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ENHANCING STUDENTS' AERONAUTICAL DECSION MAKING THROUGH SCAFFOLDING STRATEGIES FOR HIGHER ORDER THINKING

A DISSERTATION APPROVED FOR THE DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

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DEDICATION

When I married Ronald Wayne Murray, I married adventure. I will forever be indebted to his generosity of time and love; and, in this dissertation effort, for his expert aviation advice, stories from his years as a pilot and certified flight instructor, helicopter pilot, flight training program manager, and as a graduate of the United States Air Force Academy. It was Ron’s love of flight and our hours flying together that led me to achieve my private pilots’ license in 2003 and use my experience as the basis for this research. Without his assistance, freely given, I would not have obtained this important milestone in my life. I dedicate this work to my husband Ron for teaching me to “keep my head in the game.”

As a first generation American, I also proudly dedicate this work in memory of my immigrant parents, Michael Joseph and Annie Theresa Walsh. I am thankful for their love and prayers, personal sacrifices, uncompromising work ethic, and for encouraging my lifelong passion for learning.

Finally, the highest praise and honor go to Jesus Christ, my Lord and my God. I thank you because only you know where I have been and where you will now take me.

"Man's flight through life is sustained by the power of his knowledge."

Austin Dusty Miller

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ABSTRACT

Over the last few decades, classroom training in aviation education has continued mostly unchanged. It remains a highly structured presentation of information in a lecture format. The purpose of this study was to determine the effect of a method of teaching aeronautical decision making in aviation education based on integrated and scaffolded constructivist learning principles, compared to the typical structured lecture format. Although there are consistent findings in the available research literature regarding the process of integrated constructivist approaches in the classroom, few studies have focused on improving aviation student's higher order thinking by combining existing aviation concepts and tools in a cooperative learning classroom environment. Hence, this study introduced a curriculum design of explicit scaffolding of Bloom's taxonomy for higher order thinking and instructional scaffoldings for metacognition and psychological type to support learning from authentic accident cases while in cooperative groups.

The research design and assessment protocols included four scaffolding phases during a six week curriculum. National Transportation Safety Board (NTSB) accident cases in general aviation served as the educational context for the focal curriculum. The study was conducted in a classroom environment with undergraduate junior and senior aviation pilots during the first six weeks of the required course called Crew Resource Management. Pretest-posttest case study outcomes were compared between the treatments. While quantitative results did not demonstrate that the experimental condition outperformed the control condition, this study provides preliminary qualitative evidence that participants can be encouraged to think at higher levels of

cognition using the revised Bloom's Taxonomy as a probing questions guide through the use of the Case Study Questionnaire to evaluate their performance as they review accident cases. The use of the instructional scaffoldings of this study supports the development of student responsibility and a student-centered cooperative classroom.

These results have implications for both practice and research. It takes time for an instructor to learn how to teach well in an authentic constructivist learning environment. Most aviation instructors today have not been provided adequate professional development training that equips them to provide instructional scaffoldings for humanizing the learning environment. The combination of tools used in this study warrant further research to heighten both the participants' and the aviation education instructors' self-awareness for improved self-management and higher order thinking skills in aeronautical decision making.

The literature in aviation has not kept pace with the vast amount of empirical research on the value of constructivist learning principles for teaching higher-order thinking skills which involves emphasizing methods and strategies for developing cognitive skills during problem solving and decision making. The aim in delivering integrated and scaffolded constructivist learning principles would be development of practices and disposition of higher order thinking that better prepare students as pilots, particularly in the context of participating with other crew members in aeronautical decision making.

CHAPTER 1: INTRODUCTION

In many domains, consequences of errors in decision making, judgment or procedure are trivial or harmless. Pilots, however, are an exceptional group in terms of risk and safety decisions, as errors can easily result in losses of life and property. With research attributing approximately 80% of accidents to pilot error, we know that accidents of the past reoccur from year to year. Craig (2001) adds, “If pilots are making the same mistakes, then looking at past accidents is almost like looking into the future” (p. 3). Research that aims not only to describe and explain the challenges in aeronautical decision making but also introduces educational training interventions to improve the unchanging goals for flight safety is essential.

As general aviation aircraft have become more complex, the Federal Aviation Administration (FAA) introduced a concept in 2005 called the FAA Industry Training Standards (FITS) to ensure that individuals become safe and capable pilots and crewmembers by employing enhanced and effective aeronautical decision making for improved higher order thinking. According to the FAA (2008a), “emergencies require the pilot to think—assess the situation, choose and execute the actions that assure safety, not act in a rote manner” (p. 8.15). Moreover, Federal Aviation Regulation (FAR) 61.43 requires that an applicant demonstrate sound judgment to gain pilot certification or rating (FAA, 2008b). There is a strong belief in the aviation community and expressed in the 2008 Aviation Instructor’s Manual that increasing a pilots’ higher order thinking skills through effective Crew Resource Management (CRM) training will improve pilot performance and improve safety (FAA, 2008b).

In order to improve higher order thinking, CRM training is supposed to teach aeronautical decision making but has been criticized because the actual training often does not teach the type of thinking skills a pilot needs to develop in order to make good decisions (Robertson, Petros, Schumacher, McHorse, & Ulrich, 2006). McKenny (2011) uses specific details to identify some of the criticisms:

> While CRM has evolved over the past 30 years, regulatory measures have not kept up. A lack of standardized CRM terms, definitions, application methodologies and guidance is continuing to impede CRM standardization across the industry. There is no universally accepted definition of the CRM concept or category of CRM terms within the air carrier industry. Vague terms such as 'Captaincy,' 'Airmanship,' 'Followership,' and 'Synergy' lack any formal or recognized definition within the CRM concept. Industry and regulators should instead focus their efforts on producing comprehensive guidance on how to properly train CRM and measure its effectiveness across the entire culture within an airline. (p. 14-15)

Therefore, flight evaluators lack adequate standards and guidance material for crew resource management. Instead, flight instructors continue their focus on teaching basic aircraft manipulation, aircraft systems knowledge, and knowledge of Federal Aviation Regulations (FARs) in order to satisfy testing standards.

Problem Statement

Lower order thinking dominates curricula and teaching styles of general aviation training programs. Shifting curricula and instructional approaches to intentionally support and require higher order thinking skills in aeronautical decision-making is a necessary, long-term education process. Students must develop integrated understanding of metacognitive principles, self-awareness techniques, effective teamwork strategies, and applicable knowledge to be effective and efficient decision makers. The aviation industry is aware of the fundamental role of instruction and training in aviation (Moore & Telfer, 1993). Yet the contacts between providers of general aviation training and the commercial airlines who will employ their students are infrequent and the contacts with research and academic institutions even more scarce. The pressure from regulations results in few deviations from longstanding habits and methods of delivering training and a lack of incentives to explore other forms of training than those traditionally accepted by authorities (O'Hare, 2003). While regulations are supposed to be the foundation for the quality of training, in practice they combine with commercial aviation pressures to form a barrier to quality. For example, if aviation management believes that learning aeronautical decision making is something to be done purely to satisfy a regulatory authority, then the commitment is likely to be shallow. Under such conditions, quality instruction and learning are repressed.

Flight training organizations are generally not involved in educational research efforts and often lack the contacts that could give them access to the knowledge provided by research. Aviation literature refers to the relationship between basic general aviation training providers and researchers and academic institutions as a weak link, in that the transfer of knowledge between these worlds is not as effective as it could be (Craig, 2001; Helmreich, Butler, Taggart, & Wilhelm, 1995; Kanki, Helmreich, & Anca, 2010; Moore, Po, Lehrer, & Telfer, 2001). At the heart of aeronautical decision making are effective processes to augment students’ abilities to understand and bridge the emotional and logical gaps in communication in the present-day aviation crew environment, and to develop better understandings of students’ relational styles and personality traits, of both themselves and others. Specifically, evaluation of the effectiveness of non-technical skills in aeronautical decision making is very subjective and extremely variable (McKenney, 2011).

While empirically sound research has laid the groundwork for instructional scaffoldings to improve higher order thinking, there have been few empirical studies of aeronautical decision making models to help students become more self-aware of their thought processes and develop higher order thinking skills. Classroom intervention studies for teaching higher order thinking skills are available yet they are not practiced with regularity in courses on crew resource management to help improve the level of understanding and cooperation across the entire team. To be effective, training development that focuses on explicitly teaching distinctions between lower order thinking and higher order thinking while humanizing the learning environment is needed to improve safety records.

Purpose of the Study

This dissertation explores a combination of instructional scaffoldings that facilitate pilots' aeronautical decision-making, specifically focusing on scaffolding strategies for improved higher order thinking using authentic accident report case studies, a case study instrument based on Bloom's taxonomy, metacognition, psychological self-awareness, and implemented in an environment of cooperative learning. The combination of these strategies is based loosely on the cognitive apprenticeship model (Collins, Brown, & Holum, 1991) to help prepare future aviators on how to approach aeronautical decision-making.

Higher order thinking does not automatically happen because a new program is institutionalized that claims to focus on the topic. College students are capable of taking charge of their learning and improving their critical thinking skills. However, educational studies confirm that most do not (King, 1990; Schraw & Dennison, 1994; Schraw, Dunkle, Bendixen, & Roedel, 1995; Zimmerman & Paulsen, 1995). In principle, teaching decision making strategies explicitly and experientially is an important component of aviation education. Decision making is a skill that can be learned and there are many instructional types of scaffolding that can enhance the learning.

At a time in history when aviation technology complexity and risk are constantly increasing, aviation students must learn strategies to help them take charge of their learning and develop higher order thinking skills through experiential-based curricula that scaffolds authentic learning in a crew-like cooperative classroom environment. Despite the wide use of accident cases in aviation training for military and commercial aviation education, little systematic research has explored or reported on the use of authentic accident cases as a scaffolding tool to improve student higher order thinking analysis in a general aviation classroom which might positively impact associated aviation educational processes and outcomes. The current study was designed to fill this gap in the research on teaching higher order thinking skills associated with human factors in aeronautical decision making.

Justification

Current understanding of aeronautical decision making training and the need for improvement in pilot's higher order thinking skills is derived from substantial research, extensive classroom observations, and reflection upon a broad range of related research programs. However, relevant studies on aeronautical decision making and specifically non-technical skills development have been lacking in aviation education (Kanki, et al., 2010; Robertson, et al., 2006). Thus, whether the combination of the strategies in this research contributes to improvements in higher order thinking in an aeronautics education context is unknown. The present investigation asserts that flight training organizations are generally not involved in education research efforts that could provide access to empirical training knowledge. In addition, because of the regulations of the aviation community, there is pressure to perform training in established ways already accepted by the authorities rather than investigate and deploy other forms of training that foster higher order thinking, even as there is recognition that the established methods are insufficient. Joung, Hesketh, & Neal (2006) note that:

> One of the issues that should be considered in disciplines with a hierarchical command structure, like aviation, relates to a potential conflict between a training approach based on critical and adaptive thinking and traditional practices that are designed to ensure compliance with standard operating procedures. The challenge for practitioners is to deliver effective training programs that teach crew skills that improve safety while adhering to accepted organizational practices. (p. 299)

This initiative may both impact and set new standards for designing and using research-based aeronautical decision making course content to enhance the early metacognitive, interpersonal, and teambuilding skills of college aviation students growing up in the digital age. This course intervention demonstrates that when higher order thinking skills and the principles of self-awareness are systematically incorporated into the content of a CRM course, college aviation student’s decision making or judgment success may improve.

Research Questions

1. Are there significant differences in higher order thinking skills between experimental and control groups?
2. Is there a significant interaction between experimental condition and MBTI type? In other words, does the rate of improvement in higher order thinking across experimental conditions depend on whether the individual is a J or a P?
3. Does MBTI J/P preference significantly correlate with metacognitive awareness (MAI) scores?
4. Will participants in the experimental group report more positive beliefs regarding higher order thinking and the case study questionnaire, personality and self-awareness as well as cooperative learning, and overall module, than those in the control group?
5. Will there be a significant interaction between the experimental condition and MBTI J/P type on positive beliefs post treatment?

