A COMPARISON STUDY OF SIMULATION VERSUS MULTIMEDIA PRESENTATION INSTRUCTION ON FLIGHT STUDENTS’ DECISION-MAKING SKILLS

A dissertation submitted for defense to the Kent State University Graduate School of Education, Health and Human Services in partial fulfillment of the requirements for the degree of Doctor of Philosophy

by

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Aviation is often stated as being the safest mode of transportation; however the General Aviation community has reached a plateau in safety. For the last 20 years, the accident trend has remained at approximately 7 fatalities per 100,000 flight hours, though in the year 2013 there was a dip to approximately 5 fatalities per 100,000 hours of flight. One possible way to make an impact on safety issues in General Aviation would be through education, focusing on improving students’ decision-making skills, at the beginning levels of flight training to improve the decision making of the pilots throughout their flight careers. This Study investigates if the use of supplemental simulation scenarios to teach students decision making makes a difference in their proficiency. Simulation training can improve their decision-making capability beyond some of the current multimedia online instruction, which is currently being used to teach decision making. The results of this study indicate that the current stance of minimizing simulator training early in the flight training regime may not be the best course of action. If focused on the soft skills, such as decision making or communication, the use of simulation can greatly aid in the development of those critical skills.

*Keywords:* decision making, multimedia, simulation, flight education
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CHAPTER I
STATEMENT OF THE PROBLEM

The aviation industry has an excellent accident rate in comparison to other transportation options, such as automobiles (Sarter & Alexander, 2000). However, the excellent safety record only applies to the public face of aviation, the airlines or commercial aviation. Aviation is generally divided into three main segments: Military, Commercial, and General Aviation. Military aviation is the operations that are directly under the authority of the U.S. military and although they generally follow FAA regulations, they operate outside of the civilian operations and reporting. Commercial aviation is considered any operation that falls under either Part 121 or Part 135 regulations. These are the operations that will haul a large amount of people or cargo, and as such have a number of training and safety requirements as outlined within the aforementioned regulations. Some examples of the specific regulations that apply to commercial aviation are:

- 14 C.F.R. §121.101 (2014) Weather reporting facilities: Each certificate holder conducting domestic or flag operations must show that enough weather reporting services are available along each route to ensure weather reports and forecasts necessary for the operation.

- 14 C.F.R. §135.175 (2014) Airborne weather radar equipment requirements: (a) No person may operate a large, transport category aircraft in passenger-carrying operations unless approved airborne weather radar equipment is installed in the aircraft.
General Aviation, or GA, is the catchall that applies to everything left. And although there is some commercial bleed over, often in the form of 135 operators, there are often lower minimum standards as operations are wide and varied, instead of the consistent operations most of commercial aviation conduct (Federal Aviation Administration [FAA], 2008).

Although aviation in general has an excellent record, the same cannot be said of GA. Accident rates in GA have remained stable for the last sixteen years (Aircraft Owners and Pilots Association, 2012). GA is maintaining roughly 6.7 accidents per 100,000 flight hours (Aircraft Owners and Pilots Association, 2012). A number of different interventions have been attempted to mitigate GA’s accident rate over the years; however there has been little change in the accident rate. One possible reason that GA has not seen a reduction in accidents is because the GA segment of aviation is lacking consistency in equipage, training, and recurrent training. Most of the time, aviation safety systems will have a higher cost, leading many personal owners to only equip what is absolutely necessary to meet regulations, but they will skip extra safety equipment, such as an angle of attack indicator. Whereas commercial and military aviation has more dangerous or faster equipment, they have all the extra equipment to help guide their decisions. Also both the military and commercial segments have consistent training and retraining techniques and procedures to mitigate the danger. Both commercial and military aviation has shown that an organization can train its pilots one way and do it with a dependable outcome and then keep their pilots current through the use of in house programs(National Transportation Safety Board, 2010). GA consists of a number of
distinct categories of flying, each one using different levels of piloting skills. There is also not one individual group or company providing consistent training beyond the initial training. It is because of GA’s breadth and unique variety that researchers have trouble creating an effective intervention that will deal with all these diverse situations.

The National Transportation Board (NTSB) uses a number of categories to examine accident rates within GA. The NTSB categories are: personal, business, corporate, aerial applications (often agricultural operations, but also other operations such as banner towing), instructional, and other. In December 2013, there were 53 GA accidents. The category breakdown was 33 personal, 2 businesses, 0 corporate, 0 aerial applications, 9 instructional and 9 other (National Transportation Safety Board, 2013). The largest contributing group to the GA accident rate is the pleasure flying pilots; and has been shown to be consistent over time (Aircraft Owners and Pilots Assocation, 2012).

Because GA is so inconsistent, it is more difficult to examine operations in GA. Consider what would occur if you attempted to examine why a certain elementary school had consistently low standardized test scores. In this example school, you have six grade levels and a number of different teachers, making it difficult to effectively examine the school as a whole. You need to break it down to individual groups to examine what is happening. In GA’s case, the breadth of operations would indicate that each individual category will have different accident causes and possibly unique interventions. However, the most prominent research in GA has only conducted an overview analysis, rather than in individual categories (Shappell & Wiegmann, 2001). Without specifically targeting a segment of aviation, any intervention will not be able to consistently address issues in
GA, and most likely only correct a small portion of GA and thus most likely only marginally affects the accident rate.

The overview examination does provide a foundation for examining the errors in GA. The attempt to find some of the common underlying errors that led to the overall accident levels within GA was conducted by Shappell and Wiegmann (2003) in the form of a fine grained analysis of GA accidents from 1990–2000. Shappell and Wiegmann’s fine grained analysis used the now common Human Factors Analysis and Classification System (HFACS). Their analysis provided the framework for human error analysis and defined the different types of errors proposed in the Reason Model of Causation, or the Swiss Cheese Model (Reason, 1990; Wiegmann & Shappell, 2003). The research showed that the majority of accidents were caused by skill-based errors or decision errors. Although skill-based errors are the vast majority of errors shown in the GA accidents, approximately 30% of the accidents had decision errors as a contributing factor (Wiegmann et al., 2005). While it would be better to focus on the skills errors, currently the varied skill levels of the pilots and the various operations would make the expense of addressing those errors as not practical.

However, there is the possibility of using low cost simulators to address the decision errors within GA. Shappell and Wiegmann (2003) defined decision errors as thinking errors, or when pilots make poor choices. These decision errors can be a result of a lack of information, a lack of understanding, or having incorrect information (Wiegmann & Shappell, 2003). These three contributing factors to error leave a lot of room for interpretation as to what can be defined as a decision error. However, there is a
number of key issues, such as weather or aircraft control, that oftentimes can be prevented by good decisions (Aircraft Owners and Pilots Association, 2012). Because of some common elements in GA accidents it is possible to predict paths and situations and use context and the standard procedures in aviation to more accurately define decision errors.

Most tasks in aviation follow a specific path, usually mandated from the government or the insurance companies, leading to even more standardization. These are also often decision points in a flight, even if the decision is to put off finishing a checklist for a more urgent matter. The FAA regulations mandate that a person must follow all outlined procedures that the manufacturer prescribes and may not operate outside those outlined conditions (Loukopoulos, Dismukes, & Barshi, 2009).

An example of the standard procedures is an engine start in a Cessna 172R model:

1. After the preflight inspection, the pilot gets into the airplane, puts on his or her seatbelt, and then pulls out a checklist.
2. The pilot will prime the engine with the primer.
3. The pilot will then move the mixture to the full rich setting.
4. Next the pilot will turn on the power and the appropriate lights.
5. The pilot then should verify that the area around the aircraft is clear of people.
6. Finally, the pilot will turn the key and start the aircraft.

Unfortunately, the reality of operations oftentimes interrupts or changes the dynamics of these scripted events making the decisions more complicated and providing the pilot less than complete knowledge of a given situation. In any flight there is the
presence of other concurrent task demands, such as communications with air traffic control, and a procedure can be interrupted any number of times leading to slight variations in the perfect conditions expected by these scripted events (Loukopoulos et al., 2009). Because these interruptions and other task demands can disrupt the flow of the linear operations, such as following a checklist, it increases the difficulty of that task and can lead to poor choices on timing or decisions of which procedure should be use. Because these interruptions are sometimes unavoidable, the pilots will often try to anticipate the next set of instructions and attempt to predict which procedure they will need to accomplish next. Using a cueing technique is necessary to keep operational efficiency and the pilots on task (Loukopoulos et al., 2009). However, if there is a change from the expected operation, there will be an increase in workload and may lead to rushing critical decision, such as a go around.

Sometimes a person will need to go outside of those imposed constraints of procedures to address the current situation. Although it was not a GA accident, United flight 232 is one of the clearest examples of a situation that had not even been contemplated as possible. United 232 had a complete hydraulic failure, meaning that there was a failure of three separate hydraulic systems. A complete loss of hydraulics was not thought possible by anybody involved. Unfortunately, the loss of all three independent hydraulic systems led to the loss of all normal flight controls. It was the quick decisions of the pilots and crew to use differential thrust, adding more power to one engine as opposed to both engines, for steering and other personnel on the aircraft were used to share the workload that led to the relatively good outcome of the accident. The
pilots made a number of additional good decisions that saved many lives when most people felt that the aircraft and everyone on board was doomed (NTSB, 1990).

In order to train all pilots to make the proper decisions like the crew of United 232, it is critical that the pilots and operators have a solid understanding of the indicators of the different flight situations and knowledge about the operation of the aircraft systems, as well as what to do in most abnormal situations. They also must have either the time or training to address the decisions that are necessary in an emergency. If the pilot was using a mistaken assumption, then it is possible that their decisions will be compromised leading to an accident. It is possible that abnormal types of situations will come up a number of times per flight. In order to improve the decisions made by pilots GA needs to improve the speed and knowledge gathering skills of the pilots. Simulation could help students be exposed to different situations outside of the normal safe bounds of training in an aircraft and learn what is critical to observe and what is not.

By improving the decision-making skills and knowledge gathering ability of the pilots through the use of simulation training, flight instructors address the larger problem with aeronautical decision making, the time sensitive nature of the decisions made (Loukopoulos et al., 2009). Consider, for example, the loss of an engine. The time that a pilot has for restart and troubleshooting, before he or she needs to make an off field landing, is limited by the amount of altitude the aircraft had before the loss of the engine, as well as both the time it takes to recognize the situation and the gliding technique of the individual pilot. Because of time limitations, the pilot must be able to use his or her knowledge of systems and experience in flight to decide if a restart is possible and make
decisions based on their knowledge of terrain as to where to land if it is not possible to attempt a restart. Currently, checklists use memory items, tasks on a checklist that must be completed first and immediately from memory, to improve the likelihood of a positive outcome from the situation. The memory items are expected to be completed automatically from practiced memory and maybe critical to the safety of flight. Checklist required memory items also helps minimize the time lag between decision and action. Simulation would allow the pilots to practice at detecting the abnormality and addressing a given abnormal procedure safely and cheaply.

Currently pilots will go through a significant training regimen, focusing on immediate action and Stick and Rudder skills, the psycho-motor skills of flying the aircraft, even at the beginning levels. Skill type training is included all pilot levels from the Private Pilot Certificate up to, and including, Airline Transport Pilot. The key is that all pilots, civilian at least; follow the same training regimen in the beginning. However, GA still has a large number of accidents when compared to commercial aviation (Aircraft Owners and Pilots Association, 2012). One of the largest possible differences in training beyond the basics is the airlines use simulation and scenarios on a regular basis to use experience to improve the decisions and skill techniques of their pilots. They also have a required regular retraining schedule that GA does not require (14 C.F.R. § 121).

GA’s difference in accident rates raises the question of what is the difference in the training of the two separate civilian sectors of aviation. One of the largest differences appears to be that Commercial aviation makes use of simulation at all levels of training and for almost all situations, while GA does not. Commercial also uses simulation in the
retraining regimen of the airlines. A major reason for using simulation is how expensive to conduct flight training in a small aircraft let alone a Boeing 747. Simulation provides a number of advantages over the use of an actual aircraft, most notably the reduction of the costs and risks in the training. Some studies show that there is no significant difference between simulation and flight in the real aircraft; however since simulation and flight in the aircraft show no difference, there is an inherent savings in both risk and financial cost (Ortiz, 1994; Roessingh, 2005). One study even suggests that even if there was a negative transfer of skills, it still makes sense to use simulation because of the reduction in risk and the cost savings (Lintern, Roscoe, Koonce, & Segal, 1990).

Past studies have shown that even a simple desktop simulator can provide at least the ability to practice different procedures and emergencies without the cost of fuel and insurance, as well as provide the safety of not actually flying (Lintern et al., 1990; Ortiz, 1994; Roessingh, 2005). The risk reduction provided by using a simulator should not be over looked. While flight training simulates these emergencies in the air, there is always a difference between actual indications and the simulated stand-ins. Often you can simulate an emergency more accurately with a simulator than in flight, at least if you want to do it safely. Giving a student a more accurate portrayal of the signs of an abnormal event is coming means that the students would see those cues as they would in a real emergency and react accordingly.

A common example of emergency that is simulated during training is an engine failure in flight. The most common way engine failures are simulated in flight is for the flight instructor to move the throttle to the idle position in flight. By reducing the
throttle, the instructor reduces the power to idle without having the engine turned off, a safer situation in actual flight. However, if an engine actually fails, it will have different drag than an engine at idle and will effectively “feel” different to the pilot. I know from personal experience, the difference between training this way and an actual emergency. Simulating an engine failure this way will also still show the engine indicators as functioning and the pilot, deep down, knows that he or she can really just add power. As a counter to simulating engine failures in flight, using an accurate simulator will provide the correct sensations and indications for practice as well as providing the proper engine indications and feel. Thus the pilot can have a more accurate picture of what will occur when he or she attempts a procedure and the instructor can gauge whether he or she accurately knows what is going on (Leland, Rogers, Boquet, & Glaser, 2009).

This is why airlines use simulation for training emergencies and keeping their flight crews current on these procedures. Currently the training is done using a process of Advanced Qualification Program and Line Oriented Flight Training. Every pilot with an airline will go through an intensive ground course and simulation training on top of the other flight training received during their initial certification. They also conduct recurrent training in the simulators, going through the different critical procedures time and again. Direct application of the ground course material to flight quickly after being shown a procedure allows the pilot to assess their own knowledge and monitor any weaknesses they need to work on (O’Neil et al., 2000).

Simulation’s training aspects of self-assessment and knowledge monitoring may have a significant positive impact in reducing the GA accident rates, yet simulation has
not been as embraced in GA. This lack of simulator usage is especially prevalent at the lower levels of flight training, where many instructors focus, somewhat correctly, on the stick and rudder skills. By using simulation to supplement primary flight training in the aircraft, flight instructors would be able to allow the students to work out different decision strategies and instructors to provide more situations for the students. Consider the aspect of the engine fire described above. The student can safely make the mistake of over priming the engine, thus causing the engine fire, and if he or she makes an error in executing the emergency procedures, the effects of that error can be seen. Using simulation for decision making training will also allow the students to see where their learning deficiencies are and work to rectify them.

However, both Commercial and GA pilots start out in GA flight training. GA is where researchers can effect change in the system as a whole. Although it may be more difficult for any interventions to affect the skill-based errors because of the varied skill levels, simulation training can have an effect on the decision errors which is a universal skill. The way that researchers can address these issues would be through the understanding and enhancing of the decision making skills of pilots, starting at the beginning of their flight training.

**Purpose of the Study**

This research study attempts to assess the effectiveness of using supplemental simulation training on students’ accuracy in their decision making. A pilot often will have only seconds to make a decision during an emergency, or even normal maneuvering, so if a pilot needs to have decision-making accuracy. The use of
Simulation in primary flight training could, in the long term, help to reduce the accident rate in GA by acting as the platform for decision making training.

**Significance**

This study could have far reaching implications in the flight training world, especially in initial training of pilots. Currently there are limits on how much simulation can be counted for initial certificates and ratings, with the exception of type ratings used by airlines for larger aircraft. If there is a significant finding that supplemental simulation can improve decision making, the use of simulation earlier in flight training could lead to a more widespread acceptance of simulation in early flight training. Simulation in the early stages of flight would provide the platform for flight instructors to improve student decision making training. The use of simulation may also reduce the cost of flight training and make it possible for more people to learn to fly.

**Research Questions**

- RQ1: Does flight simulator training have an impact upon decision making in comparison to traditional multimedia instruction, as measured by the Situational Judgment Examination?
- RQ2: Does flight simulator training have an impact upon decision making in comparison to traditional multimedia instruction, as indicated by participants’ decision-making performance during a flight simulator scenario?
- RQ3: Does flight simulator training have an impact upon the perceived effectiveness of training in comparison to traditional multimedia instruction, as based on the survey?
Hypotheses

The hypotheses include: the simulation group will be significantly better than the online multimedia course group in decision making during both the Situational Judgment Exam and the practical simulated flight exam $H_a: \mu_{SEG} = \mu_{MMCG}$. Also, the participants will perceive the simulation training as more effective than the multimedia.

Null Hypothesis

There will be no significant difference between the simulation trained group and the multimedia trained group $H_0: \mu_{SEG} = \mu_{MMCG}$.

Variables

Covariate: Total flight time and total time using a simulator during flight training.

Dependent Variables: The change in decision-making accuracy in the Situational Judgment Exam [SJE] and simulation practical flight.

Independent Variable: The type of supplemental training received. There are two categories: supplemental simulation and supplemental online multimedia course.

Definitions

CFR Title 14 Part XXX: Part XXX refers to a specific section of the Code of Federal Regulations, Title 14 Aeronautics. Title 14 is often referred to as the Federal Aviation Regulations or FARs. For example, a part 141 flight school has a regimented training course that is approved by the FAA. Students of 141 flight schools are allowed to receive certain flight certificates at lower times than the standard part 61 training requirements.
**Commercial Aviation**: Commercial Aviation is flights that qualify under the stricter regulations of part 121 or 135. Simply put, these are airlines and charter flight operations that move unaffiliated people and cargo for hire. These regulations require a significant amount of training of their pilots and the operations are inspected more thoroughly and more often.

**Error**: Wiegmann and Shappell (2003) defined an error as an unsafe act that was not willfully against any rules, regulations, best practices, or without intent to cause the incident or accident. They further refined the concept of error by subdividing errors into three main categories: skill-based errors, decision-based errors, and perception errors.

**General Aviation (GA)**: GA is the segment of aviation that is not on-time or on-demand passenger or cargo transportation. GA includes a number of different categories of operations, including, but not limited to, flight training, government flights, and recreational flying. GA is the largest segment of aviation and is also the significant contributor to the accident rates of the United States.

**Instrument Metrological Conditions (IMC)**: Instrument Metrological Conditions is when the weather conditions are below 1000 feet ceilings for clouds and/or a visibility of less than three statute miles.

**National Transportation Safety Board (NTSB)**: The National Transportation Safety Board examines all transportation safety trends and is in charge of examining all major accidents and providing recommendations to the appropriate regulatory agency or administration.
**Practical simulation examination:** In relation to this study, the practical examination is the scenario-based test that the participants fly at the end of the treatment. The participants did not receive any guidance and made decisions based solely on the conditions presented in the simulated flight and the information given before beginning.

**Simulation:** For the purposes of this study, simulation is considered the use of electronic flight training devices that simulate actual flight conditions. As such, simulation lessons were conducted with a flight training device and the participant used the equipment to conduct a flight scenario to learn the material. This study used an Advanced Aviation Training Device (AATD) for all of the simulation.

**Soft Skills:** Soft skills refer to skills that are outside of the psychomotor skills. Communication, decision making, and situational awareness are examples of soft skills.

**Training Course Outline (TCO):** The Training Course Outline is the required flight training syllabus for each course at a Part 141 flight school. TCO’s must include individual lessons, lesson completion standards, and minimal completion time per lesson and per course, as well as lesson objectives and subject areas.

**Visual Flight Rules (VFR):** Visual Flight Rules are the rules defining when a flight may operate utilizing only visual references outside the aircraft.
CHAPTER II
REVIEW OF THE LITERATURE

The review of literature presented is to provide a foundational knowledge of the subject matter pertaining to the goals of this study. Chapter two begins by examining the aviation safety background and the types of errors that occur in General Aviation. Next, there is the examination of decisions and errors, one of the leading aspects of GA errors. Then this chapter transition to the current theories of multimedia education. Finally, this chapter concludes with a discussion of the theories and current evaluation of simulation techniques used in a multitude of industries.

Aviation Safety

Aviation accidents, like those of all complex industries, have far reaching effects. These repercussions reach far beyond the users and operators, affecting people that are not connected to aviation (Perrow, 1989). One of the greatest problems facing aviation safety is the fact that while mechanical failures have been reduced to an acceptable level, the same cannot be said about human error (Wiegmann & Shappell, 2003).

Although there is not a definitive study about the level human error plays in aviation accidents, it has reached the point where experts speculate that up to 80% of aviation accidents have some aspect that can be attributed to human error (Campbell & Bagshaw, 2002; Reason, 1990; Wiegmann & Shappell, 2003). The primary report for GA accident and safety is the Air Safety Foundation’s Nall report. The Nall report for 2012 indicated that 87% of GA accidents had a human error element, even if it was not the primary cause (Aircraft Owners and Pilots Association, 2012). The high level of
human error leads to some speculation on where the errors originate, as attacking the origin is generally the best way to correct any given problem.

A large part of the human error aspect comes from the necessity of the human in operations. While requiring human operators sounds intuitive, and it is, the concept of human error has entered into areas where one would not expect it to be. Human error has been found in the realm of Unmanned Aerial Systems (UAS), where it would seem there would be few human errors, but the military estimates that as high as 68% of incidents have human factors as causal factors (Manning, Rash, & LeDuc, 2004; Williams, 2004). However, the overall low accident rate is astonishing, given the complexity of the industry. Part of the problem is the inherent failures within any complex system (Perrow, 1989; Reason, 1990).

In any complex system or operation, factors exist within the system that provide latent hazards, regardless of the operator’s capabilities. It is these latent failures that humans tend to work around and attempt to achieve their goals in spite of the adversity within the system. Latent failures and systemic problems are where most human error originates (Loukopoulos et al., 2009; Perrow, 1989; Reason, 1990, 1997; Wiegmann & Shappell, 2003). However, humans often find ways to work around these latent issues, but you must understand the system and how it functions to do that safely.

In aviation, many of these latent failures tend to be based on resource management, but you also need to include different environmental and operational aspects as well. As such it is critical that researchers and safety analysts consider what types of errors are occurring, as well as any causes behind them. Proper error assessment
is especially critical within the realm of GA where there are less regulations, and often less recurrent training. Yet GA is also the area of aviation that is training most of the pilots flying today. To effectively examine error, error must be first clearly defined. For this study the assessment the error definition refined by Wiegmann and Shappell (2003) will be used. Wiegmann and Shappell (2003) defined an unsafe act is the act that directly resulted in the failure, be it a complete system failure or a single item failure. They further defined an error as an unsafe act that was not willfully done against any rules, regulations, or best practices, or without intent to cause the incident or accident. They further refined the concept of error by subdividing errors into three main categories: skill-based errors, decision-based errors, and perception errors.

Each type of error has its own issues and aspects that require different intervention strategies to correct the errors. Skill-based errors are the errors that occur in the “doing” part of the operation. These types of errors are very susceptible to lapses in memory and psycho-motor skill issues. Some examples of skill-based type of errors include callouts of a checklist without actually checking to verify the checklist item or not having flown for a while and bouncing on a landing (Wiegmann & Shappell, 2003). These skill-based errors can be seen in all pilots, regardless of experience. Decision errors are applied to “thinking” errors and include errors in planning and assessing the situation. An example of a decision error would be deciding to try and fly the radar gap between storms, while proper knowledge of thunderstorms would tell you that trying to fly between storms that are closing together is unsafe. Finally, perception errors occur when the operator misinterprets a situation and applies a correction that is not applicable
to the actual situation. An example of a perception error would be mis-reading a gauge in the red because of parallax. Wiegmann and Shappell postulate that perception errors lies with inappropriate action, not the misperception, which occurred during the Three Mile Island incident. While it may seem out of place when talking about aviation, Three Mile Island is the key accident that changed the concepts of safety and human error. Three Mile Island had a reactor failure and essentially a meltdown, though not to the level of the Chernobyl reactor. The operator was blamed for the disaster, but it was found that he was under trained and a single misperception led to his choice to shut down the water going to the reactor. The overall situation was caused by the perceptions of the instrumentation that led the operator to make a decision that led to a catastrophic failure of a nuclear reactor (Nuclear Regulatory Commission, 2013; Wiegmann & Shappell, 2003).

Because the different types of errors require different types of intervention strategies, it is critical to examine individual segments of a GA to find what type of errors exist within that segment and create targeted intervention strategies to correct the errors. GA needs to be further address because of all of the segments of aviation, GA has seen limited, if any, improvement in their safety record. Overall, GA maintains an average of about 6.8 accidents per 100,000 flight hours, and has done so for over 15 years (Aircraft Owners and Pilots Association, 2012). In comparison, the last major domestic air carrier accident was in Buffalo, NY, in 2009.

One of the key aspects of GA is its wide variety of operations. There are three main segments in aviation: Military, Commercial, and General Aviation (FAA, 2008).
Military aviation includes all operations that are under the military authority of the federal government; military operations can be anything from flight intercept procedures to the movement of Air Force One. The military segment is generally considered separate from civilian operations. Commercial operations consist of civilian operations that transport large amounts of people or cargo and fall under the strict guidelines of Code of Federal Regulations (CFR) Title 14, parts 121 or 135. These are almost all very similar operations and follow a similar pattern. General aviation is all of the remaining operations. GA can include the pilots flying for fun or a business. It includes local government or flight training. Wide variety in GA is what makes it harder to effect large scope changes (Aircraft Owners and Pilots Association, 2012).

Some research has been done to categorize the errors within GA. Shappell and Wiegmann (2005) examined the type of errors in GA from 1990 until 2000. Using the Human Factors Analysis and Classification System (HFACS), as well as the error definitions from above, Shappell and Wiegmann (2005) conducted an analysis of all the GA accidents. Shappell and Wiegmann looked only at accidents that were attributed to human error, further limiting the pool of accidents. While it is often the goal to find a single cause, it is possible to have multiple types of errors attributed to a single accident. Overall, what they found was not too surprising. The largest component of errors was attributed to skill-based errors, at 80% of accidents. Skill based errors being the most prevalent contributing factor in GA accidents makes sense and is by far one of the hardest issues to tackle, as there are a lot of pilots that do only the minimum to maintain flight currency. The other error category that stood out was decision-based errors. Roughly
30% of the examined accidents had some aspect of decision errors. Finally, only about 6% of the accidents had perceptual errors associated with them. Of these errors, decision making is the most manageable problem; however, the interventions attempted by the FAA seem to have limited impact on the number and types of accidents (Wiegmann et al., 2005).

It has been hypothesized that the primary contributor to the number of skill-based errors is from the large amount of pilots who fly irregularly, while decision errors are more evenly distributed throughout the accidents (Shappell & Wiegmann, 2001; Wiegmann et al., 2005). While there has not been a specific analysis of the different sectors of GA, by examining the commercial segment and comparing it to both business and other for hire operations in aviation, it can be inferred that decision errors could be addressed broadly (National Transportation Safety Board, 2010; Shappell & Wiegmann, 2001; Shappell, Detwiler, & Holcomb, 2006).

