the role of a dice. Rolling a one, two, three, or four, assigned participant one to one of the four groups. Rolling a five or six on the dice resulted in a re-roll until the number one, two, three, or four were reached. All remaining participants were automatically assigned to the respective chronological group with every other participant then receiving the opposite format scenario.

**Setting.** There was no formal setting for this study because surveys were created and distributed digitally via email. Results were collected and analyzed digitally.

**Task.** Prior to beginning each trial, participants were given an informed consent statement to assure them that no identifiable information was collected during the study. The informed consent was kept separate from the data collected for each participant.

The researcher began by sending, via email, the appropriate survey. The participant completed the survey when all questions were answered. These questions included a demographics section and two cross-country flight scenarios.
that included five Likert-type questions, which ranged from 1 to 7 and three open-ended questions for each scenario. The survey concluded with three Likert-type scale questions on learning style and frequency of obtaining a weather briefing. The researcher thanked the participant for their time and participation in the study.
Variables

Table 1. Structure of Surveys

<table>
<thead>
<tr>
<th>Survey Group</th>
<th>Order of Format:</th>
<th>Order of Scenario:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Verbal, Graphical</td>
<td>Sebring, Okeechobee</td>
</tr>
<tr>
<td>B</td>
<td>Graphical, Verbal</td>
<td>Sebring, Okeechobee</td>
</tr>
<tr>
<td>C</td>
<td>Verbal, Graphical</td>
<td>Okeechobee, Sebring</td>
</tr>
<tr>
<td>D</td>
<td>Graphical, Verbal</td>
<td>Okeechobee, Sebring</td>
</tr>
</tbody>
</table>

*All groups given verbal & graphical/textual format: within-subjects IV

Note. Order for labels for each group read as: (First, Second)

There was one within-subjects IV in this study, which was the format of the weather briefing (verbal and graphical/textual) which were given to each participant. For analysis and counter-balancing purposes only, there were two between-subjects IVs: the order in which the two formats were given to each participant and the order in which each scenario was given to each participant. Table 1 above shows how each of the IVs split all 36 participants into four groups and their respective survey format.

One of the potential covariates in this study was expertise. Expertise varies between pilots in how many total flight hours they have and the level of certification they hold. Each level of certification requires more additional items to be covered in their training, as enforced by the FAA. In this study, expertise acted as an interacting variable that could have an impact on the outcome of the study.

The three other potential covariates in this study were how often each participant
receives a verbal weather briefing before flight, how often each participant receives a graphical/textual weather briefing before flight, and if each participant believes they are a verbal learner, a visual learner, or some combination of the two.

There were five dependent variables that were measured in this study using Likert-type questions that ranged from 1 to 7 and had anchors on 1, 4, and 7. The first DV that was measured in this study was the likelihood of a “go” or “no-go” decision. The “go” or “no-go” decision was recorded for each participant and each weather scenario and format (verbal or graphical/textual). A “go” or “no-go” decision meant that the participant made the final decision to either cancel their intention to conduct a flight or to continue on the same route as described within each scenario. The anchors for decision ranged from “Extremely unlikely,” to “Neither likely nor unlikely,” to “Very likely.” The second DV was how confident the participant is in their decision they made on question 1. The anchors for confidence ranged from “Not very confident,” to “Moderately confident,” to “Very confident.” The third DV that was measured in this study was the pilot’s perception of risk associated with both scenarios he or she was given in the study. The purpose of this question was to have each participant indicate how all of the weather conditions combined affected their perception of hazards that could affect their intention to fly. The anchors for risk perception were “Low risk,” to “Moderate risk,” to “High risk.” The fourth DV that was measured in this study was how difficult the weather presented in each scenario was to interpret for each of the two scenarios. The anchors for interpretation difficulty ranged from “Easy,”
to “Moderately difficult,” to “Difficult.” The fifth DV that was measured in this study was the ambiguity of the weather for each of the two scenarios. This question was included in the survey to measure each participant’s opinion on how ambiguous the weather was for each scenario. The weather for each scenario was made ambiguous to pose a challenge for each participant by making it challenging to “go” or “no-go” based upon the motivation behind the flight (training exercise with a monetary loss/gain) and the weather being very close to VFR minimums. The anchors for ambiguity ranged from “Not ambiguous,” to “Moderately ambiguous,” to “Highly ambiguous.” Each of the five DVs were measured through a Likert-type scale item for each of the two scenarios, totaling ten questions for each survey.

**Participant protection.** Prior to beginning each survey, participants were informed that no identifiable information would be collected during the study. Because each participant received the survey over email instead of in person, a message was provided to the participant prior to beginning the survey that explained that the participant gives approval for their participation by clicking on the “next page” button when beginning the survey. Institutional Review Board (IRB) approval was obtained from FIT prior to conducting any trials with human subjects. No risk higher than daily activities was cited for this study. Citing participants’ emotions after the study was cited in the IRB as a risk due to the realism of the weather briefings used. A participant could question his or her decision-making ability given a realistic weather briefing after stating the
likelihood of a “go” or “no-go” decision. Participants had to be eighteen years of age or older and were asked to give consent prior to participating in the study.

**Time Schedule and Budget**

Study proposal and final version of survey approval – December 14, 2017

Data collection – January and February 2018

Data analysis – March 2018

Study conclusion and final report – April 18, 2018

Total cost for the study: The study did not require a budget because all surveys were generated and distributed online. Data collection and analysis was conducted with existing software that was available to the researcher.
Chapter 4: Results

Introduction

The purpose of this study was to compare a pilot’s likelihood to make a “go” or “no-go” decision to conduct or terminate a flight based upon meteorological information. Participants were presented in either a verbal format or a combined textual and graphical format with two flight scenarios involving ambiguous weather that was close to the minimum requirements for VFR. Pilots received weather briefings both verbally via a written narrative, and as graphical/textual data with a static image of a precipitation radar. Pilots were then asked a series of Likert-type scale questions and open-ended questions in order to examine the pilot’s likelihood to conduct or cancel the flight scenario, the pilot’s confidence in his or her decision, and the perception of risk the pilot experiences in each scenario. This study required statistical analysis for the quantitative portion of the data consisting of the Likert-type scale questions. Prior to the two weather scenarios that were included with each survey, demographics and current aviation experience were collected from each participant.
Table 2. Sample Demographics

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>N</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Gender</td>
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<td></td>
</tr>
<tr>
<td>Male</td>
<td>32</td>
<td>88.9</td>
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<tr>
<td>Female</td>
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<td>Total</td>
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<td>100</td>
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<tr>
<td>Age</td>
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<td></td>
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<tr>
<td>18-19 years</td>
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<tr>
<td>20-21 years</td>
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<tr>
<td>22-23 years</td>
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<tr>
<td>24-25 years</td>
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<td>11.1</td>
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<tr>
<td>≥ 26 years</td>
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<tr>
<td>Total</td>
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<tr>
<td>Experience Variable</td>
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<td>Percentage</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>----</td>
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<td><strong>Airmen Certificate</strong></td>
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<td>PPL + Instrument Rating</td>
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<td>Commercial Pilot + CFI</td>
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<td>Commercial Pilot + CFII</td>
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<td>Airline Transport Pilot</td>
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<tr>
<td><strong>Total</strong></td>
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<td>100</td>
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<tr>
<td><strong>Total Flight Hours</strong></td>
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<tr>
<td>&lt; 100</td>
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<tr>
<td>100-200</td>
<td>13</td>
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<td>201-300</td>
<td>14</td>
<td>38.9</td>
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<tr>
<td>301-400</td>
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<td>5.6</td>
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<tr>
<td>401-500</td>
<td>1</td>
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<tr>
<td>&gt; 500</td>
<td>5</td>
<td>13.9</td>
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<tr>
<td><strong>Total</strong></td>
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<td>100</td>
</tr>
<tr>
<td><strong>Total Instrument Hours</strong></td>
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<tr>
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<td>100</td>
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Table 4. Descriptive Statistics