Research Hypotheses

The research questions stated above have sufficient basis in the literature to generate limited hypotheses. On the basis of both the research questions as well as results from previous research, the following research hypotheses are generated:

Hypothesis 1: Participants receiving the nontraditional aeronautical decision making module will demonstrate improved higher order thinking skills as evidenced by higher scores on the posttest than will participants who receive the traditional module.

Hypothesis 2: Participants in the nontraditional class will report more positive beliefs about their metacognition, team members, course content and usefulness of case study application than will participants in the traditional class.

Operational Definitions of Terms

For this study, the following terms are used:

Aeronautical decision-making (ADM): A systematic approach to the mental process used by aircraft pilots to consistently determine the best course of action in response to a given set of circumstances. This term is often used interchangeable with judgment.

Authentic learning: A training environment that interacts with a student's personal goals. It must be authentic to the world in that the knowledge and skills that a student gains through experience with the classroom must be encountered in a context that is consistent with the way they will be encountered and employed in the real world (Collins, Brown, & Newman, 1989).

Bloom's Taxonomy: Six-level classification system that uses observed student behavior to infer the level of student achievement (Anderson, 2005). Moving from simple to more complex, the taxonomy's labels include remember, comprehend, apply, analyze, evaluate, and create. "It is used to encourage students to develop responsibility for their learning and increase the complexity of their critical-thinking skills, the quality of their written work, and the value of their in-class contributions" (Athanassiou, et al., 2003).

Case Study Instrument – Consisted of six questions that participants in the traditional and nontraditional classes answered on each administration of an NTSB case report. Results were analyzed and scored in terms of student's ability to improve higher order thinking skills.

Cooperative learning: An instructional scaffolding strategy that organizes students into small groups so that they can work together effectively to maximize their own and each other's learning.

Crew resource management (CRM) - Refers to the effective use of all available resources: human resources, hardware, and information. CRM training is one way of addressing the challenge of optimizing the human/machine interface and accompanying interpersonal activities. These activities include team building, information transfer, problem solving, and decision making.

General Aviation: Described by the Federal Aviation Association (FAA) as all civil aviation except that carried out by the commercial airlines. General aviation is the largest segment of aviation based on the number of aircraft, pilots, airports, and communities served—it accounts for 80% of the total certificated pilots in the United States. The total number of pilots in the United States is 618,660 (AOPA, 2012).

Higher-order thinking: In Bloom's taxonomy, analyze, evaluate, and create are considered higher order cognitive functions. When students engage in higher-order thinking, they must solve problems and develop new meanings for themselves. There is an element of uncertainty and unpredictability in the process.

Judging – Perceiving Orientation - In a complex relationship with the other elements of the MBTI, the judging or perceiving orientation reflects the dominant function of the individual and is critical to a full understanding of psychological type in problem solving and decision making.

Metacognition: Refers to instructional scaffolding in which the participant is aware that they are in control over their cognitive processes as they are engaged in learning. Activities such as planning how to approach a given learning task, monitoring comprehension, and evaluating progress toward the completion of a task are metacognitive in nature.

National Transportation Safety Board (NTSB): Independent Federal agency responsible for maintaining the government's database of civil aviation accidents and also conducts special studies of transportation safety issues of national significance. NTSB case reports were used with the Case Study instrument as the pre and posttest for higher order thinking skills.

Scaffolding: According to Smith & Ragan (2005), scaffolding is "the cognitive processing support that the instruction provides the learners, allowing them to learn complex ideas that would be beyond their grasp if they depended solely on their own cognitive resources, selectively aiding the learners where needed" (Athanassiou, et al., 2003).

The remainder of this dissertation is divided into the following chapters: Chapter 2 will discuss the literature regarding aviation education, aeronautical decision making, higher order thinking, authentic learning, scaffolding self-awareness, and cooperative learning. Chapter 3 will describe the design and procedure for this study. Chapter 4 will detail the results of this study, and chapter 5 will discuss conclusions and implications for future research.

CHAPTER 2: REVIEW OF LITERATURE

This section first provides a brief review the changing role of the pilot and current applications of higher order thinking in aviation education. Second, learning theories on higher order thinking in aeronautical decision making are explored. Third, various uses of instructional scaffolds for improving higher order thinking are presented, specifically metacognition, psychological type for self-awareness, authentic learning, and cooperative groups. Last, the importance of an effective integrated instructional strategy for higher order thinking and aeronautical decision making is discussed.

Theoretical Basis

A key assumption is that college education helps develop student thinking (Pintrich, 2002). Students can no longer be expected simply to recall facts and figures they have studied. This recall information eventually fades with time and leaves the student helpless and lost. Students therefore need to be taught how to think and reason for themselves so that they may be able to apply their knowledge in a beneficial way later in life. The goal of collegiate aviation education is to help improve the aviator's higher order thinking skills while positively impacting their attitudes and beliefs for working effectively with others whether in a single cockpit environment or in cockpit settings with two or more pilots and flight personnel. In addition to excellence in flying skills, leadership, teamwork and communication skills are among aeronautical decision making skills that are now being considered very important by airlines and regulators. These non-technical skills, called NOTECHS (Kanki, et al., 2010), that must be taught in the crew resource management classroom is a major challenge to today's aviation educators (Dahlstrom, 2002) as they must respond to the changing role of the pilot.

Changing Role of the Pilot

To clarify the demands upon today's pilots and the need for teaching pilots effective aeronautical decision making strategies, a historical review of how the role of the pilot has changed over time is provided. Beginning with World War I, aircraft were simple and communications between the pilot and the ground were problematic. The majority of military aviators were limited to using their motor skills to fly the aircraft. By the end of World War II, with rapid technical development of aircrafts, the pilot's cognitive role in the cockpit became a more crucial part of warfare. In the post-war era and throughout the Cold War, technological development led to more complex aircraft and the pilot became overloaded with work and information (Gregorich, Helmreich, & Wilhelm, 1990; Sarter et al., 2003; Sarter & Woods, 1994; Spencer, 2000). During the last decades, studies of pilot performance in terms of mental workload and situation awareness have made it obvious that the ability to present accurate and relevant information to the pilot is a key factor in the design of aircraft cockpits (Burian, Barshi, & Dismukes, 2005; Mosier, Skitka, Dunbar, & McDonnell, 2001; Olson & Sarter, 2000; Sarter, et al., 2003; Sarter & Woods, 1994; Wickens, 2002). Thus, the role of the pilot has become that of a tactical decision-maker (Dahlstrom, 2002).

In today's collegiate aviation programs, most pilots obtain their private certificate within a range of 40 to 70 flight hours. Craig (2001) explains this is the critical timeframe during which general aviation pilots build practical decision making skills and "then leave their instructors behind to enter the killing zone (p. 22)." The killing zone is described as a period that extends from 50 to 350 flight hours in which more pilots are killed than in all other periods put together. Unseasoned aviators commit the same basic mistakes that may be preventable through scaffolding successful instructional strategies for aeronautical decision making (FAA, 2008a; Hardy, Satz, Elia, & Uchiyama, 2007; O'Hare, 2003; Robertson, et al., 2006). The challenge is that with so many commercial pilots retiring and the greatest pool of next generation candidates coming from the current collegiate aviation population, something must be done to improve higher order thinking for those who are fast-tracked throughout the system.

Aviation Education in Decision Making

Aviation training is highly specialized and it represents an important category of learning in all domains because of the consequences associated with poor performance. Introduced in 2005, the Federal Aviation Instructor Training program (called FITS) represents a constructivist perspective of learning which holds that individuals construct meaning and knowledge through interpretation and that, therefore, instruction should be developed and engaged in ways that support individual knowledge construction and higher order thinking.

Aeronautical decision making training is concerned with the cognitive and interpersonal skills needed to manage a flight. Cognitive skills are defined as the mental processes used for solving problems and for making decisions. Interpersonal skills are regarded as the non-technical skills of self-awareness and relationships with others that include a range of behavioral activities associated with leadership and teamwork. Domains such as aviation have traditionally strong relations with quantitative disciplines like engineering and physics. Consequently, while they may be especially adept at dealing with mechanical issues, they tend to be less robust when dealing with interpersonal or human-centered aspects of accidents like human error and communication failures (Shappell & Weigmann, 2006).

The preponderance of decision-making errors in fatal general aviation accidents ignited a considerable body of interest in the topic of decision-making and in seeking ways of improving decision making in pilot training (O'Hare, Mullen, & Arnold, 2009). The unfortunate downside of this interest has been that pragmatic attempts to develop decision-making training in aviation have taken precedence over theory-based research on the nature and processes of decision making in the aviation environment. There is no doubt that the industry requires better theory-based tools to enable the development of successful interventions.

The instructional challenges include providing effective instruction in aeronautical knowledge at the appropriate level and aeronautical decision-making skills in large classes and providing effective and efficient customized instruction that accommodate individual learner’s needs (Robertson, 2005, p. 66). To correct or improve general aviation safety and to reduce pilot-error type accidents by 20% by 2009, a goal was established for general aviation in the Safer Skies initiative, aviation education and flight training programs must improve pilot learning in higher order thinking skills or in some way reduce bad judgments (Robertson, et al., 2006).

In reviewing the literature it is important to note that aviation education literature for classroom based aeronautical decision making training is scant. As noted by O’Hare, Mullen, and Arnold (2009) most of the focus of training is on the psychomotor skills, those needed to fly in three dimensions. Across college aviation programs, the instructional classroom focus for aeronautical decision making is loosely based on the Aviation Instructor's Handbook theoretical constructs of adult learning, updated in 2008 (FAA, 2008a). Basic knowledge acquisition strategies are presented on shallow levels not on instructional integration at deep levels. The Handbook claims to help beginning instructors understand and apply the fundamentals of instruction and how to relate this information to the task of teaching aeronautical knowledge and skills to students. For experienced aviation instructors, it claims to offer updated information useful for improving their effectiveness in training activities. While the program boasts of the underpinnings of constructivist theory of learning and supports the development of HOTS, which in aviation contexts is commonly called aeronautical decision-making, there is no discussion or step-by-step methodology for providing such training nor are there any citations for the content throughout the Handbook. For example, thirty-eight pages of the Handbook's Chapter Two are dedicated to "the learning process" and all references to Bloom's Taxonomy are to the original taxonomy rather than the revised. Here is an example of a series of statements in the section of the Handbook entitled, *Higher Order Thinking Skills (HOTS)* (FAA, 2008a):

> The constructivist theory of learning explains and supports the learning of HOTS, which is commonly called aeronautical decision-making (ADM) in aviation. HOTS lie in the last three categories on Bloom's Taxonomy of Learning: analysis, synthesis, and evaluation skills. Teaching the higher level thinking skills which are essential to judgment, decision-making, and critical thinking is important to aviation because a common thread in aviation accidents is the absence of higher order thinking skills. Instructors need to teach the cognitive skills used in problem-solving until these techniques become automated and transferable to new situations or problems. Cognitive research has shown the learning of HOTS is not a change in observable behavior but the construction of meaning from experience. (p. 2-5)

The FAA mandates that an applicant for a pilot license must demonstrate good aeronautical decision making and the FAA Industry Training Standards (FITS) now promotes a major focus on higher order thinking skills education (Appendix A). However, the type of training that students receive is not reflecting this mandate. In a descriptive research study of the educational phenomena of aeronautical decision making, Cassens (2010) revealed discrepancies in the level and quality of aeronautical decision making instruction desired and what is being delivered. While highly specialized in risk management, aviation education has been criticized because the training often does not teach the type of thinking skills a pilot needs to develop in order to make good decisions (Robertson, 2003).