**Decision Making/Error Detection**

Aviation or Aeronautical Decision Making (ADM) has been an issue for a significant amount of time, with one of the most deadly decisions being flying visual flight rules into deteriorating weather (O’Hare & Smitheram, 1995; Wiegmann, Goh, & O’Hare, 2002). Flying visual flight rules into deteriorating weather particular phenomenon has been studied by a number of researchers and yet it still continues to be an issue. The FAA includes ADM training at all levels of pilot training, inside and outside formal training settings (Federal Aviation Administration, 2013).
O’Hare and Smitheram (1995) examined the issue of decisions that led to flying visual flight rule into deteriorating conditions from a behavioral direction, looking at the pilots’ decisions in terms of their perceptions of gains versus losses. O’Hare and Smitheram examined three questions; first, do pilots frame decisions that they made in the terms of gains and losses. Using gains and losses as a decision making tool would match the utilitarian concept of people looking to move toward the most gain. However, there needs to be effective risk assessment by the pilots in question. As such the researchers’ question two was to examine if the decisions could be changed by adjusting the framing of the problem. Changing the framing was done by providing a statement of benefit or detriment to the pilot. The final question was assessing what the pilots considered relevant in their decision-making process.

O’Hare and Smitheram’s found that the majority of pilots felt that they used the gain framework, which should, according to Tversky and Kahneman (1986), make the pilots more risk adverse. If it was true that the pilots became more risk adverse, the findings should have indicated that the 80% of pilots who indicated that they were gains oriented would have turned back. However, the actual results show that pilots consistently continued on into poor weather (O’Hare & Smitheram, 1995; Tversky & Kahneman, 1986). An example of a gain scenario is if the pilot considers gains of survival and safer options. However, if you consider the loss of time and money by diverting, it would entice pilots to continue into the weather. It seems logical that the gains scenarios should be a better choice, but the pilots focused on the gains and losses.
What O’Hare and Smitheram (1995) actually found was that half of the people continued to press on. When the pilots pushed forward, their perceptions may not have matched their actual inclinations. However, there was no significant difference between the group who chose to move on and the group that chose to divert to a different airport in the pilots’ perceived inclinations to either the framework or gain/loss goals. The greatest issue the pilots considered was damage to the aircraft. However, pilots seemed to not worry as much about their passengers’ reactions. The pilots were also more concerned with factors that affected themselves; specifically what they perceived their actions would reflect upon themselves. While not indicated directly in this study, the pilots may press on because the pilots did not want to “lose face,” by not completing a flight because they “wussed out” over weather. Finally, O’Hare and Smitheram found that if the problem was framed in terms of gains, the pilots were more cautious. So it may be possible that if pilots are trained by examining the gainful options, instead of loss options, it may lead to safer behaviors and thereby safer decisions.

Decisions may also be framed in the situational assessment of the pilots. Wiegmann et al. (2002) continued to examine the issue of flying Visual Flight Rules into Instrument Metrological Conditions (IMC) phenomena. Their goal was to see the effect of that pilot experience and situational assessment had on the decision to continue into poorer weather conditions. They used 36 pilots and had the pilots conduct a simulated flight, where the participants would encounter the poor weather conditions early (short group) or later in the flight (long group). The researchers examined the situational assessment of the pilots by comparing estimated visibility and cloud ceiling compared to
the actual conditions shown. They also examined the amount of time the pilots continued into the degrading weather.

It was found that every pilot flew past the initial point of weather deterioration. However, 35 of the 36 pilots eventually diverted and the last one crashed. However, the group that encountered the weather earlier traveled significantly longer and farther into the poor weather compared to the group that encountered the weather later in the flight. There was approximately an equal amount of participants that overestimated the weather, underestimated the weather, and were correctly estimating the weather. What was interesting is that the pilots in the group that were exposed to the weather later in the flight were able to significantly better estimate the cloud ceilings while the group that got it earlier generally overestimated the ceilings (Wiegmann et al., 2002). Pilot experience was also taken into account, and as expected, those with less experience flew farther and longer into the poor weather.

Simulation has been attempted to improve aviation in the past, though only one study was found to directly address simulations effect on aeronautical decision making (ADM). Connolly, Blackwell, and Lester (1989) examined the use of simulation on ADM in flight training using 16 flight students. Each of the flight students received four hours of ground school on decision making and then four hours of decision-making training in the simulator. The second group of 13 was given four hours of basic instrument flight training and four hours of simulation training on basic instrument flying with no decision making training. To examine the decision-making skills, the participants flew a pretest cross country and a posttest cross country, both under VFR
conditions. Each flight had the same number of decisions in them. It was found that the group that had focused on Aeronautical Decision Making (ADM) performed significantly better than the group without ADM training (Connolly et al., 1989). However, the disparity between the groups' performance should have been expected as the control group only received basic instrument flight training, which does not directly link to VFR flight procedures. In addition, there was a time on task issue with this study. Essentially, the participants who were in the ADM group received eight hours of training beyond the other group. Connelly et al.’s study set the basic understanding that ADM can be trained and that it was a viable strategy to teach ADM. This study attempts to focus not on training decision making directly, but on overall training. It also attempts to address some of the weaknesses of Connelly et al.’s study by having time on task being even, and training the participants in the same topic areas as they would fly.

**Multimedia Education**

Dictionary.com defined multimedia as “the combined use of several media, as sound and full-motion video in computer applications” (Dictionary.com, 2013). Multimedia is any form of information that can provide multiple forms of information. For example, a television program provides both visual and auditory information. Auditory and visual information can be applied to almost any of the current technologies within the classroom from television to tablets. However, many of the concepts have had mixed reviews. A more modern definition may be that multimedia is an interactive multi-sensory experience (Gulliver & Ghinea, 2010).
In that vein, it is critical to consider the possibilities that exist for using multimedia as an instructional tool. In order for us to consider its implications we need to consider instructional tools as a whole. Multimedia is often presented using the latest tools, with the 1960s, 1970s, and 1980s using television and then transitioning to the CD-ROMs in the 1990s. Currently, the delivery system is the Internet and all of the possibilities of Web 2.0 and beyond contained within (Frey & Sutton, 2010). However, there is still a lot of debate as to the effectiveness of these instructional technologies.

The debate over the effectiveness of multimedia and newer instructional technologies as a whole has lasted for decades. There are over 60 different meta analyses that have been accomplished since the 1960s (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Unfortunately, these meta-analyses tended to indicate that there is often little difference with the inclusion of technology. It was shown that most of the changes found by the meta-analysis were from novelty effect or other variables (Clark, 1994; Cuban, Kirkpatrick, & Peck, 2001). Most of the technologies have come in with much promise, but just never really moved forward as well as was originally hoped. Even if there is some acceptance, there are limited uses with the general school systems use of technology (Cuban, 1986). However, even though there have been findings that show there is little additional effect on student learning, we still use the technology. In my mind, even though multimedia has proven to merely be a tool, we must develop it and use it properly to have multimedia reach its maximum effect.

Michas and Berry (2000) examined the effectiveness of multimedia presentations of procedural tasks. Procedural tasks are used directly within aviation, though the
authors focused on a first aid procedures for their studies. Michas and Berry used three experiments to examine procedural training with multimedia presentations; the first experiment was to assess a number of different media. Experiment two was to assess the beneficial effect of text and pictures and why that improved learning could not wholly be described with the duel coding theory. Finally, experiment three was to assess the contiguity effect. It was found that, even though a number of media were assessed, there was an advantage to text and line drawings together with video presentations as opposed to still pictures, line drawings, or text alone (Michas & Berry, 2000). For experiment two, the researchers found that the effectiveness of media combinations had a relationship to the extent the materials were discussed, which makes sense. Finally, their experiment showed that it could be effective to show the words and images at the same time. It should be noted, though, that Mayer’s multimedia learning concepts are generally accepted as the most effective ways to develop multimedia learning (Mayer & Anderson, 1992; Michas & Berry, 2000; Moreno & Mayer, 1999).

When looking at the studies available on the subject, even though some claim that there is no effect, we can see a lot of mixed results from many studies (Michas & Berry, 2000). These often showed that there were no significant differences between the groups, but as one examines them there is an issue. Kozma (1986) compiled a number of studies discussing the use of television, and though not a meta-analysis, he was able to show that there was still a great amount of discussion as to whether the media had an effect on learning (Kozma, 1986; Zhang, Zhou, Briggs, & Nunamaker, 2006). These early systems did not provide much in the way of interactivity. Interactivity is a key component when
discussing the use of technology and learning (Herrington & Oliver, 1996; Zhang et al., 2006).

Herrington and Oliver (1996) put forth a paper discussing the implications of multimedia and learning and its role with teachers. The goal was to address what they dubbed the “goodbye teacher” syndrome. Essentially, the designs for many self-contained multimedia learning modules are designed for the individual learner to use without a teacher involved. Using completely automated presentations would move the instructor out of the process, possibly reducing collaborative efforts. However, they discussed that it is often better to have situational learning (learning that can be applied to individual students) and collaborative learning than using wholly situational learning on an individual level. Both of these aspects are directly interactive operations that need to be considered.

Zhang et al. (2006) examined the effect of using different levels of interactive video within the online learning environment. Interactive video was defined by the research team to be “the use of computer systems to allow proactive and random access to video content based on queries or search targets” (Zhang et al., 2006, p. 17). They hypothesized that interactive video would improve test scores compared to non-interactive video and no video at all. Zhang used a pre- and posttest design to examine the improvement of the students after the lesson. There was a significant difference between the interactive video and all of the other groups. It should be noted that the other groups did not have significant differences between each other, meaning the true interactive video was the most effective mode of instruction in Zhang’s study. That
would indicate that interactive video allowed for more learning to occur as well as the other types (including in class lecture) were on par with each other. It would be inferred that more learning occurs with more interactivity.

Zhang et al.’s study (2006) missed some of the most fundamental advantages of current technology, however, such as rapid moving about the video with a minimal disruption to the course time. It is also possible with current technology to provide direct interactivity to the video itself. Parts of the video could be hyperlinked to the corresponding Wikipedia page for more information about the topic. The improved interactivity within the video provides the capability of adjusting to the learner’s preferences is one of the key abilities of current multimedia.

Although there are a number of studies that indicate technology should not matter, such as Clark (1994), a number of others, like the Zhang et al. (2006) study examining interactivity, indicate that it is actually effective (Sitzmann, 2011). The usefulness of technology is especially true when you look at the computer as a whole. There is a camp of researchers that indicate that there is a huge amount of potential within computers, and within multimedia in particular. Many interactive software provides instant feedback and effective direction (Cole & Todd, 2003; Hattie & Timperley, 2007). Feedback is one of the critical components of learning (Hattie & Timperley, 2007). With current technologies you can provide instruction to the student with real time questions that would provide an auditory buzz when the student selected the incorrect answer and then show the student a video on the missed material. However, it is important to remember
that much of learning also has to do with the design of the lesson (Charsky & Ressler, 2011; Clark, 1994; Herrington & Oliver, 1996).

A major contributor to the field of educational multimedia design and effectiveness is Richard Mayer. Through his research there has been an expansion of the how, when, and why to use the multimedia options. An example was when he found that students showed enhanced learning through the use of explanatory images (Mayer & Gallini, 1990). Essentially, the closer you keep the visual and auditory information the better off you are (Moreno & Mayer, 1999). Mayer’s research is in keeping with the concept of Dual-Coding, as we are more effective at learning when it is provided in two different channels over just one (Paivio, 1990). In essence, more information will be missed if information has to be read while watching a movie. However, more information will be absorbed if the movie is narrated.

Mayer (Mayer & Anderson, 1992) presented several cognitive theories as applied to multimedia learning. He discussed three critical cognitive processes when dealing with information and how to apply them to multimedia learning. Selecting, organizing, and integrating the information provide the basis for effective uses. Mayer, using these processes, postulated five main design principles that when applied to the multimedia should improve their effectiveness (Mayer & Anderson, 1992). First, it is best to present an explanation in both words and pictures, not words alone. An example is the experiment by Mayer and Anderson where students in two groups were provided either visual representation on how a bicycle pump works or a visual and auditory description of the pumps operations. The group that had both the visual and auditory instructions
were about twice as effective at the problem solving tests than those with just the visual representation (Mayer & Anderson, 1992).

The next principle makes sense; keep the like material together with other like materials (Mayer & Anderson, 1992). Overall, students will learn more if you keep the materials related to each other together. Taking the concept of dual coding and split attention into account, it is critical to have the information presented on different channels (Paivio, 1990). Consider watching a film with subtitles; it is possible that you miss some of the visuals while considering and processing the written information. Yet you can watch a film within your language without much issue. The fourth principle is the other principles are less important for someone who has a higher level of knowledge and better spatial learning. The final principle is keep things simple. Avoid using a lot of extraneous language.

It is also critical to keep the educators within the educational loop. There needs to be some guidance provided to the students within, at least the start of the media, for the students to have an effective educational experience (Frey & Sutton, 2010). Consider that many students, especially students without a background in the material, will need help with a starting point to the material. Maintaining the stability of the learning objectives does have an advantage over the students moving on their own through all of the media available.

These multimedia systems are designed to provide online learning through the use of interactive video with a self-paced PowerPoint and lecture notes (Zhang et al., 2006). Overall, the videos are connected with each slide of the PowerPoint, having the instructor
be seen and heard asynchronously. If it is not interacted with, the systems will simply continue through the slides and videos. However, the student has the option to move between slides and videos, pause and reread the notes provided, and even slow the system down. The interactive system study showed that with the use of interactive video there is an increase in learning (Zhang et al., 2006). However, if non-interactive video is used there was no real difference shown (Zhang et al., 2006).

What is becoming clear is that there needs to be a change in the educational research direction. There are literally thousands of articles that address the use of technology in the classroom. However, we tend to look at the macro level and not enough at the micro level (Sitzmann, 2011; Tamim et al., 2011). For example, it has been found that the use of multimedia to aid the students learning basic chemistry improved their scores (Ardac & Akaygun, 2004). We have also seen that when the media provides feedback to the students there is an increase in motivation (Ardac & Akaygun, 2004; Mayer & Anderson, 1992) provided the students are not confused on the operation of the equipment. As such, it is critical for us to continue to examine the effectiveness of multimedia on the newer platforms and techniques. A number of other concepts need to be considered when designing multimedia lessons.

**Simulation**

Simulation provides an important capability within the realm of training especially in aviation and other complex high risk industries (Kincaid, Hamilton, Tarr, & Sangani, 2003). These high risk industries require an operator with a level of mastery of skills to safely complete tasks. However, most skills, from learning the basics of
arithmetic to learning to read, follow the same pattern. As such, critical skills can be reinforced and tested by the use of simulation. Using the example of instrument flight operations, flying the aircraft without reference to the outside of the aircraft, Ortiz (1994) saw a marked improvement of initial instrument students utilizing the basic flight simulation for procedures and flight skills. However, a study by Roessingh (2005) indicated that there was no significant difference in the transfer of skills, though people were able to accomplish more maneuvers in the same amount of time compared to people only flying showing simulation as more efficient at training maneuvers but not better. However, there is not a significant amount of study into the actual effectiveness of simulation.

Simulation has been considered a valid tool in training pilots since the 1940s. Since that time the military has examined the possibilities using simulation, including mission rehearsal (Nullmeyer & Spiker, 2000). Both the US military and US airlines have accepted and tested simulation for several decades. However, the military has had the advantage of funding and even the airlines have significantly more resources at their disposal as compared to GA. Aviation was one of the first industries to really delve into simulation. Airlines make extensive use of simulation in almost all aspects of training, from systems to actual flight procedures (Kincaid & Westerlund, 2009).

Military and aviation operations share many attributes, including time sensitive decision making and risk analysis. A number of studies found that there is an increase in decision-making skills in realistic simulations, as opposed to just showing high test score performance (Freeman & Cohen, 1996; Helsdingen, van den Bosch, van Gog, & van
Merrienboer, 2010; Kincaid & Westerlund, 2009). As such, it is possible that through similar training options, such as realistic Scenario Based Training (SBT) and simulation, we can improve decision-making skills in GA pilots. Civilian training is already moving towards SBT (Ayers, 2006).

A critical aspect of SBT is the concept of realistic training, essentially training in operations and actually running through the procedure completely and in full (Ayers, 2006). SBT can be accomplished in either actual flight or simulated operations. The goal is to provide the student a realistic scenario that would occur within the realm of normal, and sometimes abnormal, operations (Ayers, 2006). The issue with the true realistic operations in aviation is the risks associated with actual flight and effectively simulating abnormal or emergency operations. As such, simulation has become critical to instructing in these more intense situations as it allows for the practice of these situations safely.

As we can see, simulation provides an important capability within the realm of training by providing a way to practice high risk situations safely. Aviation, like any complex and risky industry, is a key example of where it is necessary to practice skills in a safe environment (Kincaid et al., 2003). Consider flight instructors—these pilots must have the basic flight skills, but also the more advanced skills in both judgment (for example, when to allow a new pilot to go solo) and decision-making skills (split second decision to land in a field, instead of attempting to return to the airport). These types of skills may require a number of experiences to fully master. Yet actual flight is not a great place to practice their skills before they are certain of them. So these pilots need to be
proficient before they have to use these skills in the air. Simulation provides a method to learn and maintain proficiency of flight skills (Roessingh, 2005). Each skill can be reinforced and tested by the use of simulation, as well as forcing practical and time sensitive decisions to be made. Though the actual quality of the maneuvers flown did not show significant improvement over non-simulation groups, it has been shown that students would practice more maneuvers during simulation training compared to the flight time possible in an actual aircraft and oftentimes received better ratings on those maneuvers from flight instructors. By reducing the time it takes in the actual aircraft to learn maneuvers, leading to an advantage in cost to the student and flight school when teaching procedures by using simulation (Roessingh, 2005). Reducing the actual flight time that a student needs to be proficient reduces the cost, considering some instrument programs can be as high as $8000.

Commercial aviation has used simulation training concepts for both maneuvers and other types of training for decades (Loft, Sanderson, Neal, & Mooij, 2007). In the airlines, a key aspect of operations is what is known as Crew Resource Management (CRM). CRM is an attempt to maximize the efficiency of operations as well as reduce errors within an operating environment (Gore et al., 2010). To implement effective CRM, the airlines have at least partially embraced what is called Line Oriented Flight Training (LOFT). LOFT style of training is designed to provide the applicants the experiences that are considered common in their airline carriers and then will add several anomalies during the simulated flight. In general, LOFT has been considered the most effective way to train airline pilots (Kanki, Helmreich, & Anca, 2010).
Kincaid and Westerlund proposed a new paradigm in simulation that will move from the clunky and expensive hardware to more virtual simulation. By shifting to a more virtual simulation has been shown to be very effective within the realms of business and medicine. The shift to a more virtual simulation reduced the costs of training simulators and improved the availability of simulation to many training organizations. However, aviation has been using the lower fidelity simulation to help in flight training.

The advent of PC based simulation programs, and more advanced smaller computers in the 1990s and on, has provided much cheaper training devices for aviation. These Aviation Training Devices (ATDs) and Flight Training Devices (FTDs) have made it easier for flight students and flight instructors to provide some level of simulation without undue cost. The effectiveness of these types of systems, especially in instrument flight training, has been well documented (Gaba, Howard, Fish, Smith, & Sowb, 2001; Leland et al., 2009). There is now even discussion of using simulation for effective transfer of skills related to unusual and upset attitude recovery techniques (Leland et al., 2009).

One specific study that focused on the PC level simulation was conducted by Ortiz. Ortiz (1994) examined 60 college students without any flight experience and ran 30 students on an ELITE ATD and the other 30 students went right to flight training in the aircraft. He found that the students that conducted training using the basic simulation before flight in an actual aircraft performed significantly better than those who did not. However, it is possible that the statistical difference occurred because of time on task as opposed to the simulation. Time on task is not as much of a deterrent in simulator usage
as it could cost students $120–$200 an hour for flight training in an aircraft while simulation, such as the training done by Orbitz, is significantly cheaper and possibly free depending on the institution.

There is additional evidence that simulation, specifically in the gaming form, can train or improve employees’ knowledge (Sitzmann, 2011). Improving knowledge and skills with gaming has been accomplished specifically in customer service operations, including at Cold Stone Creamery (Jana, 2006). The training course would provide a timed situation and the person would need to serve the customer while not wasting ice cream. Similar training courses has also been used by the company Cannon to instruct their tech agents to repair company copiers (Jana, 2006).

The use of simulation games and programs can have a positive effect on the student’s motivation. Motivation can have a large effect on the student’s achievements (Zaini & Ahmad, 2010). Motivation can come from simply providing a challenge in an immersive setting (Psotka, 1995). It is critical to point out that additional motivation can come from the novelty effect of the new systems and can be reduced if the simulation is poorly designed or hard to handle (Charsky & Ressler, 2011; Um, Plass, Hayward, & Homer, 2012; Zaini & Ahmad, 2010). However, some of this motivation is most likely from the possibility for instant feedback (Cole & Todd, 2003; Hattie & Timperley, 2007; Kulik & Kulik, 1988).

Simulation has the ability to provide lifelike situations with the option of providing immediate feedback to the participants (Issenberg et al., 1999; Sarter & Alexander, 2000). Immediate feedback has been shown to improve the learning of
students (Hattie & Timperley, 2007; Kulik & Kulik, 1988; Sarter & Alexander, 2000). We also need to consider the fact that the feedback in a simulation does not always have to be provided to the student only at the end of the operation. It is possible to provide a way to freeze the simulation, be it on the computer or with gaming simulation, and provide feedback within the simulation, allowing students to improve their chances of success as they go.

**Conclusion**

The purpose of this study is to assess the effectiveness of simulation training on decision making of flight students. Currently, the FAA allows the use of multimedia training for the knowledge portion of the pilot proficiency program, but I predict that simulation on its own, or in addition to that training, would improve the weaker areas of flight training. Also I predict that simulation’s realism would improve the decision making under actual conditions, where the multimedia training may be lacking in that area. Both of these predictions match the current literature.
CHAPTER III

METHODOLOGY

This study is used as a basic comparison to examine the differences in decision making between flight students using supplemental simulation training and those using a multimedia online lesson instruction. This study used a situational judgment exam and a flight simulator exam to assess the participants’ decision-making skills. This section begins by describing the general procedures used during the study. The procedure discussion includes the research design and recruiting of subjects, as well as what was done in the study. Next, there is a description of the variables being used, including the covariate of total flight time. Measures are also included with the descriptions of the variables. Then there is a discussion on the equipment that was used. The equipment section provides a description of the flight simulator and a basic overview of the multimedia lessons.

Procedures

Research Design

This study was a simple comparison between groups of decision-making capability, based on two instructional techniques. The measures examined the mean group scores on two examinations, specifically a written Situational Judgment Exam (SJE) and a practical simulated exam. A survey and a set of interviews with the simulation trained participants examined the perceptions of the participants.

The subjects were drawn from a convenience pool; in this study participants are students at University of Alaska Anchorage within the aviation program. The sampling
procedures match the basic sampling procedures outlined by Pagano (1998), as described in the participant section below, specifically there was a random assignment of groups through the shuffle method. Many limitations and delimitations were taken into account and minimized to the best of the researcher’s ability.

**Participant Procedures**

Participants were solicited from the private pilot and instrument flight courses at University of Alaska Anchorage’s flight program. The participants were given one of two standard human subjects consent forms (one for the simulation and one for the multimedia groups) and those that chose to participate were given extra credit within one of their current courses. The students that chose to not participate were given an alternative extra credit assignment of equivalent time and value. Participant simulation flight scores and situational judgment exams were not factored into determining the participants’ course grades and were kept anonymous.

During the initial contact with the students the research was described, including the goals of the study. The students were informed of the expectations of participants verbally and written in the informed consent form. To assign groups, an equal number of each was shuffled and the participants chose one. Each of the participants’ names and the number from the sheet were recorded in a spreadsheet. The participant numbers spreadsheet was kept on the office computer of the primary investigator and was in a locked office.

The participants chose a time and day each week to complete their lesson. In order to allow for maximum flexibility, scheduling was done each week with Fridays set
to be a makeup day if any participants missed their allotted time. The first day began the first lesson. The researcher attempted to maintain the same time and day for each student; however this did not work out in all cases and each participant then set up a time for the next week’s lesson at the end of their current lesson. At the end of lesson five, the participants were given the information sheet, the survey, and if they were the simulation group, the short interview. Finally, during week six or seven they took the SJE and the simulator practical exam.

Subjects

Due to different limitations, the sample size was 18, or two groups of nine. The target was two groups of 31, so the power most likely was low. The study used participants from the flight training students at the University of Alaska Anchorage. Participants were selected first from the private pilot flight courses and then participants were solicited from the instrument ground school. Participants were solicited through a presentation within their respective ground schools. With permission from the individual course instructor, the participants were offered extra credit and a minimum of half an hour of simulation time in the Redbird SD simulator per lesson or computer lab time to complete the AOPA lesson. As per the rules, those that chose to not participate were provided with an alternative extra credit assignment. Those that chose to participate signed up on a sheet providing an e-mail address and contact phone number. They were also given the IRB consent form and a written description of the study.

Flight students tend to be a homogenous group, with most students being between the ages of 18–24, though UAA’s particular demographic tends to lean toward the higher
age range. The course population tends to reflect the industry demographics, with a 10% female enrollment and a 15% minority enrollment. These students are primarily freshmen.

**Multimedia Control Group (MMCG)**

The multimedia online course group was the control group for the simulation assessment. After the participants were assigned a group, the MMCG group was scheduled in a computer lab at the University of Alaska Anchorage Aviation Technology Center where they were to go through the entire lesson. Those assigned to the multimedia group were first given instructions on how to use the computer software and shown how to log into the Air Safety Foundation’s (AOPA) website and activate individual courses. The participants were given an overview of the study again and told that they were expected to work independently on the given lessons from Aircraft Owners and Pilots Association’s Air Safety Foundation. They then began lesson one. Each participant needed to then create an individual login for the website. It was free and open to the public, and incurred no cost to the participant.

Each participant was given one online multimedia lesson to complete per week for a five-week period, with the goal being all of the participants were to take the course as a group at the same time and in the same room. The requirement of having everyone in the same room at the same time was changed as some of the participants got a later start due to scheduling issues. For example, one conducted two lessons in week three in order to catch up. Participants that were in the room together were told to log into the AOPA’s Air Safety Foundations course catalog. Each participant took the same lesson
on that day in the following order: Week 1: Saying It Right: Mastering Radio Communications; Week 2: Weather Wise Visual Flight Rules flight Into Instrument Meteorological Conditions; Week 3: Do the Right Thing; Week 4: Know Before You Go Navigating National Airspace; and Week 5: Mountain Flying. These lessons are further explained in Table 1. Participants were instructed to read each slide and watch each video in the course, no shortcutting. The participants then printed off the completion certificate with their participant number as their name. Each lesson was approximately 30 minutes long, with sign in and sign out and procedures briefing before each lesson. Each lesson was expected to take approximately 40 minutes. At the end of the final lesson, in week 5, the participants took the survey and filled out the basic information questionnaire. See Figure 1 for an example of the course slide.