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<tr>
<th>Dependent Variables</th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sebring</td>
<td>Okeechobee</td>
<td>Sebring</td>
<td>Okeechobee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision Verbal</td>
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<td>1.12</td>
<td>1.89</td>
<td>0.78</td>
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<td>1.22</td>
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<td>Decision Graphical</td>
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<td>1.39</td>
<td>3.22</td>
<td>1.79</td>
<td>2.78</td>
<td>1.72</td>
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<tr>
<td>Confidence Verbal</td>
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<td>0.71</td>
<td>6.00</td>
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<tr>
<td>Confidence Graphical</td>
<td>6.22</td>
<td>1.09</td>
<td>5.33</td>
<td>1.32</td>
<td>5.56</td>
<td>1.01</td>
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<td>1.13</td>
<td>4.56</td>
<td>1.24</td>
<td>4.56</td>
<td>1.51</td>
</tr>
<tr>
<td>Risk Graphical</td>
<td>5.11</td>
<td>1.27</td>
<td>4.44</td>
<td>1.13</td>
<td>5.11</td>
<td>1.62</td>
</tr>
<tr>
<td>Difficulty Verbal</td>
<td>2.44</td>
<td>1.81</td>
<td>2.44</td>
<td>1.33</td>
<td>2.11</td>
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<tr>
<td>Difficulty Graphical</td>
<td>2.78</td>
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<td>2.22</td>
<td>0.97</td>
<td>2.33</td>
<td>1.22</td>
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<td>Ambiguity Verbal</td>
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<td>2.56</td>
<td>1.51</td>
<td>3.56</td>
<td>1.67</td>
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<tr>
<td>Ambiguity Graphical</td>
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<td>2.06</td>
<td>2.22</td>
<td>1.09</td>
<td>3.44</td>
<td>1.59</td>
</tr>
</tbody>
</table>

Quantitative Data

This study required a repeated measures MANOVA to measure the impact that the format of a preflight weather briefing had on decision making and several other dependent measures. However, in order to test for order effects, the order in which the scenarios were presented and the order in which the formats were presented were coded into two between-subjects variables (scenario order: Okeechobee first, Sebring first; format order: graphical first, verbal first). A three-way MANOVA was performed with these two between-subjects variables and the single within-subjects variable. Order effects were evident from the significant interactions between the order variables.

Data Screening. There was a linear relationship between the dependent variables, as assessed by multiple scatterplots; one for each DV. There was no
evidence of multicollinearity, as assessed by Pearson correlation (|r| < 0.3). No
univariate outliers were observed in the data, as assessed by the inspection of one
scatterplot for each DV, and no multivariate outliers in the data. All DV values
were normally distributed, as assessed histograms produced for each DV. Box’s M
test for homogeneity of covariance matrices could not be performed due to fewer
than two nonsingular cell covariance matrices within the data. Homogeneity of
variances was assessed by Levene's Test of Homogeneity of Variance (p > .05).
Three additional Likert-type scale questions were added at the end of the survey to
measure how often they use a verbal weather briefing, how often they use a
graphical weather briefing, and what type of learner they believe they are (ranging
from exclusively a verbal learner to exclusively a visual learner). These three
measures were ran as covariates within the analysis, with none found as being
statistically significant.

**MANOVA.** A repeated measures MANOVA was run with one within-
subjects independent variable, weather briefing format, and two between-subjects
independent variables, the order of the weather and the order of the two scenarios.”
The five DVs in the study were decision (based on likelihood to “go” of “no-go”),
confidence in the decision, risk perception, interpretation difficulty, and ambiguity.

During the multivariate test, no significant interaction effect was found
between the within-subjects variable (format) and the between-subjects variables
(format order and code order), F(5, 28) = 5.000, p = .097, Wilks' Λ = .728, partial
The value of Wilk’s Lambda as well as minor significance for decision and confidence prompted the researcher to move onto the univariate tests.

After the multivariate test, univariate tests to measure main effects were conducted because the five DVs were not expected to be highly correlated. No main effect for the format of the weather briefing on any of the DVs was found for decision (\( F(1, 32) = 1.326, p = .258, \text{partial } \eta^2 = .040 \)), confidence (\( F(1, 32) = 1.225, p = .227, \text{partial } \eta^2 = .037 \)), risk (\( F(1, 32) = .705, p = .407, \text{partial } \eta^2 = .022 \)), interpretation difficulty (\( F(1, 32) = .237, p = .630, \text{partial } \eta^2 = .007 \)), or ambiguity (\( F(1, 32) = 1.852, p = .183, \text{partial } \eta^2 = .055 \)).

There was not a significant interaction between the format of the weather briefing, and the order in which the format was presented, on any of the DVs, including decision (\( F(1, 32) = .099, p = .756, \text{partial } \eta^2 = .003 \)), confidence (\( F(1, 32) = 1.914, p = .176, \text{partial } \eta^2 = .056 \)), risk (\( F(1, 32) = .044, p = .835, \text{partial } \eta^2 = .001 \)), interpretation difficulty (\( F(1, 32) = .059, p = .809, \text{partial } \eta^2 = .002 \)), or ambiguity (\( F(1, 32) = .667, p = .420, \text{partial } \eta^2 = .020 \)).

There was, however, a marginally significant interaction between the format of the weather briefing and the order of the scenario presented for decision, \( F(1, 32) = 3.956, p = .055, \text{partial } \eta^2 = .110 \). When Sebring was presented first, the pilot was more likely to “go” for the verbal format than the graphical format. When Okeechobee was presented first, the pilot was much more likely to “go” for the graphical scenario than the verbal. There were no significant interactions for confidence (\( F(1, 32) = .000, p = 1.000, \text{partial } \eta^2 = .000 \)), risk (\( F(1, 32) = 2.160, p = .149 \)).
= .151, partial η2 = .63), interpretation difficulty (F(1, 32) = .533, p = .471, partial η2 = .016), or ambiguity (F(1, 32) = .074, p = .787, partial η2 = .002).

There were also a statistically significant interaction between the format of the weather briefing, the order that the formats were received, and the order that the scenarios were received for decision, F(1, 32) = 4.833, p = .035, partial η2 = .131, and for confidence F(1, 32) = 6.201, p = .018, partial η2 = .162. Pilots were more likely to “go” in trial one than they were scenario two, regardless of which scenario or briefing format was presented first. The only exception to this was when Okeechobee verbal was presented first. Therefore, pilots were much less likely to go when presented with Okeechobee verbal first and Sebring graphical second. In trial one, pilots were most likely to “go” when presented with Okeechobee graphical and least likely to go when presented with Okeechobee verbal. For trial two, pilots were most likely to “go” when presented with Sebring graphical format but were least likely to “go” when presented with Okeechobee in the graphical format (see Figure 1 below). Pilots were more confident when presented with both Okeechobee scenarios first, but then lost confidence when presented with the Sebring scenarios second. Pilots who received Sebring in graphical format first gained confidence after they received Okeechobee in verbal format second. There was no change in confidence when receiving Sebring in verbal format first and Okeechobee in graphical format second. In trial one, pilots were most confident when they received Okeechobee in verbal format and least confident when receiving Sebring in graphical format. In trial two, pilots were most confident
when receiving Okeechobee in graphical format and least confident when receiving Sebring in verbal format (see Figure 2 below).

There were not significant interactions for risk perception, $F(1, 32) = 0.000, p = .100$, partial $\eta^2 = 0.000$, interpretation difficulty, $F(1, 32) = .237, p = .630$, partial $\eta^2 = .007$, or ambiguity, $F(1, 32) = .074, p = .787$, partial $\eta^2 = .002$.

After the MANOVA was performed, a post hoc test was performed as an ANOVA. This ANOVA analyzed the IV, briefing format, but in a between-subjects design against all DVs. The goal of performing this test was to analyze only the first trial for all 36 participants using a between-subjects design so that only the format of the briefing would be tested against the five DVs, with the order of the format and order of the scenarios excluded. Using this method, half of the participants received a verbal briefing while the other half received the graphical/textual briefing. Results were found to be not significant for any of the five DVs: likelihood to “go” or “no-go,” confidence in this decision, perception of risk, difficulty to interpret weather in briefing, and the ambiguity of the weather in the briefing. By performing this post hoc test, it was found that using the within-subjects design was the correct choice in order to provide statistically significant results using the variables and instrument in this study.
Figure 1. Likelihood to Make a “Go” or “No-go” Decision

Note. The superscript on the left of each line identifies which scenario was presented first (S=Sebring, O=Okeechobee) and which format was first (V=verbal, G=graphical) for each group. The superscript on the right of each line identifies which scenario and format was second for each group.
Figure 2. Confidence in Decision
Note. The superscript on the left of each line identifies which scenario was presented first (S=Sebring, O=Okeechobee) and which format was first (V=verbal, G=graphical) for each group. The superscript on the right of each line identifies which scenario and format was second for each group.