Cassens (2010) explored multiple elements related to teaching pilots aeronautical decision making. The study revolved around the results from two surveys – one for an expert aviation faculty group and the other for a flight instructor group – designed to collect and analyze perceptions of how aeronautical decision making should be taught, how it is being taught, what elements of aeronautical decision making collegiate flight departments should be teaching, and whether or not the elements are being taught. Results revealed that instructors did not often encourage students to *identify judgment errors during flight*, which was a method that the faculty perceived as important. Regarding the items for *decision making* and *headwork,* faculty members rated these items as highly important yet the means for the flight instructors responses indicated that they were not consistently encouraging the conscious use of these aeronautical decision making elements with their students. In addition, faculty believed it was highly important to *introduce complex, time constrained, and stressful problems* *into the training*; however this method was rarely used by the instructors. Two other items of interest were that both faculty and instructors reported the *use of realistic scenarios to help build decision making skills* as least used and least important, respectively. Further there was little to no emphasis placed on *personality influences in regard to decision making* by either the faculty or instructors. The FAA Instructor Manual references using personality assessments such as the Myers-Briggs Type Indicator (FAA, 2008a, p. 1-2). In summary, pilots need to practice and develop their decision making skills in training to compensate for their lack of experience yet this study demonstrates that they are often not afforded the opportunity to do so.

The notion of the integrated approach for the aeronautical decision making module was interesting because most aviation classrooms were dominated by teacher lecture modes. Students expected to receive a course syllabus and then check the boxes of assignments to accomplish the goals. Marshall & Horton (2011) inquire, if the goal is higher order thinking and the world of aviation education is fundamentally behavioral in construction, how is it possible to shift the learning to a student-centered model of responsible inquiry and learning? Effective inquiry based learning environments provide an active setting for students that provides essential scaffolding based on each student’s readiness.

There have been many aeronautical decision making models that have been developed to improve the decision making or judgment skills of pilots. These models usually fall into one of two categories: classical or naturalistic. Classical involves step-by-step linear processes that include identifying the problem, developing alternatives, weighing the benefits and disadvantages, choosing alternatives, and evaluating the effectiveness of the selected alternatives (Kanki, et al., 2010). The emphasis is not on what the decision makers actually do, but what they should do. The classical theories are taught with popular worked examples of major commercial airline accidents. The challenge with the majority of curricula is that they are designed for commercial or military crews where up to fifteen members of a crew may exist. The general instructional approaches vary little across collegiate programs and include a historical review of the same five major commercial accidents that occurred between 1977 and 1985. These accidents are explored to help students understand the problems that manifest in pilot error related airline accidents that claimed hundreds of lives and include the Tenerife accident, United flight 171, Eastern flight 4011, Air Florida flight 90, and Delta flight 191.

Conceptual team tools of the aviation culture are rare because most aeronautical decision making data is conveyed in an instructor-led environment to each individual through a logical process or checklist as a filter for the culture of aviation – the culture of safety. Instructor led methods to teach aeronautical decision making often contain minimal explicit practice of higher order thinking during the processing of these major airline accident cases. Among synonymous and overlapping aeronautical decision making concepts introduced to the students during the training are these mnemonics: IMSAFE checklist, PAVE checklist, the Five Ps (5 Ps), the 3P Model, the CARE checklist, TEAM model, OODA Loop; and the DECIDE Model. Unfortunately, in some cases, knowledge remains bound to surface features of the problems as they appear in textbooks and class presentations (Resnick, 1987). Standardized aeronautical decision making tests reflect little to no demonstration of effective ways to improve higher order thinking.

The naturalistic approach to higher order thinking in decision making is about how pilots use their experience to make decisions in a field setting (Kanki, et al., 2010). One of the issues of concern in organizations like the FAA with a hierarchical command structure relates to a potential conflict between a training approach based on a naturalistic approach which includes critical and adaptive thinking compared with classical or traditional practices that are designed to ensure compliance with standard operating procedures. The challenge for practitioners is to deliver naturalistic types of training programs while adhering to accepted organizational practices. To make real differences in student’s aeronautical decision making, aviation educators need to understand the nature and the value of higher order thinking with regard to instructional scaffolds, and devise methods appropriate to learning that practice. The following section turns to higher order thinking, emphasizing characteristics and functionality, and how it can be taught effectively in the aviation classroom.

Higher Order Thinking

The first goal of training should be to support higher order thinking skills to enable and support long term retention and transfer of aviation learning content. In aviation, Moore and Telfer (1993) first drew attention to the difference between surface and deep learning approaches in commercial aviation training. Moore, Po, Lehrer, & Telfer (2001) contend that higher order transfer, like higher order thinking skills, depends on constructing knowledge from each scenario in a thoughtful manner. It involves the conscious formulation and discussion of abstract problem solving in one situation that allows making a connection to another (Salomon & Perkins, 1989).

The ability to engage in purposeful, self-regulatory judgment is widely recognized as an important, even essential, skill. Abrami et al (2008) researched available empirical evidence on the impact of instruction on the development and enhancement of critical thinking skills and dispositions and discovered 117 studies based on 20,698 participants, the findings of which make it clear that improvement in students' critical thinking skills and dispositions cannot be a matter of implicit expectation. Although higher order thinking skills, critical thinking, and problem solving skills are not synonymous, they have similar properties and overlapping areas (Bradshaw, Bishop, Gens, Miller, & Rogers, 2002). Higher order thinking occurs when a person takes new information stored in memory and interrelates, rearranges and extends it to find possible answers in perplexing situations (Lewis & Smith, 1993).

Ennis (1985) argues that critical thinking comprises a significant portion of higher order thinking skills. Dispositions include being open-minded, paying attention to the total situation, seeking reasons, and trying to be well-informed. Abilities include clarity and inference related to decision making in an orderly and useful way, often called problem solving. Importantly, and often lost in the general aviation community, effective aeronautical decision making takes place in the context of effectively interacting with others. The educational goal of fostering higher order thinking has been the emphasis of numerous books and research (Bissell & Lemons, 2009; Ennis, 1985; Facione, Sanchez, & Facione, 1993; Greeno, 1997; Halpern, 1998; Perkins & Salomon, 1988; Resnick, 1987; Robertson, 2003; Zohar & Dori, 2003). Widespread support and agreement demonstrate that the various definitions address some component of higher order thinking. Each of the programs and experiments described by these authors has variations on the theme of higher order thinking development.

Bloom's Revised Taxonomy

Higher order thinking skills as taught in aviation education and other educational institutions have traditionally been defined as the upper three levels of the taxonomy previously called analysis, synthesis, and evaluation (Bloom, 1956) and now under the Revised Bloom's Taxonomy these upper three levels are labeled analyze, evaluate, and create (Krathwohl, 2002). A brief description of the differences between the two models can be found in Appendix B. Bloom's Revised Taxonomy classification from the lowest level of cognitive development to the highest level, now uses verbs to identify each of the six categories: (1) Remember; (2) Understand; (3) Apply; (4) Analyze; (5) Evaluate; and, (6) Create. It provides an organizational structure that gives a commonly understood meaning to objectives classified in one of its six categories, thereby enhancing communications (Krathwohl, 2002).

According to Swart (2010) knowing originates with the lower two levels of hierarchy, while doing incorporates the higher four levels. Low order transfer primarily reflects extended practice of aviation facts and the distance of transfer depends on the amount of memorization and practice with low requirement for reflective thinking. High order transfer, like higher order thinking skills, depends on constructing knowledge from training in a meaningful and reflective manner. It involves the conscious formulation and discussion of abstract problem solving in one situation that allows making a connection to another (Salomon & Perkins, 1989). Reigeluth and Moore

(1999) suggest the distinctions between the three components of the original terms of higher order thinking – analysis, synthesis, and evaluation – are only useful in deciding what to teach, not in deciding what method should be used to teach them because they can be taught using similar methods. The two levels of Bloom’s taxonomy called comprehension and application are presented as the lower levels to demonstrate a hierarchy leading to higher order thinking skills (Ennis, 1993).

In Bloom’s Taxonomy of Educational Objectives (Anderson, 2000, p. 71), developed in 1956, Bloom argued that the six levels of mastery are arranged hierarchically by the level of mental complexity involved. General aviation flight training requires all six levels to achieve mastery but the FAA curriculum materials reveal outlines and tests primarily consisting of the original lower order thinking skills – knowledge, comprehension, and application – rather than materials or exercises preparing pilots to use their higher order thinking skills. By classifying knowledge or thinking skills into a hierarchical format, Bloom and his team created a tool they hoped would continue to evolve. The intent was that the taxonomy would provide a common vocabulary to help improve communication among educators. However, it was not Bloom’s intent that his taxonomy be the end to a discussion about the classification of thinking skills, “We do not regard it as perfect or as completed” (Bloom, 1956, p. 24). The value of using the taxonomy for the improvement of higher order thinking in various disciplines is presented next.

In a qualitative study of clinical teamwork, the framework of Bloom’s Taxonomy was used as an educational intervention to critique a patient scenario with the objective of teaching nurses how to prevent future patient complications. Larkin &

Burton (2008) developed in-depth case study to enable nurses to pay careful attention to not only the details of the patient history but more importantly to the communication among the various health care team members. Providing nurses with methods and forms that facilitated critical thinking processes allows them to reach correct diagnosis and implement more timely interventions. Results showed staff members became significantly more aware of the necessity to effectively communicate with each other and other members of the health care team by focusing on specific, crucial patient data.

In another study using Bloom's taxonomy (Veeravagu, Muthusamy, Marimutha, & Subrayna, 2010), a correlation design was conducted to explore the relationship between student performance and the level of thinking process of Bloom's Taxonomy in answering reading comprehension questions. Students performed better in questions with lower level thinking compared to higher order questions. Students faced difficulty when answering the higher levels question 4, 5, and 6 called analyses, synthesis, and evaluation. The findings conclude that there is a relationship between the level of thinking and the students' ability to answer them correctly.

As another example, Bloom's Taxonomy was used as a way to reinforce aspects of higher order thinking critical to the quality of college student's lives and their future management careers (Athanassiou, et al., 2003). The study involved the development and evaluation of a metacognitive framework based on Bloom's taxonomy to promote student self-learning. The study used repeated-observations of open-ended written assignments which were content analyzed for performance on the six criteria. Use of the taxonomy as a scaffolding device required that the student determine the level of his or her work. The instructor designed a checklist to note what levels of cognitive development were manifested in the student's work and coded the Bloom's levels 1 through 6. An average score of cognitive development was computed for each student. A pretreatment was compared to a posttreatment case study and the hypothesis was that the posttreatment scores would be greater after an emphasis on Bloom's levels of cognitive development. A Wilcoxon matched pair test showed improvement concluding that repeated attention to the steps of the Bloom's Taxonomy may increase the tendency to apply higher levels of the taxonomy to analyzing case studies. Students responded positively to the instructor's emphasis of Bloom's taxonomy and to the post evaluation.

Class discussions moved away from students seeking to simplify the materials and generalize toward evidence of higher order thinking at work through various perceptions, critical debate, and evaluations. Qualitative results from analysis of student comments showed that they found the taxonomy useful and was described by the authors as "helping them out of the trap of not recognizing what they do not know." One participant commented that it "was like a roadmap." Another said, "The taxonomy has given me a closet with all the hangers for my ideas right there." Students need opportunities for practicing their learning strategies. This can happen via proper testing at the various levels of Bloom's taxonomy (Chowdhury, 2004).

In a yearlong exploration of the relationship between student self-assessment and different cognitive levels, Clauss and Geedey's (2010) goal was to determine whether or not the accuracy of student self-assessment or metacognitive ability via knowledge surveys depended upon the Bloom level of the task. The researchers predicted that students would have more difficulty accurately self-assessing at higher Bloom levels. That is, as students confronted more complex, less clearly structured tasks like the highest level, six, they would be less likely to "know what they know." In other words, the student's ability to self-assess would decrease at higher levels of Bloom's questions. The study predicted that students would not "know what they knew" with more open-ended questions representing higher Bloom's level questions. The study results did not support the hypothesis that increasing Bloom's levels leads to decreasing student ability to self-assess.

Bloom's Critics

Criticisms of Bloom's taxonomy include its design and its lack of theory and validation (Athanassiou, et al., 2003; Bereiter & Scardamalia, 1998; Booker, 2007; Postlethwaite, 1994). The major problems critics find with the design is that the six distinct levels with a hierarchy of increasing complexity is unproven. Also a concern to critics is that the taxonomy is developed at the behavioral level rather than at a theoretical level and lacks evidence of this behavioral underlying construct. In fact, critics note that Bloom's taxonomy is not, strictly speaking, even a taxonomy, because its *taxa* do not meet the mutually exclusive criterion demanded of them (Chrisman, Hofer, & Boulton, 1988). This set of critical arguments supports Bloom's assertion of the classification as a useful beginning. The use of Bloom's as a methodology also may not be attractive because of time constraints. It is difficult to find evidence that students understand higher order thinking or have learned how to do it effectively because of the taxonomy (Bissell & Lemons, 2009). Like other studies seeking to enhance or improve student's higher order thinking, a challenge exists in first defining the construct.