Table 1

Multimedia Course Descriptions

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOPA ASF: Weather Wise VFR flight into Instrument Meteorological Conditions <a href="http://www.aopa.org/lms/courses/vfr-into-ime/fb.cfm">http://www.aopa.org/lms/courses/vfr-into-ime/fb.cfm</a></td>
<td>This course focuses on the effects on pilots, instrument or non-instrument, of entering Instrument Meteorological Conditions unexpectedly. It also includes what do when this does happen.</td>
<td>~30 min</td>
</tr>
<tr>
<td>AOPA ASF: Say It Right: Mastering Radio Communication <a href="http://flash.aopa.org/asf/radiocomm/swf/flash.cfm">http://flash.aopa.org/asf/radiocomm/swf/flash.cfm</a></td>
<td>This course provides instruction on proper communication techniques, including priorities of flying and communications with other pilots.</td>
<td>~30 min</td>
</tr>
</tbody>
</table>

(Table continues)
Table 1 Continued

*Multimedia Course Descriptions*

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOPA ASF: Know before you go, Navigating Today’s Airspace</td>
<td>This course instructs students on the various airspaces and what to expect when flying in those airspaces. This also includes information on how the airspace is arranged and when you will enter them.</td>
<td>~30 min</td>
</tr>
<tr>
<td><a href="http://flash.aopa.org/asf/kbyg/swf/flash.cfm">http://flash.aopa.org/asf/kbyg/swf/flash.cfm</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOPA ASF: Mountain Flying</td>
<td>This course instructs the student on the dangers of flying in mountainous areas. This will include some basic weather and handling of in flight emergencies.</td>
<td>~30 min</td>
</tr>
<tr>
<td><a href="https://flash.aopa.org/asf/mountainFlying/html/flash.cfm">https://flash.aopa.org/asf/mountainFlying/html/flash.cfm</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOPA ASF: Weather Wise Ceilings and Visibility</td>
<td>This course will provide a more in depth knowledge in the formation of low visibility conditions and the dangers that are included.</td>
<td>~30 min</td>
</tr>
<tr>
<td><a href="http://flash.aopa.org/asf/wxwise_ceilingvis/html/weatherSafety.cfm">http://flash.aopa.org/asf/wxwise_ceilingvis/html/weatherSafety.cfm</a></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Column one lists the Air Safety Foundation (ASF) course title and weblink. Column two provides a brief description of what material is covered and column three provides the average time of the course provided by Air Safety Foundation. These courses are free and public, but also are considered acceptable for continuing education from the FAA.
Figure 1. Example of course slide. The courses have a number of slides and video presentations which provided information to the students.

On the sixth week, the participants took the SJE. They were also given a 30-minute introduction on the use of the Redbird SD simulator (AATD). The introduction to the AATD included 15 minutes of explanation and 15 minutes of time for the participants to practice with the AATD. The practice time was to help minimize the concept of looking for controls and confusion from the AATD. The AATD was configured for an aircraft with which the participants were familiar, in this study it was a Cessna 172. After the simulator introduction, both groups were given the practical flight scenario. The participants were only examined on their decision-making skills, and not their flight skills, thus if they crashed during the practical flight scenario there would be no penalty if that crash was not associated with a decision. Focusing on the decision making skills was to offset the practice effect from the SEG using the AATD for extended time. If for any
reason, portion could not complete the flight portion immediately after the exam they
could reschedule up to a week after the scheduled time in order to accommodate their
schedule.

Simulation Experimental Group (SEG)

The SEG was given the same SJE as the multimedia group and was given the
same instructions as the other group as to the study set up. The SEG, however, also
received a 15-minute overview on how the Redbird SD operates as well as 15 minutes to
practice with the Redbird SD before their first lesson. The practice session included how
to use the systems, individual flight controls, and how to operate the communications
panel.

At the beginning of a training session, the researcher pre-positioned the aircraft to
the set location, based on the written scenario (Appendix A). They also verified that the
simulator was functioning. When the participant arrived, the researcher had the
participant sign in using his or her participant number and the time arriving. The
researcher then provided a brief overview of what the scenario would entail and what
equipment if any the participant would need during the scenario.

Each participant then flew an approximately 30 minute simulation scenario that
had the elements covered in the multimedia courses (for example, low ceilings, low
visibilities) listed in the last section, once a week for a five week period. They followed
the same topic progression as the other group. The specific topics per lesson are listed in
Table 2. Beginning each lesson, the researcher answered questions about the scenario
and read off of the specific lesson content as the participant flew the scenario. The
researcher also acted as the Air Traffic Controller when necessary. At the completion of the scenario, the participant signed out of the room in the same way he or she signed in.

Table 2

Scenario Subjects

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Topic</th>
<th>Matching AOPA lesson</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Communication</td>
<td>Say It Right: Mastering Radio Communication</td>
<td>30 Min</td>
</tr>
<tr>
<td>2</td>
<td>Visual Flight Rules (VFR) into Instrument Metrological Conditions (IMC)</td>
<td>Weather Wise VFR flight into IMC</td>
<td>30 Min</td>
</tr>
<tr>
<td>3</td>
<td>Basics of effective decision making</td>
<td>Do The Right Thing: Decision Making for Pilots</td>
<td>30 Min</td>
</tr>
<tr>
<td>4</td>
<td>Mountain Flying</td>
<td>Know Before You Go: Mountain Flying</td>
<td>30 Min</td>
</tr>
<tr>
<td>5</td>
<td>Airspace</td>
<td>Know Before You Go: Navigating Today’s Airspace</td>
<td>30 Min</td>
</tr>
<tr>
<td>6</td>
<td>Exam</td>
<td></td>
<td>30 Min</td>
</tr>
</tbody>
</table>

The participants were expected to complete one scenario per week and each participant completed the same lesson as the other participants that week. However, due to a scheduling conflict with the simulator and a person starting the treatment late, two participants needed to conduct two lessons in a week, one in week two and one in week three. At the completion of the lesson, the participant worked with the researcher to verify his or her next scheduled date and if necessary adjust the schedule to ensure no miscommunication. During week five, the participants were given the survey, filled out the basic information sheet, and received the short interview.
On the sixth week, the participants took the SJE posttest. When the participant arrived, they signed in as usual. However, they then immediately got instruction on starting the SJE. Afterward, the participants flew the practical flight scenario using the Redbird SD. If for any reason they were unable to complete the flight portion immediately after the exam, they could reschedule up to a week after the scheduled time in order to accommodate their schedule. The researcher observed the practical exam and followed the outlined procedures and assessment protocols (Appendix C). After the completion of the flight the participant signed out. Finally the researcher entered the data from the flight assessment immediately into a spreadsheet. The researcher graded the paper SJE at a later time, but the data were entered no later than a week after the exam had been taken.

**Collecting Data**

The SJE was conducted at the end of the treatment period. The exam was given in paper format, with each participant identified only by his or her participant number. Participants were given one hour to take the exam. The exams were collected at the end of the hour whether or not the participant completed the exam. It is important to note that the subjects did not use their names, but did use their group. So the simulation group wrote *sim* and the multimedia group wrote *MM* on their exams.

The SJE consisted of five questions per subject area. Participants were told to select the answer that best matched what they would do for each given scenario question with no write ins allowed. These questions (Appendix B) are designed to be a simple scenario in which the participant provided what they would do in the situation. Each
participant’s completed exam then had the answers compared to the ranked answers given by two current flight instructors and an operations manager with significant flight experience. Participants got a higher score on a given question if they selected a better answer. After the exams were graded, the scores were compared between groups. The simulator group scores were then compared to the multimedia group scores.

The participants were also given a simple survey (Appendix D) that assessed their perceptions of the training and the training’s motivating factors. Each group was given an individualized survey with three categories of questions. The first set of questions was about their perceptions of the design of the training and the equipment. The second set was on their perceptions about the effectiveness of the training. These questions used a scale of zero to five on various statements pertaining to the training with these surveys (Appendix D). Also included was a basic information sheet to get current information about their flight experience.

The practical exam was conducted using the REDBIRD SD FTD, a non-motion Advanced Aviation Training Device (AATD), where participants were instructed to fly a set scenario with a number of decisions imbedded into it (Appendix C). Before they began, they were given a review of the individual control operations, to include special emphasis on the use of the flight controls. The researcher then loaded the data file on the Redbird SD and verified that the program placed the aircraft on runway one at Kent State University Airport (1G3). The researcher and participant then followed the given scenario listed in Appendix C. Finally, the simulation group was given a short interview about their perceptions of the use of the simulator and the effectiveness of the training.
The interview gave the researcher the opportunity to ask more in-depth questions than the survey.

Variables and Measurements

The independent variable for this study was the supplemental instruction type, specifically simulation versus multimedia instruction. The groups were randomly assigned and each participant was tested in a consistent manner. The measures and variables are described below.

Measurements

Three main dependent variables were assessed. The first variable was decision-making accuracy. Decision making was assessed by the Situational Judgment Exam (SJE) and the Practical Simulation Exam (PSE). The SJE had five questions from each lesson, for a total of 25 questions. All SJE questions were multiple choice, where each answer was worth one to four points, based on the appropriateness of the decision, as rated by the panel of experts. The individual’s decision-making accuracy was indicated by how well the participant scored on the SJE. The participants that scored higher therefore showed better decision-making skills. Participants were scored based on the effectiveness and safety of their decisions, as well as how well the decision follows the federal regulations when compared to a baseline set of answers from an independent flight training expert. It should be noted that the initial questions were vetted through an experienced flight instructor in an open format (non-multiple choice) to examine the both questions and answers. The multiple-choice questions were created and adjusted based
on the feedback from that experienced flight instructor. Once the questions were created, the second step was to have those answers assessed and marked.

The choices were ranked based on safe and efficient answers to the situation by a group of flight instructors and flight operations manager from University of Alaska Anchorage. Each of the evaluators was asked to give his or her assessment on how correct a given choice was for the given question. Each was to examine and rank the four answers from most correct to least. To assign final values to the questions, the majority rule was used and points were assigned based on which answer got the most votes for best, followed by the next most votes with second best. There were differences, but a majority was often found. In the rare cases where there was not a majority for an answer, the researcher was the tie-breaker. There was a majority for the other three answers in all but two cases. There will be further discussion on the validation techniques later in this chapter.

To provide a value of the participants’ judgment, each answer had a value assigned based on the rank that the faculty and flight instructors gave the answer. The best answer was worth four points for the question, the second best was worth three points, and so on until the worst was assigned one point. With each question having a maximum score of four points, the maximum score for the exam was 100 points. Table 3 has a sample of a question from each subject as well as the examination objective of the subject area. The complete exam is provided in Appendix B.
### Table 3

**Situational Exam Subjects and Example Questions**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Objective</th>
<th>Sample question</th>
</tr>
</thead>
</table>
| **Communication** | Miscommunication can lead to a number of flight issues and is a safety issue. We hope to see a solid set of decisions based about when and how to communicate. | You are flying along when you begin to have engine roughness. You apply carburetor heat and after a several minutes you notice the engine smooths out, however you have gotten yourself lost. What is your initial action?  
   a) Continue flying the aircraft and focus on control until you can communicate with someone. (4pts)  
   b) Fly the aircraft to a higher altitude and focus on the chart to find your position. (3pts)  
   c) Immediately attempt to contact local air traffic control. (1pt)  
   d) Begin to adjust the Navaids until you find a signal that is usable. (2pts) |
| **Visual Flight Rules (VFR) into Instrument Metrological Conditions (IMC)** | This is considered one of the most deadly situations within general aviation. We are looking for decisions that indicate an understanding on the danger and acceptable counter actions. | During a local flight to the practice area you quickly notice that the visibility is dropping fast. However it still looks to be VFR, though marginally. You need to consider your options. What will you do?  
   a) I will do the 180 degree turn around. (4pts)  
   b) I will attempt an off field landing. (1pt)  
   c) I will try to fly under the clouds to the nearest airport. (2pts)  
   d) I will attempt to continue to my destination. (3pts) |
| **Overall Safety** | These are the basic skills that the FAA looks to and is examining. We are looking for the participant to understand how to make these decisions. | In aviation, the environment is often changing. Before flying it is often considered a best practice to have defined your personal minimums for safe flight. Considering a rapid change in weather conditions during a flight such as a wind shift to beyond your crosswind limit, when is it acceptable to go past your personal minimums?  
   a) When you are faced with no other safe option, such as a low fuel situation. (4pts)  
   b) When you are flying with an instructor and are trying to learn. (2pts)  
   c) When you have a set “escape plan” like if I am not on a stable approach by 200ft AGL then I will go to an alternative airport. (3pts)  
   d) Anytime the safety of flight maybe compromised more by inaction. (1pt) |

*(Table continues)*
Table 3 (continued)

Situational Exam Subjects and Example Questions

<table>
<thead>
<tr>
<th>Subject</th>
<th>Objective</th>
<th>Example question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain Flying</td>
<td>The group examined is learning within a mountainous area. We are looking</td>
<td>You have a complete electrical failure at night in the mountains. While an</td>
</tr>
<tr>
<td></td>
<td>for the participants to make safe choices when dealing with the basics of</td>
<td>inconvenience, it does not truly affect your flight, at least until you notice</td>
</tr>
<tr>
<td></td>
<td>mountain conditions and the limited options they may face.</td>
<td>the smell of ozone. You know this may be an electrical fire. So what do you</td>
</tr>
<tr>
<td></td>
<td></td>
<td>believe is your best option in this situation?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a) After extinguishing the fire, land as soon as practical at an airport. (4pts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Find and land at the nearest suitable road. (1pt)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Extinguish the fire and then find a place to land. (3pts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Radio a mayday and land on the nearest road. (2pts)</td>
</tr>
<tr>
<td>Airspace</td>
<td>Most participants have little experience with more complex airspace. This</td>
<td>You are flying from Kent State Airport (1G3) to Detroit (DTW). You notice that</td>
</tr>
<tr>
<td></td>
<td>lesson will see if they are able to learn the material and make good</td>
<td>your flight takes you through two blue airspaces with the markings R-1923 and</td>
</tr>
<tr>
<td></td>
<td>decisions on a type of flying they are not familiar with.</td>
<td>P-403. How would you handle these airspaces?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a) Plan around the P-403 and contact the controlling agency for R-1923. (3pts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Attempt to fly above both of them. (2pts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Plan around them over Lake Erie. (1pt)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Plan around them over land. (4pts)</td>
</tr>
</tbody>
</table>

Note. This table is a basic overview of the SJE. Table 3 is to provide the reader with the general goals of the examination including a sample question from each section.

Practical Decision Making

Finally, participants from both treatment groups were given a simulation practical exam. Participants who had not used the simulator were given a 30-minute introduction to get used to the simulator. Then participants from both treatment groups were given the same scenario listed in Appendix C. The scenario lasted approximately 45 minutes and assessed the instruction covered in the five lessons. The scenario is listed in Appendix C. The participants had four main decisions that were assessed:
1. The first decision was the decision of the proper altitude for the cross country operations. Participants derived the altitude from the weather given. During real world operations, the pilot would have to select the most advantageous altitude to accomplish the goal of getting to their destination. That decision takes into account the current winds at altitude, but also included an assessment of pilot and aircraft limitations, such as not flying into the clouds if you are not instrument rated, and fuel assessment. There were eight total possible points. The researcher observing the flight noted what decision the participant made and graded them based on the associated rubric (Table 4).

Table 4

*Rubric for Decision 1: Altitude Selection*

<table>
<thead>
<tr>
<th></th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accounting for the ground obstacles</strong></td>
<td>Any below 2000</td>
<td>2500-3000</td>
<td>Above 3000</td>
</tr>
<tr>
<td><strong>Weather minimums</strong></td>
<td>Above 5500</td>
<td></td>
<td>At or below 5500</td>
</tr>
<tr>
<td><strong>Regulations</strong></td>
<td>Does not follow the cruising altitude rules</td>
<td></td>
<td>Does follow the cruising altitude rules</td>
</tr>
<tr>
<td><strong>Winds</strong></td>
<td>4000 and above</td>
<td>3500</td>
<td>3000</td>
</tr>
</tbody>
</table>

2. The next decision the pilot needed to make was what to do when Cleveland ATC denies entry into Class B airspace. There were a number of allowable options, but some are not as efficient as others, such as going around the airspace and adding time to the flight. The scenario represented the real world
delays associated with larger airports and small aircraft. In addition to the delays, decision two examined the communication and the understanding of airspace. There was a total of six points possible. The researcher observing the flight noted what decision the participant made and graded them based on the associated rubric (Table 5).

Table 5

**Rubric for Decision 2: Class B Airspace**

<table>
<thead>
<tr>
<th>Choice</th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situational Awareness</td>
<td>Does not realize</td>
<td>Realizes</td>
<td></td>
</tr>
<tr>
<td>Understanding of the Regulations</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

3. The third decision was an assessment of visibility knowledge and options as to what to do when conditions change from visual flight rules to instrument meteorological conditions (IMC). The visibility was reduced in increments until it was only two miles. Lowering visibility is common during the changes of the seasons, especially in Ohio. Decision three simulated flight into IMC conditions. It has been noted that inadvertent flight into IMC has been a major cause of fatalities in general aviation (Kennedy, Taylor, Reade, & Yesavage, 2010; Wiegmann et al., 2002; Wiggins & O’Hare, 1995). There were six total possible points for the third decision assessed. The researcher
observing the flight noted what decision the participant made and graded them based on the associated rubric (Table 6).

Table 6

*Rubric for Decision 3: VFR into IMC*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not realize</td>
<td>Continue</td>
<td>Do 180, Divert</td>
<td>Land Off Field, Contact ATC</td>
</tr>
<tr>
<td>Does not realize</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entering Visual Flight Rules into Instrument Meteorological Conditions</td>
<td>Yes</td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

4. The final decision was what to do when an adverse event occurs. The researcher induced carburetor ice into the simulation. Decision four assessed the student’s emergency actions and decision making under a time constraint. Time constraint is often an element of an emergency, especially in aviation, often limiting the options available to the pilots to produce a safe outcome. Using a simulated engine failure during a high workload segment of the flight when over water provided an assessment of the participants’ decision making ability under stress and time constraints. There were eight points possible for this decision. The researcher observing the flight noted what decision the participant made and graded them based on the associated rubric (see Table 7).
Table 7

*Rubric for Decision 4: Engine Failure in Flight*

<table>
<thead>
<tr>
<th></th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>Divert</td>
<td>Land off Field</td>
<td>Carb Heat, Land at SKY, Run Checklist</td>
</tr>
<tr>
<td>Situational Awareness</td>
<td>Does not realize</td>
<td></td>
<td>Realizes</td>
</tr>
<tr>
<td>ATC</td>
<td></td>
<td>Squawk 7700</td>
<td>Contact ATC</td>
</tr>
<tr>
<td>Entering VFR into IMC</td>
<td>Yes</td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

Each of the above evaluations were scored based on the decision-making skills of the participants, not the flight capability of the participant. Not examine the participants’ flight ability was done to minimize the practice effect that should come from the SEG being more familiar with the simulator itself. It should also be noted that there is not always a middle ground when the students make a decision. At times safe operation and regulations will require certain actions to effectively protect the aircraft, pilot, and public. As such, several of the decisions have a good or poor option. These specific decisions provided more feedback as to how well the participants learned the regulations that should influence decisions within their courses.

To examine the total number of choices that were made by each group, in each category of decision, we took each group’s total poor, fair, and good decisions and compared the two groups using a basic $t$-test. The total score is part of the ANCOVA. By looking at a poor error count, the researcher was able to examine which group made more poor decisions and indirectly made less safe decisions.
**Covariate**

Finally the individual’s total flight time was used as the general gauge of the overall experience of the pilot. As such, the total flight time was used as a covariate to minimize the impact that the experience has on the pilot’s SJE scores and the simulation scenario. Originally, it was planned to also use the participant’s total simulated time as an additional covariate for the simulation scenario; however, by including the instrument flight students and the changing rules by the FAA, there was not an even distribution of simulator time and it did not meet the assumptions for an ANCOVA.

**Measurement Validation**

While there was limited time to fully address the validation of the instruments used, there was an attempt made to improve the validity of the instruments. The SJE questions were first designed around the information provided in the lessons the participations took. Once the questions were created, two flight instructors were consulted to provide feedback and open ended answers to the questions. After recording those answers and shifting them to a multiple choice format, one flight operations manager (also a pilot) and two more flight instructors were asked to rank the answers from one to four. A majority ruled and conflict was addressed through discussion until a consensus on the final ranking was made.

The PSE decisions were based around more common or dangerous situations in aviation as described in the literature (Aircraft Owners and Pilots Association, 2012). Low altitude and visual flight rules into instrument metrological conditions are often connected to loss of control and are some of the more deadly situations (Aircraft Owners
and Pilots Association, 2012). Airspace incursions are not often deadly, but because they deal with legal issues and can cost a pilot their certificate, they were included. Finally, the engine failure was used to address the time dimension and how it impacted decision making. Each of these situations has been used separately in training before by the researcher and have in his experience been able to test decision making, but were never used cohesively in the same scenario prior to this study.

**Equipment**

We used a Redbird SD Advance Aviation Training Device, or AATD (see Figure 2). A Redbird SD is an FAA Certified AATD that has all functional controls and most of the avionics have functioning physical switches, however the AATD lacked any form of motion. The Cessna 172 digital model was used for all simulation. A Cessna 172 is the closest model of aircraft to which the students are exposed in their flight training. The Redbird SD AATD was used by the simulation group for their training as well as to conduct the PSE for both Groups.

The multimedia courses are provided by the Aircraft Owners and Pilots Association’s (AOPA) Air Safety Foundation free to the flying public and are approved by the FAA to be used as ground training for pilots for their required recurrent training. AOPA courses can run on computers and cell phones with java and/or flash enabled. However, the participants were required to use the computer lab to maintain the integrity of the experiment and to keep more accurate track of the time spent on each lesson.
Figure 2. A Redbird SD AATD example. Figure 2 shows the panel and display from the Redbird SD. Source: http://www.redbirdflightsimulations.com.sd/

**Data Analysis**

**RQ1:** Does flight simulator training have an impact upon decision making in comparison to traditional multimedia instruction as measured by the Situational Judgment Examination?

To test this question, a one-way analysis of covariance (ANCOVA) was used to do the comparison between the group means. We used an alpha level of .05 for significance and the null hypothesis was $H_0: \mu_{sim} = \mu_{multimedia}$. The alternative hypothesis statement was $H_a: \mu_{sim} > \mu_{multimedia}$. The covariate used was the student’s total flight time. The primary comparisons for the ANCOVA were based on the final score on the mean SJE for each group. However, the mean scores between the different
topics within the SJE were also examined using a \textit{t-test}. The SJE overall analysis is to indicate if simulation may be more useful in a given area of flight training on a multiple choice exam similar to the FAA knowledge exams. These are indicated within the ANCOVA matrix indicated in Table 8. Total flight time was used as a covariate to minimize the effect the different experience levels had on the SJE scores. As such an ANCOVA provided a statistical control to those differences in experience. Total flight time was collected from the participant just before taking the SJE, not when he or she started, to account for the continued training, as each student progresses differently (some slower, some faster).

**RQ2:** Does flight simulator training have an impact upon decision making in comparison to traditional multimedia instruction as indicated during the flight simulator exam?

Since it is impractical and can be risky to introduce additional flight examination to test the decision-making skills in an actual aircraft in marginal conditions, we used a simulator flight scenario to examine the participant’s decision-making skills in as close to actual conditions as possible, the PSE. The participants flew a preset route and a specific scenario without any guidance from the researchers, though the researcher did act as ATC to provide realism and complete the airspace scenario requirement. The researcher then scored the imbedded decisions within the scenario. The simulator score was based on the decisions made during the flight, with a total of 28 points possible for each flight as discussed in the above section on the practical simulator scenario. The mean score of the
group was used to compare the simulation and the multimedia groups. The comparison matrix is shown in Table 9.

Table 8

**Situational Judgment Exam Comparisons**

<table>
<thead>
<tr>
<th>Section Scores</th>
<th>SJE total Mean Group Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simulation</strong></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
</tr>
<tr>
<td>Visual Flight Rules (VFR) into Instrument Metrological Conditions (IMC)</td>
<td></td>
</tr>
<tr>
<td>Basics of effective decision making</td>
<td></td>
</tr>
<tr>
<td>Mountain Flying</td>
<td></td>
</tr>
<tr>
<td>Airspace</td>
<td>Total out of 100</td>
</tr>
<tr>
<td><strong>Multimedia</strong></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
</tr>
<tr>
<td>Visual Flight Rules (VFR) into Instrument Metrological Conditions (IMC)</td>
<td></td>
</tr>
<tr>
<td>Basics of effective decision making</td>
<td></td>
</tr>
<tr>
<td>Mountain Flying</td>
<td></td>
</tr>
<tr>
<td>Airspace</td>
<td>Total out of 100</td>
</tr>
</tbody>
</table>

*Note.* The decision-making score is the mean score of the group on the SJE. We also examined the individual section scores to see if there were any differences between the five topics between the groups.

Before the participants arrived, the researcher configured the initial setup of the simulator for the PSE. He or she set the initial point of the aircraft at Kent State Airport (1G3). The clouds and visibility should match the actual weather given in the weather report: scattered layer of clouds 2200 ft, broken 3000 ft, overcast 4100 ft with 10 miles visibility. However the winds were kept at zero; reducing the realism by keeping the winds at zero helped to reduce some of the errors that the participants may have had with the use of the simulator. Most of the time the simulators are more sensitive to the control inputs of the pilot than the actual aircraft.
For the analysis, I used an alpha level of .05 and I used a null hypothesis of 

\[ H_0: \mu_{\text{sim}} = \mu_{\text{multimedia}} \]

and an alternative hypothesis statement of \[ H_a: \mu_{\text{sim}} > \mu_{\text{multimedia}} \]. For the ANCOVA using the covariate of total flight time. Total flight time was used as a covariate to minimize the impact of using additional participants from the instrument course rather than just the primary private pilot training. The ANCOVA design is indicated in Table 9. It is important to reiterate that I only examined the decision-making aspect of the simulator exam, not the actual capabilities of flying the machine.

Table 9

**Practical Exam Comparison**

<table>
<thead>
<tr>
<th>Decision Score</th>
<th>Simulator practical score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation</td>
<td></td>
</tr>
<tr>
<td>Cruising Altitude</td>
<td>Total Score out of 28 possible</td>
</tr>
<tr>
<td>Waiting for clearance for class B airspace</td>
<td></td>
</tr>
<tr>
<td>Flight with deteriorating weather conditions</td>
<td></td>
</tr>
<tr>
<td>Engine Failure</td>
<td></td>
</tr>
<tr>
<td>Multimedia</td>
<td></td>
</tr>
<tr>
<td>Cruising Altitude</td>
<td>Total Score out of 28 possible</td>
</tr>
<tr>
<td>Waiting for clearance for class B airspace</td>
<td></td>
</tr>
<tr>
<td>Flight with deteriorating weather conditions</td>
<td></td>
</tr>
<tr>
<td>Engine Failure</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* The simulator practical score is based on the final score of the participants’ decisions made during the final simulated scenario. This will only be based on their decisions made, not on their ability to fly the simulator.
**RQ3:** Does flight simulator training have an impact upon the perceived effectiveness of training in comparison to traditional multimedia instruction?

The participants were given a survey at the end of their practical exam. The questions (Appendix D) used a Likert like scale and short answer for participants to provide the strength of their feelings for their training and motivation. The first set of questions addressed the perceptions of the decision-making experience of the participants and the second set of questions were used to assess the participants’ motivation in relation to the training. The first segment of two questions was an assessment of whether they enjoyed the training and if they would like to use the training. The next five assessed their experience with the technology. The technology questions examined how usable the technology was and thereby whether the participants felt it would be practical to use simulation or multimedia presentations.