Open-Ended Questions

Each survey contained four open-ended questions for both of the two weather scenarios, which resulted in a total of eight open-ended questions per participant. The open-ended questions designed and included in the instrument captured the “why” behind the Likert-type scale responses provided by the participants. The four questions captured how the pilots reached the decision to “go” or “no-go,” what risks they perceived after reading the weather briefing, how
these risks affected their decision, and the reasons for the levels of confidence they listed for each scenario. A categorical analysis method was used to find commonalities or differences between the verbal and graphical/textual formats for the weather briefings and any answer to an open-ended question that stood out or directly tied into a hypothesis from this study.

**Qualitative Analysis**

**Analysis Procedure.** The qualitative analysis software, Nvivo®, was used to analyze the four open-ended questions for each of the two weather scenarios. The open-ended responses provided by all 36 participants were compiled into two documents: verbal and visual (graphical/textual) formats. A categorical analysis process was then performed through identifying common answers or themes among all 36 answers per participant. To visualize this data, four comparison diagrams were formed. These diagrams show the same open-ended question asked in both scenarios. The bubbles at the center of the diagram represent the format of weather briefing presented: either verbal or visual. These bubbles are linked to the open-ended question that was asked (the same question repeated twice for the two weather scenarios). Each bubble that branches off of the open-ended question bubbles are the categories of common answers found when analyzing the open-ended responses. The numbers at the center of the bubbles show the number of responses by participants per category for a particular question. The “child” label on each arrow linking the bubbles together represents the software identifying the
flow from the weather briefing format, to the open-ended question, and then to the category as a parent-child relationship.
Weather Briefing Format Comparison

Figure 3. How Pilots Reached the Decision to “Go” or “No-go” for Each Scenario
The first open-ended question asked to each participant in both the verbal and visual formats for each weather briefing scenario was how the pilot rated the likelihood to either “go” or “no-go” on a VFR flight to the specified airport. This question generated many different types of answers and had the highest number of categories compared to the proceeding three questions. As seen in Figure 1, the most popular response for the verbal scenario was that 20 of the 36 pilots cited low cloud ceilings as the factor that contributed the most to their decision. This was followed by seven of the 36 pilots citing precipitation as the second highest factor when indicating how likely they were to proceed with their flight. These responses were also the highest reported factors for the visual scenario, with eleven of the 36 pilots indicating low ceilings and fourteen of the 36 pilots indicating that precipitation was a contributor to their likelihood to “go” or “no-go.”

It is interesting to point out that 20 out of 36 pilots cited low ceilings as a contributor to their likelihood to decide to “go” or “no go” in the verbal scenario, while only 11 did the same in the visual scenario. Likewise, 14 out of 36 pilots cited precipitation as a contributor to their likelihood to make a decision in the visual scenario, while only seven of the 36 pilots did the same in the verbal scenario. There were six of the 36 pilots in the visual scenario and two of the 36 pilots in the verbal scenario that identified a lack of weather information in their briefing, and this contributed to their decision to “go” or “no-go.” Contributors to decision-making that were only mentioned for the verbal briefing included not being comfortable with a solo flight and that the weather conditions in the briefing
were poor for a possible emergency situation. Each of these were reported by one out of 36 pilots. Likewise, asking for ATC assistance (reported by one out of 36 pilots), not being able to call a weather briefer (reported by one out of 36 pilots), and the usage of the visual radar (reported by 5 out of 36 pilots) were unique to the visual briefing format and were each listed by one out of 36 pilots.

For the verbal weather briefing, five of the 36 pilots said that the type of flight they were conducting played a role in proceeding with or cancelling their flight. The type of flight depends on whether VFR or IFR is being followed or the fact that a training flight was being used in each scenario. In the visual briefing, five of the 36 pilots identified using the image of the radar, which shows the location and intensity of precipitation, as a contributor to their decision-making. The lack of aviation experience or a higher pilot certification was listed by four pilots for the verbal weather briefing and one pilot for the verbal briefing as a contributor to their final decision.
The second open-ended question asked to participants regarding the two scenarios was to identify risks that they perceived after analyzing each weather briefing. According to Figure 2, the risk reported the most was precipitation, with eight of the 36 pilots identifying this in the verbal scenario and twelve of the 36 pilots identifying this in the visual scenario. Low ceilings were the next-highest reported risk in each briefing, with five of the 36 pilots reporting it in the verbal scenario.
briefing and nine of the 36 pilots reporting it in the visual briefing. A third common perceived risk between the two formats was that the briefing does not provide a full picture of the weather, with three of the 36 pilots and five of the 36 pilots reporting this in the verbal and visual briefing respectively. The remaining risks perceived in each briefing had two or fewer pilots report them. For the verbal briefing, two of the 36 pilots identified past experience with poor weather as a risk, while the motivation or purpose for flying and the weather conditions being poor for emergency situations being reported each by one pilot. In the visual briefing, the same pilot as in Question 1 listed the inability to call a weather briefer as a perceived risk. Just as in the verbal weather briefing, a pilot identified the reported weather in the visual scenario as being poor for a possible inflight emergency.
Figure 5. How Perceived Risks Influenced the Decision of Each Participant
The third question pilots were asked regarding both weather scenarios were how the risks they perceived affected their decision to “go” or “no-go” is displayed in Figure 3. For a third time, low ceilings and precipitation were reported in both formats. Seven of the 36 pilots reported low ceilings and one pilot reported precipitation as risks that impacted their decision-making for the verbal weather briefing. In the visual briefing, five of the 36 pilots reported low ceilings while three of the 36 pilots reported low ceilings as risks that affected their decision.

The motivation or purpose of the flight was the highest-reported risk that affected a pilot’s final decision between both formats, with seven of the 36 pilots reporting this in the verbal briefing and six of the 36 pilots reporting it in the visual briefing. A few participants indicated that the weather scenarios did not provide a full picture of the weather for the route they were flying, with three of the 36 pilots indicating this in the verbal briefing and two of the 36 pilots indicating this in the visual briefing. When it came to a lack of aviation experience or holding a higher pilot certificate, four of the 36 pilots reported this as a risk that affected their decision to fly in the verbal briefing while only one pilot reported this in the visual briefing.

Past experiences with poor weather was reported by four of the 36 pilots in the verbal briefing with two of the 36 pilots reporting the same for the visual briefing. The last commonly reported risk that affected decision-making between both scenarios was weather that was too poor for an inflight emergency, one pilot reported this in the verbal briefing and two of the 36 pilots reported this for the
visual briefing. There were responses that were unique to the visual briefing that did not fit into any of the existing categories. The first was that one pilot reported a lack of equipment inside of the aircraft that could provide inflight weather information. The second unique response, also reported by only one pilot, was that the weather in the scenario was deemed specifically “not hazardous” and therefore the entirety of the information in the briefing was not a risk that affected decision-making.

Figure 6. Reasons for Reported Level of Confidence in Decision
The fourth and final open-ended question asked to all participants twice, once per scenario, was to provide an explanation for the level of confidence that they expressed through answering the Likert-type scale question. The responses are summarized in Figure 4. Past experiences with poor weather was the most common answer for the verbal scenario reported by eight of the 36 pilot responses, while six of the 36 pilots reported the same in the visual scenario. The next highest-reported reason for each participant’s level of confidence was the motivation or purpose for their flight reported by six of the 36 participants in the verbal briefing and four of the 36 pilots in the visual briefing. Three of the 36 pilots in the verbal scenario answered that the briefing does not provide a full picture of the weather for the flight while five of the 36 pilot participants answered the same for the visual scenario. The last common reason for the level of confidence between participants from both scenarios was the lack of aviation experience or pilot certification. This was reported by two of the 36 pilot participants in the verbal scenario and by four of the 36 pilot participants in the visual scenario.