In decision making, aviation problems often have no clear solution and demand problem solvers consider alternative goals as well as handle competing goals. This requires decision makers to control and monitor the selection and approach to their goal of effective assessment. Instructional procedures to provide temporary support for student's initial learning of higher order thinking skills are needed before they reach intended goals.

Instructional Scaffoldings

The FAA has stated: "Pilot training will require emphasis and focus on higher order thinking skills to help pilots learn how to think instead of simply what to think" (as cited in FAA, 2003, p. 12). Higher order thinking has been addressed using scaffolds as instructional procedures to provide temporary support for student's initial learning before they reach intended goals (Palincsar, 1986b). An important instructional concept is that of scaffolding, which is a process of guiding the learner from what is presently known to what is to be known. According to Vygotsky (1978), the notion of scaffolding is derived from "zone of proximal development" theory, that is, "the distinction between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). Hogan and Pressley (1997) discuss scaffolding as modeling the desired behaviors, offering explanations, inviting student participation, verifying and clarifying student understandings, and inviting students to contribute clues.

Teaching Bloom's Taxonomy is a scaffolding device to improve higher order thinking. Hogan and Pressley (1997) described the process of scaffolding as an instruction device that provides individual students with intellectual support so they can function at the cutting edge of their cognitive development. Scaffolding allows students to perform tasks that would be slightly beyond their ability without that assistance and guidance from the teacher.

Other instructional scaffoldings researched in the next four sections for this literature review include metacognitive skills, psychological type for heightened self-awareness, authentic learning, and cooperative learning - all cognitive processes and strategies used during problem solving (Brown, 1987). The absence of such an integrated framework of scaffoldings can cause students to mindlessly and superficially attempt to problem solve without consideration of whether that idea makes sense on its own or how it integrates with other ideas (Pressley, Wood, Martin, King, & Menke, 1992).

Metacognition

Metacognition emphasizes the learner's self-awareness of their knowledge and learning, active involvement and engagement in their learning, reflection, monitoring, and self-regulation of their learning experience, resulting in effective academic performance. Research indicates that internal commitment, purposeful reflection, and a personal investment in the learning processes must be present for effective learning to occur (Resnick, 1987). Consistent with constructivist views of learning, metacognition encourages students to become involved in their own learning, allowing them to actively engage and reflect on their experiences.

Purposeful, self-regulatory judgment or metacognition is a human cognitive process (Facione, et al., 1993). The cognitive processes of analysis, comparison, inference, and evaluation are involved in various combinations in reasoning tasks, as are the three metacognitive and self-regulation components of planning, monitoring, and reviewing/revising for higher order thinking skills (Quellmalz, 1985). Resnick's view demonstrates that "elaborating the given material, making inferences beyond what is explicitly presented, building adequate representations, analyzing and constructing relationships" all are involved even in the most apparently elementary mental activities (Lewis & Smith, 1993 as cited in Resnick, 1987).

Metacognition can be defined as reflection on our own thinking processes. It refers to knowledge about cognitive processes as well as the ability to control or regulate these processes (Pintrich, 2002). Generally people do not develop good metacognitive strategies without overt guidance and direction. Blickensderfer (2007) discovered that assessing metacognitive strategies for the purpose of learning new information and skills positively affected performance. King (1989) examined the effectiveness of self-questioning as a metacognitive strategy on students reading comprehension. She found that self-questioning encourages self-monitoring as students gained more control over their cognitive processes through internal dialogue which helped them to more methodically analyze problems. "From a metacognitive perspective it can be said that self-questioners know what they know and, as importantly, they know what they don't know" (King, 1989, p. 367).

By college, most students have metacognitive knowledge about their learning, but often do not choose to use this knowledge to increase their performance. Even skilled adult learners can display poor monitoring under controlled conditions (Schraw, et al., 1995). By presenting an explicit instructional approach prior to testing, monitoring accuracy has been shown to increase and it also appears to improve with training and practice (Nietfeld, Li, & Osborne, 2005; Schraw & Moshman, 1995).

The Metacognitive Awareness Inventory (MAI) is an instrument developed by Schraw and Dennison (1994) to assess metacognitive knowledge and metacognitive regulation. Using the MAI, Young and Fry (2008) studied college students who were offered the MAI in a total of 15 classes to determine how the MAI relates to broad and single measures of academic achievement in college students. Two classes were administered in person, while the remaining classes were self-administered online. Results showed only minor differences between the experimental and the control group on pre-measurement metacognitive knowledge scores.

Batha and Carroll (2007) administered Schraw's Metacognitive Awareness Inventory to university students and then assigned them two decision-making tasks, one strategic and one tactical. Among other indicators, results showed that poor decision-makers benefited from metacognitive strategies provided by the instructors. Results of two experiments (Schraw & Dennison, 1994) showed that the MAI positively correlated with theoretical predictions of the two factors of metacognition called knowledge and regulation, indicating that the Metacognitive Awareness Inventory measured the two kinds of metacognitive knowledge reliably and had good predictive ability for future performance. Schraw (1997) reports a study in which researchers find that individuals having access to general metacognitive knowledge use it to their advantage to make more accurate judgments of performance and monitor their performance in difficult and unfamiliar domains.

Nietfeld and Schraw (2002) conducted a study to determine whether strategy training and prior knowledge improved monitoring accuracy and confidence judgments. The results of this experiment showed that brief strategy training can improve performance, confidence, and monitoring accuracy, but only for the short-term. A one-week delayed posttest did not replicate the same results. In another study, Netfield, et al., (2005), reported that metacognition assists in learning by increasing the efficiency of perceptual resources, allowing for deeper processing of information, and increasing accuracy of performance monitoring.

Volet (1991) demonstrated that coaching relevant metacognitive strategies in conjunction with the teaching introductory computer science materials resulted in improved short and long term learning. The results of Volet's study showed that students who received metacognitive coaching passed the computing course more frequently and also obtained significantly higher grades than students who did not receive the metacognitive coaching.

Schraw and Dennison (1994) argue that metacognitively aware learners are more strategic and perform better than unaware learners because they are able to plan, sequence, and monitor their learning in a way that directly improves performance. However, numerous factors can produce unreliability in metacognitive performance. One major difficulty experienced by researchers has involved the selection and validation of research methods.

The general aviation pilot in a technically advanced aircraft operates within an increasingly complex environment, characterized by new computer technology, greater information-processing demands, and a need to solve more ill-defined, novel, and complex organizational problems. General aviation pilots must not only demonstrate higher order thinking sills but also be able to apply them, and effective application of these capacities requires metacognition. Next, instructional scaffolding for improved higher order thinking must also include providing effective and efficient customized instruction that accommodate individual learner's cognitive and metacognitive approaches to learning (Robertson, 2005, p. 66).

Self-Awareness through Psychological Type

In general, there is a need to develop a problem-solving/decision-making process that is both scientific and considerate of how self-awareness of individual differences and viewpoints positively impact higher order thinking. Students who believed they are capable were more likely to report use of cognitive strategies and to be more self-regulating in that they reported more frequent use of metacognitive strategies (Pintrich & de Groot, 1990). Separate research on metacognition and cognitive styles has identified important individual differences in how people approach and solve problems and make decisions (Felder, Felder, & Dietz, 2002; Felder & Silverman, 1988; Huitt, 1992; Myers, McCaulley, Quenk, & Hammer, 1998).

One of the world's most widely used psychological instruments for ascertaining personality styles is the Myers-Briggs Type Indicator (MBTI), developed by Isabel Briggs Myers and based on the theories of Carl Gustav Jung. Myers' goal was to make the concept of psychological type, as described by Jung, understandable and useful in people's lives. As Jung stated, "Much apparently random variation in human behavior is actually quite orderly and consistent, being due to certain basic differences in the way people prefer to use perception and judgment" (Myers, et al., 1998, p 3). The MBTI identifies personality preferences that can help explain why certain people are attracted to other people or to certain careers and why people often find it difficult to understand one another. The instrument itself does not make predictions of success about particular types nor is it trait driven and diagnostic in design.

The theory of psychological types of the MBTI describes eight functions, divided into processes, attitudes, and orientations toward the outer world. Individuals use the four basic mental processes of sensing, intuition, thinking, and feeling on a daily basis. Myers' theory assumes that each individual uses all eight functions – Extraversion, Introversion, Sensing, iNtuition, Thinking, Feeling, Judging, Perceiving – but that one of each pair on the psychometric scale is preferred over the other. The four psychometric pairs consist of first, the energy attitudes of Extraversion or Introversion; second, the perceptive mental functions of Sensing or Intuition; third, the judging mental function of Thinking or Feeling, and fourth, the outer world orientation attitudes of Judging or Perceiving. A basic explanation of each of the four scales is provided in Appendix C.

There are sixteen intricately differentiated whole types represented by the combination of one preference from each of the scales. These sixteen types, represented by names such as ENFP, ESFJ, INTP, and ISFP, are best used as whole types. For example, an individual's preferences might be extraversion, sensing, feeling, and judging, the ESFJ psychological type. Since each preferred function is used more often, it becomes better developed and leads to surface traits, behaviors, and skills associated with that preference (Myers, et al., 1998, p. 3).

Over the past 65 years, as the MBTI psychological type theory has become well known and widely used, it is unfortunate that misinterpretation and misuse by untrained individuals has also increased. Nevertheless, the accurate and ethical applications of the

MBTI theory have considerable value for informing practice and research across multiple domains of accounting, aviation, dentistry, education, engineering, law, management, and software programming (DiTiberio, 1996; Dollar & Schroeder, 2004; Emerson & Taylor, 2007; Golden, 2009; Hamilton & Ripley, 2004; Harvey, Murry, & Markham, 1995; Hughes, 1994; Jones, Courts, Sandow, & Watson, 1997; Kreienkamp, 1983; McCaulley & Natter, 1974; Moutafi, Furnham, & Crump, 2007; Opt & Loffredo, 2003; Provost & Anchors, 1987; Roush & Atwater, 1992; Sears, Kennedy, & Kaye, 1997; Tammy & Dave, 2001; Thompson & Bing-You, 1998; Wheeler, Hunton, & Bryant, 2004; Yang & Lin, 2004).

Jungian typology purports that personality is a relatively stable characteristic of an individual. While we cannot change our innate preferences dramatically, students can become aware of their tendencies and the implications and choose to take action. Individuals can reflect on their cognitive preference to help us understand their own approach and the approach of others and how two people with opposite approaches working together can offer valuable insights into decision making. For example, versions of the Federal Aviation Instructors Handbook printed since the early 80’s up to and including the 2008 version have referenced the topic of personality types and exclusively referred to the MBTI as the only tool of choice. “Not only does personality type influence how one learns, it also influences how one teaches. Learning one’s personality type helps an instructor recognize how he or she instructs” (FAA, 2008a, p. 1-3). Referencing the section in the Instructor’s Handbook called *Terms used in Advisory Circular 60-22 to explain concepts used in Aeronautical Decision Making* *training, Personality* is defined as the embodiment of personal traits and characteristics of an individual that are set at a very early age and extremely resistant to change.

It is in this same spirit of using personality type as a tool for identifying preferences that the practitioners include the MBTI as an instructional strategy. According to McCaulley (1974), the MBTI's value lies in its unique compilations of occupational, social, and educational life preferences and success profiles of specific MBTI types into Type Table Distributions. The MBTI serves as a means through which personality issues can be identified, discussed, and explained in non-threatening and helpful ways. The instrument helps to present practitioner expertise and opinions in a way that is more acceptable to each individual. Further, analysis of participant's MBTI types individually and as a whole group can save time and add to a practitioner's credibility by providing clues to likely areas of conflict in a team setting.