For example, if the majority showed that they were not comfortable with using the simulator technology then the participants may not have learned as much as they could have. Questions eight through 10 provided an assessment of their perceptions about the skill transferability to the real aircraft. Table 10 shows the common questions between the two groups. Finally, the last three questions assessed the perceptions specific to the type of training, so these questions were different between the two surveys. Table 10 provides a complete list of questions and the Likert like scale. There were three additional questions on the survey for each group, however these were not assessed in this study and were used only for additional development of course work.
Table 10

*Common Questions*

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>I found the training enjoyable.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>I would like to have more of this type of instruction on different topics.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>It was easy to use the training materials.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>The training was interactive.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>The training was effective at teaching procedures and explaining the operation of the aircraft throughout the topic areas.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>The scenarios presented in the training were realistic and I believe they could happen.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>The technology used for the instruction functioned exactly as expected and without error.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>The materials Improved my knowledge about the subjects taught.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>The training will improve my decision-making skills as a pilot.</td>
<td>0 to 5</td>
</tr>
<tr>
<td>The training provided me with the skills that will be easily transferred to actual flight operations.</td>
<td>0 to 5</td>
</tr>
</tbody>
</table>

*Note.* 0 = not at all; 1 = slightly; 2 = somewhat; 3 = mostly; 4 = very significantly; 5 = entirely

The reason for the assessment of the perceptions of the participants was that if the participants believe the method is working, even if statistically it is not significant, then it should still have a positive effect on the participants’ performance (Turan, Demirel, & Sayek, 2009). The survey provided a more refined view of the practical significance of the intervention and let us explore if pilots are gaining confidence in their decision making in high stress, time sensitive, matters. To examine the differences between the groups, the researcher examined the totals of the questions that were the same between the surveys. Each sub grouping was examined using *t-tests* on the average.
The simulation group had an additional exit interview to gain a deeper understanding of the perceived value of simulation training, further providing knowledge of practical significance. We asked seven primary questions and then any follow up questions that were required. The seven primary questions were:

1. Please explain how you feel that the simulation training will affect the way you fly.
2. What was the most useful part of the simulation training?
3. Did you see any problems with the simulation? If so, please explain what they were.
4. Do you have any suggestions to improve the simulation to help you understand the application of skills during flight better?
5. Which subject that was covered in the simulation training was best augmented by the simulation?
6. Were there any topics that you felt were not aided by simulation?
7. What was your overall comfort level of using the simulator?

The first question was to examine the perceived value in the “real world” that the simulation had to the participant. If the participants were able to explain how the simulation training has changed their flying then the explanation should indicate their learning. If they were unable to articulate how they expect to change their flying, the inability to address the question may indicate a lack of knowledge.

Question two gauged what the participants perceived as the most useful portion of the simulation training to them. If the participants can directly point to an area that really
was helped by the simulation, focusing on that topic would allow flight instructors to focus training on those areas that the participants found useful, possibly increasing motivation. Focusing on specific useful aspects of simulation use improves resource allocation, as well as provides further research opportunities.

Question three was only applicable if there were perceived issues with the simulation training. If the participants all had similar issues with the simulation training, we could first examine the specific issue through future research as to why the participants were having issues with that aspect of simulation training. Second, for the topics the participants felt that the simulation was not as effective, it might be wise to not use simulation as a training media. It is also possible to adjust the simulation to improve its training in those deficient areas.

Question four’s goal was to address possible gaps in useful simulation training. If the participants had suggestions that could improve the transfer of training, it would be useful for future research. Looking at the suggestions would also be useful in examining the training course for further research.

Question five was a more direct examination of our training materials and topics. These answers would also allow for a more focused simulation training in the future. If we see the participants choosing the less applied training subjects (such as safety) then we may be able to more effectively use simulation in those areas. The choices of the participants may provide insight into their goals and what should be further researched.

Question six was a counter to question five, examining what the participants felt was less effectively taught by the use of simulation. Knowing what the participants felt
was less useful is more useful in the long run than knowing what was the most useful; if students do not see the actual advantage to a set of training then they are less likely to apply themselves.

Question seven was an examination of the participants’ feelings toward the simulator itself. If the participants were not comfortable with the simulation and its operation would have a de-motivational effect on their performance in the simulator. A lack of comfort could be transferred to the actual aircraft and could cause the students to leave flying. It could also indicate a limitation in this study, because if the participants were not comfortable with the simulator then any decision-making errors associated with the simulation may have been associated with the discomfort instead of their capability.
CHAPTER IV

RESULTS

Chapter 4 contains the results for each of the three research questions. The analysis of the data was conducted using SPSS version 21. The results description begins by describing the overall analysis process, including a brief review of the variables and measures. Each research question and the results for that question will be described. In the case of the qualitative data associated with the short interviews, the coding percentages are described and a table has the questions and an example of an answer given. A brief overview of the results will be given at the end of the chapter.

Overall Analysis Process

This study investigated the differences between the use of simulations and multimedia as a medium for delivering supplemental flight training upon primary flight students’ decision-making skills. The two groups examined were the simulation trained group, Simulation Experimental Group (SEG), and a multimedia trained group to act as the control, Multimedia Control Group (MMCG). Research Question 1 was examined using an Analysis of Covariance (ANCOVA) comparing the two groups Situational Judgment Exam (SJE) scores using total flight time of the participants (TT) as the covariate. T-tests were also used for Research Question 1 to examine the group differences in each segment of the SJE. Research Question 2 was analyzed using an ANCOVA design with TT as the covariate, comparing the groups’ total mean scores on the Practical Simulation Exam (PSE). Research Question 2 used t-tests to examine the group differences between the SEG and MMCG on individual decisions and the total
number of poor decision. Research question 3 used surveys and short interviews to examine how effective the participants perceived the training. The surveys used a Likert like scale and were examined using $t$-tests for each similarly grouped question. Finally, a qualitative interview with each simulation participant was conducted to discuss the usefulness of the training and ways to improve the training. The survey data was coded only by the PI, looking for specific common topics.

Four instruments were used to provide data for this study.

1. Situational Judgment Exam (SJE). A 25 question multiple choice exam separated into five topic areas that the participants were exposed to in the study.

2. Practical Simulation Exam (PSE). The participants were observed making a typical style flight in an Advanced Aviation Training Device (AATD) while certain decision points forced the participants to make choices. These choices were graded and then the participants moved on in the flight.

3. Questionnaire. The questions given to participants examined how they felt the training went and how useful the training would be in actual flight.

4. An interview. The interview questions examined how effective the participants felt the simulation was during their training. The participants’ answers were coded and placed into categories for analysis.

Another variable that was necessary was the use of Total Time (TT) as a covariate; TT was chosen as a covariate since it was a key measure of the participants’ total experience. Aeronautical Decision Making (ADM) has been shown to change as
experience and certificates are acquired (Wiggins & O’Hare, 1995). To address the possibility of a disparity in experience between the SEG and MMCG, TT was used as a covariate to control for the variance from the participants’ flight experience. Any flight time used to apply for a pilot certificate or rating is required by federal regulations (Federal Aviation Administration, 2013) to be logged in a log book. The TT collected from participants’ logbooks at the end of the study, giving an assessment of participants and group experience levels. In order to meet the assumption that both the SEG and MMCG variances of total time were the same, a Levene’s Test was completed with an $\alpha = .05$. The results, $F(1,16)=1.059, p = .319$, indicate the groups did not differ on the TT. Each group also had one part 61 training pilot and each had one female.

**Training Results**

Outside of the measures, there was anecdotal observations that from the training showing some unique results. The observations showed some specific actions that the SEG showed that were out of the ordinary during training. Both the SEG groups training in lesson two, inadvertent flight into instrument meteorological conditions, and lesson three, the safety issue lessons. In lesson two, the participants were given a scenario where the flight visibility was gradually reduced. However, even though several participants expressed some distress as the weather changed, only two conducted a 180-degree turn and one of those chose to turn back around at a higher altitude to try and make the destination. Not turning around is counter to the training and requirements as well as being one of the most deadly situations a pilot can be caught in (Aircraft Owners and Pilots Association, 2012; Kennedy et al., 2010; Wiggins & O’Hare, 1995)
In lesson three, the participants had to select their flight altitude and then make decisions based on certain failures and unusual events. A majority of the participants selected a lower altitude, appearing to forget that clouds are given in above ground level (AGL), not above Mean Sea Level (MSL), leading to the participants not being able to adjust to the emergency conditions and crashing. Also, five of the nine participants missed the alternator failure eventually leading to a complete electrical failure; most noticed that the vacuum failure occurred as their instruments directly in front of them began to change in response to the failure causing them to lose radio communication and the ability to call for help.

**Research Question 1 Results**

The first research question asked: Does flight simulator training have a significant impact upon ADM in comparison to traditional multimedia instruction as measured by the SJE? The null hypothesis for research question 1 was $H_0: \mu^{\text{SEG}} = \mu^{\text{MMCG}}$, the alternative hypothesis was $H_a: \mu^{\text{SEG}} \neq \mu^{\text{MMCG}}$. Research question 1 was further examined based on the following topics: communication, mountain flying, visual flight rules into instrument meteorological conditions, airspace, and decision making. The groups’ individual subject scores were analyzed using a $t$-test between the groups on the written exam. The communication segment examined their ability to make decisions on when, how, and with whom to communicate. Visual flight rules into instrument meteorological conditions examined the participants’ ability to assess the flight conditions and make a decision based on those conditions to avoid flight into instrument meteorological conditions. Safety segment of the SJE was an overall assessment of the participants’
aeronautical decision making under different safety scenarios. The mountain flying questions on the SJE was an assessment of the participants’ ability to assess and make decisions dealing with different terrain and high altitude performance conditions. Finally airspace questions on the SJE assessed the participants’ ability to address the various airspace configurations and how to approach problems within the system. Both groups took a SJE with the same scenarios based on the specific training given in the interventions. The Analysis of Covariance showed no significant difference between the SEG and MMCG groups’ overall performance on the SJE, $F(1,15) = 2.344, p = .267, \eta^2_p = .005, R^2 = .027$, with an observed $\beta = .943$. Table 11 provides the means and standard deviation for the assessment. Results from the SJE indicate that we fail to reject the null hypothesis that there is no difference between the groups, though the MMCG group scored slightly higher than the SEG.

Table 11

*ANCOVA Analysis of Situational Judgment Exam*

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Adjusted Means</th>
<th>SD</th>
<th>$F$-test</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation Group</td>
<td>82.28</td>
<td>82.436</td>
<td>6.350</td>
<td>2.344</td>
<td>.613</td>
</tr>
<tr>
<td>Multimedia Group</td>
<td>83.33</td>
<td>83.175</td>
<td>5.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Total Time (TT) is acting as the covariate for the ANCOVA.

T-tests were then used to examine the individual topic areas. Since the covariate appeared to have little effect on the ANCOVA, $R = -.150$ for the SJE and $R = .204$ for the
PSE respectively, the t-tests were a more efficient way to analyze the data. The null hypotheses for the individual topic areas is \( H_0: \mu_{\text{SEG}} = \mu_{\text{MMCG}} \) and \( H_a: \mu_{\text{SEG}} \neq \mu_{\text{MMCG}} \). The scores are shown in Table 12 which indicates the overall group scores and results SEG had a mean score of 18.67 on the communication topic while the MMCG had a mean score of 17.33. The \( t \)-test showed no significant difference between the two groups, \( t(16) = 1.600, p = .129, d = .75 \), but the SEG did score above the MMCG on the communication topic. Visual flight rules into instrument meteorological conditions topic had the SEG have a mean test score of 15.22 and the MMCG had a mean score of 17.56. The MMCG showed a significant difference over the SEG on the SJE for visual flight rules into instrument meteorological conditions, \( t(16) = -2.274, p = .037, d = -1.07 \). The scores for the safety segment of the SJE were a mean score was 14.56 for the SEG and the MMCG 15.22. The \( t \)-test showed no significant difference between the two groups, though in this case the MMCG was higher, \( t(16) = -.489, p = .631, d = -.22 \). The mountain flying portion of the SJE results show a mean score for the SEG of 16.00 and a mean score of 15.78 for the MMCG. Again the SEG scored higher than the MMCG without significance, \( t(16) = .389, p = .703, d = .181 \). The airspace portion of the SJE showed the SEG with a mean score of 17.83 and the MMCG had a mean score of 17.44. There was no significant difference between the two groups, with both groups scoring similarly but with the SEG slightly being ahead of the MMCG, \( t(16) = .685, p = .503, d = .324 \). While most subject areas were not statistically significant, the SEG scored higher on three of the five categories in the MMCG, which would indicate at least some practical significance.
Table 12

*T-Tests Analysis of Situational Judgment Exam Subjects*

<table>
<thead>
<tr>
<th></th>
<th>Simulation Group</th>
<th>Multimedia Group</th>
<th>t-test</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Communication</td>
<td>18.67</td>
<td>1.414</td>
<td>17.33</td>
<td>2.062</td>
</tr>
<tr>
<td>VFR into IMC</td>
<td>15.22</td>
<td>2.774</td>
<td>17.56</td>
<td>1.333</td>
</tr>
<tr>
<td>Safety</td>
<td>14.56</td>
<td>2.186</td>
<td>15.22</td>
<td>3.456</td>
</tr>
<tr>
<td>Mountain Flying</td>
<td>16</td>
<td>1.000</td>
<td>15.78</td>
<td>1.394</td>
</tr>
<tr>
<td>Airspace</td>
<td>17.83</td>
<td>1.541</td>
<td>17.44</td>
<td>.726</td>
</tr>
</tbody>
</table>

*p < .05

**Research Question 2 Results**

The second research question asked: Does flight simulator training have an impact upon decision making in comparison to traditional multimedia instruction as indicated by participants’ decision making performance during a flight simulator scenario? The null hypothesis for research question 2 was Ho: $\mu^{\text{SEG}} = \mu^{\text{MMCG}}$, the alternative hypothesis is $H_a: \mu^{\text{SEG}} \neq \mu^{\text{MMCG}}$. To examine the effectiveness of the participants’ decision-making capabilities, the participants were operating an aircraft Advanced Aircraft Training Device (AATD) in a simulated flight and given a number of scenarios for them to address during the flight. The simulation group trained with the AATD while the Multimedia group used only the AOPA multimedia courses.
ANCOVA was used to compare the two groups’ overall decision-making ability, using TT as the covariate, for the overall analysis of the total decision-making score for the flight. The SEG had a mean score of 20.33 out of 26 total possible points while the MMCG’s decisions scored a mean of 16.78. The analysis of covariance showed that the simulator group performing significantly better than the multimedia group $F(1,15) = 5.638, p = .031, \eta_p^2 = .273, R^2 = .303$, with an observed $\beta = .397$. The result means and standard deviations are shown in Table 13.

Table 13

<table>
<thead>
<tr>
<th>ANCOVA Analysis of Practical Simulation Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Simulation Group</td>
</tr>
<tr>
<td>Multimedia Group</td>
</tr>
</tbody>
</table>

*p < .05

T-test was also conducted on each of the four decisions that the participants faced in the practical flight exam. The decisions the participants needed to make during the simulated flight were the selection of an initial altitude, airspace clearance, visual flight rules into instrument meteorological conditions, and finally engine failure on final. Table 14 shows the overall results of the t-tests. Both SEG and the MMCG had a mean of 6.67 on the selection of altitude, showing no significant difference between the groups, $t(16)= .000, p = 1.00, d = .00$. SEG had a mean score of 5.22 and the MMCG had a mean score 3.44 on the decision through the class B airspace, the t-test shows a significant difference
between the groups, $t(16) = 2.280, p = .037, d = 1.07$. The VFR into IMC decision had the SEG showing a mean score of 3.89 and the MMCG shows a mean score of 2.89. There was no significant difference between the groups on VFR in IMC, $t(16) = 1.136, p = .273, d = .54$. The SEG did score higher than the MMCG, $t(16) = 1.252, p = .778, d = .59$ for the decisions made during the engine failure in flight, however there was no significant difference between the groups on decisions to address the engine failure on final approach.

Table 14

*T-Tests Analysis of Practical Simulation Exam Subjects*

<table>
<thead>
<tr>
<th>Simulation Group</th>
<th>Multimedia Group</th>
<th>$t$-test</th>
<th>$p$ values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Altitude Selection</td>
<td>6.67</td>
<td>.5</td>
<td>6.67</td>
</tr>
<tr>
<td>Airspace Clearance</td>
<td>5.22</td>
<td>.441</td>
<td>3.44</td>
</tr>
<tr>
<td>VFR into IMC</td>
<td>3.89</td>
<td>1.764</td>
<td>2.89</td>
</tr>
<tr>
<td>Engine Failure</td>
<td>4.56</td>
<td>1.014</td>
<td>3.78</td>
</tr>
</tbody>
</table>

* $p < .05$

A second data point analyzed for Research Question 2 was to examine the overall quality of each participant’s decisions in the flight. Each participant’s choices were marked on one of up to three levels for critical elements of his or her decisions (Appendix C). The lowest level was Poor—these aspects of the participant’s decision that could lead to increased difficulty in operations or dangerous situations. A marking of fair
indicated that, while not optimal, the choice should not under most circumstances lead to more dangerous situation. An assignment of the good mark to a decision indicates that the decision was a good choice often reducing the danger.

A T-test was used to examine the poor decisions, specifically it compared total counts for each group. The total number of decisions labeled as poor on the rubric was tallied for each participant and aggregated into a mean for the group. The MMCG made significantly more poor decisions with the SEG mean of 1.33 versus the MMCG mean of 3 with result of $t(16) = -2.486, p = .024, d = -1.04$. The t-test indicated a difference between groups with the SEG making overall better decisions compared to the MMCG.

**Research Question 3 Results**

The third research question was: Does flight simulator training have an impact upon the perceived effectiveness of training in comparison to traditional multimedia instruction based on the survey? The null hypothesis for research question 3 was $H_0$: $\mu_{SEG} = \mu_{MMCG}$; the alternative hypothesis is $H_a$: $\mu_{SEG} \neq \mu_{MMCG}$ for each topic. A questionnaire was given to the participants that used Likert like scales was used to get an overall assessment of the feelings of the participants about the intervention they received. A short interview was conducted with only the SEG to examine that group’s overall assessment of their perceptions of the simulation training regimen.

The questionnaire questions and group mean for each of these are shown in Table 15. The first 10 questions out of 13 were used to compare the SEG and MMCG’s perception of training. Of the 10 questions that were the same between the groups, the questions were further categorized into three sub-categories: enjoyment, experience with
the technology, and perceptions of training effectiveness. The first two questions gauged the participant’s enjoyment of the training. Each of these questions directly asked if the participant liked the training and whether he or she would like to have more training in the same style as received in the experiment. The next five questions examined whether he or she felt that the technology worked as expected and how usable that technology was to him or her. Each question in the technology segment addressed how effective the technology was at addressing the participant’s training needs. Technology included ease of use, feedback, and realism, with the feedback being critical aspects of any training. Lastly, the remaining questions asked the participant if he or she felt that the training would transfer to practical flight.

Table 15

*Common Survey Questions and Means Per Group*

<table>
<thead>
<tr>
<th>Question</th>
<th>SEG Mean</th>
<th>MMCG Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I found the training enjoyable.</td>
<td>4.33</td>
<td>3.44</td>
</tr>
<tr>
<td>I would like to have more of this type of instruction in many different topics.</td>
<td>4.22</td>
<td>2.78</td>
</tr>
<tr>
<td>It was easy to use the training materials.</td>
<td>3.89</td>
<td>4.89</td>
</tr>
<tr>
<td>The training was interactive.</td>
<td>4.67</td>
<td>4.00</td>
</tr>
<tr>
<td>The training was effective at teaching procedures and explaining the operation of the aircraft.</td>
<td>4.00</td>
<td>3.78</td>
</tr>
<tr>
<td>The scenarios presented in the training were realistic and I believe they could happen.</td>
<td>4.89</td>
<td>4.11</td>
</tr>
</tbody>
</table>

(Table Continues)
Table 15 (Continued)

Common Survey Questions and Means Per Group

<table>
<thead>
<tr>
<th>Question</th>
<th>SEG Mean</th>
<th>MMCG Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>The technology used for the instruction functioned exactly as expected and without error.</td>
<td>3.11</td>
<td>4.67</td>
</tr>
<tr>
<td>The materials improved my knowledge about the subjects taught.</td>
<td>4.50</td>
<td>3.78</td>
</tr>
<tr>
<td>The training will improve my decision-making skills as a pilot.</td>
<td>4.56</td>
<td>3.89</td>
</tr>
<tr>
<td>The training provided me with skills that will be easily transferred to actual in-flight operations.</td>
<td>4.78</td>
<td>3.33</td>
</tr>
</tbody>
</table>

Note. The Likert like score was 0-5, with 0 = not at all, 1 = slightly, 2 = somewhat, 3 = mostly, 4 = very significantly, and 5 = entirely agree with the statement.

Perception of Value questions examined how the participant felt the training would be able to help him or her in real life experiences. Perception of value is a critical question to let us know if simulation training was improving pilot performance in his or her own mind. The survey questions directly addressed perception of value question, asking whether the participant felt that the training would improve his or her decision making and knowledge, as well as if he or she believed these skills would transfer to his or her performance in the cockpit. Overall, the SEG did indicate a higher mean score for both the enjoyment and applicability segments. However, the MMCG indicated that they had a better experience with the technology itself. Because the MMCG had a better experience with technology tells us the technology we use is a key question in planning training. The overall analysis of the survey showed no significant difference between
groups, but slight variations between the groups can be seen, leading to some interesting points to consider in future research.

The SEG indicated that they enjoyed the training more than the MMCG, with means 8.56 versus 6.22 respectively. The t-test showed a significant difference between the two groups, $t(16)=3.407, p = .004, d = 1.61$. SEG had a lower mean score on the experience with technology, with the SEG with a mean of 20.56 compared to MMCG’s 21.44. However, the t-test showed no significant difference between the two groups, $t(16)= -0.841, p = .413, d = -0.39$. Means for the perception of value was 13.33 for the SEG and 11.00 for the MMCG. There was no significant difference between the two groups, $t(16)= 2.021, p = .060, d = .95$. A complete breakdown of the individual groupings scores can be seen in Table 16.

Table 16

<table>
<thead>
<tr>
<th></th>
<th>Simulation Group</th>
<th>Multimedia Group</th>
<th>t-test</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>8.56</td>
<td>.882</td>
<td>6.22</td>
<td>1.856</td>
</tr>
<tr>
<td>Experience with Technology</td>
<td>20.56</td>
<td>1.810</td>
<td>21.44</td>
<td>2.603</td>
</tr>
<tr>
<td>Perception of Value</td>
<td>13.33</td>
<td>2.236</td>
<td>11.00</td>
<td>2.646</td>
</tr>
</tbody>
</table>

*p < .01
Interviews

The participants in the SEG were given an exit interview examining the participants’ perceived value of their simulation training toward their flight training. Nine participants took part in the interviews. Seven primary questions were asked in a one on one conversation style interview, with the researcher taking notes. The interview results showed a wide range of thoughts on what was actually effective and what was perceived to be truly effective to each person. It was possible for the participants to be coded in multiple areas for a single answer. The total breakdown of the categories and questions are shown in Table 17.

Table 17

Interview Questions and Coding

<table>
<thead>
<tr>
<th>Question</th>
<th>Coding</th>
<th>Sample of a response</th>
</tr>
</thead>
</table>
| Question 1: Please explain how you feel that the simulation training will affect the way you fly. | 7 Situational Awareness  
1 focus on slowing down  
3 exposed to new knowledge | Positive influence, really forced me to be situational awareness and pay attention. Because of the Different locations and unfamiliar airspace. |
| Question 2: What was the most useful part of the simulation training? | 4 seeing the consequences of their actions  
1 immediate feedback  
3 improved situational awareness  
2 indicated that the High Altitude flight was the most useful. | They stated that there is an importance to having good decision-making skills. Poor decisions have real consequences. |
| Question 3: Did you see any problems with the simulation? If so, please explain. | 8 realism of the simulation,  
1 scenario topics may not have fit.  
1 no problems. | The fact that the simulator lacked full motion prevented the more life or death feel to the flight. Also the engine had issues starting and that was an issue. |

(Table continues)
Table 17 (Continued)

*Interview Questions and Coding*

<table>
<thead>
<tr>
<th>Question</th>
<th>Coding</th>
<th>Sample of a response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 4: Do you have any suggestions to improve the simulation to help you understand the application of skills during flight</td>
<td>2 nothing needed to change</td>
<td>“If the display was more realistic, had a tough time with distance in the sim. Motion doesn’t make that much difference in the sim. Very realistic airplane control wise though.”</td>
</tr>
<tr>
<td></td>
<td>2 adding motion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Realism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 large visual field</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Advanced scenarios</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Clearer Audio</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 accurate flight model</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Depth perception</td>
<td></td>
</tr>
<tr>
<td>Question 5: Which subject that was covered in the simulation training was best augmented by simulation?</td>
<td>3 High altitude</td>
<td>Density altitude best used the sim. Legend was confirmed and it made a bigger impression.</td>
</tr>
<tr>
<td></td>
<td>3 decision making (safety) lesson</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Airspace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Communication</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Basic flight skills in all of them</td>
<td></td>
</tr>
<tr>
<td>Question 6: Were there any topics that you felt were not aided by simulation?</td>
<td>3 Airspace</td>
<td>High density altitude, Follow On: Why: Because I fly in a cold climate.</td>
</tr>
<tr>
<td></td>
<td>2 Landing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 High altitude</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 stated that all of them are fine.</td>
<td></td>
</tr>
<tr>
<td>Question 7: What was your overall comfort level using the simulator?</td>
<td>4 comfortable</td>
<td>Certain situations, some things like landing not so much. Doesn’t come close to real landing. When you are in the plane you have pressure to do well, in the sim not so much.</td>
</tr>
<tr>
<td></td>
<td>1 Very comfortable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 took a while to get there</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 GPS was different</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 All but landings</td>
<td></td>
</tr>
</tbody>
</table>

Question one asked participants how they felt that the simulation training would affect the way that they fly. After reviewing the responses from the participants’ answers were coded. Situational awareness codes applied to any response that dealt with knowing what was happening in the aircraft, the location of the aircraft, and/or awareness.
of the weather around the aircraft. 78% of participants indicated that they would work to improve their situational awareness after the simulation training. Sample responses coded with situational awareness are:

- The lessons opened my eyes about the number of potential problems in flight, high altitude especially.
- Yes, mostly the decision-making lesson, I now look at the annunciator lights and engine gauges more often.
- “Positive influence, really forced me to be situational awareness and pay attention.”

Of the participants, 33% indicated that the overall exposure to new knowledge changed how they flew. Any time the participant answered with a statement of knowledge gained or new knowledge that statement was coded to exposure to new knowledge. Two example responses were:

- “It introduced a number of factors that weren’t always at the forefront of the mind. The scenarios that you wouldn’t try out in a regular plane.”
- The scenarios put me into new situations and experiences. Believes that it will lead to more consideration of key factors like (Participant specifically said): Weight and Balance, Density Altitude, Finding Alternate Airports, Decision making.

Finally 11% indicated that they would focus on slowing down. The response was: I think I will take things slower, showed me more it is worth it to take more time rather than getting into a dangerous situation. And read the charts better before you go. Be
familiar with where you are going. This response fell into the overall situation awareness code grouping.

Question two asked participants what they felt was the most useful part of the simulation: 44% of participants indicated their ability to see the consequences of their actions. Any time the participants indicated that seeing the direct outcome of their actions was coded as consequences, consequences includes any responses that used the word consequences, or dying. Examples of answers coded with consequences were:

- The participant stated that there is an importance to having good decision-making skills. “Poor decisions have real consequences.”

- “The most useful part was the dying part. You need to fly the plane to the ground and be thinking about the flight the whole time, even when things go wrong.”

Another 11% showed that the immediate feedback was most useful. The only response that met the immediate feedback code was “Hands on operations were really helpful.” The participant said that they were a hands-on learner. They also stated that immediate feedback was key, stating that: “Both the debrief at the end and the feedback from the inputs into the sim.” 33% indicated that the simulation improved their situational awareness. As in question 1, situational awareness was applied to any answer that discussed knowing what was happening in the aircraft, the location of the aircraft, and/or awareness of the weather around the aircraft. Two additional examples of situational awareness statements were:
• Unusual radio calls, had one in flight and the sim lessons wrong. Keep attention to all of the gauges and what does it mean. Pay attention to all instruments and note errors. And tailwinds come in to play.

• “Biggest thing was the ammeter being off.”