Categories that were unique to the verbal scenario were low cloud ceilings (reported by five of the 36 pilot participants) and the weather being too poor to handle a possible inflight emergency (reported by one pilot participant). There were also two categories of answers in the visual briefing regarding the
participants’ level of confidence in their decision to “go” or “no-go.” The first was that the combined data between the image of the radar and the graphical/textual weather data matched each other, which was reported by eight of the 36 pilot participants. The second category was only answered by one participant, this pilot felt uncomfortable calling and receiving weather information from a briefer that they did not personally know.

Summary

The quantitative results of this study suggest that there were two statistically significant interactions: for both decision and confidence between the format of the weather briefings, order of the weather briefings, and order of the scenarios. This means that the significant interaction is only present for two out of the five DVs when they interacted with the one within-subjects IV and both between-subjects IVs. There was also a marginally significant interaction between decision and the order of the two scenarios. When these results are analyzed alongside of the qualitative data that was collected, the reason behind this statistical significance can be determined.
Chapter 5: Conclusion

Research Summary

This study was designed around the existence of the various formats of preflight weather briefings that are currently available to general aviation pilots. The first format is a verbal briefing that is obtained when a pilot calls a weather briefer and receives raw data and interpretations of this data over the phone. The second format is a graphical/textual (visual) weather briefing, where a pilot will obtain raw weather data in the form of text and images (usually weather charts or diagrams) on a desktop computer or tablet display. The FAA has provided pilots with recommendations on the best way to obtain a weather briefing, as well as outlined how various learning styles can be applied to aviation training.

The purpose of this study was to compare the two formats of a preflight weather briefing on a pilot’s likelihood to make a “go” or “no-go” decision, the confidence a pilot has in this decision, and the pilot’s perception of risk after reviewing the briefing. The instrument for this study was a digital survey that contained two flight scenarios, each to a different destination and each with differing weather conditions that were highly ambiguous and close to the minimums for IFR. Both scenarios contained a preflight weather briefing, with the verbal briefing being a summarized narrative of a FSS reading out weather information while the graphical/textual briefing showed a single line of raw textual data and one color image of a precipitation radar. The study used a within-subjects design by giving each participant both flight scenarios each using one of the two
The study also incorporated a counter-balanced design by altering the order in which both the briefing formats and scenarios were delivered to a participant, totaling in four different surveys distributed to the group of participants.

The target population is all general aviation pilots due to the types of weather briefings they receive before flight. The accessible population is the Part 141 pilot school, FIT Aviation LLC. A power analysis was conducted to determine a sample size of 36 participants which were then chosen through convenience sampling from the accessible population. The 36 participants were randomly assigned to one of the four groups and digital surveys were distributed.

A repeated measures MANOVA was used for statistical analysis of the quantitative data, which was made up of five Likert-type scale questions per each scenario that measured the likelihood of a “go” or “no-go” decision, confidence in the decision, risk perception, difficulty to interpret each briefing, and the ambiguity of the weather in each briefing. A categorical analysis was used for the qualitative data, which was made up of four open-ended questions per scenario. These open-ended questions were intended to capture the “why” behind each quantitative question by asking participants to describe how they reached their decision, the risks they perceived, how the risks impacted their decision, and the reasons for their level of confidence in their decision.

The results of the study were that there was a statistically significant interaction for both decision and confidence between the within-subjects IV (both
briefing formats given to each participant) and both between-subjects IVs (order of the formats and order of the scenarios). There was marginally statistical interaction between decision and the order of the scenarios. This, combined with the categorically analyzed qualitative data revealed the causes of these interactions and the impacts they had on the purpose of this study.

**Discussion**

**Differences in survey scenarios and briefing formats.** The scenario that used Okeechobee as the destination airport presented weather in the form of a relatively low cloud ceiling, reduced visibility, and the presence of rain showers. The scenario that used Sebring as a destination airport also presented weather that included reduced visibility, but with a very low cloud ceiling and no reported precipitation. The high ambiguity of these two scenarios being close to IFR minimums was intended to make the pilot’s decision to “go” or “no-go” on a VFR flight challenging. Although the weather conditions in each scenario were different, the order of these scenarios had a statistically significant interaction between both formats of weather briefings and the order of these two formats.

Significant differences in the means for decision and confidence were found for each group of participants depending on which scenario was coupled with either the verbal or visual, graphical/textual, briefing. Therefore, the quantitative data was analyzed with respect to four groups of participants made up of the combinations of the two between-subjects IVs. The four groups (A, B, C, and D) were based upon which combination of scenario and briefing format they received.
first: Sebring verbal for Group A, Sebring graphical for Group B, Okeechobee verbal for Group C, or Okeechobee graphical for Group D. This resulted in four separate means when analyzing the two between-subjects IVs alone. Next, the within-subjects IV was that both types of briefings, verbal and graphical, were given to each participant. When each of the between-subjects IVs were paired with the within-subjects IV, this resulted in two separate groups of four means, resulting in eight means that were analyzed against one another.

**Interactions for Decision and Confidence.** There was a statistically significant interaction between the likelihood to make a “go” or “no-go” decision and the confidence in this decision, when they interacted with weather briefing format, the order of these formats, and the order of the scenarios given to each participant. In order to find the causes behind these interactions, the decision and confidence of each of the four groups of pilots were analyzed against one another (refer to figures 1 and 2).

Overall for the decision to “go” or “no-go,” participants in trial one were more likely to “go” when they received a graphical briefing first. However, these same pilots were less confident in this decision. This is because pilots could visually see where hazardous weather (in this case precipitation) is located in relation to their origin and destination. However, these pilots were not confident in this decision which may be due to pilots having to weave in and out of hazardous weather while enroute; a behavior that does not promote a safe flight. Pilots who received the verbal briefing first were less likely to fly but were more confident in
this decision. This may be due to pilots not being able to see precipitation or low cloud ceilings when the format was verbal. Because pilots were provided information only in a verbal briefing, they were confident in terminating the flight due to the lack of multiple sources of information, specifically missing visual information.

For the second trial for decision and confidence, pilots who received the Sebring graphical scenario were the most likely to fly but were not confident in their decision. The Sebring flight contained very low cloud ceilings, low visibility, but no precipitation. In the graphical/textual briefing, the text stated that there were low ceilings, but this could not be depicted in the visual aid, which only showed precipitation. For this scenario, no precipitation was present. The textual data listed that fog was present at Sebring while the visual aid did not show any hazard near this airport. The pilots who received this scenario were likely to fly but were not confident in their decision. This was due to the graphical/textual data not supporting one another and being unable to portray a common threat between them. The difference between the textual and graphical data was intended as the precipitation radar pictured on each survey is able to show the location and intensity of rain, but not fog. The information between the textual and graphical sources did not directly contradict one another, but it instead made the pilots more carefully analyze the radar image after reading the line of raw textual weather data. Pilots could have fully understood the hazards that both the precipitation and low clouds posed if the graphical/textual data showed the same information. Likewise,
the Okeechobee graphical scenario, when presented second, made pilots the least likely to fly but the most confident in this decision. This is due to the precipitation being considered a greater threat when presented after the low ceilings from the Sebring scenario. This result shows an order effect when the pilots were presented with the scenario involving low cloud ceilings. Although these low ceilings were first considered hazardous, the pilots were even less likely to “go” but more confident in this decision during the second trial due to the precipitation being considered a comparatively greater threat.

Overall, the most interesting interaction for decision was the difference between trials one and two when the Okeechobee verbal scenario was presented first. This was the only group of pilots whose likelihood to make a “go” decision sharply rose while their confidence in this decision sharply fell when they received the Sebring graphical scenario second. This was due to the Okeechobee scenario, which involved precipitation that was only being depicted verbally, being a poor combination of format and weather. Pilots were unable to visually see the location and intensity of the precipitation and were only told of its presence near Okeechobee. This resulted in pilots that were unlikely to fly and were confident in that decision. Upon receiving the graphical/textual Sebring scenario, the pilots saw a visual aid that displayed very low cloud ceilings and no precipitation. The weather diagram showed no precipitation over Sebring, as also depicted in the line of textual weather data. In the textual weather data, Sebring was reporting very low ceilings. Because the weather diagram was not able to depict cloud ceilings, there
was no conflict between the textual weather and the diagram either. The pilots
were likely satisfied with receiving a more cohesive briefing that did not clearly
present hazardous weather and this resulted in the higher likelihood to fly but less
confidence due to the high chance of low cloud ceilings.