Type Table Distributions. In order to use the data obtained through research studies of type in any discipline, a Type Table Distribution is compiled as a descriptive statistic of the population under study. A Type Table is a device for seeing all the types in relation to each other. It arranges the types so that those in specific areas of the table have certain preferences in common and hence share whatever qualities arise from those preferences. To compare one group with another, the Association for Psychological Type accepted an analysis tool, known as the Selection Ratio Type Table (SRTT), (Myers & McCaulley, 1985). Miles and Huberman (1994) have suggested analytic techniques of analysis such as using arrays to display the data, creating displays, tabulating the frequency of events, ordering the information, and other methods. A Type Distribution of MBTI Traditional Age College Students is represented in Figure 2.1.

The type table is a visualization tool that is useful for discussing the dynamic qualities and interactions of preference combinations. One of the most common and basic descriptive statistics is to first review the population by the eight preferences. It is the composite of the largest number of each pair that identifies the group type. Next, practitioners compare or contrast any pair of preferences as displayed in the calculations to the right on Figure 2.1. For example, it is the grouping of the mental functions, ST, SF, NF and NT, that focuses on the combination of perception and judgment.

Alternatively, by the rows, the four attitudes are IJ, IP, EP and EJ. There are also more complex groupings, such as combinations of perception and orientation to the outer world, which are SJ, SP, NP and NJ, or combinations of judgment and orientation to the outer world, which are TJ, TP, FP, and FJ.

SENSING		INTUITION			
Thinking	Feeling	Feeling	Thinking		
ISTJ N = 2573 9.47%	ISFJ N = 2352 8.66%	INFJ N = 885 3.26%	INTJ N = 997 3.67%	Judging	INTROVERSION
ISTP N = 1216 4.48%	ISFP N = 1351 4.97%	INFP N = 1495 5.51%	INTP N = 1142 4.21%	Perceiving	INTROVERSION
ESTP N = 1257 4.63%	ESFP N = 1767 6.51%	ENFP N = 2496 9.19%	ENTP N = 1363 5.02%	Perceiving	EXTRAVERSION
ESTJ N = 2879 10.60%	ESFJ N = 2875 10.59%	ENFJ N = 1309 4.82%	ENTJ N = 1199 4.42%	Judging	EXTRAVERSION

		N	%
Eight Preferences	E	15145	55.77
	I	12011	44.23
	S	16270	59.91
	N	10886	40.09
	T	12626	46.49
	F	14530	53.51
	J	15069	55.49
	P	12087	44.51

Attitude Pairs	IJ	6807	25.07
	IP	5204	19.16
	EP	6883	25.35
	EJ	8262	30.42
Function Pairs	ST	7925	29.18
	SF	8345	30.73
	NF	6185	22.78
	NT	4701	17.31
Perception and External Orientation	SJ	10679	39.32
	SP	5591	20.59
	NP	6496	23.92
	NJ	4390	16.17
Judging and External Orientation	TJ	7648	28.16
	TP	4978	18.33
	FP	7109	26.18
	FJ	7421	27.33
Energy and Perception	IN	4519	16.64
	EN	6367	23.45
	IS	7492	27.59
	ES	8778	32.32
Energy and Judgment	ET	6698	24.66
	EF	8447	31.11
	IF	6083	22.40
	IT	5928	21.83

Figure 2.1 MBTI Traditional Age College Students Male and Female
N=27156 (F=14,519, M=12,637)

What makes the MBTI so powerful is that it is not only a tool for understanding current issues but for anticipating possible communication problems. This tool becomes the basis for discovering and discussing potential areas of strengths and weaknesses, such as blind spots. The data arrayed in a Type Table helps MBTI practitioners better understand the descriptive makeup of the population under study.

STJ Predominance in Aviation. In contrast to the general population and consistent with data from other aviation studies of personality measures, MBTI type table distributions suggest that those attracted to a professional pilot career differ from the normal population. On the basis of the 16 distinct type patterns, there is a much higher percentage of STJs (both introverted and extroverted) in the aviation entrants (Bullis, 2009; Devlin & Singh, 2010; Felder, 2005; Kutz, Brown, Carmichael, & Shandiz, 2004; O'Hare, et al., 2009; Roen-Pearson, 1986; Wiggins, 1998; Wiggins & Parker, 1998). This prevailing MBTI type pattern of aviation research consistently shows that the STJ aviator is drawn to the risky and challenging field of aviation but is often is ill-equipped to spontaneously and effectively handle interpersonal communications errors. The psychological type makeup of this STJ majority of students who pursue college aviation programs do not tend to value the non-technical skills elements of human factors and self-awareness which requires attention to and improvement of interpersonal competencies necessary to crew resource management.

Wiggins and Parker (1998) studied the preponderance of ESTJ and ISTJ types enrolled in aerodynamics and it led to a series of questions and experiments that the authors believed could help faculty to develop more effective teaching strategies. A study of 128 students at Embry-Riddle Aeronautical University revealed that 67% of the sample preferred sensing, 80% preferred thinking, and 67% preferred judging. Over 45% of the sample was STJ. The data supports the hypothesis that the students in the Aeronautical Degree program are more likely to be STJ than are the traditional general college student population. Several studies of career selection suggest that certain psychological types have a larger representation than would normally be expected in the general population.

Consider the fact that over 50% of US Army War College (AWC) students share the three letters STJ of their MBTI profile (Allen, 2009). At the individual level, almost 70% of the students have a Sensing preference, 88% have a Thinking preference, and 70% have a Judging preference. While the MBTI type profile is not predictive in all situations, it does indicate how most military training conditions are structured. The stereotypical US AWC student with an ESTJ or ISTJ profile tends to be rewarded as an efficient problem solver (Allen, 2009).

Devlin & Singh (2010) report the results of their study suggesting that officers and enlisted share similar preferences. Both officers and enlisted ranks had a preference for introversion, sensing, thinking and judging. Thus, the type was the ISTJ personality. The J-P scale showed the greatest difference between officers and enlisted members. Although both preferred judging, 81.8% of officers had that preference versus 54.2% of enlisted members. The work that is completed in the military is very structured; there are timelines and deadlines for almost all work. Careful planning and foresight are used to limit surprises and unexpected changes. Officers are most likely to be responsible for setting the deadlines and timetables and taking decisions, while enlisted personnel are required to follow and meet these deadlines. This work structure may explain why the discrepancy exists in their traits. Moreover, officers are trained in making decisions, which may increase their preference for judgment.

A review of general officers' MBTI results in 1995 revealed that 50 percent preferred S and J (Hermeon, Lyon, Martens, Walker, & Conn, 1995). A review of Air War College classes from 1993-2003 showed 54 percent of the students to also validate the combination of S and J preferences (Davidson, 2004). SJ types hunger for responsibility and predictability. They like standard operating procedures, trust the past and tradition, and seek security and stability. Those characteristics can be a liability when major changes are occurring since SJ types are often moved out of their comfort zone. Recognizing specific characteristics within the Air Force senior leadership provides a greater understanding of the dynamics of leadership, what may be causing some of the early resistance, and why it is often so difficult to achieve lasting change. Leaders often underestimate how hard it is to make major changes in an organization in which the majority of members prefer the status quo.

Because STJ types - both ISTJ and ESTJ - tend to comprise the highest percentage of the aviation classroom as well as the military classroom, it is important to understand them (Allen, 2009; Bullis, 2009; Devlin & Singh, 2010; Hatfield, 1988; Hughes, 1994; Kutz, et al., 2004; Martinussen, 1996; McGlohnn, King, Retzlaff, Flynn, & Butler, 1996; Retzlaff, King, & Callister, 1995; Schwartz, 2009; Wiggins & Parker, 1998). STJ types tend to be detailed, past/present oriented, literal, logical, analytical, and live life in an ultra-structured manner exhibiting control of the environment to ensure that tasks are accomplished. This STJ type easily order, directs, and decides and is often considered the authoritative types. This can be contrasted with the opposite of

STJ, the NFP types who are considered by the Army War College to be the strategic leaders. In that role, NFPs provide vision, shape culture, establish shared values, align goals with stakeholders across a full range of missions, represent the organization, and manage change (Bullis, 2009).

Most of the structured aviation curriculum fits the STJ style and therefore can move the group dynamics of the class to a more intense level. For example, STJs prefer staying precisely on time, following the agenda and permitting no deviations, surprise, or fun. This STJ attitude will be even more accentuated when the group type is J as opposed to P. To avoid group lopsidedness, the instructor may need to compensate or at least be aware of the differences in terms of type dynamics. The goal is not to allow the group to be shortchanged in its ability to learn from itself by being more influenced by similarities than group differences. It is equally important to remember that a minority type within the group, INTP, for example, can be seen by an unreflecting majority as a problem or be made by them into a scapegoat (Kroeger, Thuesen, & Rutledge, 2002).

While students of all psychological types enroll in CRM aviation courses, from a CRM communication standpoint, ISTJs are not as naturally in tune with their own emotions or with the emotions of others as some other types (Craig, 2001; Kreitler, Dansereau, Barth, & Ito, 2009; McCaulley & Natter, 1974; Myers, et al., 1998; Wiggins, 1998). In fact, the same would be true of most participants whose last two letters are "TJ." Often labeled perfectionists, TJ types have a tendency to take other people's efforts for granted as they also take their own efforts for granted. Aeronautical decision-making in crew resource management relies on taking others efforts into account constantly and responding appropriately.

Roen-Pearson's (1986) study of 33 all male U. S. Air Force pilots ages 17-29, Figure 2.2, reveal the group type to be ESTJ, representing 30% of the group or ten pilots, and ISTJ, represented by 18% or six pilots. The 21 J-type pilots in this sample represented 64% of the class. Those with a combined preference for S and J were represented by 49% of the class.

	SENSING		INTUITION		
	Thinking	Feeling	Feeling	Thinking	
INTROVERSION	ISTJ N = 6 18.18%	ISFJ N = 0 0.00%	INFJ N = 0 0.00%	INTJ N = 4 4.05%	Judging
	ISTP N = 3 9.09%	ISFP N = 0 0.00%	INFP N = 1 3.03%	INTP N = 1 3.03%	Perceiving
EXTRAVERSION	ESTP N = 2 6.06%	ESFP N = 1 3.03%	ENFP N = 1 3.03%	ENTP N = 3 9.09%	Perceiving
	ESTJ N = 10 30.30%	ESFJ N = 0 0.00%	ENFJ N = 0 0.00%	ENTJ N = 1 3.03%	Judging

		N	%
Eight Preferences	E	18	54.55
	I	15	45.45
	S	22	66.67
	N	11	33.33
	T	30	90.91
	F	3	9.09
	J	21	63.64
	P	12	36.36

Attitude Pairs	IJ	10	30.30
	IP	5	15.15
	EP	7	21.21
	EJ	11	33.33
Function Pairs	ST	21	63.64
	SF	1	3.03
	NF	2	6.06
	NT	9	27.27
Perception and External Orientation	SJ	16	48.48
	SP	6	18.18
	NP	6	18.18
	NJ	5	15.15
Judging and External Orientation	TJ	21	63.64
	TP	9	27.27
	FP	3	9.09
	FJ	0	0.00
Energy and Perception	IN	6	18.18
	EN	5	15.15
	IS	9	27.27
	ES	13	39.39
Energy and Judgment	ET	16	48.48
	EF	2	6.06
	IF	1	3.03
	IT	14	42.42

Figure 2.2 Type Table Distribution of United States Air Force Pilots
N=33

In her second sample of 222 University of North Dakota student pilots, Figure 2.3, all males and ages 17-29, the results show that ESTJ pilots were in the majority representing 21% or 47 pilots followed by the ISTJ representing 12% or 26 of the pilots. The 119 J-type pilots in this sample represented 54% of the class. Those with a combined preference for S and J represented 41% of the class.