22% indicated that the High Altitude lesson was the most useful. The High altitude code was only applied if the participant directly referenced the high altitude or density altitude lesson. Two responses that matched high altitude are:

• “The lesson of the high altitude, one of the most important lessons, learn how to lean and how degrading altitude is to performance.”

• “[The] most useful was the density altitude seeing the effects. I would not be able to get that here most likely.”

Question three examined the weakness that the participants perceived in the use of simulation by asking what questions. Eighty nine percent of the participants indicated that the realism of the simulator was a problem. Answers were coded with realism if they indicated the feel of the simulator, graphics, motion, or depth perception was problematic. Two examples of responses with the realism code were:

• “The biggest problems were with depth of field and descent model is off.”

• “Ability to perceive depth sucks, perception sucks, and inability to see behind for landing.” Graphics did not show the terrain as well as it should have.

Eleven percent of participants indicated that the specific scenario topics didn’t fit the use of the simulator. The one participant indicated that some of the scenarios were really bad situations that most likely would not be entered. “The decision making and
high density altitude scenarios I would have done more ground work and avoided the problems.” Eleven percent stated there were no issues with the use the simulator. Specifically, “There was little problems with the use of the simulator for these topics, everything we went through could happen in real life and should be aware of the consequences without the real consequences.”

Question four asked participants to suggest improvements to the simulator training. Of the participants, 22% indicated that nothing needed to be changed. Anytime the participant indicated that there was no need to change things or everything was good, it was coded as nothing needs to be changed. An example of a “nothing” code was:

- “I have no suggestions, the sims already helped as I have apply the info to real life.”

Another 22% of the participants indicated that adding motion would help. If the participants stated motion at any time in their response it was coded as motion. An example of motion was:

- “Add motion and maybe clearer auditory information. Particularly if something goes wrong.”

Twenty two percent of the participants indicated realism. Realism was coded for participants indicating realism or auditory information in their responses. Another example of a realism response was:

- “None, it would just be nice if it was a more realistic environment.”

22% indicated the depth perception or visual field was off. An example of the depth code was: “If the display was more realistic, I had a tough time with distance in the sim.”
Questions five and six examined what topics were addressed effectively by the use of simulation and which were not. Thirty three percent of the participants stated that the high altitude scenario worked well with simulation, with one participant stating, “Density altitude was the best used the sim. The legend was confirmed and it made a bigger impression.” Another 22% indicated that density altitude was not enhanced by simulation in question six, with one indicating, “Not really any, though the density altitude could have been done without the sim probably just as effectively.” Another 33% indicated that the decision-making scenario was the most augmented by simulation with no one indicating that it was not helped by the use of simulators. One of the participants indicated that the instrument flight rules and decision-making lessons were helped by the simulation, though they specifically said that the instrument flight rules lesson used simulation the best. The participant stated that the simulation improved his instrument scan and addressed critical aspects that were not included in his training before this experiment. One participant continued by saying, “You see what happens when you don’t do what you say you are going to do.” Of the participants in the SEG, 22% indicated that the communication and airspace lessons were helped with simulation, with one participant stating, “The use of radio communication and airspaces, in real life you can get flustered and aggravated. Sim allows for mistakes to learn from. Density altitude also showed how it [the aircraft] reacted.” In contrast 33% stated that the airspace lesson was least helped by simulation, with one participant saying, “Nothing hurt, but the airspace one in the sim didn’t add anything.” Eleven percent stated that just basic flight skills were aided by the use of simulation. However, 22% indicated that
landing was not aided by the simulation, with one participant indicating, “Any landings just did not work, it was a lack of depth perceptions.” Finally, 22% said that all of the operations were aided by simulation.

Question seven and the final question asked about the overall comfort level with the use of simulation. Seventy eight percent said they were comfortable with the use of the simulator, 11% said very comfortable, and finally 22% said that they were comfortable after a while, but it sometimes took time to adjust. An example of a response was “certain situations, some things like landing not so much. Doesn’t come close to real landing. When you are in the plane you have pressure to do well, in the sim not so much.”

Summary

Research question 1’s assessments showed no significant difference between the groups on the written SJE, and as such the null hypothesis was not rejected. Both of RQ2’s measures showed a significant difference, with the SEG scoring higher than MMCG on the practical simulation exam. As such, the null hypothesis is rejected for Research Question 2. Finally, RQ3 had no difference between the groups on the surveys, so the null hypothesis is not rejected. The interviews yielded a number of consistent codes, with situational awareness, most people having issues with the realism of the simulation, and most people also comfortable with the use of the simulators.
CHAPTER V
DISCUSSION

This study examined a gap within the existing literature on using simulation in flight education, specifically simulation’s effect on flight students’ aeronautical decision-making ability. There were two groups in the study, the Multimedia Control Group (MMCG) and the Simulation Experimental Group (SEG). The participants’ aeronautical decision making (ADM) was tested in two ways, through a practical simulation examination (PSE) in an AATD (Advanced Aviation training Device) and then a multiple choice Situational Judgment Exam (SJE). Participants were also surveyed about their opinion of the training. The primary finding of this study showed that simulation improved aeronautical decision making of participants in the experimental group during the PSE in the AATD given at the end of the training. The PSE required the participants fly from the KSU airport to Sandusky airport in a simulated environment. During the PSE, the participants were exposed to different situations that required them to make decisions on how to respond to a given abnormal situation and continue on the flight. Participants’ decisions were then graded based on the safety and legality of their choices.

Participants were given a multiple choice SJE that used basic scenario multiple-choice questions to gauge the participants’ decision-making capabilities. The SJE questions addressed different flight situations, such as requirements for entry into Class B airspace, in scenario based questions. The participants were graded on their answers based on a how correct their selection was, as compared to senior instructors answers. There was no significant difference between the groups on the SJE.
The final segment of the assessments was a survey to both groups and an exit interview with the SEG. The survey was to gauge the participants’ feelings of enjoyment, effectiveness of the technology, and the perception of the value of training with these technologies. The survey showed significant difference between the groups’ feelings about the training, specifically with the participants’ enjoyment of their training. The interviews was able to examine specific advantages and issues with the use of simulation in the training. The major findings of this study point to the practical application of simulation to address decision-making errors in flight training students.

**Findings and Theoretical Discussion**

**Research Question 1**

Research Question 1: Does flight simulator training have an impact upon aeronautical decision making (ADM) in comparison to traditional multimedia instruction as measured by the SJE? There was no significant difference between the SEG and the MMCG on the overall score on the SJE, $F(1,15) = 2.344, p = .267, \eta_p^2 = .005$, with an observed $1-\beta = .943$. Although the lack of significance was unexpected, there are several possible reasons that there was no difference between groups. One issue was the overall lack of subjects.

Since both groups were taught the same material, in the limited scope of the short written scenarios it is possible that both groups would be drawn to the same solutions to the presented problems. For example, one of the scenarios was: “You are flying along when you begin to have engine roughness. You apply carburetor heat and after a several minutes you notice the engine smooths out, however you have gotten yourself lost. What
is your initial action?” The overall SJE results showed that MMCG had a mean score of 83.3 out of 100 possible points, while the SEG had a mean score of 82.3 with no significant difference between the groups. A possible explanation is that the participants were taught the same material and so made the same decisions based on the options given to them on the exam. Because of the style of the exam, multiple choice, the exam would be more focused on the baseline knowledge of the applicants as opposed to critical think choices. Even with using scenarios as opposed to simple rote questions, the participants would be limited to the options given. As such, participants from both the SEG and MMCG would draw more on their overall knowledge in aviation and less on the knowledge and decision making skills learned during the experiment. Both the groups had equivalent background knowledge, and the new knowledge gained was of the same pilot certificate level, possibly making the SJE less effective at detecting decision making skill.

It is possible because of the applied nature of learning in a simulated environment that the participants would have a harder time using their knowledge and skills on the more constrained multiple choice exam. All of the SEG’s training was focused on making decisions real time and in a free flowing environment, allowing participants to create choices to address any given situation instead of being provide with four possible answers. The multiple choice question answers may not have given the participant a choice they thought was viable and so they would make their best guess. In contrast MMCG, which had taken multiple choice exams during their training, at the end of each lesson, would have a slight advantage over the SEG. A multiple choice exam would lead
to a possible practice effect for the MMCG. There was no time limit given for the written exam, thus, the participants could take all the time they needed. Another aspect of flight that the SJE was lacking was a time element. In an actual flight, most, if not all of the decisions, are made under some form of time limitation. While the SJE was designed to be able to measure decision making, the goal of the study, it did not add the time element that simulation would contain. So it is possible that the MMCG was more familiar with the testing style, leading to a practice effect.

The familiarity with scenario style multiple choice exams would come from the nature of the training the participants received. The participants from the MMCG had the option to go back and review items in their online course and take all the time they needed on the basic multiple choice quizzes that were imbedded in their training modules. By contrast, the SEG would have the equivalent scenarios given in the real world context, with a time constraint and the requirement that the participant provide an immediate answer through action. While the participants in the SEG would be able to restart the scenario if they crashed, they had to make the decisions in the moment and work hard to make the best ones. And yet the two groups had very similar outcomes of the exam, showing that even at a disadvantage the SEG were as capable as the MMCG in the more abstracted decision-making exam.

The observed power of this the SJE was $\beta = .943$. The low statistical power made it more difficult to find significance. With more subjects, including the possibility of expanding the applicant pool beyond the instrument course, there would be a better chance at finding differences between the groups. One subject on the SJE did have
significance though, visual flight rules into instrument meteorological conditions. The significance of visual flight rules into instrument meteorological conditions was toward the MMCG, $t(16) = -2.274, p = .037, d = -1.07$. In this case, the type of questions asked in the multimedia course for the flight into poor weather would match the type of questions that were asked on the SJE. While the MMCG would not have seen the specific questions before, the participants in the MMCG would have been exposed to similar questions likely providing a possible advantage.

**Research Question 2**

Research Question 2: Does flight simulator training have an impact upon decision making in comparison to traditional multimedia instruction as indicated by participants’ decision making performance during a flight simulator scenario? Both groups were placed in an AATD at the end of their training and given a typical flight scenario to fly. During the simulated flight, the participants were given different situations that forced the participants to make different decisions. The results of the PSE were the SEG had a significantly higher decision-making capability than the MMCG during the applied portion of the experiment as a whole, $F(1,15) = 5.638, p = .031, \eta^2_p = .273$, with an observed $1-\beta = .397$. The SEG also had a significantly higher decision-making score than the MMCG for the airspace topic specifically as well, $t(16) = 2.280, p = .037, d = 1.07$. Finally, the SEG had significantly less poor decisions during the simulated flight than the MMCG, $t(16) = -2.486, p = .024, d = -1.04$.

One aspect of simulation training that would lead to the improved decision making of the participants was the nature of the feedback that the simulation provided.
Not only was the feedback given immediately to the simulation group, but the feedback was based on the reaction of the aircraft to those decisions. There was a certain level of intensity tied to having the simulated aircraft crash with you at the controls. However, it is possible that there was also a practice effect. Every effort was put forth to remove the practice effect between groups, including not examining the actual flight ability and giving the participants from the multimedia group a half an hour of time to learn to operate the AATD before their assessment. However, it is possible that there was a practice effect, no matter how minor. Much like the effects of taking the multiple exam quizzes with the MMCG and the SJE, participants in the SEG had been exposed to the type of testing that the PSE used to assess decision making. Overall, the SEG received two and a half hours longer per participant in the AATD than the MMCG. Not only would the participants in the SEG be more comfortable at the controls of the simulator, they may also have been more used to the visual and auditory cues that the AATD provides. For example, if the participants in the MMCG did not notice the reduction in sound when the engine failed, it is possible that they would delay any decision simply because they were not aware of the failed engine.

However, another aspect of training at UAA that would minimize the practice effect is all of the participants had been in the AATD before as part of the ground school; and in this case all of the participants have taken the ground school course at UAA. The simulation time was not logged nor used for official flight training making it more difficult to gauge the participants’ familiarity with the simulators. As a course requirement, all students are to spend two hours in the same AATD that was used in the
study. As such all of the participants should have been familiar with the simulator prior to this study. Also each participant of the MMCG was given a half an hour of additional time for familiarization of flying the AATD before the PSE. This time in addition to the participants’ previous experience with the AATD should have minimized the practice effect between the groups, however there is still a chance that there was some practice effect affecting the results.

All of the participants, including the multimedia students, appeared to be competent with the AATD and the transition to the AATD seemed to be efficient, most likely because of their prior exposure to the AATD as a required portion of ground school. TT is a direct indication of the participants overall flight experience. TT is every hour the participant has flown in an actual aircraft toward currency and the addition of a new certificate or rating, as per federal regulation (Federal Aviation Administration, 2009). There was no significant difference between the groups’ flight experience based on the total time, \( t(16) = .887, p = .388, d = .42 \). The lack of significance indicates that the experience level of both groups was essentially the same, implying that the groups’ time and experience with flying actual aircraft, should not have a major effect on the results. The results also tend to match the current educational theories of learning through experiences, or experience based learning, indicating that the practice effect in the AATD was minimal (Andresen, Boud, & Cohen, 2001; Boud, Cohen, & Walker, 1993).

A more plausible explanation for the superior performance of the SEG was that use of simulation provided the realistic experiences that would show the consequences of the decisions made by the participants. The feedback from an answer or action is a
critical learning tool, and one of the more influential aspects of learning in many fields including medicine and aviation (Hattie & Timperley, 2007a; Helsdingen et al., 2010; S Barry Issenberg, McGaghie, Petrusa, Lee Gordon, & Scalese, 2005). In two separate meta-analyses, feedback has been listed as the number one critical aspect of simulation in medicine (S Barry Issenberg et al., 2005; McGaghie, Issenberg, Petrusa, & Scalese, 2010). Simulation can provide critical immediate feedback and learning from experience in aviation in a much less risky environment than flight in an aircraft. As such it is often applied in the commercial airlines later in a pilot’s career (Nullmeyer & V.A., 2000).

What this study shows is the effectiveness of using simulation on decision-making skills using that feedback from the decisions they made early in their flight training. While actual flight training in an aircraft will still need to be done, using simulation could improve decision making skills earlier in a student’s flight training and already has been shown to speed up the training process (Roessingh, 2005). There is cross over on this question with research question 3, the interviews with the SEG had several participants indicate that feedback, often in the form of seeing the consequences of one’s choices, was the key to learning during the study.

There are some researchers that are not as accepting of technology, such as simulators, being as useful in training. While Clark (1994) often argued that the technology has little effect on the students’ learning, and that training with the use of simulation is just a fancy technology, simulation provides a number of advantages over static or even interactive multimedia presentations, both of which are beyond what was available in the early 1990’s. This study showed a significant practical application of
simulation, as well as a practical effect with most effect sizes being moderate to strong. Several studies in different disciplines show that there is an advantage to the use of simulation in providing experiential learning (Butler, 2011; Gaba et al., 2001; Leland et al., 2009; Wiegmann et al., 2002). Results from this study also seemed to show that experiential learning aided in decision-making training. Simulation provided an applied and practical application and as such allowed for better development of participants’ decision-making skills during a limited time.

Experiential learning provided by simulation use could provide better mental models of different abnormal or dangerous situations for students to use in flight. Learning by experience safely is not always possible in aviation; because of the time constraints of emergencies or abnormal situations, it is oftentimes impossible to get a complete picture of the situation (Reason, 1990; Wiegmann & Shappell, 2003). One possibility to address in flight decision making is to use simulated events on the ground to provide new pilots a better common schema for abnormal and emergency situations. By providing pilots variations on types of emergencies, such as engine fire in flight and on startup, the students would be able to learn the subtle differences in indications and improve the accurate detection of the emergency. Using simulation to experience abnormal situations is a concept currently being explored in the area of aeronautical decision making, though through the use of videos and written information (Plant & Stanton, 2015). However, the current findings from Plant and Stanton show that world-based concepts, those based outside of the individual as opposed to internal like schema, had more of an influence than the schema based effects. The simulation allows for pilots
to experience the world-based effects as well, in a safe environment. Either way, simulation should provide an effective platform for developing decision-making skills from either direction.

A number of additional studies and analyses examine flight training with simulation; however there is often a lack of clear results (Carretta & Dunlap, 1998; Goetz, Harrison, & Robertson, 2012; Ortiz, 1994; Taylor, Dixon-Hardy, & Wright, 2014). Many of the studies mentioned indicated a lack of solid empirical data available. More specifically, there was a lack of studies examining the effectiveness of simulation on participants’ softer skills, such as decision making. Soft skills tend to be thinking skills, outside of the general psycho-motor skills, such as decision making or communication. Over time there have been a number of studies that attempted to show that simulation provided a more effective transfer of manual skills to flight in an actual aircraft, most of these studies have not shown significance (Carretta & Dunlap, 1998; Lintern et al., 1990; Ortiz, 1994; Roessingh, 2005). This study filled the gap examining the soft skills application of simulation training.

The applied and comparison nature of this study provided an examination into the use of simulation for aeronautical decision making, beyond the single study found that examined the same concept. Connolly et al. (1989) looked at the effectiveness of using simulators to teach decision making. The Connolly study found that the use of simulation was advantageous toward teaching decision making. However, the results of Connolly’s study, the experimental group having performing better than the control, should have been expected as the control group only received basic instrument flight
training, which does not directly link to the VFR flight procedures that were being examined. In addition, there was a time on task issue with Connolly’s study. Essentially, the participants that were in the aeronautical decision making training group received eight hours of training beyond the other group. Connelly’s study did set the basic understanding that ADM can be trained in a simulator and that it was a viable strategy to teach ADM; however there was little more than that. This study attempts to focus not on training decision making directly, but on overall training with simulation and multimedia and how it affected the participants’ decision making. Only one lesson in this study, as opposed to Connelly’s, for both groups was focused on decision making, the SEG safety lesson and the aeronautical decision making lesson for the MMCG. While not directly training decision making in all of the lessons as opposed to focusing on aeronautical decision making is a fine distinction, the results did indicate that training standard operations with a simulator would improve aeronautical decision making. Also, as discussed previously, allowing students to directly see the results of their actions led to better decision making, at least for short term. This study also addressed some of the weaknesses of Connolly’s study by equalizing time on task even and training both groups of participants in the same topic areas as they would fly in the assessment. If you look at the improvement of practical decision-making skills shown in this study through the use of three hours of training in the AATD, it could be possible to reduce the number of decision-based errors in General Aviation through more widespread use of simulators.

This study added to the literature by examining the use of simulation at an initial stages of pilot training and attempted to address a number of gaps in the Connolly et al.
An aspect that this study and Connolly fail to address is the long-term effect of simulation training early on the pilot’s decision making. The specific purpose of training decision making is to improve safety by creating pilots with the capability to see changes in the situation and make decisions quickly with the information available. That is why future studies need to continue to work with initial flight students, hopefully finding ways to build decision making skills from the very beginning of their training. Future studies will also need to address whether the private and instrument students using simulation would continue to make better decisions long term.

**Research Question 3**

There was little difference between the two groups’ overall feelings toward the training as indicated by the responses from the survey. However, the responses on the first two questions of the survey indicated that the SEG enjoyed their training more than the MMCG, $t(16)=3.407, p=0.004, d=1.61$. This result makes sense, as the SEG was working in a novel environment that allowed participants to make all of the decisions, even during the training, and manipulate the controls of the simulated aircraft. The SEG enjoyed the training better than the MMCG, even if it was because of the novelty effect. The literature does have a number of studies that show simulation helps motivate students in a number of fields not just aviation, however (Alinier, Hunt, Gordon, & Harwood, 2006; Devanathan & Sethuramalingam, 2012b; Faria, 1998). Enjoyment can be a great motivator for students to continue to improve their skills, making simulation an excellent motivator for people (Pintrich & de Groot, 1990; Um et al., 2012). Thus the use of
simulation would or could help students complete their initial flight training through improved motivation.

The SEG did have higher scores on the enjoyment and perceived values, though only the enjoyment showed significance. This significance with enjoyment makes sense since the SEG was using the AATD, possibly adding a novelty effect. However, simulation shares a number of aspects with gaming, which has been shown to improve motivation for learning (Garris, Ahlers, Driskell, Garris, & Driskell, 2002; Lloyd, 2015). Hence, the SEG tended to enjoy the training in the simulator more than the siting in front of the computer clicking through scenarios. The realistic feedback through the simulation would directly link to the participant’s concept of the applicability of the training. The SEG participants have seen what happens when they moved the yoke at slow speeds and low altitude as opposed to the MMCG who would click on a choice and watch a movie of the consequences.

Another finding that was not significant at an α level of .05 but requires discussion was the perception of value on the survey. The finding came back with p value of 0.060, a strong level of significance with such a small sample size. Based on personal experiences and interactions with the aviation community, there appears to be a general dislike of the use of simulators at the initial levels of flight training. It is possible that this dislike of the use of simulation is hampering the use and development of instructional techniques with simulation. By improving the perception of the value of simulation in GA it is possible to improve the utilization of simulators and lead to more research into how to better use low fidelity simulation in instruction.
If simulation is added to early flight training for the proper topics students, like the participants, may see more value in the use of simulation and hence be more inclined to use simulation for instruction while working toward a better understanding as to how to use simulation more effectively. Another possible area of research that could lead to an overall improvement in the perception of value in GA is the use of simulators in recurrent training. If AATD’s or other flight training devices could be used as part of a flight review, completing that flight review could become a less expensive and more convenient option for some many pilots who do not own their own aircraft.

To achieve the improvement in perception though, this study indicates that focusing on a softer skill, such as decision making, would also be a good way to use simulation. This would require a shift away from, at least slightly, the basic maneuvers-based training currently serving as the focus in both initial flight training and recurrent training. However, the training can be done on different types of simulators, including the less expensive lower fidelity flight training devices usually available to GA. Finally, the lessons should be clearly defined with real world situations to enhance their value.

There is the possibility that the results of the other survey items were similar due to the topics used during the training. Considering this study’s topics were, at least partly, discussed in the college courses the participants were taking throughout the study, the topics may have led to a certain amount of boredom. Another possibility is the participants’ specific interest levels may have been the same on the studies aviation topics. Either way, there could have been an effect on the survey. Participant interests most likely would show in the perceived value of the training, if the participants were
interested in the topic area then it stands to reason that they would have a higher perception of value. The larger surprise was the segment in the survey about the functionality of the equipment. Both the AATD and the computers the participants used during the study worked well. Yet both groups seem to indicate that they were dissatisfied, at least somewhat, with the way the technology worked. One possible explanation of the dissatisfaction with the technology of the systems that both groups were using was the age of the equipment. Although the AATDs were newer models, they were not the highest end models and they were not the newest. Sometimes with the limitations of the software, the AATD may not have emulated the aircraft perfectly and that lack of realism could cause some of the choices participants made to have different outcomes than what they felt should have happened.

While the two systems used did work well, there were minor issues that did happen during the training part of the study that could have also affected the participants’ feelings about the technology used. The MMCG used a computer lab that had a slow internet connection, which would lead to lengthy lag times on the computer, thus increasing the participants’ frustration while taking a lesson. The AATD occasionally had some issues on start up for some of the participants, including the necessity to start the simulator over and in one case have the participant return the next day to conduct the training. Several other times during the training the engine would not start due to a glitch in the AATD program. All three of these technological issues would lead to the lower ratings from both groups. However, the SEG interview questions expanded on the
information from the survey and provided more depth of information from the participants on their training experience.

Interview Question Discussion

Interviews were conducted to examine how the SEG perceived the benefits of simulation training. The seventh and final question should have been the first however, how comfortable were you with the simulator? A majority of participants indicated that they were comfortable with the use of the simulator. Seven participants indicated that they were comfortable with the use of the simulator; of those one was just okay with it, one was very comfortable with it, but that participant had used the AATD before. Outside of the comfort level, there were a number of aspects of their simulation training that the participants discussed.

Sometimes the responses of the participants showed a lack of overall knowledge that could be attributed to their lack of experience. For example, one participant indicated that they felt the simulator did not augment the high altitude lesson because he flies in a cold climate, meaning that the aircraft will operate with a higher level of performance, hence the aircraft will not be hampered. However, even in Alaska, temperature and air pressure vary greatly. For example, during the summer months the city of Fairbanks, Alaska, can reach upwards of a hundred degrees and has a high base altitude. Hot weather and altitude dramatically decreases aircraft performance, which is what the lesson simulated. The fact the participant felt that because of his current flying needs, it was not a critical aspect of training. So it is clear that the current perception of value was based on the stage of training and the participants’ assessment of their own
situation. It is possible that tunnel vision may be focusing participants only on the current training needs and not on their eventual goals or safety, and this lack of vision could be causing some interference with learning. Participants who perceived values solely based on their current needs were not looking at the larger picture of flight, including the range of flights they will have over the course of their careers and even the differences in seasons. This tunnel vision may lead to a lack of understanding of different abnormal situations and lead to an error. One contributing factor in decision making errors can be a lack of understanding (Wiegmann & Shappell, 2003).

All of the participants felt that the simulation training would affect the way that they fly, at least in some way. The significant finding on the PSE appears to back up the participants’ statements. The SEG did perform better than the MMCG. Many of the training topics used in this study are not focused on in the basic flight courses and not practiced in the normal primary flight training of the students. At this time, most primary flight training avoids the use of simulation, making several of the topics used unsafe to teach in a real aircraft. Three participants indicated in question one of the interviews that the scenarios brought factors to their attention that flight instructors would not have normally been able to provide in the course of normal flight training. The change in the behaviors was a goal of this study. Because if the use of simulation, changes the basic flight behaviors of pilots was shown in the PSE. The significance in the PSE indicates that it would possible to use simulation to produce pilots with better decision-making skills.
Another discussion point that came out of the interviews was planning and situational awareness. Situational awareness is a term in aviation that is applied broadly to any situation where a pilot is not aware of where they are and/or their aircraft’s attitude in reference to the planet. Several participants indicted that they would be taking more time for decisions and a focus more on their situational awareness. Situational awareness was indicated by seven of the nine participants as something on which the simulation training has had an effect. A lack of situational awareness can also be a contributing cause of poor decision making (Endsley & Garland, 2000; Stanton & Chambers, 2001), as such having situational awareness at the forefront of student training is a major safety advantage. One specific participant stated, “I think I will take things slower, it [the scenario with being lost] showed me it is worth it to take more time rather than getting into a dangerous situation.” The participant addressed an issue with planning each flight, which becomes critical as the pilot moves into commercial operations. Many times, at least in the researcher’s personal experience, students rush through procedures. By slowing down, a pilot will be able to look at the bigger picture and improve the choices they make by being more situationally aware. It should be noted that situational awareness was mentioned in several questions throughout the interviews. The reason that situational awareness comes up so often is because simulation allows the instructor the ability to safely induce situations that are adverse and can distract a pilot (Connolly et al., 1989; Gaba et al., 2001). One participant indicated that they noticed the loss of the attitude indicator, but not the alternator warning light and they would then look for these changes on the entire panel. Actually failing the instrument in flight would be unsafe to
do in the aircraft, but provides the participant the effect safely. Since one of the most fatal events in aviation, Loss of Control (LOC), occurs because of loss of situational awareness, it would be beneficial to have the primary flight students train in simulators using scenarios specifically designed to address situational awareness (N. B. Sarter & Woods, 1991; Stanton & Chambers, 2001).

Question two followed with the theme of immediate feedback. Four participants indicated that being able to see the consequences of their actions was the most useful part of the training. Following along the same lines, one participant indicated that the immediate feedback was the most useful part of the training. Another stated, “the most useful part was the dying part.” Dying would most definitely be categorized as a consequence. Three of the participants further indicated that the improvement of their situational awareness was the most useful aspect of the training. Participants reactions match several outcomes in the current literature (Cole & Todd, 2003; Hattie & Timperley, 2007; Issenberg et al., 2005) and show how powerful the immediate feedback, provided by a simulator, can be. Consider the impact of being able to allow students to see the effect of their choices inflight before they were in the aircraft. Students would be able to make mistakes and adjust their decisions before encountering the specific abnormal situation in an actual aircraft.