The null hypothesis for the likelihood to make a “go” or “no-go” decision
was rejected.

H₀ – The delivery of preflight weather in verbal or graphical/textual formats
will not have an effect on a pilot’s likelihood to make a “go” or “no-go”
decision to conduct or terminate a flight.

The likelihood for a pilot to make a “go” or “no-go” decision had a
statistically
significant interaction with the order in which a pilot receives different formats of
preflight weather information.

The null hypothesis for the confidence in the decision made by each pilot
was rejected.

H₀ – The delivery of preflight weather in verbal or graphical/textual formats
will not have an effect on a pilot’s confidence to make a “go” or “no-go”
decision to conduct or terminate a flight.

The confidence a pilot had in their decision to “go” or “no-go” had a
statistically significant interaction with the order of the weather briefings
received before flight.
The null hypothesis for the perception of risk for a weather briefing failed to be rejected.

H₀ – The delivery of preflight weather in verbal or graphical/textual formats will not have an effect on a pilot’s perception of risk for his or her particular flight.

No statistical significance was found for the perception of risk by each pilot depending on the different formats of weather briefings received before flight.

**Discussion on Open-ended Questions for Decision and Confidence.**

When analyzing the open-ended question on how each participant reached their decision, the most common response for the verbal and graphical/textual briefing was low ceilings and precipitation. This indicated that a pilot’s likelihood to “go” or “no-go” on either of the two scenarios were based primarily on the specific adverse conditions that were depicted in both briefings. Because both scenarios were matched with verbal and graphical/textual briefings between all four surveys, an equal number of participants were presented with low ceilings and precipitation presented both verbally and graphically/textually. Unique to the verbal weather briefing was that the briefing didn’t provide the full “weather picture,” which was reported by six of the 36 participants. Unique to the graphical/textual weather briefing, the usage of the colored picture of the precipitation radar influencing a final decision was reported by five of the 36 participants. This is due to a precipitation radar showing both the location and intensity of rain, while the verbal
briefings in this study only indicated that showers were present at the destination airport.

When analyzing the open-ended question on the confidence each participant had in their decision to “go” or “no-go,” past experiences with poor weather was reported by a large number of participants for both the verbal and graphical/textual briefing formats. This was an important observation as past experience with a specific type of weather condition could have affected a participant’s confidence to proceed with the flight under similar conditions. This explained why the majority of the participants in this study ranked their confidence in both scenarios highly. On a seven-point Likert-type scale, the lowest average score for a group in either briefing format was 5.22. This was well situated between the middle score on the Likert-type scale, which represented “moderately confident” and the highest score, which represented “very confident.”

A second open-ended response that was moderately common between the verbal and graphical/textual briefings for confidence was “purpose or motivation for the flight.” The two scenarios in each survey were specifically set up to be training flights that had to be conducted under VFR conditions. This meant that pilots with an instrument rating and experience flying in IFR conditions could not proceed if they felt they could not conduct the flight under VFR. Also, a training flight had implications for both pilots who are students in aviation and flight instructors who took part in this study. Aviation students would be motivated by the fact that they were paying for this flight, whether it could be successfully
completed or not once the flight departed. In this case, aviation students will be biased towards either a “go” or “no-go” decision due to monetary constraints. Beginning a flight that would have to be cancelled midway would result in spending money on the flight time without the completion of the flight lesson. Deciding to “no-go” would delay the student’s training at least until the hazardous weather moves away from the destination airport. Flight instructors were motivated by the training flight scenario by the fact that they would be getting paid for their participation if the flight departed but were also responsible and had an influence on the decision-making of an aviation student they would be flying with for their flight. Instructors could also be biased towards a “no-go” decision by being responsible for decisions made by their students. A flight into hazardous weather would be the shared responsibility between the instructor and the student.

The last significant piece of qualitative data was in responses to the open-ended confidence question for the graphical/textual briefing format. Eight out of the 36 pilots indicated that the fact that the combined graphical and textual weather data provided in the graphical/textual weather briefing had an influence on their confidence in their decision to “go” or “no-go.” The combination of this data is unique only to the graphical/textual weather briefing and not the verbal weather briefing. This directly supported the quantitative data which showed decreased confidence in the decision to fly for three out of the four groups between the verbal and graphical briefings.
Groups A and C, which both received the verbal weather briefing first, reported decreased confidence after receiving the follow-up graphical briefing. Group C, which first received a graphical briefing containing low ceilings, low visibility, and no reported precipitation also reported lowered confidence when they received their follow-up verbal briefing, which contained showers but heightened cloud ceilings and visibility. It was concluded that the majority of the participants in this study will be more confident in their decision to “go” or “no-go” based upon the specific order in which they received their weather briefings. As depicted in this study, receiving a verbal briefing before a graphical/textual briefing, regardless of the type of weather depicted in each briefing, lowered their confidence level. Receiving a verbal briefing before a graphical/textual briefing in which the data does not match (in this case, precipitation visible on a colored radar image but not reported in the graphical/textual data) also lowered their confidence level. However, the participants who received the graphical/textual briefing with data that matches, followed by a verbal briefing, resulted in higher confidence in their decision to “go” or “no-go.”

Due to these statistically significant results, the null hypothesis that stated the delivery of preflight weather in a verbal or graphical/textual format did not have an effect on a pilot’s confidence in their decision to make a “go” or “no-go” decision so it was rejected. The order in which a pilot receives a verbal or graphical/textual weather briefing did have an impact on the confidence in their decision based upon the type of weather that the pilot encounters on a flight.
Implications for Practice

The results of this study suggest that the order in which a pilot receives either a verbal or graphical/textual weather briefing does have an impact on their likelihood to make a decision to “go” or “no-go” and on their confidence in this decision. It was concluded that depending on the type of weather that is being depicted, it is important which briefing is received first. Concerning weather changing from VFR to IFR due to visibility restrictions by clouds or rain, pilots should carefully select which format of a weather briefing they receive first.

In this study, only specific combinations of weather conditions and the varied orders of receiving a verbal and graphical/textual briefing yielded significant results. It was hard to issue specific and useful recommendations from this data for the benefit of general aviation pilots receiving a preflight weather briefing.

The data from this study suggested that pilots will be more likely to fly if they receive a graphical/textual weather briefing first. However, this will result in lowered confidence. Receiving a verbal briefing first will lower the likelihood to fly while raising confidence. Receiving a second briefing that is in a different format than the first will likely alter both decision and confidence. For example, if pilots receive a verbal briefing and delay their departure time, they may elect to receive a second briefing to get updated weather information. If this second briefing is in a different format, this could magnify the effects that the changed weather conditions can have on both their likelihood to fly and the confidence in this decision.
The quantitative data and data from the open-ended questions suggest that the order in which a pilot receives a verbal and graphical/textual weather briefing does have an influence on their decision-making and confidence. There was one very important takeaway from the quantitative data alone: the order in which a pilot receives weather briefings on a multi-leg flight. This study provided each participant with two flight scenarios in varying order. Both destinations were VFR training flights to an airport in Central Florida with similar weather between both scenarios. This simulated a pilot flying multiple legs, beginning at the origin airport and flying to either Sebring or Okeechobee, and then proceeding to the final destination. Multi-leg flights within the same region of one state is very common to general aviation training flights, which is directly relatable to the accessible population used in this study. The statistically significant data showed that the order in which a pilot receives different formats of weather briefings dependent upon the type of weather at their destination affects the likelihood to make a decision as well as the confidence in this decision. If a pilot is receiving a weather briefing for the first leg, the type of weather should determine which format of briefing should be used. Upon reaching this destination if the pilot decides to continue with the flight, the pilot will then receive another briefing for the second leg. If the weather conditions have changed since receiving the first briefing, the pilot should consider which format of briefing to use due to the prior exposure to the initial weather and briefing from the first leg.
Due to the order effects found within this study, the decision a pilot makes in the first leg will affect the decision and confidence for the second leg. This can be due to several factors, such as the pilot becoming acute to changing weather conditions as he or she proceeds from the first leg to the second, or if the pilot considers the details from the first briefing while analyzing the second. Even though two separate briefings were received for two different legs of the flight, a pilot may not be able to isolate the details of the second briefing, and the decision and confidence from the first leg will affect the decision and confidence made on the second leg.