	SENSING		INTUITION		
	Thinking	Feeling	Feeling	Thinking	
INTROVERSION	ISTJ N = 26 11.71%	ISFJ N = 0 0.00%	INFJ N = 2 0.90%	INTJ N = 9 4.05%	Judging
INTROVERSION	ISTP N = 16 7.21%	ISFP N = 6 2.70%	INFP N = 6 2.70%	INTP N = 9 4.05%	Perceiving
EXTRAVERSION	ESTP N = 23 10.36%	ESFP N = 10 4.50%	ENFP N = 17 7.66%	ENTP N = 16 7.21%	Perceiving
EXTRAVERSION	ESTJ N = 47 21.17%	ESFJ N = 18 8.11%	ENFJ N = 3 1.35%	ENTJ N = 14 6.31%	Judging

Eight Preferences

	N	%
E	148	66.67
I	74	33.33
S	146	65.77
N	76	34.23
T	160	72.07
F	62	27.93
J	119	53.60
P	103	46.40

Attitude Pairs	IJ	37	16.67
	IP	37	16.67
	EP	66	29.73
	EJ	82	36.94
Function Pairs	ST	112	50.45
	SF	34	15.32
	NF	28	12.61
	NT	48	21.62
Perception and External Orientation	SJ	91	40.99
	SP	55	24.77
	NP	48	21.62
	NJ	28	12.61
Judging and External Orientation	TJ	96	43.24
	TP	64	28.83
	FP	39	17.57
	FJ	23	10.36
Energy and Perception	IN	26	11.71
	EN	50	22.52
	IS	48	21.62
	ES	98	44.14
Energy and Judgment	ET	100	45.05
	EF	48	21.62
	IF	14	6.31
	IT	60	27.03

Figure 2.3 Type Table Distribution of University of North Dakota N=222 Student Pilots

Proponents of psychological assessments and the network of certified MBTI practitioners realize the system of psychological type as a valuable aid to personal development and growth. Unfortunately, some researchers have administered the MBTI and then incorrectly assumed, without participant validation, that the resulting four letter type represented an individual's psychological type. Since the outcome of any self-report instrument can be affected by a multitude of variables, practitioners who understand the MBTI and its purpose as an indicator will ensure that the individual is provided an in-depth explanation of the foundational theory. Once the theory is explained, individuals are asked to self-assess, and then the MBTI results are returned for comparison purposes. They are provided reading material of the four-letter type for further confirmation as a form of validity. This process is called verification of type or best-fit type.

Dynamics of the Judging – Perceiving Orientation. In a complex and dynamic relationship with the other elements of type, the judging or perceiving orientation reflects the dominant function of the individual and is critical to a complete and useful understanding of psychological type (Myers, et al., 1998; Myers & Myers, 1980). Researchers have investigated the particular relationship of Jung's theory on individual differences in problem solving and decision-making such as time management, controlled processing, goal achievement orientation, and leadership style, which are noteworthy (Beckham, 2009; Edwards, 2003; Felder, et al., 2002; Felder & Silverman, 1988; Huitt, 1992; Rutledge & Tucker, 2003).

In the MBTI, judging means preferring to make decisions and have things settled and decided. Judging does not mean judgmental in the sense of making negative evaluations about people and events. For example, the language of a person who prefers judging tends to be declarative, consisting of closed statements, definitive decisions, or opinions. Judging types often report difficulty staying open to discussion by exploring options or alternatives rather preferring closure (Kroeger, et al., 2002; Lawrence, 1982; Myers, et al., 1998; Rutledge & Tucker, 2003). People who prefer judging are likely to be seen as highly self-regulated making lists of things to do for task completion; get their work done before playing; plan work to avoid rushing just before deadline; make decisions quickly, sometimes without enough information; and may focus too much on the goal or plan and thereby miss the need to change directions (Myers, et al., 1998).

In MBTI terms, perceiving refers to how one prefers to take in information or gather data from the world around them. Perceiving does not mean having quick and accurate perceptions about people and events. For example, the language of a perceiving type tends to be interrogatory, consisting of questions, options, and alternatives. Perceiving types often report difficulty making closed-ended statements and/or opinions rather preferring to stay open to respond to whatever happens next (Kroeger, et al., 2002; Lawrence, 1982; Myers, et al., 1998; Rutledge & Tucker, 2003). People who prefer perceiving are observed to keep strict plans to a minimum; approach work as play or mix work and play; work in bursts of energy, prefer pressure prompts just before deadlines; may stay open to new information too long and miss making decisions; and find it difficult to settle on one direction or plan (Myers, et al., 1998). As Lawrence (1982) wrote:

> The P [Perceiving] way of studying …is a different way, but not better or worse. The research on type and learning does not show that Js [Judging students] learn more than Ps [Perceiving students]. But the research does suggest that the natural J [Judging] drive toward closure gives Js an advantage in fitting their learning into that system that awards grades. (p. 27)

The J style defines one who prefers structure, order, and closure in their outer world lifestyle. These types of participants appear to be purposeful, organized, and decisive. A hallmark J attribute is their nature to cease data collection as soon as it is possible to decide. The P style is discernible by a need for spontaneity, flexibility, and keeping options open. A hallmark P attribute is that they tend to delay decisions as long as possible in order to take in more information with the hope of making better choices. P's approach life with an openness to change and the intent to experience as much as possible (Myers & McCaulley, 1985; Roush & Atwater, 1992). McClure and Werther (1993) report an exercise in time management and how related team tension was substantially reduced when Judging types were assigned the roles of scheduling whereas the role of identifying options were assigned to Perceiving types. The perspectives of both types were encouraged in group work and were assimilated into a coherent and well thought-out plan.

In the Myers-Briggs Step II model, Judging is further described by the five constructs (a) *systematic*, (b) *planful*, (c) *early-starting*, (d) *scheduled*, and (e) *methodical*. Perceiving has been further described by the five constructs (a) *casual*, (b) *open-ended*, (c) *pressure-prompted*, (d) *spontaneous*, and (e) *emergent* (Quenk, Hammer, & Majors, 2001).

Based on data from the Center for Applied Psychological Type (CAPT) in Gainesville, Florida, the majority of undergraduate students report a preference for judging. Sixty percent of over 16,000 freshmen at three state universities validated their type as judging students. An interesting contrast is that almost 64% of Rhodes Scholars were perceiving students. CAPT reported also that 65% of 2,282 college faculty members prefer judging. The data confirms that being outcome-oriented, goal-motivated, academically persistent, standards-based, on time, and in place may be a natural advantage in college (Myers, et al., 1998, p. 277). Judging students have an advantage because their academic practices more closely resemble those of the majority of their teachers and "fit more easily into the academic world of learning by the calendar and clock." Participants who report a P preference are instead process-oriented, experience-seeking, time-flexible, spontaneous, and autonomous. These descriptors highly correlate with the MBTI P type preference, who comprise close to 45% of U.S. college students. In contrast to the J types who find instructional systems tend to favor their preferences, students who do not fit the J type mold, but are instead process-oriented, experience-seeking, spontaneous, and autonomous or P types may be at higher risk for academic failure (Beckham, 2009; Lawrence, 1982; Myers, et al., 1998).

Aviation education reflects the dominant culture of educational practices based on a military model. As such, aviation curricula believed to be outcome-oriented, goal-motivated, performance-driven, standards-based, timely, accurate, and within budget are seen as acceptable. These descriptors highly correlate with the preferences of those who validate the J preference as their outer world orientation attitude. Conventional aviation education study methods unwittingly may contribute to a sense of frustration for students whose outer world orientation, or P practices, may be judged to be inferior or at higher risk for failure.

Research reveals that internal commitment, purposeful reflection, and a personal investment in the learning processes must be present for effective learning to occur (Resnick, 1987). In a study of the leadership styles of Js and Ps (Roush & Atwater, 1992), the J leaders were negatively correlated with the Passive Management or Laissez-Faire leadership style whereas P types were positively correlated with these leadership styles. In addition, the P types were more aware of their passive approach and had more consistent self-ratings than the Js. They were, in other words, profoundly aware of their passive leadership. To become metacognitively aware means the learning must be process-oriented, experience-seeking, time-flexible, spontaneous, and autonomous to be successful (Cubukcu, 2009; Fox & Riconscente, 2008; Palincsar, 1986a; Schraw & Moshman, 1995).

In a qualitative, grounded theory study, Beckham (2009) examined the unconventionally time-flexible and process-oriented approaches employed by many successful students, including those with the MBTI psychological preference for Perceiving who comprise close to 50% of U.S. college students. The purpose of the study was to increase understanding of successful students whose approaches are diverse from the conventional ideal. Focused on nineteen academically successful students, the theoretical dimension called Perceiving and its effect on use of time and space was observed.

> At the core of Judging is the issue of control – control of time, control of space, and control of self. In contrast, at the core of Perceiving is a sense of freedom – freedom in time, freedom in space, and freedom for self. (p. 172)

Beckham (2009) described that typical ideas of college success and study skills taught students how to maintain control, not to enjoy their freedom, and that the imbalance of control and freedom created inequity. Beckham identified three important changes for faculty:

> (1) stop idealizing the breaking up of work processes and allow work to be done all at once; (2) when students can do well at the last minute, let them do so without criticism; and (3) stop harping on procrastination as harmful and stress-producing in all cases as this standpoint is not defensible. (p. 213)

Too many Perceiving voices were silenced by the dominant Judging ideal. Thus, the study revealed that nontraditional strategies are effective and, for Perceiving students, they are essential.

A number of studies also have shown that the J-P dichotomy of the MBTI distinguishes two types of decision-making approaches. For example, in a study of 168 participants, Rutledge and Tucker (2003) compared their MBTI Judging-Perceiving scale results as assessed against their Apter Motivational Style Profile (AMSP) results. In the AMSP there is a scale referred to as the telic state which identifies deferred gratification concern in the interest of goal accomplishment. Consistent with the J’s preference not to be distracted from a direct path toward the goal, this state is seen as negative. In the AMSP paratelic state, motivation comes from the passion of the process or activity itself as a welcome part of the journey. Behaviorally, P's tend to exhibit more adaptability, flexibility, and may be more tentative in their external decision-making process which is consistent with the AMSP paratelic state, which literally means "beside the goal" (Rutledge & Tucker, 2003).

Another study provides support for the notion that Judging can be thought of as a preference for controlled processing (Edwards, Lanning, & Hooker, 2002). The type of information processing exhibited by individuals based on the last letter of their MBTI, J or P, has been found to impact accuracy. Edwards (2003) purports that people usually believe that putting additional cognitive effort into an information processing task is the best way to achieve accuracy. However, not all people will have a preference for controlled processing as evidenced by the difference between an individual's preference for either the J or P orientation to the outer world. The study used a traditional persuasion paradigm to assess controlled processing differences between judging and perceiving types of 212 college students. Participants were asked three questions about the quality of arguments in an essay – their thoughts while reading the message as a measure of elaboration, their processing of the message for greater recall of the material, and their attitude while scrutinizing the arguments. As predicted, when judging type and perceiving types were compared, judging types listed a greater number of thoughts, had greater recall, and there was a significant interaction between the Judging preference and argument strength. In addition, high levels of causal uncertainty combined with Judging were associated with significant differences in attitude such that strong arguments led to more positive attitudes.

MBTI Critics. Critics of MBTI argue that the resulting sixteen personality profiles are so broad and ambiguous that they can be interpreted to fit almost anyone. Pittenger (2005) was critical of the MBTI, suggesting that insufficient evidence supports the claims made about the MBTI to include the support of unique types. Because all the correlations were made on dichotomous scales, Pittenger suggested the data do not support the claims that the MBTI properly identifies the uniqueness of 16 types. In 1998, an updated version of the MBTI, called Form M, was released which has psychometrically enhanced scoring. Salter, Forney, & Evans (2005) claim that researchers like Pittenger are guilty of applying data from the longstanding previous version, MBTI Form G, when discussing type validity and reliability. The Form M scoring, in contrast, uses item response theory and a preference clarity index to provide measurement precision and to gauge the individual's preference clarity.