Another two participants specifically indicated that the aircraft performance lesson really surprised them and was the most useful part of the training. The first participant stated “I would not be able to get that here most likely”, referencing his primary flight training. The second participant just stated that the lesson on performance
was the most critical. Both of these participants are pointing out the power of simulation, the ability to provide unique experiences to the users. Even low fidelity PC-based simulators have provided some benefit to users in the past (Leland et al., 2009; Ortiz, 1994; Roessingh, 2005). Currently most primary flight instruction occurs in the aircraft, though any pilot may be motivated to use simulation in the future as a way to augment their time in the actual aircraft. This motivation will be especially true as the cost of simulation is reduced. Simulation would help pilots more of the decision-making scenarios than they would normally have achieved without it, and would in turn improve the pilots’ decision making skills.

Not all of the participants felt that the simulation used in this study was as effective as it could have been. Almost universally the largest issue was the realism of the simulation, or in more technical terms, the fidelity of the AATD. All but one of the participants had the same code for the analysis, the realism of the AATD. Several answers were based around it lacking the feel of actual flight—a lack of motion cues that limited the effectiveness of the training. One participant stated, “aside from being a simulator, no. It just does not work exactly like the real airplane.” Most of the participants also indicated that improved realism would help improve the training. Two participants indicated that the use of motion would have provided a more realistic simulation. One of those participants stated, “With the current technology, not sure. What about adding motion? I have used it [simulation], when it comes down to it, it [simulation] helps but I do not think it would be the make or break of training.” One participant felt that if they had a larger visual field, beyond the 140 degrees provided,
they would have been able to conduct maneuvers better and get more out of the flight. Several of the participants indicated that the AATD’s realism, specifically the depth perception, was not as effective as it should have been and should be improved. Two participants stated that the simulator and scenarios were good and should be left alone.

The addition of motion would add a certain amount of kinesthetic sensations. However, goal of this study was to examine simple simulators, ones that GA training facilities could afford and use. In future studies it would be critical to analyze the differences in the effect on decision making using multiple levels of simulation fidelity. Because of the costs associated with the higher levels of simulators, most flight schools are not capable of affording them. Basic motion simulators are affordable but may not provide enough motion to make a difference in training both “Stick and Rudder” skill as well as the soft skills. Realism in these lower level simulators is may be an issue; it just costs too much to emulate the real aircraft. However, in the case of this study the lack of realism did not reduce the applied effect on the participants. There is also foundational research that indicates the effectiveness of even low fidelity simulation (Nullmeyer & Spiker, 2000; Ortiz, 1994; Paetkau, Bissonnette, & Taylor, 2013; Roessingh, 2005; Yuen, 2010).

The participants appeared to be looking to have the simulator and lessons focus on flight maneuvering, which was not the point of the training. Effective maneuvering and landings is often times outside of the capabilities for all but the most advanced flight simulators. However, the participants in the SEG did make better decisions than the MMCG achieving the goal of the decision making training. The difference between
expectations of the participants and the actual goal of the training may be the reason that the realism of the simulation was a consistent point of issue in the interviews. If the participants focused on the goal of decision making then they may have felt differently about the realism. This difference between the expectations and the actual goals of the training may indicate a bias toward the use of aircraft over simulators. Another comes from the requirements to fly as a commercial pilot. Pilots may feel that because AATD (and most simulators) cannot be logged as part of total time for training and eventual employment the time was just not as valuable to the participants as time in the aircraft. In response to the phenomena, it would be beneficial to give a more thorough description of the goals of any simulation training as well as the overall benefits to the flight student. Bringing the expectations more in line with the goals would also improve the students’ understanding of why simulation is used in lieu of training in the aircraft. Discussions and study into the use of simulation in initial pilot training may eventually lead to the adjustment of regulations to allow more simulated time to count toward certificates and ratings.

However, even with the issues that the participants perceived with the AATD, there were a number of specific lessons that they felt greatly improved their skills. Three of the participants explicitly indicated that the high altitude lesson was especially effective. One participant stated, “high density altitude, no question.” High density altitude was surprising to hear from the participants, because all of the pilots were training in Alaska, a mountainous state that does have various high altitude and short runways. High altitude training should be a critical portion of training anywhere but
especially here. However, most of the training at UAA occurs in the populated Matanuska-Susitna Valley, and while it is talked about and sometimes demonstrated there is not always the opportunity to show the limits of an aircraft performance. Matanuska-Susitna Valley is one of the lower field elevation locations in the state and has less problems dealing with density altitude, so the high altitude lesson in particular lesson would appeal to the participants that are looking to fly to the more remote places in Alaska. Another three participants indicated that they got a lot out of the decision-making lesson, with one participant indicating the aft center of gravity’s impact on the flight being the best simulated event. Another participant indicated that the failures in the decision-making lesson changed how they currently fly. Most participants that talked about situational awareness indicated that the safety lesson, a lesson with a number of system failures, provided understanding their current limitations. Several participants also indicated that their secondary choice was the visual flight rules into instrument meteorological conditions, which is intriguing as the MMCG did better on in the SJE when dealing with visual flight rules into instrument meteorological conditions, though not on the PSE. It is possible that the practical aspects of flying into instrument meteorological conditions did not transfer well from the AATD to the written exam. However, the decision making skills learned in the visual flight rules into instrument meteorological conditions transferred better to the applied flight of the PSE and while it did not show statistical significance there was a moderate effect $d = .54$. Considering visual flight rules into instrument meteorological conditions is one of the most deadly situations in GA (Aircraft Owners and Pilots Association, 2012; Jacobson, 2010), even a
slight improvement could mean a large difference in safety. In future studies would be useful to examine the use of visual flight rules into instrument meteorological conditions simulation training with more subjects and focusing solely on that topic.

The answers from the participants show that they did see value in the use of the simulator for practicing decision making is in the scenarios that are too dangerous for actual flight. The interview answers and the overall results of the study match most of the established literature (Devanathan & Sethuramalingam, 2012a; Gibb, Ercoline, & Scharff, 2011; Leland et al., 2009). However, currently pilots can only use a small amount of training in a simulation device toward their initial certificates or ratings (Federal Aviation Administration, 2013). Yet the participants of this study can see value in using simulation in flight training. The use of simulation and it effectiveness is especially true considering the dangers of training decision making in an actual aircraft. Using simulation would also allow students to experiment with more actual emergencies without endangering them or their flight instructors. Requiring a certain amount of time in the simulator, specifically targeting certain areas, would be a way to improve these crucial safety skills, while not taking away from the also crucial actual flight time.

**Overall Discussion**

The SJE indicated that both the SEG and MMCG had equivalent levels of topic knowledge. Though, the MMCG did do slightly better than the SEG, there was no significant difference between the groups on the SJE and the scores were nearly identical. The results from the SJE directly show simulation was just as effective as the multimedia training. Thus, even on the FAA knowledge exams or other written exams, simulation
could be used in lieu of multimedia training without degrading student knowledge and comprehension. Research in fields outside of aviation show the effectiveness on using simulation while maintaining or exceeding required knowledge levels (Alinier et al., 2006; Faria, 1998; Gaba et al., 2001). However, since there was significance between the groups during the PSE, it is inferred that simulation is a superior training tool when used for decision making training. While the difference between groups will not provide a theoretical change on its own, it does present an interesting question: why were the two groups different between the SJE and the simulated flight?

The difference between the two SJE scores may indicate while those students that are trained with multimedia presentations are able to take the multiple choice exams well, multimedia training pilots may not be able to directly apply the material in actual flight as well as simulation trained pilots. There is also the possibility that multiple choice exams may not be as effective at examining application of skills in a time constrained environment, like the MMCG was exposed to in their individual lessons. Multiple choice tests would be less effective in the case of this study as the skill of decision making is a softer skill that is not as well suited to defined choices. There is also the possibility that the MMCG had a practice effect with the style of questions, leading to a higher score on the SJE. Though, the SJE was not given on the computer there would still be the possibility that the MMCG had a higher level of practice with scenario based multiple choice questions. SEG was shown to have the same level of knowledge as the MMCG without the possible practice effect, effectively doing better. The SEG had experiential learning on specific scenarios dealing with the subject matter, so their decision-making
skills would be more visible in the applied situation, such as during the PSE. The difference most likely has come from the application of experiences as opposed to any difference in knowledge, matching some of the earlier literature (Alinier et al., 2006; Devanathan & Sethuramalingam, 2012a; Goode, Salmon, & Lenné, 2013; Ortiz, 1994; Roessingh, 2005).

Beyond the multiple choice SJE, the shift in the SEG’s attitude toward decision making could provide an increase in safety within the GA community. If nothing else, improvement in situational awareness could help improve safety (Belcastro, 2001; Prince & Salas, 1997; Stanton & Chambers, 2001; Douglas a. Wiegmann et al., 2002) A number of the SEG participants indicated that they would also take more time on the ground before the flight and the additional time will also have an effect on safety, preventing many airborne incidents by finding the issues with the flight while still on the ground. Taking additional time on the ground would be used to better plan for contingencies and gain a better situational awareness of the surrounding areas, especially the weather. All of the planning and ground time would indicate that there was an effect on safety, at least in a practical sense.

One of the more unique aspects of this study was the use of primary or instrument flight students and testing their decision-making skills. Most aviation studies focus on the later stages of flight, often at a professional level as opposed to the student pilot level. This study was focused on flight students at either the student pilot level working toward their private pilot certificate or the next step with private pilots working toward their instrument rating. Pilots at these level are just now developing both their flight skills and
basic habits, such as effective decision making, that will follow them through their entire career (Federal Aviation Administration, 2009). There have been a few studies and discussions on the use of scenario based training to improve decision making (Alinier et al., 2006; Ayers, 2006). In one of these studies, Ayers (2006) examined the use of intermediate fidelity simulation on undergraduate nursing students showed similar results, with a significant improvement in the practical test decision making, but little difference in the perceptions of the training. Given both aviation and nursing use high stress, high risk, and time sensitive skills, it stands to reason these would show similar results and be comparable. The interview responses from the participants in this study matched the results of Ayers’ (2006) study as well. Most of the participants from this study indicated that they felt that the simulation was not the same as the aircraft, much like the nurses felt that the simulation was not a perfect analogy to the human body. However, both this study and Ayers’ study showed that there was an improvement with the use of even low cost and low fidelity simulation.

This study was able to infer that it was plausible to teach decision-making skills with lower cost lower fidelity simulations. While most studies that have examined PC based simulation only have found a reduction in the total flight time it takes to complete the training (Leland et al., 2009; Ortiz, 1994; Roessingh, 2005), there was still a reduction in the time it took to complete maneuvers in the aircraft. So these affordable simulators could be employed by educators specifically to address the soft skills like decision making.
Focusing on the soft skills is the major shift in flight training thinking. First, by applying a series of simulation scenarios and placing the students in unfamiliar situations, it would be possible, based on this study’s results, to help those students improve their decision-making skills. Oftentimes the focus has been on the transfer of manual flight skills, where there was usually little difference between actual flight training and simulation (Carretta & Dunlap, 1998; Goetz et al., 2012; Ortiz, 1994; Roessingh, 2005). However, this study examined the use of simulation on soft skills, specifically decision making. Focusing on soft skill training with simulators shows promise, at least initially, for initial training of decision making to students. How well these skills will be maintained would have to be examined longitudinally and is beyond the scope of this study. It is possible that continued simulation through training on these skills would be necessary to maintain the skills.

Another advantage to the use of simulation is the reduced costs of flight training. This study focused on using AATD’s, a relatively affordable simulation system that can be used to mimic any number of aircraft. AATD’s cost $32,800 to several hundred thousand (Redbird Flight, 2016). However, the AATD used in this study was a basic model without motion or anything other than basic graphics and was not certified by the FAA to train landings. The cost of simulators that are capable of training any maneuver are cost prohibitive and take up a lot of room that many flight schools may not have, and this cost is the major limitation. As such it is critical to focus on the current affordable systems. However, as technology continues to improve the costs and size of the advanced technology will decrease leading to more effective simulators at the primary
levels of flight training. Using simulation earlier in flight training would reduce the costs to both the students and the flight schools by allowing students to work out some of the soft skills, like decision making and communication, while in the simulator as opposed to an aircraft that needs fuel, maintenance, and other fixed and non-fixed costs. The difference in costs to the student could be hundreds of dollars per hour and the school saves even more.

Outside of the planned measures, some anecdotal information was observed during the SEG’s training scenarios. Every single participant had been through the private pilot ground school and was able to provide the basic information for the lessons in the basic lesson briefing. However, there were a few lessons where the participants did not operate as they said they would. In lesson two specifically, the participants were given a scenario where the flight visibility was gradually reduced. Inadvertent flight into instrument conditions is considered one of the deadliest situations that GA aircraft can encounter, often leading to loss of control (Aircraft Owners and Pilots Association, 2012). The standard response to inadvertent flight into bad weather is to conduct a standard rate turn (3 degrees per second) for 180 degrees. However, both groups tended to continue into deteriorating weather. The SEG did do better than the MMCG on the PSE; however, during the training they often continued forward into poor weather, even in distress. This result would indicate a possible gap in the participants’ knowledge. The participants did not truly understand the actual danger associated with flight into IMC and were not as concerned in the deteriorating weather in the AATD. Though participants had an understanding of the proper procedure, they did not have the applicable experience to
understand the effect on safety that flight into the adverse conditions would have. The AATD was able to provide the experience and a simulation of how slowly the clouds and visibility can come down. The experience most likely improved the SEG’s decisions during the PSE. Although there was not a significant difference between the groups on the visual flight rules into instrument meteorological conditions, there was a difference. Any improvement here is a major step forward, considering how dangerous flight into instrument meteorological conditions can be. Even a small difference unto itself could provide a significant safety improvement in general aviation (Douglas a. Wiegmann et al., 2002; Wiggins & O’Hare, 1995).

**Limitations**

Students were attending associated flight training, at their documented level. Each participant continued to gaining flight experience toward the certificate or rating of that course throughout the study, be it private or instrument flight, during the experiment. During that time the participants should have been improving their understanding of aviation as the course progresses from their own courses as much as our supplemental training. As such it is possible that the students gained different levels of flight instruction based on the time of day they fly and the different weather. To mitigate the possible instructional type issue, this study included two participants who were trained outside of UAA in separate experimental groups. There is also the advantage of flight training that is under part 141 of the regulations. The requirement is the use of a standardized curriculum, further minimizing the chance that participants in the two groups had wildly different training.
This study also makes the assumption that the students involved were actively flying. The assumption that they will be continuing to grow in their knowledge outside of the study. Each student should improve throughout the experiment. To control at least some of the increase in experience by using total flight hours as a covariate and keeping the groups even.

There is also the assumption that the SJE will assess the proper knowledge and decision-making capabilities of the students. To help ensure SJE was assessing the decision making properly, we took the subject material directly from the lessons both groups used in the experiment. We also provided base line answers that were created using expert flight instructors that then added validity. The simulation exam is also assumed to provide a realistic example of flight conditions to illicit actual flight decisions.

Another assumption is the treatment types, the simulation lessons and multimedia online courses, effectively addressed factors that will affect decision making. The topics used for the lessons in this study were chosen because they are focused on decision making and where the decisions will lead to either regulation violations or increased risk—often both. The topics chosen should improve the likelihood that the participants’ decision-making process will be affected by the treatments.

It is also possible that, even though they were instructed not to, the participants discussed the exam with each other, breaking the independence of the test. However, it is unlikely that the participants discussed the exam because the exam was given the same
day as the participant was given the flight exam and most likely they would have discussed both exams, not just the one.

**Delimitations**

The largest delimitation is the limited resources available at University of Alaska Anchorage. There currently is no graduate program associated with the aviation program and as such there are no graduate assistants available. The flight instructors have limited time that needs to be spent working with their individual students.

First, all of the research needed to be conducted by the author of this study. The researcher gave the instruction, conducted the measurements, and analyzed the participants’ decisions. To minimize the effects of the researcher being required to conduct the study on his own, the researcher used an evaluated multiple choice exam and adhered to pre-created rubrics for evaluating the performance in the flight simulator. Since the researcher was conducting the study, there was a limited amount of time for the researcher to conduct the study. The researcher is a full time teaching professor at the University of Alaska Anchorage and had a number of requirements that limited his availability to run subjects.

Another limitation on the use of the simulators was availability and cost of those simulators. While safer and cheaper to operate than an actual aircraft, flight simulators have maintenance and operational costs associated with them. The cost is paid for with flight students’ fees during their training, and because of the requirement of flight students to use the flight training devices, there was a limitation for the amount of time that is available for this study. The study could not disrupt normal flight training. The
lower priority on the use of simulators also limited the amount of time available to conduct the simulator training group sessions.

Although the program at the University of Alaska Anchorage is well established, there are a limited number of flying students at any one time. At the time of this study, there were approximately 72 actively flying students in the program. Of those, we needed to examine the students that were in the early stages of flight training. Requiring the lower level students limited the available students to approximately 35. In addition to the limited number of students, many of the students at the University of Alaska Anchorage are non-traditional, leading to a lower level of participation as most students are also working full time and have families. Because of these factors, we were unable to reach the number of participants estimated necessary for the statistical power we had hoped to achieve.

Another delimitation was the types of training that were conducted. As an important note, all of the certificates (pilot certificates) and ratings (instrument rating) are federal certificates, thus they are valid anywhere in the United States of America. As such there are a number of standards that the FAA uses to ensure that anyone holding a pilots certificate is capable of flight in a majority of environments. These minimum standards are outlined in the FAA’s Practical Testing Standards (PTS) and the training requirements are outlined in the federal regulations (Federal Aviation Administration, 2013). Each of the topics used in this study would fall under the requirement for aeronautical decision making. Any flight students will be trained under one of two training regulations, either part 141 or part 61. The required training topics and skills
between these two regulation training methods are the same, but the instruction is conducted differently and so the minimal training hours are different between them, with part 61 having more freedom and less structured so there are more training hours required than a student in the structured part 141 course. These students must follow an FAA approved training schedule and may not deviate outside of a block of training. The University of Alaska Anchorage has all of the students take the same part 141 ground school regardless of the training regulation they choose to use, to allow for a solid foundation of the required knowledge. However, the students may conduct their flight training under either training regulations depending on if they are flying with the school, if they are using specific financial aid, or any number of other factors.

**Future Study Considerations**

While this study accomplished the goals it set, a number of questions arouse that will need to be addressed in future studies. First, whereas a number of people were interested in being part of the study, most of them were too advanced in their flight training. By limiting the level of flight training and school, this study limited its overall subject pool. To improve both the generalizability of the training and the number of subjects, it would be more advantageous to expand the pool to include part 61 and 141 students outside a college environment. Using different and more students will bring in a number of new variables, outside the regimented programs of universities but will provide more of the generalizability necessary to show that the use of simulation is an effective intervention for improving decision-making skills.
Another possible way to address the lack of participants would be to conduct the study using a repeated measures methodology. Using repeated measures would take more time, but with each participant taking the multimedia training first and then the simulation flights, this study would have had a group of eighteen instead of two groups of 9. There would also be little chance of a practice effect affecting the results since there is only one group and each received the same training. However, there is always a chance using a pre/posttest scenario that there could be a testing effect if the proper precautions are not taken.

Another question that needs to be addressed is the different aspect of flight students’ perceptions of the use of simulation as well as its effectiveness of simulation on decision making throughout a pilot’s career; for example, a study looking at the overall perceptions of simulation from an airline pilot versus commercial and private pilot. Considering the participants were all primary students, at the student to private pilot level of flight training, most of them had minimal experience with the AATD. There is anecdotal evidence that shows a bias away from the use of simulation at these initial levels. Specifically, in the researcher’s experience flight schools do not use, or minimally use, simulation before and after the instrument rating. Even in instrument, it is really only used as a procedure trainer and not for soft skills, like decision making. Since these levels are the foundation of the students’ flight career and habits, the primary flight training level is critical in the formation of decision making techniques. There should be a study examining the effectiveness of simulation, both initially and longitudinally throughout their flight careers.
There will also need to be an assessment of the degree that simulator fidelity effects pilots through soft skill training. As indicated in the interview questions, the participants felt that the simulator did not feel or act like a real aircraft would. At the initial flight training level, and in most flight training schools, the simulation resources are not available for full immersion. It is just too expensive. However, if it can be shown that putting primary students in a full motion simulator greatly improves decision making, it may be worth finding a way to do so.

A future study examining the fidelity link to decision-making skills would most likely require three groups. The first group would use either a Basic Aviation Training Device (BATD) or a non-motion AATD; the second group would use an AATD with motion; and the final group would use a Level C (full motion and landing training certification) or better flight simulator. Each group would go through the same training scenarios and should take the same tests. Making each group go through the same scenarios and tests would eliminate the possible testing bias from the MMCG on the written exam or the practice effect from the SEG, as all of the groups would use simulation. Another aspect that would need to be integrated into any future research would be to include a larger sample from outside a university setting. Increasing the group of possible applicants would help generalize the results.

Considering that the participants did score similarly, regardless of group, on the SJE one could wonder if we could adjust the online courses to integrate some form of scenario simulation on a higher level. By expanding and allowing some open ended choices in different scenarios throughout the lesson and then provide some of the more
severe consequence of those choices, it should be possible to improve the overall decision making of a student. Another possibility is just using simulation for training as it does provide a similar level of knowledge for the written exam. Future research should include multiple levels of online courses, with different levels of scenario interaction as well as comparisons between those media and varying levels of simulation fidelity. Keep the one level as the “choose your own adventure style” and another that has a way for students to “fly” as part of the lesson, on the computer, with the keyboard as the controls.

Another possible study would examine the application of time as a variable in decision making. Since most aviation decisions have a critical time element, it would be important to examine if the use of simulators can improve response time. This type of study should be done by first teaching the concepts while stopping at each decision point. Next, a scenario using a fairly large response time frame should be used (i.e., they are flying at high altitude and have an engine failure). The next few lessons would incrementally decrease the time available for decision making until finally, in the last session, the least amount of time possible for a decision should be used. Continuing the engine failure in flight scenario, the engine failure would occur right after takeoff. In this way, one could measure the decision making skills learned by the student. Most likely, one could examine the changes between each of the interval shifts and compare all of them through repeated measures to test how training affects efficiency of decision making.

Moving forward there needs to be additional research on the effective use of low fidelity simulations in training, specifically as to which type of training most benefits
from the use of simulation. While this study showed some applied significance regarding decision making, there may be other ways to use simulation in early flight training. As such, a study should be done using maneuvers which require various skill and knowledge levels; the responses to these maneuvers can then be compared with each other. Once more optimal topics are found, lesson and curriculum for those topics will need to be refined and tested.

Further study also needs to be conducted which examines the role that distractions play in pure knowledge acquisition. It is possible that distraction may have played a role in how the MMCG did during the PSE. As such running a series of low and high distraction lessons and testing participants’ knowledge after each lesson would examine how distractions effect knowledge acquisition, as opposed to skill acquisition as this study examined.

Finally, a study needs to be conducted to examine the transfer of decision-making skills directly to flight training in the actual aircraft. Examining the skill transfer would be difficult, however, as many of the scenarios that lend themselves to simulator training have a higher degree of risk associated with them. To mitigate the risk it would be prudent to instead of examining the decisions in actual dangerous situations, examine how the participants act and change their behavior based around flight planning, weather examination, and inflight decisions that may not be as hazardous but still require a thoughtful decision be made. An example of a thoughtful decision could be the decision to reject a landing because it feels wrong as opposed to push through to land the aircraft. The participants would have to be evaluated by their flight instructors. It would also be
possible to have the check instructors for both stage examinations or final flights for certificates or ratings to provide an evaluation of the participant’s decision making since they need to do that anyway.

**Conclusion**

There is a very specific gap in the literature relating to aviation simulation training. The gap specifically addresses a key safety issue in aviation, decision making. Simulation used to enhance decision making has not been extensively examined in the literature, and it is a contributing factor in a number of aircraft accidents. Oftentimes decisions made in flight will lead to undesirable outcomes. As discussed in the introduction, the accident rate in General Aviation has long been plateaued. If the research community can address student decision making, we may be able to make a positive impact on GA’s accident rate.

This study set about to find if it would be effective to use supplemental simulator training to improve decision making in pilots early in their flight training. In a practical sense, evidence showed simulation improved decision making during a practical application of the training. There was also a significant difference between the groups with the number of poor decisions made during the PSE. The written exam showed very little difference in scores. Within the bounds of the limitations of this study, there was a difference in the performance of the simulator group when it came to decision-making capabilities when in a simulated flight. The time in the simulator does seem to improve decision making in these early flight students, and this change could have an impact in the participants decision making throughout their careers. While this study cannot tell if
an increase in the use of simulation would lead to a long-term improvement in decision making, this is a promising first step to seeing if it will do so. The results of this study indicate that the current stance of minimizing simulator training early in the flight training regime may not be the best course of action. If focused on the soft skills, such as decision making or communication, the use of simulation can aid in the development of those critical skills eventually improving aviation safety.
APPENDICES
APPENDIX A

TRAINING COURSE OUTLINE FOR SIMULATION TRAINING
Appendix A

Training Course Outline for Simulation Training

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Topic</th>
<th>Matching AOPA lesson</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Communication</td>
<td>Say It Right: Mastering Radio Communication</td>
<td>30 Min</td>
</tr>
<tr>
<td>2</td>
<td>Visual Flight Rules (VFR) into Instrument Metrological Conditions (IMC)</td>
<td>Weather Wise VFR into IMC</td>
<td>30 Min</td>
</tr>
<tr>
<td>3</td>
<td>Basics of effective decision making</td>
<td>Do The Right Thing: Decision Making for Pilots</td>
<td>30 Min</td>
</tr>
<tr>
<td>4</td>
<td>Mountain Flying</td>
<td>Know Before You Go: Mountain Flying</td>
<td>30 Min</td>
</tr>
<tr>
<td>5</td>
<td>Airspace</td>
<td>Know Before You Go: Navigating Today’s Airspace</td>
<td>30 Min</td>
</tr>
<tr>
<td>6</td>
<td>Exam</td>
<td></td>
<td>30 Min</td>
</tr>
</tbody>
</table>

Instructions:

This TCO is to act as a lesson hand out and guide for the participants. The participants will be reading each lesson before conducting the simulation flight and then fly the scenario for the given lesson. The researcher will provide the additional requirements, such as ATC communications, or any other guidance that the participant asks for. The simulator does not have pre-programmed lessons but needs to be set up and prepared before each lesson by the researcher. The scenario at the beginning of the lesson is used to set up the simulator.

Participants:

Follow through and read each segment, then fly the simulator, using the directions provided. The researcher will not help you by providing information other than in the form of ATC communications. They also can provide you with help in the operation of the simulation system. For example, they will not be able to tell you how to use a VOR, but can pause the simulation at your request. The researcher will be adjusting the settings as you fly to meet the learning objectives of each lesson.
Lesson 1: Communications

Objectives: The student shall be able to communicate effectively with the researcher using the proper communication techniques.

Scenario: While flying you encounter a layer of clouds that obscures the ground. After a few minutes you discover you are no longer sure of your position. As such you will need to use communications to help pinpoint your position and reach a safe landing position. As it stands now you are not instrument current.