Another important factor to consider is the availability of equipment at various airports from leg to leg. An airport that has technology such as computers or tablets available for use will allow pilots to obtain graphical/textual weather briefings. However, depending on the size, location, and type of clientele, a smaller airport may only have telephones available, making a verbal briefing the only format available to visiting pilots. In this case, this study shows that pilot should be aware of the preflight briefing equipment available at the various airports along their intended route of flight. If changing weather is to be encountered during the various legs and pilots are forced into choosing one format over another due to equipment limitations, decision and confidence could be affected.

**Recommendations for Future Studies**

This study should be replicated in the future using a greater sample size in order to increase the statistical power in the MANOVA. This could possibly
provide statistical significance for risk perception depending on whether a verbal and a graphical/textual briefing is received in a certain order.

In a future study, it would be interesting to repeat the study using different visual aids for the graphical/textual briefing for both the Sebring and Okeechobee scenarios. Different visual aids include charts that show cloud coverage, precipitation, and areas affected by fog or haze. The visual aid selected in the current study depicted the entire state of Florida and encompassed both Okeechobee and Sebring. Precipitation was visible between the origin of the flight, Melbourne, and when the scenario has the pilot flying to Okeechobee. This is much less apparent when flying from Melbourne to Sebring. However, there was a small possibility that being exposed to this image when first presented with the graphical/textual briefing could have affected decision, confidence, risk perception, interpretation, and ambiguity if the pilot later analyzed the verbal scenario while recalling information from this image. The image was not visible when analyzing the verbal scenario, regardless of which order each scenario was presented.

This study should also be replicated with scenarios that provide greater amounts of weather information in greater detail. The increased realism and content of a simulated cross-country flight scenario will decrease the likelihood that response bias occurred. Participants will be less likely to find the flaws and inaccuracies of the scenarios and realizing what the survey instrument is attempting to measure. The way the different types of briefings could be presented to participants could also be more realistic. The realism used in this study pertains to
the physical delivery of the data, not the content of the data itself. The content of the data used in the current study was realistic, even if they were snippets of a full preflight briefing. For example, the verbal briefing could be a timed phone call, delivered via an audio recording, in a controlled environment. The graphical/textual scenario could be presented on a tablet or desktop computer screen. By utilizing both of these more realistic methods, the reduction in response bias will likely have a positive impact on the accuracy of answers provided by participants.

There were several topics that were explored in the literature review of this study that can be incorporated into future research on the different formats for preflight weather briefings. The first topic was memory recall, as used in a study by Blachstein & Vakil (2015) and a different study conducted by Little (2016). This type of study would have participants reviewing a weather briefing and then testing them at a later time to see how easily and accurately information can be recalled. This ties directly into the results of this study if a pilot is using different formats for a weather briefing for the same flight. If the pilot plans on receiving a verbal weather briefing followed by a graphical/textual weather briefing, or the same in the reverse order, his or her ability to recall information from the first briefing when analyzing the second is very important to decision-making, risk perception, and confidence. Likewise, a study can be conducted between the usage of a verbal, graphical/textual, or both briefings used at once to see how easily and accurately information can be recalled during flight. It would be interesting to test
the effects of the prefight environment (usually at an airport or another facility on
the ground prior to flight) versus the cockpit environment on memory recall.
Another topic for possible future research would be to make directional hypotheses
on the same two briefing formats, compared to learning styles: verbal and
graphical/textual.

The second topic from the literature review that can be used in future
research in addition to the results from this current study is working memory
capacity. This would be the amount of information that can be stored in the short-
term for recall at a time in the near future. This could also be tied directly into a
study that has pilots receiving a briefing in one format and then the same briefing in
a second format. The pilots would then be tested in the amount of information
between analyzing both briefings that is held within working memory. A pilot
could also be exposed to one or both briefing formats and then tested in a cockpit
environment on the same preflight weather briefing to measure the quantity of
information that is held in working memory between analyzing the briefing(s) and
then conducting the flight.

A third area for potential future research, related to the findings of this
study involve PCAP, a model based off attribution theory. Two subconstructs that
make up PCAP are PCA and AMC. These topics were explored during the
literature review of the current study, but these are related to aviation memory and
decision-making when pilots have to react to controllable or uncontrollable events
in their environment. It was stated that this study used only weather scenarios and
related risks, which were all uncontrollable by the pilot. The only controllable actions a pilot has during preflight related to weather are how he or she obtains a weather briefing and the “go” or “no-go” decision that is made after the briefing is analyzed. A future study could place the pilot in a cockpit environment during a flight after a preflight weather briefing has been received and analyzed. Although weather phenomena that occurs during flight are still uncontrollable by the pilot, the reactions he or she makes to this weather are well within his or her control. Decisions such as changing course around weather, diverting to another destination or back to your origin, or relying on other sources of data besides your weather briefing (such as contacting the FSS for more current information or using an inflight weather radar) are easily controllable by the pilot and can directly tie into the DVs that were measured in this study: decision, confidence, and risk perception.

The fourth topic identified for future research is pilot pitfalls, specifically get-there-it is. Pilot pitfalls can stem from both the motivation behind the purpose of the flight and the personality of the individual pilot. Get-there-itis can occur when the pilot is motivated by the need to fly either for pleasure or commercial reasons. In this current study, a flight lesson with monetary motivation was used for participants that were either aviation students or flight instructors. Although this study specified the motivation behind the flight in both scenarios, different pilot pitfalls can be explored in future studies with similar objectives. For example, one weather briefing can be used on multiple cross-country scenarios with a
different motivation behind each flight. One flight could be for pleasure, one could be for monetary gain, and the last could be an emergency situation; each with their own level of motivation. The impact of different weather briefing formats on decision, confidence, and risk perception could be measured in several trials, each involving a motivation to test for a possible interaction.

A fifth area for potential future research is the incorporation of a proven tool to measure preflight risk, such as the InFO tool (FAA, 2007). Although a Likert-type scale measure was included in this current study to capture perceived risk for each participant in both scenarios, a tool that specifically lists all types of potential risks for pilots to identify and cross-check with their own flight plans could yield interesting findings. When given a list of potential threats, a pilot would have to go through his or her flight plan in detail to see if any of these risks are apparent in the preflight weather briefing or not. It is possible that in the current study, pilots misread or misinterpreted some of the weather and did not perceive it as a risk. The two scenarios in this study were also fairly concise and could only use a small amount of possible risks to the safety of a flight. A future study could incorporate both a more complex series of cross-country scenarios with different formats of weather briefings while pilots use a tool, like the InFO, to address and analyze all risks perceived.
Conclusion

According to the National Transportation Safety Board (NTSB), 29% of all GA accidents and 40% of fatalities are classified as being weather related between the years of 2000-2011 (FAA, 2015). It is clear that weather is not only a force behind accidents that can severely damage aircraft and property, but also have a high likelihood of being fatal to pilots and passengers both in the air and on the ground. The way pilots determine their decision to conduct or terminate a flight, also known as “go” or “no-go,” can change the outcome of a potentially fatal accident. How a pilot receives and understands weather information before conducting a flight largely depends upon the type of weather briefing they receive and the order in which they receive this information. This is all dependent upon the type of weather the pilot will be flying into and how well they can perceive risks within their preflight weather briefing. This study did not look at the entire process or best practices behind a pilot receiving and understanding the perfect weather briefing, but instead highlights an important topic within aviation weather related information services. Pilots should make an effort to use new technologies and old methods for receiving weather briefings in a particular order that coincides with the type of weather they may encounter during flight. By incorporating this practice into their preflight routine, this may have an impact on a safe outcome for any flight that has the potential to encounter hazardous weather.
References


United States of America, Department of Transportation, Federal Aviation Administration. (2016). Aviation Weather (AC No: 00-6B). Washington DC: FAA.


Thank you for participating in this survey related to thesis research on preflight weather data. No personal information will be collected on this survey and your responses will be used for data analysis purposes only.