An expert practitioner can counter the negative claims of any critic by helping users understand the theoretical underpinning of the tool which was to make Jung's theory of psychological type practical and useful in people's lives (Myers, et al., 1998). Therefore, an individual who has completed the 93-question, Form M MBTI and attended a qualified practitioners' workshop to help validate their self-assessed results, has as a goal applying the knowledge gained to better understand themselves (self-awareness) and build more effective relationships with others. Specifically, in the case of the MBTI, individuals should learn that their four letter type is made up of four preferences and can learn to adapt to each situation and consciously choose an opposite preference as appropriate to a given situation. There may be preference tendencies because of one’s type but users learn from an ethical practitioner that preferences are never to be used as excuses. For example, Introverts are not led to believe that they can be excused from team discussions. Likewise, Judging types are not led to think that it is acceptable to satisfy their need for closure and therefore be the one to wrap it up and decide what to do and neglect to keep the discussion open to hear views of others, as may be their tendency. These may be tendencies of Introverts and Judgers but qualified practitioners ensure their audience learns that these tendencies are not universal among types and that we can consciously identify and develop our less preferred tendencies.

Some also worry that, once an individual’s type is made known to others such as a university career counselor or employer that the individual may be stereotyped or pushed in a certain direction regardless of his or her desires (Boyle, 1995; Healy, 1989). Finally, some psychologists have criticized the MBTI system on the grounds of "confirmation bias," meaning that people tend to behave in ways that are predicted for them. For example, once a person learns that the MBTI results reveal he or she is extraverted, those behaviors will more likely manifest (Hicks, 1984; Kalsbeek, 2003; Langan-Fox & Shirley, 2003; Pittenger, 2005). Ethical practitioners of the MBTI emphasize that personality is one, albeit an important one, of many factors that account for success in career choice. Other influences include age, culture, experience, skills, task difficulties, and many other external factors that may have nothing to do with one’s MBTI type.

People of all types are employed in the aviation industry and research data show that the Extraverted and Introverted STJ types are the most common types in the military, as certified flight instructors, and in collegiate aviation programs. One way to use this Type Table information is to learn more about the individuals with the most frequently occurring type and use the information to help guide organizational decisions about development, change, organization, design, and more. When an educational organization can identify the personality preferences of its students, for example, it can make better decisions about the types of interventions that may be needed and may ensure that minority preferences are identified and not taken for granted or ignored.

To summarize, the MBTI has been subjected to a development process of more than sixty years, and its validity and reliability have been scrutinized by many studies. Although the MBTI has its detractors, over three million people take the MBTI each year making it the most widely used and thoroughly researched instruments used to identify psychological types (Quenk, 2009). While many studies take cognitive style into account for instructional design, they do not suggest than an instructor should try to create a separate environment for each student. Rather, the use of instructional strategies that acknowledge and consider student differences in relationship to the development of higher order thinking should be implemented (Wiggins, 1998, p. 36).

Sadler-Smith (1997) summed up the concept of accommodating MBTI type preferences with a recommendation for a balanced approach in the development and production of learning materials. This balanced approach, he argues, must allow students the chance to work within their preferences while encouraging them to undertake authentic tasks and activities that are not congruent with their preferences.

Authentic Learning

A training environment must be authentic both to the student and to the discipline of the training. It must be congruent with the student's personal goals and authentic in that the knowledge and skills gained in that environment must be encountered in a context consistent with the way they will be encountered in the real world (Collins, et al., 1989).

To make new FITS aeronautical decision making material meaningful, it must be designed so students can easily access and connect previous learning and experiences with the new content. Students who have validated their preference as Judging may be comfortable in classrooms with high levels of task orientation. Perceiving types, on the other hand, may be more comfortable in informal classrooms with more individualized instruction (Beckham, 2009; Fisher & Kent, 1998).

Authentic learning is grounded in and derived from constructivist epistemology. The main elements of authentic learning are content, context, community, and participation which, taken together, offer intriguing opportunities for instructors to engage with these learners in novel and meaningful ways (Lawrence, 1982; McCaulley & Natter, 1974; Myers, et al., 1998; Stein, 1998). Collins, Brown, and Newman (1989) suggests that higher order learning through cognitive and metacognitive processes can best be taught with methods that employ an authentic learning approach. One effective way is through stories or narratives which promote a natural and powerful form for storing experiential knowledge that is essential to problem solving. The main goal is to apply lessons learned from the stories to new problems. With adequate scaffolding, the instructor can create strategies for higher order thinking to solve problems. The reuse of cases is essential to learning how to perform complex tasks (Jonassen & Hernandez-Serrano, 2002). An assumption shared by all of these researchers is that stories can function as a substitute for direct experience, which novice problem solvers do not possess.

Realistic problems have a motivational effect because they engage learners more deeply when the outcome of the problem intrigues the learners (Savery & Duffy, 1995). Constructivist theory suggests that students prior knowledge plays an important role in a scaffolding strategy as it allows them to bring information to the strategy in order to elaborate and make meaning (Foote, 1998). For example, a study presenting trainees with a range of firefighting examples and “war stories” was presented in one of two formats – either errorless or exposure to error – was designed to help increase awareness of problem issues on the fire ground and enhance the trainee’s options. Participants were fifty-nine fire-fighters at a Fire Brigades College. The researchers (Joung, et al., 2006) predicted that error exposure training would result in better performance as indicated by the responder’s ability to identify the problems and have access to a collection of appropriate responses.

Results demonstrated that the group that was given error-filled war stories was able to generate more appropriate alternative actions when they were asked what they would do next compared to the error free group. Observations were made that the participants in the error-filled story group seemed to be reflecting more critically on fire-fighting procedures than the group who were given the standard errorless training protocol. As evidence that the error-story trainee’s appeared to have more active involvement during the case study discussion, researchers noted that participants were more eager to learn from their mistakes and voluntarily suggested ways that the incidents could have been better managed. In addition, they initiated greater discussion with one another and some volunteered their own experiences to these incidents. In contrast, the errorless-story groups presented with conventional training were observed to be generally subdued and passive in their discussion.

Case based reasoning was the approach used by O'Hare (O'Hare, et al., 2009) to enhance aeronautical decision making. Widely used in medicine (Baumberger-Henry, 2005; Dori, Revital, & Tsaushu, 2003; Montes, Padilla, Maldonado, & Negretti, 2009) and law (Callister, 2010) case based reasoning as authentic learning has not been systematically used or studied in the context of collegiate or general aviation training and development.

In a recent study, twenty-six undergraduate students participated in a study on the effect of case-based training on decision making in flight (O'Hare, et al., 2009). Upon reading a case, participants completed either a free recall or a reflection task. The free recall task involved participants writing as many details about the case as they could recall. The reflection task consisted of five questions created for participants. The first question asked participants to "Briefly list the pilot's actions leading up to and during the incident." The second question asked for rationale or cause of each action. Third, participants were asked to argue or defend whether actions were contributory to the results. The fourth question asked participants to reflect on options available that could have been taken by the pilot. Finally, they were asked to identify guidelines or principles that could be applied to similar events in the future. The results revealed that participants in the reflection task exercise made more appropriate and timely decisions in a posttest simulated flight than participants who participated in the free recall task (O'Hare, et al., 2009).

Edelson (1996) provides evidence of a case-based teaching system with meaningful and authentic content. It consisted of two components that included a task environment and a storyteller. The task was engaging and the storyteller monitored the student’s interactions with the task to help them learn. This active learning engaged the student in the pursuit of tasks that provide both motivation and opportunity for learning. Meaningful cases help students learn and authentic learning results in a wealth of knowledge that can be included in the case instruction to provide powerful narrative memory links (Jonassen, 2003a).

Aeronautical decision making training presented as not only facts based and standard operating procedures oriented but also reflective, authentic, and community based scenarios are excellent forms of instructional scaffolds (Brantley-Dias, Kinuthia, Shoffner, de Castro, & Rigole, 2007). Effective inquiry based learning environments provide an experiential environment for students and deliver requisite scaffolding based on each student’s readiness (Marshall & Horton, 2011). Such balance will help develop individual members’ decision-making skills and prepare them to work more effectively as members of cooperative groups.

Cooperative Learning

The study of cooperative, competitive, and individualistic efforts is commonly recognized as the oldest field of research in social psychology (Johnson & Johnson, 2009; Johnson, Johnson, & Smith, 2007). In field experiments of four to thirty weeks in duration, classroom-based cooperative approaches, results of increased learning are well documented and include better learning and transfer, higher self-esteem and more positive attitudes (Gillies, 2006; Grant-Vallone, 2011; Johnson & Johnson, 1999, 2009; Johnson, et al., 2007; Lave & Wenger, 1991; Millis, 2010; Nussbaum, Alvarez, McFarlane, Gomez, & Claro, 2009; O'Donnell, Dansereau, Hall, & Rocklin, 1987).

Cooperative learning requires more direction than merely asking students to get in a group and work on an assignment together. Cooperative learning, when designed and managed properly, turns groups into teams. Most researchers and practitioners of cooperative learning agree that successful teams are small, stable, and heterogeneous, and have been adequately prepared for working together. The adoption and continuous use of a formal instructional model in which instructors carefully design lessons and activities that are suitable for use by teams is assurance of teamwork. Ice breakers and team building activities are introduced and are designed to create a social and emotional atmosphere of encouragement that contributes to a sense of positive relationship building behaviors among the members.

According to research and practitioner literature on cooperative learning (Johnson & Johnson, 1994; Kagan, 1989; Slavin, 1991), student's knowledge acquisition may be enhanced when cooperative or team learning strategies are incorporated into the curriculum. Slavin (1991) defines cooperative learning as instructional methods in which small groups of students work together towards a group goal. The five basic elements of cooperative learning include (1) positive interdependence so that group members understand that they share mutual goals in resolving exercises that are assigned; (2) individual accountability to ensure that each member is held responsible to do their share of the processing; (3) face-to-face interaction for meaningful and interactive conversations and learning; direct and overt attention to healthy social skills interactions (4) social skills for enhanced communication and conflict management; for example, when students exhibit specific, effective forms of interpersonal communication in their learning groups, the instructor uses the opportunity for educational purposes and explicitly praises the behavior(s) as a demonstration of effective team building principles; and, (5) group processing to identify goals, and process any problems members are having in working together effectively. Cooperative learning ensures that participants are meaningfully and actively involved in learning and refers to the use of groups as an instructional tool rather than an overarching teaching style (Stevens, Slavin, & Farnish, 1991).

Research indicates that students who participate in cooperative learning group tasks tend to have higher test scores, higher self-esteem, improved social skills, and greater task comprehension. Noted as a characteristic of group learning that is critical to success is active participation is required of the student in the learning process (Baumberger-Henry, 2005; Felder & Brent, 1994; Johnson & Johnson, 1994).

Several research interventions have attempted to promote effective cooperative learning environments. For example, O'Donnell, Dansereau, Hall, & Rocklin (1987) designed a script for cooperative learning group members with explicit activities. Ninety-three college participants completed a two-session experiment. Students in scripted dyads were provided specific instruction on how to interact effectively with their partners in a cooperative learning format. Students in unscripted dyads were assigned to a group and simply given the direction to assist each other in learning the material but were provided no specific guidance. Results demonstrated that students in scripted dyads reported significantly more positive comments about their partners, indicated lower levels of anxiety when faced with a new partner on a subsequent task, and developed more similar perceptions of the learning situation to those of their partners than those in the unscripted dyads. Participants in the unscripted dyads were observed to behave as thought the assignment was to be completed by each individual as opposed to working together.

Teachers who help students see the value of cooperative learning behaviors can significantly affect their later success in a world where the Lone Ranger is no longer a viable model (Millis, 2010). Cooperative learning offers an efficient, learner-centered approach to instruction. Following highly structured practices for responsible group work can enhance a host of other didactic approaches and can result in both deep learning and higher order thinking.

The National Survey of Student Engagement (2007) confirms that student engagement in cooperative groups with high impact practice reported greater levels of deep learning and greater gains in personal development. In addition, results show that participation in learning communities was also noted to have a “compensatory effect” on grades and students likelihood of returning for a second year of college. Classroom based cooperative learning approaches that leads to increased learning are well-documented (Bransford, Brown, & Cocking, 2000; Johnson & Johnson, 1994, 1999, 2009; Johnson, et al., 2007; Millis, 2010). The type of cooperative learning that shows greatest progress and meaningful learning is when both the instructor and students pay attention to what is going on during group work and among members of the team. In addition to working together cognitively to resolve the problem, there are the socio-cognitive aspects of group work that emphasizes interpersonal and leadership skills necessary to facilitate discussion, ensure all ideas are heard, treats all members respectfully, and draws in even the most unenthusiastic members.