1.) Start
   a. Step 1: Initially, you will need to get your bearings. This will require time for you to think about what is going on. As such you need to focus on flying the aircraft first. This is always the top priority. Because of this, you will be already at altitude so you should establish yourself in a simple turn and maintain control of the aircraft to prevent a safety issue. I recommend a continuous turn to also hold your position. Once established move onto step 2.
   b. Step 2: Once you are flying the aircraft and stable then attempt to find your position. You may use any instruments available to you; however, in this instance you are not aware of the local VOR’s or other NAVAIDs. This leaves you the last option to communicate and attempt to find your position. Move to Step 3.
   c. Step 3: Communicate with the local ATC, in this case 118.1. Normally, you find this on a chart as you should have a vague idea of your location. If you do not, you always have the final emergency frequency on 121.5. This has provided you the foundational concept of the priority of operations. Continue flying while you contact ATC.
      i. Pilot priorities
         1. Aviate
         2. Navigate
         3. Communicate

2.) How to make a call
   a. There are four parts to any radio call, and it always follows the same pattern.
      i. First, you always wish to get the attention of who you are calling. So in this case you will start the communication with “Akron/Canton Approach”
      ii. It is key to identify yourself, so that they know who you are and what they should be looking for. In this case you are “Redbird 2AK”
      iii. As ATC will be looking for you, you should provide them any position information you know, this is also where you would place ATIS information if you have it. In this situation “Unknown position, negative information”
iv. Finally, you will get to tell them what you want. In this case “I need help, I am lost and need a position and guidance back to an airport”

1. So to put it together
   a. Akron/ Canton Approach
   b. Redbird 2AK
   c. Unknown Position, negative information
   d. I need help, I am lost and would like to get vectors back to Akron/Canton

3.) What you will get is what is known as Flight Following. Essentially, you will receive the same basic services as an IFR flight. While this is a simplification, ATC will call out traffic and provide the pilot some basic guidance. Listen to ATC and follow their instructions to get you Akron Fulton (AKR)
   a. Traffic Advisories are provided to you noting the location of traffic close to you. During a VFR flight in Visual Meteorological Conditions you will need to see and avoid. However, this is to provide you additional information and act as a second set of eyes.

4.) Contacting non-towered airports is more of an effort than contacting aircraft that are actively flying in the pattern or operating on the ground. Keeping this in mind, when you are contacting non-towered airports YOU need to provide your location and intentions. As such the radio calls are similar to other radio calls, however, you need to call out your location within the traffic pattern. You also need to end every transmission with the airport you are flying from. For example as you turn onto the base leg you need to call out: “Kent State Airport, Redbird 2AK, and Turning base runway 1, Kent State”. Now you work through the pattern at Akron/Fulton.

5.) Working with a tower at a tower controlled airport provides a simplified operation. You will not have to announce where you are. However, you will have to contact the tower after you have received ATIS. ATIS is the automated information system that provides information such as current weather and active runway. When you have received the information, you then contact the tower. After that just follow the ATC directions. You must follow any accepted clearance so you have the option to deny a clearance, this is often used for what is known as Land and Hold Short Operations. This is when you are expected to land and stop before another runway that crosses the runway. Follow through and finish your flight to Akron/Canton from a takeoff at Akron/Fulton. Receive ATIS, Contact the Tower and Deny a LAHSO.
   a. Towered Operations
      i. Order of calls
      ii. Pattern Calls

6.) If for any reason you find that you cannot contact another facility or you are having a major problem, such as mechanical failure or being lost, you can contact the emergency frequency 121.5. You can also communicate through the use of different
transponder squawk codes, specifically 7500 (Hijacking), 7600 (loss of communication), and finally 7700 (Emergency). You will lose your radios at some point, squawk the proper code and work to contact the emergency frequency.

Lesson 2: Visual Flight into Instrument Conditions

Objectives: Understand the issues associated with Visual Flight Rules flight into Instrument Meteorological Conditions.

Requirements: Weather packet and analysis

Scenario: You are flying on a cross country on your way to a job interview. As you continue you notice that the weather is not as predicted and has shown to be variable. You have pressed on.

1. Visual Flight Rules into Instrument Meteorological Conditions is one of the most dangerous situations a GA pilot of any level can be exposed to. Why? Consider the rapid change to move from visual to instrument flight. You have the general transition to instrument scan, which would require some time to adjust. As a pilot, you would be exposed to the possibility of spatial disorientation from the Semi-circular canals as well as overall confusion from instantly being exposed to a lack of visual reference. Continue flying and follow the researcher’s requests both as a pilot and outside of the pilot. Continue flight and work to maintain flight.

2. One thing you should consider during the flight is the general atmospheric changes. If the Temperature and the dew point began to move together condensation is possible. Even without clouds, haze and fog are possible. Also if you take into account the atmospheric standard lapse rate, 2 degree Celsius per 1000 feet. This would provide you some estimate of where clouds could occur. While conducting this flight consider and call out the temperatures as you fly. This could help you catch the formation of clouds or reduced visibility.
   a. Example: The surface temperature is 15 degrees. Dew point is 7 degrees. The 8 degree difference divided by the lapse rate of 2 degrees/1000 feet means clouds could be expected to be at 4000 feet above ground level.

3. Very rarely does the flight weather instantly change. Indications of changes to the weather often show a number of shifts such as a slowly lowering of a cloud layer or the visibility will drop just a little over time. If you can observe and catch this starting to occur it can give you the edge in finding a safe option of getting out of the problem. Call out when you think things are changing and make a decision whether to move forward or other options. You are expected to make your choice and do it.
a. Fronts are one of the few exceptions that would lead to a very rapid change. It is key to find this information before flight. Cold fronts often have icing and turbulent air. This is dangerous. Warm fronts are often tamer, but will often extend out farther and should not be considered safe. While rare some of the most severe weather can come from warm fronts. Look at the weather and find it first.

4. So you are entering or have entered Instrument Meteorological Conditions. Many of you have been taught to do a 180 degree turn. This is one option, and often times harder to do if you are disoriented. There are a number of tradeoffs associated with deteriorating weather conditions. You must look primarily at if you are able to maneuver without actually increasing your disorientation. If you are in it and having trouble turning CALL FOR HELP from ATC and try and remain wings level. This is best to keep from additional physiological disorientation. Flying under the conditions can work well, but only if the altitude is available to safely fly beneath them. Something that many pilots fail to consider is an off field landing. Yes, this is hard for a pilot to consider, but should be considered as an effective and possibly safer option. For this flight, try each of these. If you have your instrument rating, please do not ask to file an IFR flight plan. Focus on VFR maneuvers. Many VFR into Instrument meteorological Conditions accidents have come from instrument rated pilots and this should be considered effective training and practice.

Lesson 3: Aeronautical Decision Making

Objective: The student shall be able use basic decision-making guidelines to make effective decisions during the flight simulation.

Required items: Weather packet and a flight plan.

Winds aloft will be different from the forecasted 120 at 15. At 1500ft. change the winds to 35 kts.

Three emergencies:
1.) Alternator failure (At 1500ft)
2.) Vacuum failure at 6 minutes
3.) Engine failure 20 minutes in, the restart if possible on final approach, fail again 1 minute after that.

Scenario: Your significant other would like you to fly over to Youngstown for lunch and a quick trip around the pattern. At the same time, you also should drop off the tools that you have been promising your boss you would to drop off at the mechanics shop at the airport. So you load up the aircraft, get the weather and plan the flight the night before. You are now getting ready to check your planning and conduct the flight.
1. Decision making in flight starts well before the take-off. It is key that you find and understand the issues associated with operating an aircraft and planning. This is often called the Go/No Go decision, it is the overall decision as to whether you will actually take the flight. Now this does not mean that you will have to continue the flight and you should consider all of the available options to you during the flight. Considering the current weather provided, consider whether you will take this short flight or not. Things to consider:
   a. With the tools involved you may not be able to fly with full fuel. A simple short flight like this can lead to complacency, and you should make every effort to examine your fuel level. Poor Fuel Management has led to several flights ending up in a field or just short of the runway. Also keep in mind regulations require a fuel reserve of 30 minutes during the day and 45 minutes at night.
   b. Your weight and balance as well as your performance will have an effect on your safe completion of the flight. Examine it and consider weather’s place in it.
   c. Weather is often the wild card of the flight. Winds aloft is a forecast product and often times it is old data when you are attempting to fly. This is the key to successful in-flight decisions, because understanding the limitations of the weather products and if available the weather in the cockpit will help keep you alert and observant of the weather around you.
   d. You also need to consider your capabilities in the aircraft. There is a large difference between the regulated currency and your actual proficiency. We often consider that if we are current that is the same thing as being competent. This is not the case, consider the fact that this is the third lesson in the simulator, do you feel capable to operate and fly this piece of equipment? Consider this as you make your go/no go decision.
   e. So looking at the information and data do you think you can make this flight? Make your decision and tell the researcher what you would like changed to make the flight doable if your decision is go.

2. Because of the raw amount of variables involved in flight you will need to consider all of the changes on the fly.
   a. Nothing will stay the same as you have planned as most planning is accomplished using weather forecasts and weather that is surface based instead of aloft. As such you should use your planning for only the initial parts of the flight. You then should figure on calculating the winds and ground speed as well as outside observations.
   b. When you are making in-flight decisions you need to take all of the available, often in a limited quantity because of time constraints, and choose the most efficient or safest option. To help aid this through this flight and others, I recommend using the following steps:
i. Anticipate- always be trying to examine and evaluate your environment and look for problems ahead of time. This can include the use of communications and ATC.

ii. Evaluate - what is going on and the parts of the problems forming. This can start with initial planning and what is different in-flight.
   1. Temperature/Dew point spread can help you identify the location of clouds and areas of reduced visibility.
   2. Ground speed can indicate different winds and can change your time en route.

iii. Recognize - when things are starting to change for the worst. This may sound easy, but this is often where accidents can be traced to. It is rare that a person actually chooses to fly into danger intentionally.

iv. Act - you need choose and take the best action that you believe will achieve a safe outcome.

v. Repeat the process as necessary.

c. Workload can affect your capability to perform and make decisions. Remember the priorities of flight: Aviate, or fly the aircraft; Navigate, or know where you are and where to go, and finally Communicate. Always fly first and keep the aircraft under control.

3. Always keep your own personal minimums in mind. When you start your flying career you will have lower minimums, and in many categories you may have problems conducting different type of flights. As you grow in experience, you will need to adjust your minimums up or down, however, you need to keep to the minimums as often as you can. Sometimes it is possible for you to have some or many of your minimums, for example lower ceilings and lower visibility, just at your minimums. This requires you to do a risk assessment and you will have to make a judgment call on what you believe is safe.

4. Always leave yourself an out. Several back up plans are useful. As you conduct this flight talk about your contingency plans out loud to yourself. This often keeps the fresh and can reduce the time it takes you to react to varying conditions.

Lesson 4: Mountain Flying

Objective: The student shall be able to identify some of the dangers when flying within a mountainous area. They will be able to recognize these dangers during the simulated flight.

Required Items: Flight plan and Weather packet
   Temp 30 Degrees Celsius
   Engine failure after 25 min
Scenario: You are going to fly from LXV (Lake Co) to AEJ (Central Colorado Regional County). Unfortunately, it is in the middle of July and you are flying a mighty 172! During this flight, your researcher will be changing both the density altitudes and winds aloft to simulate the effect of flying through the mountains.

1. Flight planning, like for any other flight, is an important piece of flight. However, when you are flying in a mountainous area you need to take extra care to deal with the altitudes of the ground. This means that you must understand the concepts of aircraft performance inside and out. In this case, you really need to understand the effect density altitude has on performance. Depending on the time of day and outside air temperature, you can have drastically decreased performance with a normally aspirated engine. Remember that you have better aircraft performance in more dense air.
   i. Density Altitude
      1. Temperature has an inverse effect of performance, so as temperature goes up the density of the atmosphere goes down. Mid-afternoon, depending on latitude, can be the worst time to fly when you are talking performance.
      2. Pressure has a normal relationship with density, so if atmospheric pressure increases so does density. Watch out for low pressure systems and fronts.
      3. Increasing Humidity will decrease pressure. So the most dangerous situation in the mountains is when there is a hot and humid day with a low pressure system moving through.

2. When you are flying in mountainous areas you need to not just plan, but also be aware of changes in the performance of the aircraft and the weather around you. If the winds pick up over the crest of a mountain you can have a mountain wave form in a stable atmosphere. This will have some of the most dangerous turbulence outside of a thunderstorm. It is indicated often by a cloud forming at the peak of the mountain and smooth looking clouds known as lenticular clouds. In those clouds you can have wind speeds up to 80 knots. In a small aircraft it is also possible to get trapped in the wave, requiring you to turn 45 degrees off course to break out. There are many other issues that can affect your decisions and the safety of flight.
   a. Just like stated in other lessons you need to be aware of changes in flight. Not only are you monitoring for clouds and visibility, which has increased risks in mountainous areas, but you need to constantly be aware of your aircraft performance.
      i. Watch for both winds aloft and temperature changes. Winds aloft changes can affect your ground track, and when you are flying below the peaks of a mountain range this can push you into the ground and create a Controlled Flight Into Terrain (CFIT).
situation. The risk of this occurring increases with a decrease in flight visibility.

b. Performance issues are normally encountered during takeoff and landing, however during all phases of flight it is important to consider your performance and how to actually improve what you have.

   i. Leaning the fuel air mixture is critical any time you are flying higher than a density altitude of 3000 feet. The key to leaning is you need to lean for what you are attempting to do. Normally, you are looking for best economy, or the balance between speed and fuel consumption. Normally, this is leaning the engine until you are at peak Exhaust Gas Temperature and then increasing the fuel until you are 50 degrees lower than that peak. For best power you should lean for peak.

   ii. Landing strip options may be limited, especially if you are in an emergency situation. If you are losing visibility and you lack navigation options it may be best to land off field. If this is the case a road may work if it is not a busy one or with a lot of power lines near it. While it is limited in mountainous areas, an open field will give you a chance to be clear of populations. Watch for ruts and use soft field techniques. Finally, along rivers often have clear areas of dirt or gravel. If you are going to attempt this, also follow with the soft field technique, but also keep in mind you need to stay away from the water.

   iii. Climb Performance is greatly reduced the higher you go, keep this in mind when attempting to cross peaks. You should keep track of the temperature to help decide if you can make it.

**Lesson 5: Airspace Flying**

**Objectives:** The student will be able to communicate and properly enter the different airspaces up to and including class B airspace.

**Required Items:** Sectional, TAC chart, and frequency sheet.

**Scenario:** You have been asked to fly from Kent State Airport to Akron/Canton. Once there you are to pick up a package and fly it up to Cleveland Hopkins airport. Along the way you need to properly enter each airspace and properly communicate with each location.

1.) Using charts for navigation is a key aspect of flying, especially when you are dealing with a complicated set of airspaces. A key reminder about airspace: Class A airspace is everything from the transition altitude of 18,000 feet MSL up to, but not including 60,000 feet. This is a critical point because, while rare, people have
been blown in from an up draft. Other than that most airspaces are unique. As such you need a chart to handle finding the information about the airspace, such as communication frequencies and boundaries. A sectional chart provides effective airspace knowledge for all flights below 18,000 feet. It is the most often used chart.

a. Look at your flight paths and notice the blue dashed lines around your initial departure point. This indicated a class D airspace. You must communicate with this airspace. However, once they say your call sign you are allowed to fly into the airspace. YOU DO NOT NEED A CLEARANCE.

b. Akron/Canton has solid magenta lines around it, indicating it is class C. Before entering you must establish communications like class D, but you also must have a working mode C transponder. They will give you a squawk code to place in the transponder.

c. Finally, Cleveland has solid blue lines, before crossing those you need clearance to enter. That means you need to hear the words “Cessna 12345, you are cleared into Cleveland’s Class Bravo airspace.” This will be followed by a squawk code and radar vectors for your courses. There is no exception to this situation, you must accept the vectors. If you are not cleared into the airspace, you will need to remain outside of the airspace. You cannot enter. As such there are TAC charts that are used for a zoomed in view around Class B airports. Use the TAC chart provided to avoid Cleveland Class B airspace until cleared.

d.

2.) Intercept procedures are used if you enter a special use airspace. This is especially true for the Air Defense Identification Zone (ADIZ) or a Temporary Flight Restriction (TFR). Two military aircraft will approach you. One will follow behind you as one will come up on the right side of the aircraft. They will attempt to contact you on 121.5. If communication cannot be established the lead aircraft will fly in front of you and lead you to an airport. Follow and use rocking wings in response for yes or change your pitch for no.

a. Rocking Wings in response
b. Expect Left Bank first and follow the aircraft.

c. Monitor 121.5
APPENDIX B

SITUATIONAL JUDGMENT EXAM
Appendix B

Situational Judgment Exam

Instructions
You will be given a number of short scenarios that will describe a basic aviation event with a question at the end of the scenario. After reading scenario you are to choose the answer that best addresses the situation at hand. In all of these scenarios make the assumption that Visual Flight Rules are in effect and you should consider yourself a VFR pilot.

Say It Right: Mastering Radio Communication

1) You are flying along when you begin to have engine roughness. You apply carburetor heat and after a several minutes you notice the engine smooths out, however you have gotten yourself lost. What is your initial action?
   a. Continue flying the aircraft and focus on control until you can communicate with someone. (4pts)
   b. Fly the aircraft to a higher altitude and focus on the chart to find your position. (3pts)
   c. Immediately attempt to contact local air traffic control. (1pts)
   d. Begin to adjust the Navaids until you find a signal that is usable. (2pts)

2) You are inbound to Franklin, Pennsylvania. It has been an uneventful flight, but you are now approaching a class D airport. Upon initial contact you are told by ATC “aircraft attempting to contact Franklin, stand by”. What actions should you take first?
   a. Circle outside of the airspace until your call sign is used in a radio transmission. (4pts)
   b. Continue to head to the airport and call in 5 minute intervals until you receive acknowledgement. (3pts)
   c. Climb above the airspace and do not talk to the airport. (1pt)
   d. Route yourself around the class D airspace. (2pts)

3) You are flying from Kent, Ohio to Pittsburg, Pennsylvania, and you will be flying through several Terminal Radar Approach Control Facilities (TRACONs). You have many options when it comes to using these TRACON’s, which of the following would you do in relation to the TRACON to complete this trip?
   a. As long as I am not in the airspace I would focus on not using them and more on my own navigation. (3pts)
   b. I believe that the cursory flight following would be handy and should be requested. (4pts)
c. I would ask for radar vectors as much as possible. (2pts)
d. I should plan to be in the controlled airspace as much as possible for maximum control. (1pts)

4) As you prepare for a flight from Grafton, North Dakota to Crookston, Minnesota, you decide to plan out your communications ahead of time. You’re departing a non-towered airport and moving to a class D airport but there is class G airspace between the airports with a great enough distance so you cannot get ATIS. How will you initially communicate with Grafton and how will you set yourself up to contact Grand Forks? Assume you have one radio with two slots for frequencies.
   a. Set in Grafton and Grand Forks ATIS in the radios, immediately begin monitoring ATIS upon departure. (1pt)
   b. Set in Grafton and Grand Forks ATIS in the radios, wait to begin monitoring ATIS upon until you have departed the pattern. (4pts)
   c. Set in Grafton and Grand Forks Tower in the radios, immediately begin monitoring Tower upon leaving the pattern. (3pts)
   d. Only have Grafton on the radio until you are well outside of the pattern. (2pts)

5) When flying through northern Minnesota, you begin to have engine trouble, though it is still running. You discover to your dismay that you are outside of communication for any ATC and possibly outside of radar coverage. What should your initial action be?
   a. Contact 121.5 and declare Mayday. (2pts)
   b. Activate the ELT with the switch in the cockpit. (1pt)
   c. Turn the aircraft to the nearest suitable place to land. (3pts)
   d. Attempt to find the nearest airport and turn toward it. (4pts)

Visual Flight Rules Flight into Instrument Meteorological Conditions
1) During a local flight to the practice area you quickly notice that the visibility is dropping fast. However it still looks to be VFR, though marginally. You need to consider your options. What will you do?
   a. I will do the 180 degree turn around (4pts)
   b. I will attempt an off field landing. (1pt)
   c. I will try to fly under the clouds to the nearest airport. (2pts)
   d. I will attempt to continue to my destination. (3pts)

2) You are flying in a clear air mass, however, you are approaching a large body of water. This often has an effect of the visibility. What would you like to know to help you assess the changing weather?
   a. Current pilot reports in the area. (4pts)
   b. Local Terminal Area Forecast reports for the area. (1pts)
c. Runway visibilities. (3pts)  
d. Dew points for local airports. (2pts)

3) While flying on a westward cross country, you are approaching a cold front. Knowing what you know of cold fronts, what action do you believe would be most helpful in preventing flight into IFR conditions and still get you where you need to go safely?
   a. Observe the clouds and winds in flight, if you see building divert. (1pt)  
   b. Divert to a nearby airport and wait for the front to pass. (2pts)  
   c. Continue through if you do not see any clouds in your flight path. (3pts)  
   d. Call and get frequent weather updates from flight watch on 122.0 (4pts)

4) You are flying your aircraft in the Midwest and choose to contact the nearest ASOS. You can receive Surface Observations (METAR) and Terminal Area Forecasts (TAF). These are great tools but have limitations, if you were flying a hundred miles, how would you best use this inflight information?
   a. Listen to as many as I can and look for trends. (2pts)  
   b. Listen to one at a time, switching to the next one when you are passing the previous, looking for what is changing. (3pts)  
   c. Listen to the TAF’s and time it to be in the forecasted safe times. (1pt)  
   d. Focus on my observations and use them as additional information. (4pts)

5) You are on a long cross country over rural Pennsylvania. You look down to adjust the flight plan in your GPS and when you look up you are solid Instrument Meteorological Conditions, in this case 2 miles visibility. Under what, if any, circumstances would you continue on and why?
   a. No, there are no situations where I would continue. (3pts)  
   b. Yes, If I could see an airport. (4pts)  
   c. Yes, if I can contact ATC for help. (2pts)  
   d. Yes, I would attempt to fly straight and level to prevent disorientation. (1pts)

Safety

1.) You are considering flying on a hot and muggy day. The performance you calculated indicates that your aircraft performance provides 100 feet of safe clearance on the short runway. You have three passengers in your aircraft and you ran the numbers showing that you are at max weight and forward Center of Gravity (CG), just barely within the limits. Should you take off and why or why not?
   a. No, the forward center of gravity may make it so that we will not get airborne. (3pts)  
   b. Yes, our calculated performance is taking into account a legally loaded aircraft. (4pts)  
   c. Yes, because there is a margin of error included in the performance calculations. (1pt)
d. No, the performance numbers are derived from data collected by test pilots. (2pts)

2.) In aviation, the environment is often changing. Before flying it is often considered a best practice to have defined your personal minimums for safe flight. Considering a rapid change in weather conditions during a flight such as a wind shift to beyond your crosswind limit, when is it acceptable to go past your personal minimums?
   a. When you are faced with no other safe option, such as a low fuel situation. (4pts)
   b. When you are flying with an instructor and are trying to learn. (2pts)
   c. When you have a set “escape plan” like if I am not on a stable approach by 200ft AGL then I will go to an alternative airport. (3pts)
   d. Anytime the safety of flight maybe compromised more by inaction. (1pt)

3.) You are planning for your longer cross country to grandma’s house. During your planning you notice that while it is clear now and predicted to remain so throughout your flight a warm front is moving through the route. Which would you consider your planning priority, considering you wish to see your grandmother on this day?
   a. I would attempt to find a way to make the trip another day. (1 pt)
   b. I would plan for a number of alternative locations along the route in case the visibility or ceilings come down. (4pts)
   c. I would change the route to the north of the Low pressure system to avoid the fronts. (2pts)
   d. I would just plan a series of weather stations to listen to and plan on returning home if the weather gets bad. (3pts)

4.) You are flying in excellent weather. It has been a great day, but it is getting late and you notice that you are having trouble staying awake. You also know that it is getting dark and you have not flown at night for a while. That is when it hits you; you are lost without a GPS but you still remember the basics of Navaid navigation. You wanted to get to your mom’s house for the night. What do you do?
   a. I should a pilot declare an emergency and get ATC help. (1pt)
   b. I will try and return home, since I know the area the best. (3pts)
   c. I would look for the nearest airport and land and get a friend to pick me up in a car. (4pts)
   d. Continue on, using current charts and non-GPS nav aids. (2pts)

5.) You are attempting to fly to a job interview at Western National Bank. The weather is looking good at both your destination and your departure for the night
flight, but you predict that you only will have approximately 45 minutes of fuel reserve upon arrival. Do you go and why?
   a. I go, we have the legally required fuel reserve. (4pts)
   b. I go, the job interview is important. (3pt)
   c. I reschedule, we are cutting really close to the requirements for the flight. (2pts)
   d. I reschedule, the weather used to plan is only a forecast. (1pt)

**Mountain Flying**

1) You have a complete electrical failure at night in the mountains. While an inconvenience, it doesn’t truly affect your flight, at least until you notice the smell of ozone. You know this may be an electrical fire. So what do you believe is your best option in this situation?
   a) After extinguishing the fire, land as soon as practical at an airport. (4pts)
   b) Find and land at the nearest suitable road. (1pts)
   c) Extinguish the fire and then find a place to land. (3pts)
   d) Radio a mayday and land on the nearest road. (2pts)

2) You notice while flying that you are entering an inversion layer. The Outside Air Temp is at 85 degrees. You are approaching a mountainous area of higher peaks, your initial calculations place you at having 500 feet of clearance. What do you expect as you approach the mountain?
   a) You should expect that you will be able to make 500 ft clearance. (1pt)
   b) You will be closer to the mountain but should be safe enough to continue. (2pts)
   c) You should look for a pass to go through as you will be too close. (3pts)
   d) You should wait for a day with better performance. (4pts)

3) You take off and notice that you are not flying at the predicted performance for the aircraft. You checked the temperature and winds and they match. You notice that your engine is not at the correct power for the settings you have. How would you adjust the fuel air mixture to adjust for your altitude?
   a) Lean the engine until you have peak EGT and then reduce it by 50 degrees. (4pts)
   b) Lean the engine until you have peak EGT and maintain it at peak. (3pts)
   a) Lean the engine until you have engine roughness and then enrichen the mixture until it runs smooth. (2pts)
   b) Leave it alone as you will most likely change altitudes and this will in turn change the engine mixture. (1pt)

4) While flying in the mountains, you notice that there may be some adverse weather approaching. In this case, we are talking about high winds and possible clouds, some are rotating. Who should you contact about weather updates and what should you expect as you enter the area?
   a) 122.0 and you should expect mountain waves. (4pts)
   b) 121.5 and you should declare an emergency because of the turbulence. (1pts)
c) Local ATC and you should expect to have wind shear. (3pts)
d) Contact FAA flight service and expect IFR conditions. (2pts)

5) Approaching a mountain, you notice that there is a cloud rapidly forming over the peak, as well as smooth looking clouds ahead of the mountain. What type actions should you take?
   a) Divert to a nearby airport. (4pts)
   b) Approach the mountain range head on. (1pt)
   c) Approach the mountain range at about 45 degree angle. (2pts)
   d) Climb higher than the peak to stay out of the wind. (3pts)

Know Before you Go: Airspace You may use a sectional for these.