1. **Which airman certification do you currently hold?**
   - Private Pilot
   - Private Pilot + Instrument Rating
   - Commercial Pilot
   - Commercial Pilot + CFI
   - Commercial Pilot + CFII
   - Airline Transport Pilot (ATP)

2. **What is your age?**
   __________________

3. **What is your gender?**
   __________________

4. **How many total flight hours do you currently have?**
   __________________

5. **How many instrument hours (simulated + actual) do you currently have?**
   __________________
Please read the following scenario and answer the questions accordingly.

You are about to conduct a VFR training flight from Melbourne, FL to Sebring Airport in Central Florida. You call the flight service station on 1-800-wxbrief to obtain your preflight weather briefing. The weather briefer tells you that current conditions enroute include broken clouds at 900 ft and a flight visibility of 7 statute miles.

6. **How likely are you to proceed with your flight under VFR conditions?**

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. **How confident are you in the decision you made?**

<table>
<thead>
<tr>
<th>Not very confident</th>
<th>Moderately confident</th>
<th>Very confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. **What is your perceived level of risk for the weather-related threats on this flight?**

<table>
<thead>
<tr>
<th>Low risk</th>
<th>Moderate risk</th>
<th>High risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. In this scenario, the weather conditions are ______ to interpret.

<table>
<thead>
<tr>
<th>Easy</th>
<th>Moderately Difficult</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

10. In this scenario, the weather conditions are ______.

<table>
<thead>
<tr>
<th>Not ambiguous</th>
<th>Moderately ambiguous</th>
<th>Highly ambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

11. Describe how you reached your decision to “go” or “no-go” under VFR conditions.

12. Describe the risks you perceived after receiving the preflight weather briefing for this scenario.

13. How did these perceived risks impact your decision to “go” or “no-go?”

14. What were your reasons for your level of confidence in this decision?
Please read the following scenario and answer the questions accordingly.

After you arrive at Sebring Airport in central Florida, you are instructed that you are to fly a second VFR flight from Sebring to Okeechobee Airport, just north of Lake Okeechobee in Central/Southern Florida. There is no cell phone reception or phones within the airport, but the FBO does have an iPad that runs the application, ForeFlight. You use ForeFlight to obtain your preflight weather briefing. The weather closest to your destination is as follows:

27005KT 6SM VCSH FEW009 SCT015 BKN025
15. How likely are you to proceed with your flight under VFR conditions?

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16. How confident are you in the decision you made?

<table>
<thead>
<tr>
<th>Not very confident</th>
<th>Moderately confident</th>
<th>Very confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. What is your perceived level of risk for the weather-related threats on this flight?

<table>
<thead>
<tr>
<th>Low risk</th>
<th>Moderate risk</th>
<th>High risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. In this scenario, the weather conditions are ______ to interpret.

<table>
<thead>
<tr>
<th>Easy</th>
<th>Moderately Difficult</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

19. In this scenario, the weather conditions are ______.

<table>
<thead>
<tr>
<th>Not ambiguous</th>
<th>Moderately ambiguous</th>
<th>Highly ambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20. Describe how you reached your decision to “go” or “no-go” under VFR conditions.
21. Describe the risks you perceived after receiving the preflight weather briefing for this scenario.

22. How did these perceived risks impact your decision to “go” or “no-go”?

23. What were your reasons for your level of confidence in this decision?

24. How often do you receive a verbal weather briefing from 1-800-WXBRIEF?

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Sometimes</th>
<th>Every time I fly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
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<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

25. How often do you receive a visual weather briefing from an online website or application on your computer or tablet?

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Sometimes</th>
<th>Every time I fly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
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<tr>
<td></td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

26. In a learning situation, sometimes information is presented verbally (e.g., with printed or spoken words) and sometimes information is presented visually (e.g., with labeled illustrations, graphs, or narrated animations). Please circle your learning preference.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly more verbal than visual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately more verbal than visual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly more verbal than visual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equally verbal and visual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly more visual than verbal</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately more visual than verbal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly more visual than verbal</td>
<td></td>
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</tr>
</tbody>
</table>
Appendix B: Preflight Weather Data Survey B

Preflight Weather Data Survey

Thank you for participating in this survey related to thesis research on preflight weather data. No personal information will be collected on this survey and your responses will be used for data analysis purposes only.

27. Which airman certification do you currently hold?
   - Private Pilot
   - Private Pilot + Instrument Rating
   - Commercial Pilot
   - Commercial Pilot + CFI
   - Commercial Pilot + CFII
   - Airline Transport Pilot (ATP)

28. What is your age?
    ________________

29. What is your gender?
    __________________

30. How many total flight hours do you currently have?
    __________________

31. How many instrument hours (simulated + actual) do you currently have?
    __________________
Please read the following scenario and answer the questions accordingly.

You are about to conduct a VFR training flight from Melbourne, FL to Sebring Airport in central Florida. There is no cell phone reception or phones within the airport, but the FBO does have an iPad that runs the application, ForeFlight. You use ForeFlight to obtain your preflight weather briefing. The weather closest to your destination is as follows:

22004KT 7SM BKN009
32. **How likely are you to proceed with your flight under VFR conditions?**

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

33. **How confident are you in the decision you made?**

<table>
<thead>
<tr>
<th>Not very confident</th>
<th>Moderately confident</th>
<th>Very confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

34. **What is your perceived level of risk for the weather-related threats on this flight?**

<table>
<thead>
<tr>
<th>Low risk</th>
<th>Moderate risk</th>
<th>High risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>6</td>
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<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

35. **In this scenario, the weather conditions are ______ to interpret.**

<table>
<thead>
<tr>
<th>Easy</th>
<th>Moderately Difficult</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
36. In this scenario, the weather conditions are ______.

<table>
<thead>
<tr>
<th>Not ambiguous</th>
<th>Moderately ambiguous</th>
<th>Highly ambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

37. Describe how you reached your decision to “go” or “no-go” under VFR conditions.

38. Describe the risks you perceived after receiving the preflight weather briefing for this scenario.

39. How did these perceived risks impact your decision to “go” or “no-go”?

40. What were your reasons for your level of confidence in this decision?
Please read the following scenario and answer the questions accordingly.

After arriving at Sebring Airport in Central Florida, you are instructed that you are to fly a second VFR flight from Sebring to Okeechobee Airport, just north of Lake Okeechobee in Central/Southern Florida. You call the flight service station on 1-800-wxbrief to obtain your preflight weather briefing. The weather briefer tells you that current conditions enroute include few clouds at 900 feet, scattered clouds at 1,500 feet, and broken clouds at 2,500 feet. Flight visibility is reported as six statue miles and showers have been reported in the vicinity.

41. How likely are you to proceed with your flight under VFR conditions?

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

42. How confident are you in the decision you made?

<table>
<thead>
<tr>
<th>Not very confident</th>
<th>Moderately confident</th>
<th>Very confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

114
43. What is your perceived level of risk for the weather-related threats on this flight?

<table>
<thead>
<tr>
<th></th>
<th>Low risk</th>
<th>Moderate risk</th>
<th>High risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

44. In this scenario, the weather conditions are _____ to interpret.

<table>
<thead>
<tr>
<th></th>
<th>Easy</th>
<th>Moderately difficult</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td></td>
<td>7</td>
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</tr>
</tbody>
</table>

45. In this scenario, the weather conditions are ______.

<table>
<thead>
<tr>
<th></th>
<th>Not ambiguous</th>
<th>Moderately ambiguous</th>
<th>Highly ambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

46. Describe how you reached your decision to “go” or “no-go” under VFR conditions.

47. Describe the risks you perceived after receiving the preflight weather briefing for this scenario.
48. How did these perceived risks impact your decision to “go” or “no-go”?

49. What were your reasons for your level of confidence in this decision?

50. How often do you receive a verbal weather briefing from 1-800-WXBRIEF?

<table>
<thead>
<tr>
<th>Never</th>
<th>Sometimes</th>
<th>Every time I fly</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

51. How often do you receive a visual weather briefing from an online website or application on your computer or tablet?

<table>
<thead>
<tr>
<th>Never</th>
<th>Sometimes</th>
<th>Every time I fly</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

52. In a learning situation, sometimes information is presented verbally (e.g., with printed or spoken words) and sometimes information is presented visually (e.g., with labeled illustrations, graphs, or narrated animations). Please circle your learning preference.

<table>
<thead>
<tr>
<th>Strongly more verbal than visual</th>
<th>Moderately more verbal than visual</th>
<th>Slightly more verbal than visual</th>
<th>Equally verbal and visual</th>
<th>Slightly more visual than verbal</th>
<th>Moderately more visual than verbal</th>
<th>Strongly more visual than verbal</th>
</tr>
</thead>
<tbody>
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<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
Appendix C: Preflight Weather Data Survey C

Preflight Weather Data Survey

Thank you for participating in this survey related to thesis research on preflight weather data. No personal information will be collected on this survey and your responses will be used for data analysis purposes only.

53. Which airman certification do you currently hold?
   - Private Pilot
   - Private Pilot + Instrument Rating
   - Commercial Pilot
   - Commercial Pilot + CFI
   - Commercial Pilot + CFII
   - Airline Transport Pilot (ATP)

54. What is your age? 
   ____________

55. What is your gender? 
   __________________

56. How many total flight hours do you currently have? 
   ____________

57. How many instrument hours (simulated + actual) do you currently have? 
   ____________
Please read the following scenario and answer the questions accordingly.

You are about to conduct a VFR training flight from Melbourne, FL to Okeechobee Airport, just north of Lake Okeechobee in Central/Southern Florida. You call the flight service station on 1-800-wxbrief to obtain your preflight weather briefing. The weather briefer tells you that current conditions enroute include few clouds at 900 feet, scattered clouds at 1,500 feet, and broken clouds at 2,500 feet. Flight visibility is reported as six statute miles and showers have been reported in the vicinity.

58. How likely are you to proceed with your flight under VFR conditions?

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

59. How confident are you in the decision you made?

<table>
<thead>
<tr>
<th>Not very confident</th>
<th>Moderately confident</th>
<th>Very confident</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
60. What is your perceived level of risk for the weather-related threats on this flight?

<table>
<thead>
<tr>
<th>Low risk</th>
<th>Moderate risk</th>
<th>High risk</th>
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</thead>
<tbody>
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</tbody>
</table>

61. In this scenario, the weather conditions are _____ to interpret.

<table>
<thead>
<tr>
<th>Easy</th>
<th>Moderately difficult</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

62. In this scenario, the weather conditions are ______.

<table>
<thead>
<tr>
<th>Not ambiguous</th>
<th>Moderately ambiguous</th>
<th>Highly ambiguous</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>7</td>
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</tbody>
</table>

63. Describe how you reached your decision to “go” or “no-go” under VFR conditions.

64. Describe the risks you perceived after receiving the preflight weather briefing for this scenario.

65. How did these perceived risks impact your decision to “go” or “no-go?”

66. What were your reasons for your level of confidence in this decision?
Please read the following scenario and answer the questions accordingly.

After arriving at Okeechobee Airport in Central/Southern Florida, you are instructed that you are to fly a second VFR flight from Okeechobee to Sebring Airport in central Florida. There is no cell phone reception or phones within the airport, but the FBO does have an iPad that runs the application, ForeFlight. You use ForeFlight to obtain your preflight weather briefing. The weather closest to your destination is as follows:

22004KT 7SM BKN009
67. How likely are you to proceed with your flight under VFR conditions?

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Very likely</th>
</tr>
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<tbody>
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68. How confident are you in the decision you made?

<table>
<thead>
<tr>
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</tbody>
</table>

69. What is your perceived level of risk for the weather-related threats on this flight?

<table>
<thead>
<tr>
<th>Low risk</th>
<th>Moderate risk</th>
<th>High risk</th>
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</tbody>
</table>

70. In this scenario, the weather conditions are ______ to interpret.

<table>
<thead>
<tr>
<th>Easy</th>
<th>Moderately Difficult</th>
<th>Difficult</th>
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</thead>
<tbody>
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</table>

71. In this scenario, the weather conditions are ______.

<table>
<thead>
<tr>
<th>Not ambiguous</th>
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<tbody>
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</tbody>
</table>

72. Describe how you reached your decision to “go” or “no-go” under VFR conditions.
73. Describe the risks you perceived after receiving the preflight weather briefing for this scenario.

74. How did these perceived risks impact your decision to “go” or “no-go”?

75. What were your reasons for your level of confidence in this decision?

76. How often do you receive a verbal weather briefing from 1-800-WXBRIEF?

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Sometimes</th>
<th>Every time I fly</th>
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77. How often do you receive a visual weather briefing from an online website or application on your computer or tablet?

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78. In a learning situation, sometimes information is presented verbally (e.g., with printed or spoken words) and sometimes information is presented visually (e.g., with labeled illustrations, graphs, or narrated animations). Please circle your learning preference.

<table>
<thead>
<tr>
<th>Strongly more verbal than visual</th>
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Appendix D: Preflight Weather Data Survey D

Preflight Weather Data Survey

Thank you for participating in this survey related to thesis research on preflight weather data. No personal information will be collected on this survey and your responses will be used for data analysis purposes only.

79. Which airman certification do you currently hold?
   ○ Private Pilot
   ○ Private Pilot + Instrument Rating
   ○ Commercial Pilot
   ○ Commercial Pilot + CFI
   ○ Commercial Pilot + CFII
   ○ Airline Transport Pilot (ATP)

80. What is your age?
   ________________________

81. What is your gender?
   ________________________

82. How many total flight hours do you currently have (round to the nearest 100)?
   ________________________

83. How many instrument hours (simulated + actual) do you currently have (round to nearest 10)?
   ________________________
Please read the following scenario and answer the questions accordingly.

You are about to conduct a VFR training flight from Melbourne, FL to Okeechobee Airport, just north of Lake Okeechobee in Central/Southern Florida. There is no cell phone reception or phones within the airport, but the FBO does have an iPad that runs the application, ForeFlight. You use ForeFlight to obtain your preflight weather briefing. The weather closest to your destination is as follows:

27005KT 6SM VCSH FEW009 SCT015 BKN025
84. How likely are you to proceed with your flight under VFR conditions?

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

85. How confident are you in the decision you made?

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</table>

86. What is your perceived level of risk for the weather-related threats on this flight?

<table>
<thead>
<tr>
<th>Low risk</th>
<th>Moderate risk</th>
<th>High risk</th>
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</table>

87. In this scenario, the weather conditions are ____ to interpret.

<table>
<thead>
<tr>
<th>Easy</th>
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88. In this scenario, the weather conditions are ____.

<table>
<thead>
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</tbody>
</table>

89. Describe how you reached your decision to “go” or “no-go” under VFR conditions.

90. Describe the risks you perceived after receiving the preflight weather briefing for this scenario.

91. How did these perceived risks impact your decision to “go” or “no-go”?

92. What were your reasons for your level of confidence in this decision?
Please read the following scenario and answer the questions accordingly.

After arriving at Okeechobee Airport in Central/Southern Florida, you are instructed that you are to fly a second VFR flight from Okeechobee to Sebring Airport in central Florida. You call the flight service station on 1-800-wxbrief to obtain your preflight weather briefing. The weather briefer tells you that current conditions enroute include broken clouds at 900 ft and a flight visibility of 7 statute miles.

93. How likely are you to proceed with your flight under VFR conditions?

<table>
<thead>
<tr>
<th>Extremely unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Very likely</th>
</tr>
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94. How confident are you in the decision you made?

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</table>

126
95. What is your perceived level of risk for the weather-related threats on this flight?

<table>
<thead>
<tr>
<th>Low risk</th>
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96. In this scenario, the weather conditions are _____ to interpret.

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97. In this scenario, the weather conditions are ______.

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98. Describe how you reached your decision to “go” or “no-go” under VFR conditions.

99. Describe the risks you perceived after receiving the preflight weather briefing for this scenario.
100. How did these perceived risks impact your decision to “go” or “no-go”?

101. What were your reasons for your level of confidence in this decision?

102. How often do you receive a verbal weather briefing from 1-800-WXBRIEF?

<table>
<thead>
<tr>
<th>Never</th>
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<th>Every time I fly</th>
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103. How often do you receive a visual weather briefing from an online website or application on your computer or tablet?

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