1. You are flying up to 21,000ft in your brand new Cirrus SR-22Turbo. What should you expect at the higher altitudes?
   a. All aircraft will be using pressure altitude. (3pts)
   b. The winds aloft should be higher. (2pts)
   c. Aircraft will be flying faster. (1pt)
   d. All of the above. (4pts)

2. On a flight from Kent State Airport (1G3) to Mansfield (MFD). How would you figure out what the equipment is required for this trip?
   a. Look at the course line and find all of the airspaces along the route. (4pts)
   b. Contact the airports at both ends and ask what is required. (2pts)
   c. Look for all of the Navaids along the route. (3pts)
   d. The basic VFR required equipment by the regulations should be sufficient. (1pt)

3. You are flying from Kent State Airport (1G3) to Detroit (DTW). You notice that your flight takes you through two blue airspaces with the markings R-1923 and P-403. How would you handle these airspaces?
   a. Plan around the P-403 and contact the controlling agency for R-1923. (3pts)
   b. Attempt to fly above both of them. (2pts)
   c. Plan around them over Lake Erie. (1pt)
   d. Plan around them over land. (4pts)

4. You were flying your normal route when you discover that you have been intercepted, in this case for entering a TFR. The aircraft is pulling in front of you. What should you do next?
   a. Rocking Wings in response. (4pts)
   b. Expect Left Bank first and follow the aircraft. (2pts)
   c. Monitor 121.5 and attempt to contact them. (3pts)
d. Operate under the assumption that everything is okay now as they have pulled ahead of you. (1pt)

5. You are transitioning from Burke Lakefront airport to Cleveland’s class B airspace directly above. How would you handle the communication transition between the two airspaces?
   a. Immediately switch from Burke Lakefront to Cleveland’s frequency when departing the runway. (1pt)
   b. Wait until given frequency change from Burke Lakefront tower. (3pts)
   c. Wait until you are within 100ft of the top of the Class D airspace and then contact Cleveland. (2pts)
   d. Continue to fly below class B until you can contact Cleveland or Burke gives you a frequency change. (1pt)
APPENDIX C

SIMULATED FLIGHT SCENARIO
Simulation Evaluation Scenario
Research Evaluation Form

SUBJECT _______________________________________________________________

DATE ________________________________________________________________

TIME OF SCENARIO ___________________________________________________

RESEARCH ASSISTANTS CONDUCTING SCENARIO:

Experimenter - __________________________________________________________

Controller - ____________________________________________________________

Other - __________________________________________________________________

______________________________________________________________________

Instructions for Researcher:

Before the participants arrive you will need to configure the initial setup of the simulator. Set the initial point at Kent State Airport. The clouds and visibility should match the METAR below: scattered layer of clouds 2200ft, broken 3000ft, overcast 4100ft with 10 miles visibility. However keep the winds at 0, while this is reducing the realism some this will reduce some of the issues with the participants controlling the simulator. Finally, make sure you have filled out the above part of this form completely.

Before even giving the participants the flight plan to the participant, you are to give a briefing on the operation of the flight controls and simulator operation. This will be a five minute discussion where you show the participants the location of switches and how to move the controls. Then you will have the participants do a ten minute familiarization flight where they may do any maneuvers in clear VFR weather. None of this is to be included in evaluating the participant.

To maintain realism, you the researcher will need to act as the air traffic controller for communication as well as any other communication the participants attempt. While the exact phraseology is not critical for the participants at this stage of flight, you have been provided a simple set of expected communications and responses by you in a chronological order. These are marked with a communication indicator. Each decision
that you will have to keep track of is given with decision designator. If there is a designation with a number it is applicable to this study and those topics that apply specifically to the training given in this study. However, in any flight situation there may be other decisions that need to be made and these are indicated as possible decisions (as it is possible that this situation may not occur), you just need to fill in the form provided just like the rest of the decisions.

This scenario is designed to examine the participant’s decision-making capabilities in a near lifelike operation. As such it is critical that the participants only see the portion that is designated for them. In this case it will be marked as Student Part and will be colored in blue. Also the participants will be given the appropriate sectional (in this case Detroit) and a completed flight plan. Because of the level of training that the participants may be at (early to mid-primary flight student) it is allowable for you to explain the flight plan and basic information about that form. It should be noted that the participants will should have a basic knowledge of the aviation weather format, but if necessary you may tell them what the codes mean but not what you think for the altitudes.
For Student Use

Narrative: You are at Kent (1G3) when you receive a phone call. A fellow student is currently stuck at the Sandusky (SKY) and we need you to go pick them up.

You have completed the aircraft weight and balance calculations and find everything is within limits. You then get the current weather listed below and you have completed the general flight plan. You need to decide what altitude you will be flying, expecting to lift off in an hour. Explain why you choose the altitude you did.

Working... Please wait.

********** Departure Closest Terminal Weather **********
SPECI KAKR 021301Z AUTO 25008KT 10SM SCT022 BKN030 OVC041 09/05 A2983 RMK AO2 T00890050

!AKR 09/008 AKR RWY 7 PAPI UNUSBL 7 DEG R CRS
!AKR 04/011 AKR AIRSPACE SEE ACO 04/002 AIRDROP THU TUE 1500-0230 1404250115-1501010230
!AKR 04/005 AKR TWY B SOUTH OF RWY 7/25 CLSD 1404151614-1412312359EST

********** Destination Closest Terminal Weather **********
METAR KPCW 021254Z AUTO 24014KT 200V270 10SM OVC060 11/07 A2980 RMK AO2
METAR KPCW 021313Z AUTO 24014KT 10SM FEW021 BKN060 OVC070 11/07 A2980 RMK AO2 $

********** Surface Observations **********
METAR KPOV 021256Z AUTO 26010G16KT 10S M BKN019 BKN025 OVC031 08/04 A2982 RMK AO2 T00860040
no reports available for 29G
METAR KCAK 021251Z 25009KT 10SM OVC021 09/04 A2983
METAR KBKL 021253Z 23013KT 10SM BKN029 BKN055 OVC070 09/05 A2980 RMK AO2 SLP092 T00940050
SPECI KAKR 021301Z AUTO 25008KT 10SM SCT022 BKN030 OVC041 09/05 A2983 RMK AO2 T00890050
METAR KBJJ 021256Z AUTO 25011KT 10SM BKN025 OVC031 09/04 A2984 RMK AO2 SLP107 T00890044 TSONO
METAR KCLE 021251Z 24011KT 10SM BKN025 BKN055 OVC070 10/04 A2984 RMK AO2 SLP104 T01000044
METAR KBJJ 021256Z AUTO 25011KT 10SM BKN025 OVC031 09/04 A2984 RMK AO2 SLP107 T00890044 TSONO
METAR KBJJ 021256Z AUTO 25011KT 10SM BKN025 OVC031 09/04 A2984 RMK AO2 SLP107 T00890044 TSONO
METAR KPCW 021254Z AUTO 24014KT 200V270 10SM OVC060 11/07 A2980 RMK AO2
METAR KPCW 021313Z AUTO 24014KT 10SM FEW021 BKN060 OVC070 11/07 A2980 RMK AO2 $
****** Terminal Forecasts ******
TAF KCAK 021130Z 0212/0312 24010G18KT P6SM OVC025 TEMPO 0212/0214
- SHRA
  FM021700 24012G20KT P6SM OVC035
  FM022300 23008KT P6SM OVC070
TAF KCLE 021130Z 0212/0318 24012KT P6SM OVC025 TEMPO 0212/0213
- SHRA
  FM021600 25012G20KT P6SM OVC035
  FM030000 23010KT P6SM OVC070

****** FD Winds Aloft Forecast ******
DATA BASED ON 020600Z REQUESTED
VALID 021800Z FOR USE 1500-0000Z. TEMPS NEG ABV 24000 ALTITUDE
FT 3000  6000  9000  12000  18000  24000  30000  34000  39000  4000
AGC 2519 2629-01 2630-06 2632-07 2556-18 2594-28 741840 742748 741052 2522+03
CLE 0099 0099-02 0099-07 2715-10 2524-22 2548-33 247643 248447 248549 2519+02
CMH 2418 2623-01 2627-07 2630-09 2542-20 2467-31 249542 740847 249650 2419+03
Researcher Simulation Scenario

Researcher Only.

DECISION 1

Rubric for weather altitude selected choice:

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<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
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<tr>
<td>Accounting for the</td>
<td>Any at or</td>
<td>2500-3000</td>
<td>Above 3000</td>
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<tr>
<td>ground obstacles</td>
<td>below 2500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weather minimums</td>
<td>Above 5500</td>
<td></td>
<td>At or below 5500</td>
</tr>
<tr>
<td>Regulations</td>
<td>Does not follow the cruising altitude rules</td>
<td></td>
<td>Does follow the cruising altitude rules</td>
</tr>
<tr>
<td>Winds</td>
<td>4000 and above</td>
<td>3500</td>
<td>3000</td>
</tr>
</tbody>
</table>

Using the flight plan provided, fly this flight as you have planned.

The simulator should be set for current weather at AKR.

SPECI KAKR 021301Z AUTO 25008KT 10SM SCT022 BKN030 OVC041 09/05
A2983 RMK AO2 T00890050

1. POSSIBLE DECISION: This will mean that the clouds will be lower than forecast en route. This may lead to an inadvertent flight into Instrument Meteorological Conditions (IMC). If this occurs mark here ___ and describe their decision upon entering IMC or upon discovering the poorer weather(Circle all that apply):
   a. Continue on
   b. Do a 180 degree turn
   c. Contact ATC
   d. Land off airport
   e. Divert
   f. Other(describe)

__________________________________________________________
__________________________________________________________
__________________________________________________________
__________________________________________________________
__________________________________________________________
__________________________________________________________
<table>
<thead>
<tr>
<th>Choice</th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
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<tbody>
<tr>
<td>Continue</td>
<td></td>
<td>Do 180, Divert</td>
<td>Land Off Field, Contact ATC</td>
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<table>
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<th>Situational Awareness</th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
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<tbody>
<tr>
<td>Does not realize</td>
<td></td>
<td>Realizes</td>
<td></td>
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<table>
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<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
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<td>YES</td>
<td></td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>

Winds aloft should be: 300/26, this is a variation from the forecast winds and should NOT be told to the participant. If they discover this then mark here __.

As the student takes off note the decision for altitude: DECISION

Communication: Observe the ground track, the student needs to contact CAK before reaching 2500’. Indicate if they did: ________

a. If yes respond: “Cessna 123KS you are cleared on course, contact departure on 118.6”

b. If no contact: “Aircraft in Class Charlie airspace, contact Departure on 118.6. You are in violation of the airspace.” Then when they contact tower read the yes response.

Communication: The participant should climb to their chosen altitude and turn on track.

a. Note any major deviations in:
   i. Heading: ________
   ii. Altitude: ________
   iii. Airspeed: ________

DECISION 2: Before the participant reaches Cleveland Class B airspace, mark whether they contact CLE. ___

a. If no: “Aircraft entering Cleveland Class B airspace, Depart Class B airspace and state intentions” After the participant responds go to Yes.

b. If Yes: “Cessna 123KS, standby”

c. Indicate what the participant does:
   1. Continue into class B
   2. Circle to wait
   3. Diverts around class B
   4. Other(describe)

<table>
<thead>
<tr>
<th>Choice</th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue</td>
<td></td>
<td>Divert</td>
<td>Circle</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Situational Awareness</th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not realize</td>
<td></td>
<td>Realizes</td>
<td></td>
</tr>
</tbody>
</table>
After 5 minutes state:

“Cessna 123KS, you are cleared into the Cleveland Class Bravo airspace. You are to maintain 4500 feet and own navigation.”

DECISION 3 Ten minutes after the student is established on course and at altitude reduces the visibility by increments of 0.5 miles until the participant reacts or the visibility reaches 2 miles. Indicate their reaction:
   a. Continue on
   b. Do a 180 degree turn
   c. Contact ATC
   d. Land off airport
   e. Divert
   f. Other (describe)

<table>
<thead>
<tr>
<th>Choice</th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter Visual Flight</td>
<td>Continue</td>
<td>Do 180, Divert</td>
<td>Land Off Field, Contact ATC</td>
</tr>
<tr>
<td>Rules into Instrument Meteorological Conditions</td>
<td>Does not realize</td>
<td>Realizes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

After the participant makes a decision improve the visibility to 5 and have them return to course and continue to on planned route.

DECISION 4 When SKY is in 3 nm away, fail the engine and state their reaction:
   a. Turn on the carburetor Heat
   b. Run through the engine failure checklist
   c. Land off field
   d. Land at SKY
   e. Divert and try and make another airport
   f. Squawk 7700
   g. Contact ATC
   h. Other (describe)

<table>
<thead>
<tr>
<th>Choice</th>
<th>Poor (0)</th>
<th>Fair (1)</th>
<th>Good (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Divert</td>
<td>Land off Field</td>
<td>Carb Heat, Land at</td>
</tr>
<tr>
<td>Situational Awareness</td>
<td>Does not realize</td>
<td>Realizes</td>
<td>SKY, Run Checklist</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------</td>
<td>---------</td>
<td>-------------------</td>
</tr>
<tr>
<td>ATC</td>
<td>Squawk 7700</td>
<td>Contact ATC</td>
<td></td>
</tr>
<tr>
<td>Entering VFR into IMC</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

Participant then lands at Sandusky or whatever choice they made with the engine failure.
APPENDIX D

SURVEYS AND INTERVIEW QUESTIONS
Appendix D

Surveys and Interview Questions

Participant Number

Basic Information form

Gender: __________________

What regulation part you are training under? 141 or 61

Pilot and Instructor Certificates and Ratings (Please circle all that apply):

<table>
<thead>
<tr>
<th>Private</th>
<th>Commercial</th>
<th>ATP</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFII</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MEI</td>
</tr>
</tbody>
</table>

Total Flight Time: ________________

Total Instrument Flight Time (Simulated and Actual): ________________

Have you used a FTD or Simulator for part of your flight training? Y or N

Total Simulator or FTD Time: ______________________
Simulation Training Survey
Raymond Weber
University of Alaska Anchorage
Kent State University

Rate the following statements on a scale of 0 to 5: 0 = not at all 1 = slightly 2 = somewhat 3 = mostly 4 = very significantly 5 = entirely

a) I found the training enjoyable.
b) I would like to have more of this type of instruction in many different topics.
c) It was easy to use the training materials.
d) The training was interactive.
e) The training was effective at teaching procedures and explaining the operation of the aircraft.
f) The scenarios presented in the training were realistic and I believe they could happen.
g) The technology used for the instruction functioned exactly as expected and without error.
h) The materials improved my knowledge about the subjects taught.
i) The training will improve my decision-making skills as a pilot.
j) The training provided me with skills that will be easily transferred to actual in-flight operations.
k) The controls and avionics accurately represented an aircraft configuration that you were familiar with.
l) The visuals of the simulation allowed me to understand the situation and see the results of my decisions.
m) The simulation reacted appropriately to my inputs and provided appropriate feedback while maneuvering the simulator.

Are there any comments that you wish to provide about my supplemental training that was not addressed in the above questions?
Multimedia Training Survey
Raymond Weber
University of Alaska Anchorage
Kent State University

Rate the following statements on a scale of 0 to 5: 0 = not at all  1 = slightly  2 = somewhat  3 = mostly  4 = very significantly  5 = entirely

1.) I found the training enjoyable.
2.) I would like to have more of this type of instruction in many different topics.
3.) It was easy to use the training materials.
4.) The training was interactive.
5.) The training was effective at teaching procedures and explaining the operation of the aircraft throughout the topic areas.
6.) The scenarios presented in the training were realistic and I believe they could happen.
7.) The technology used for the instruction functioned exactly as expected and without error.
8.) The materials improved my knowledge about the subjects taught.
9.) The training will improve my decision-making skills as a pilot.
10.) The training provided me with skills that will be easily transferred to actual in flight operations.
11.) The aircraft shown represented a typical aircraft that I would be using in my flight training.
12.) I had the option to select a choice and see the results of that choice.
13.) The multimedia courses’ pace was comfortable.

Are there any comments that you wish to provide about my supplemental training that was not addressed in the above questions?
Interview Questions:

1.) Please explain how you feel that the simulation training will affect the way you fly.

2.) What was the most useful part of the simulation training?

3.) Did you see any problems with the simulation? If so, please explain what they were.

4.) Do you have any suggestions to improve the simulation to help you understand the application of skills during flight better?

5.) Which subject that was covered in the simulation training was best augmented by the simulation?

6.) Were there any topics that you felt were not aided by simulation?

7.) What was your overall comfort level of using the simulator?
APPENDIX E

INTERVIEW QUESTION RESPONSES
## Appendix E

### Interview Question Responses

Table E-1

Research Question 1

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Answer</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Opened my eyes about a number of potential problems, high altitude especially. More aware of what could go wrong.</td>
<td>Situational Awareness</td>
</tr>
<tr>
<td>11</td>
<td>“I saw an improved instrument scan looking for issues. An overall awareness.”&lt;br&gt;Follow up “of What?”: Anything, focused on systems and where you were.</td>
<td>Situational Awareness</td>
</tr>
<tr>
<td>12</td>
<td>“I think I will take things slower, showed me more it is worth it to take more time rather than getting into a dangerous situation. And read the charts better before you go. Be familiar with where you are going.”</td>
<td>Focus on slowing down</td>
</tr>
<tr>
<td>13</td>
<td>Yes, mostly the decision making. Now I look at <strong>annunciator</strong> and engine gauges. Now looks at winds also because of the mountain flying. Improving your situational awareness</td>
<td>Situational awareness</td>
</tr>
<tr>
<td>14</td>
<td>The scenarios put myself into new situations and experiences. I believe that it will lead to more consideration of key factors like (Participant specifically said): Weight and Balance, Density Altitude, Finding Alternate Airports, Decision making</td>
<td>Exposure to new knowledge</td>
</tr>
<tr>
<td>15</td>
<td>“Positive influence, really forced me to be situational awareness and pay attention.”&lt;br&gt;Why: Because of the Different locations and unfamiliar airspace.</td>
<td>Situational Awareness</td>
</tr>
<tr>
<td>16</td>
<td>“Better situational awareness, as far as prior to takeoff. It came down to the go/no go decision. Always play on the side of caution. Gives you</td>
<td>Situational Awareness</td>
</tr>
</tbody>
</table>
something else to think about, you may introduce into the normal flight. Aviate, Navigate, Communicate.”

17 In a positive manner, learned a few things. Example: High density effects greatly affected him. Exposure to know knowledge

18 “It introduced a number of factors that weren’t always at the forefront of [my] mind. The scenarios that you wouldn’t try out in a regular plane.” Exposure to new knowledge
### Table E-2

**Research Question 2**

**Question 2** What was the most useful part of the simulation training?

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Answer</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Unusual radio calls, had one in flight and the sim lessons wrong. Keep attention to all of the gauges and what does it mean. Pay attention to all instruments and note errors. And tailwinds come in to play.</td>
<td>Situational Awareness</td>
</tr>
<tr>
<td>11</td>
<td>“Hands on operations were really helpful.” I said they are a hands on learner. Also stated that immediate feedback was key. “Both the debrief at the end and the feedback from the inputs into the sim.”</td>
<td>Feedback</td>
</tr>
<tr>
<td>12</td>
<td>“[The] most useful was the density altitude seeing the effects. I would not be able to get that here most likely.”</td>
<td>High Altitude</td>
</tr>
<tr>
<td>13</td>
<td>“Biggest thing was the ammeter being off.”</td>
<td>Situational Awareness</td>
</tr>
<tr>
<td>14</td>
<td>There is an importance to having good decision-making skills. Poor decisions have real consequences.</td>
<td>Consequences</td>
</tr>
<tr>
<td>15</td>
<td>“The lesson of the high altitude, One of the most important lessons, learn how to lean and how degrading altitude is to performance.”</td>
<td>High Altitude</td>
</tr>
<tr>
<td>16</td>
<td>The realization that you can easily get into these situations that can kill you. Situational awareness and single pilot resource management. Being put into uncomfortable situations.</td>
<td>Situational Awareness, Consequences</td>
</tr>
<tr>
<td>17</td>
<td>It is easier to interpret the effects of what you do and how your actions change things.</td>
<td>Consequences</td>
</tr>
<tr>
<td>18</td>
<td>The most useful part was the dying part. You need to fly the plane to the ground and be thinking about the flight the whole time, even when things go wrong.</td>
<td>Consequences</td>
</tr>
</tbody>
</table>
Table E-3

Research Question 3

Did you see any problems with the simulation? If so, please explain what they were.

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Answer</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>“Ability to perceive depth sucks, perception sucks, and inability to see behind for landing.” Graphics did not show the terrain as well as it should have.</td>
<td>Realism</td>
</tr>
<tr>
<td>11</td>
<td>“There was little problems with the use of the simulator for these topics, everything we went through could happen in real life and should be aware of the consequences without the real consequences.”</td>
<td>None</td>
</tr>
<tr>
<td>12</td>
<td>The graphics could go up, but its flying in the sim. It helps the most with the checklists and procedures, but you may get overload if you try and learn them while doing so in the sim.</td>
<td>Realism</td>
</tr>
<tr>
<td>13</td>
<td>“The biggest problems were with depth of field and descent model is off.”</td>
<td>Realism</td>
</tr>
<tr>
<td>14</td>
<td>Some of the scenarios are really bad situations that may not apply. “The decision making and high density altitude scenarios I would have done more ground work and avoided the problems.”</td>
<td>Scenarios Fit</td>
</tr>
<tr>
<td>15</td>
<td>“Not as much kinetic felling, motion was missing.” Sound was off and didn’t feel right</td>
<td>Realism</td>
</tr>
<tr>
<td>16</td>
<td>Seem to have a personal preference, sim maybe doesn’t simulate the plane completely. I felt that it is better than just reading or watching videos, but it is not the same as flying the real plane.</td>
<td>Realism</td>
</tr>
<tr>
<td>17</td>
<td>“Aside from being a simulator, no. It just does not work exactly like the real airplane.”</td>
<td>Realism</td>
</tr>
<tr>
<td>18</td>
<td>“The fact that the simulator lacked full motion prevented the more life or death feel to the flight. Also the engine had issues starting and that was an issue.”</td>
<td>Realism</td>
</tr>
</tbody>
</table>
Table E-4

Research Question 4

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Answer</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>“Having greater than 140 degree for the 45 degree turns and adjust [the graphics] to improve depth perception.”</td>
<td>Visual Field</td>
</tr>
<tr>
<td>11</td>
<td>Everything was helpful, Stated that everything seemed like it was set up well, Might be better with more advanced scenarios.</td>
<td>Advanced Scenarios</td>
</tr>
<tr>
<td>12</td>
<td>“If the display was more realistic, I had a tough time with distance in the sim.” Motion doesn’t make that much difference in the sim. Very realistic airplane control wise though.</td>
<td>Depth</td>
</tr>
<tr>
<td>13</td>
<td>Depend on what you are teaching, if doing emergency better flight model. Nothing wrong with it for decision making.</td>
<td>Flight model</td>
</tr>
<tr>
<td>14</td>
<td>“I have no suggestions, the sims already helped as I have apply the info to real life.”</td>
<td>Nothing</td>
</tr>
<tr>
<td>15</td>
<td>“Add motion and maybe clearer auditory information. Particularly if something goes wrong.”</td>
<td>Motion realism</td>
</tr>
<tr>
<td>16</td>
<td>“None, it would just be nice if it was a more realistic environment.”</td>
<td>Realism</td>
</tr>
<tr>
<td>17</td>
<td>“With the current technology, not sure. What about adding motion? I have used it, when it comes down to it, it helps but I do not think it would be the make or break of training.”</td>
<td>Motion</td>
</tr>
<tr>
<td>18</td>
<td>The simulation worked pretty well in all areas, it was really useful by moving the participant to different unfamiliar areas. This moved them out of their comfort zone.</td>
<td>Nothing</td>
</tr>
</tbody>
</table>
Table E-5

Research Question 5

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Answer</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>“The use of radio communication and airspaces, in real life you can get flustered and aggravated. Sim allows for mistakes to learn from. Density altitude also showed how it [the aircraft] reacted.”</td>
<td>Communication Airspace</td>
</tr>
<tr>
<td>11</td>
<td>Airspace and high altitude was mentioned several times. He also thought that the IFR lesson was very useful.</td>
<td>Airspace High Altitude</td>
</tr>
<tr>
<td>12</td>
<td>“Density altitude was the best used the sim. The legend was confirmed and it made a bigger impression.”</td>
<td>High Altitude</td>
</tr>
<tr>
<td>13</td>
<td>Adds the opportunity to fail anything in a reasonably realistic panel environment. In reference to the decision-making scenario.</td>
<td>Decision Making</td>
</tr>
<tr>
<td>14</td>
<td>“Decision making”</td>
<td>Decision Making</td>
</tr>
<tr>
<td>15</td>
<td>“Learning to flying straight and level, aircraft control.” Landing is more difficult. Practicing emergency maneuvers.</td>
<td>Basic Flight Skills</td>
</tr>
<tr>
<td>16</td>
<td>“The Aft CG on the Decision making lesson. Just in the fact that you do not practice with CG limits flying. Main question was would you take off, in the sim you could experiment and it leads to a crash.”</td>
<td>Decision Making</td>
</tr>
<tr>
<td>17</td>
<td>“High Density, no question.”</td>
<td>High Altitude</td>
</tr>
<tr>
<td>18</td>
<td>IFR and Decision making lessons, with IFR being the most augmented. Improved scan and inclusion of critical aspects that were not included before. “You see what happens when you don’t do what you say you are going to do.”</td>
<td>Decision Making</td>
</tr>
</tbody>
</table>
Table E-6

*Research Question 6*

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Answer</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>“Any landings just did not work, it was a lack of depth perceptions.”</td>
<td>Landings</td>
</tr>
<tr>
<td>11</td>
<td>Thinks that any topic is better for the sim.</td>
<td>Good</td>
</tr>
<tr>
<td>12</td>
<td>“Nothing hurt, but the airspace one in the sim didn’t add anything.”</td>
<td>Airspace</td>
</tr>
<tr>
<td>13</td>
<td>Airspace “It really depends on how familiar you are with the class B.”</td>
<td>Airspace</td>
</tr>
<tr>
<td>14</td>
<td>High density altitude, Follow On: Why: “Because I fly in a cold climate.”</td>
<td>High Altitude</td>
</tr>
<tr>
<td>15</td>
<td>“For sure the landings, [the simulator is] more sensitive to air speed.” Very tough to judge distances, and can’t see past 90.</td>
<td>Landings</td>
</tr>
<tr>
<td>16</td>
<td>“I think they were all equal, prefer that hands on feel”. So all were valid.</td>
<td>Good</td>
</tr>
<tr>
<td>17</td>
<td>Transitioning between airspaces.</td>
<td>Airspace</td>
</tr>
<tr>
<td>18</td>
<td>“Not really any, though the density altitude could have been done without the sim probably just as effectively.”</td>
<td>High Altitude</td>
</tr>
</tbody>
</table>
Table E-7

*Research Question 7*

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Answer</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>“For the most part, different GPS though.”</td>
<td>GPS</td>
</tr>
<tr>
<td>11</td>
<td>He was very comfortable with the sim, however he had used it before.</td>
<td>Comfortable</td>
</tr>
<tr>
<td>12</td>
<td>“Yes, very comfortable.”</td>
<td>Very Comfortable</td>
</tr>
<tr>
<td>13</td>
<td>After the first flight was good.</td>
<td>Took a while</td>
</tr>
<tr>
<td>14</td>
<td>“Yes, I was comfortable with the sim use.”</td>
<td>Comfortable</td>
</tr>
<tr>
<td>15</td>
<td>“Certain situations, some things like landing not so much. Doesn’t come close to real landing. When you are in the plane you have pressure to do well, in the sim not so much.”</td>
<td>Landings</td>
</tr>
<tr>
<td>16</td>
<td>“The biggest issue was the lack of flying a Cessna, so it took some time.” Need some more familiarization time.</td>
<td>Took a while</td>
</tr>
<tr>
<td>17</td>
<td>“Yes, no problems what so ever.”</td>
<td>Comfortable</td>
</tr>
<tr>
<td>18</td>
<td>“Okay”</td>
<td>Comfortable</td>
</tr>
</tbody>
</table>
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