Small group cooperative learning is not universally endorsed or practiced in the aviation classroom. The dominant style of aviation teaching is a model where the instructor talks and the students listen. The goal is to maintain control, ensure task attention, and maximize instructor-led teaching. The organization of any classroom into small groups to foster the improvement of higher order thinking skills requires a deliberate effort on the instructor's part to help learners understand the value of working together and instructionally scaffolding the process to ensure success. Researchers agree that developing students' interaction skills, promoting cooperative learning, and providing students with stimulating learning environments is hard to design and manage and it takes considerable time (Baumberger-Henry, 2005; Felder & Brent, 1994; Millis, 2010; Stevens & Slavin, 1992).

Summary

The challenge in aviation education is that with so many commercial pilots retiring, the greatest pool of next generation pilot candidates coming from the collegiate aviation population. Something must be done to improve higher order thinking for all college students and particularly for those who are pilots. A well-designed and experiential intervention would be especially timely for those collegiate pilots who are fast-tracked throughout the FAA national system. Extensive evidence indicates that instructional scaffolding strategies are effective in promoting higher order thinking skills in various disciplines (Athanassiou, et al., 2003; Beckham, 2009; Clauss &

Geedey, 2010; Edwards, 2003; Felder, 2005; Johnson & Johnson, 1999; Nietfeld, et al., 2005; Schraw & Dennison, 1994). Several interventions in an aviation classroom setting have been studied (Devlin & Singh, 2010; FAA, 2003; Hermeon, et al., 1995; Kreienkamp, 1983; O'Hare, et al., 2009; Robertson, 2003, 2005; Roen-Pearson, 1986; Wiggins, 1998; Wiggins & Parker, 1998). However, most of the instructional interventions or strategies that have been examined use one or two well-structured contexts for higher order thinking, problem solving or decision making and rarely in combination with two or more other strategies. In the aviation classroom, teaching higher order thinking skills involves emphasizing methods and strategies for cognitive learning theories such as cased based problem solving (Jonassen & Hernandez-Serrano, 2002; O'Hare, et al., 2009; O'Hare & Wiggins, 2004). The instruction must be student centered, use authentic case studies, demonstrate cooperative learning, and be customized to help students become more metacognitive and self-aware in the process (Kerka, 1992). Robertson (2003) contends that the current FAA training could benefit from improvements to the curriculum to include more guidance and active classroom engagement by the pilot in learning problem solving and decision-making.

For classroom instruction to be effective for today's pilots there must be a comprehensive program of integrated instructional scaffolding explicitly taught for improving higher order thinking in aeronautical decision making that includes a model of metacognition such as the Metacognitive Awareness Inventory (MAI), psychological self-awareness though the Myers Briggs Type Indicator (MBTI), authentic learning using official accident reports, and active decision making in cooperative groups. Since these strategies alone are proven contexts for expert-like problem solving and reasoning activities, a combination of them used to teach aeronautical decision making could result in a classroom environment that is meaningful, authentic, and effective for the improvement of higher order thinking.

The present study provides a theoretical integration of scaffolding strategies that expands the empirical literature in aeronautical decision-making, allowing researchers to better understand the process of delivering training in the classroom. This research aims not only to describe and explain the challenges in the training but also introduce explicit scaffolding of Bloom's taxonomy for higher order thinking and instructional scaffoldings for metacognition and psychological type to learn from authentic accident cases while in cooperative groups to address the unchanging goals for safety in flight. Scaffolding designed to encourage social interactions and facilitate joint decision making will lead to richer knowledge construction (Nussbaum, et al., 2009). The current study also address a gap in the existing literature by attempting to answer whether general aviation accident cases will have an impact on improving participants' higher order thinking in aeronautical decision making.

CHAPTER THREE: METHODOLOGY

This mixed methods experimental case study investigated whether combined instructional scaffoldings would have a positive effect on participants' higher order thinking skills. The study also explored relationships between participants' responses and psychological type, as hypothesized by Carl Jung and measured by the MBTI, while participants worked alone and in groups. Participants comprised a relatively homogenous group of Aviation students enrolled in an accredited university flight program. Quantitative methods alone would not provide a comprehensive view of how the experimental condition influenced participants' self-awareness of higher order thinking during and after individual and group processes. Therefore, qualitative methods also were used to help clarify results and triangulate findings. The term explanatory design is used to describe this type of mixed method study (Creswell, 1998). The following sections present the research questions and hypotheses, participants, design, materials, instruments, data collection procedures, and data analysis.

Research Questions

The central question derived from the literature and addressed in this study explored the combination of instructional scaffoldings for authentic learning, self-awareness as a metacognitive and psychological construct, and cooperative learning as key factors associated with higher order thinking skills improvement in a non-traditional aeronautical decision-making module of a required course called Crew Resource Management. Accordingly, the study attempted to answer five related questions:

1. Are there significant differences in higher order thinking skills between experimental and control groups?
2. Is there a significant interaction between experimental condition and MBTI type? In other words, does the rate of improvement in higher order thinking across experimental conditions depend on whether the individual is a J or a P?
3. Does MBTI J/P preference significantly correlate with metacognitive awareness (MAI) scores?
4. Will participants in the experimental group report more positive beliefs regarding higher order thinking and the case study questionnaire, personality and self-awareness as well as cooperative learning, and overall module, than those in the control group?
5. Will there be a significant interaction between the experimental condition and MBTI J/P type on positive beliefs post treatment?

Participants

The purposive population sample for this study was undergraduate junior and senior students at a public university in the south central United States enrolled in the senior-level College of Aviation Crew Resource Management (CRM) course during fall 2010 and spring 2011. The participants comprised a relatively homogeneous group with respect to their flight education and previous experiences with human factors courses. Each student reported those data on a socio-demographic questionnaire prior to the condition assignment.

The researcher selected these participants as a basis for the research because they were professional members of a clearly defined and available population that volunteered to participate in the study with faculty and professional aviation management support. The capstone aviation CRM course is designed to ensure that aviation students encounter human factors associated with aeronautical decision-making and is a requirement for all aviation majors. In addition, the researcher is a private pilot and obtained ground school training at the same educational institution and knows the deficits inherent in the CRM curriculum for teaching higher order thinking skills. The researcher has also taught a human factors section of the CRM course since 2003 and knows that the participants would benefit from a study of this nature. Further, educational psychology is a domain in which the researcher possesses adequate knowledge to support participant learning and has over 5,000 hours of certified adult education instruction. The researcher understands that purposive sampling can be highly prone to researcher bias and ensured that the selection of this nonrandom sample was based on clear theoretical criteria, described later in this chapter under the section entitled Internal Validity.

The study was conducted over a six-week period, including a total of 14 hours of classroom training, during two semesters. A total of 32 students were enrolled in the study, 16 in fall 2010 and 16 in spring 2011. Each semester, one group was assigned to the non-traditional module (experimental) and the other to the traditional module (control). Two students did not complete the course and the actual number of participating students was 30.

Students were assigned to the modules after the researcher scored the MBTI assessments for all participants. Selection of class members by gender and MBTI psychological type was made so that both classes had equal number of females and equal number of participants with a preference for Perceiving (P), both of which were minorities in the group. The fall 2010 group had all males. The spring 2011 cohort had four females so the experimental and control conditions each had two females. In addition, each student's overall grade point average was obtained (with written permission) from university records and used as a covariate, as were college major, year in college, and the number of prior aviation courses completed that introduced human factors and CRM as part of the curriculum, since having prior knowledge of the concepts may provide students with an advantage in accident case analysis as a key component of this study.

Of the 30 subjects, 26 (86.6%) were male, 26 (86.6%) were aged 18-21, 30 (100%) were Caucasian, 18 (60%) were seniors, and 26 (86.6%) were aviation majors (see Tables 3.1 and 3.2).

Table 3.1
Demographic Data

Sex	**N (%)**	**Age**	**N (%)**	**Year**	**N (%)**
Female	4 (13.3%)	18-21	28 (93.3%)	Junior	14 (40%)
Male	26 (86%)	22-28	2 (6.6%)	Senior	18 (60%)

Table 3.2
Subject Major Areas

	Majors			
	Professional Pilot	Air Traffic Control	Aviation Management	Other
N (%)	22 (73.3%)	4 (13.3%)	4 (13.3%)	2 (6.6%)

In addition, within this group of participants, 17 (56%) reported that they had taken at least one aviation human factors or safety course. With regard to their understanding of CRM and aeronautical decision-making, 22 (73%) reported that they knew very limited information about CRM topics. With regard to participants' self-awareness, 6 (20%) reported that they had taken the MBTI in a prior college course and one could recall their four-letter type but none could discuss the theory of psychological type. Student's MBTI type preference scores were calculated as frequency distributions. Of the 16 type preferences, five (INFJ, ISFP, ESFP, ENTP, and ENFJ) were not represented. Table 3.3 displays type preferences, percentage, and frequency.

Table 3.3
Participant MBTI Personality Types

Type Preference	N (%)
ISTJ	8 (26.6%)
ISFJ	2 (6.6%)
INTJ	3 (10%)
ISTP	3 (10%)
INFP	2 (6.6%)
INTP	2 (6.6%)
ESTP	1 (3.3%)
ENFP	2 (6.6%)
ESTJ	3 (10%)
ESFJ	2 (6.6%)
ENTJ	2 (6.6%)

Group or team type is determined by taking the larger number of participants representing each of the dichotomies. In this case, regarding the energy attitude dichotomy, 12 participants reported a preference for Extraversion and 20 participants reported a preference for Introversion. Therefore, Introversion (represented by I) was the group type preference for the energy attitude. On the data-gathering or perceiving dichotomy, 19 participants reported Sensing and 13 participants reported Intuition. Therefore, Sensing (represented by S) was the group type preference for data-gathering.

For the cognitive decision-making or judging function, 22 participants reported Thinking and 10 participants reported Feeling. Therefore, Thinking (represented by T) was the group type preference. On the outer world orientation attitude, a main focus of this study, 20 participants reported Judging and 12 participants reported Perceiving. Therefore, Judging (represented by J) was the group type preference for outer world attitude. The composite of all four dichotomies is ISTJ and is identified the group type for this case.

ISTJ also was the most represented type on the class population type table, with eight members validating that type. While ISTJ types comprise only about 6 percent of the general population, they comprise about 30 percent of the U.S. armed forces and, as discussed in the Literature Review, are the most likely to choose a career in aviation, closely followed by the ESTJ (Chidester, Helmreich, Gregorich, & Geis, 1991; Hamilton & Ripley, 2004; Martinussen, 1996; McGlohnn, et al., 1996; Retzlaff, et al., 1995; Schwartz, 2009; Wiggins, 1998). The ISTJ's four preferences are found overwhelming in the military: the combined Army, Navy, Air Force, and Marines is 55 percent Introverted, 72 percent Sensing, 90 percent Thinking, and 80 percent Judging.

Materials/Instruments

Seven instruments were used to collect data for analysis. Both experimental and control conditions included collection of: (1) demographic questionnaire, (2) Case Study instrument, (3) Metacognitive Awareness Inventory (MAI); (4) Myers Briggs Type Indicator (MBTI) personality profile, (5) Beliefs and Perceptions Questionnaire, (6) Classroom observations, and (7) Semi-structured interviews.

The instruments are listed and explained in Table 3.4.

Table 3.4
Materials and Instruments

Data Source	Description of Source	Description of Data Yielded
Socio-demographic questionnaire	Five-item Internet questionnaire with multiple choice and open ended questions	Participants self-report related to experience, previous courses, major, and year in college
Grade Point Average (GPA)	Signed Consent Forms for approved release of GPA	GPA for each participant used as a control variable
Case Study Instrument	Six-question instrument designed to reflect the theoretical framework of Bloom's taxonomy	Participants complete a pre- and post-test case study
Metacognitive Awareness Inventory (MAI)	52-statement paper and pencil, self-report questionnaire designed to measure knowledge and regulation of cognition	Taken before and after the intervention, higher scores correspond to greater metacognitive knowledge and regulation
Myers-Briggs Type Indicator (MBTI)	93-question paper and pencil self-report psychometric questionnaire to measure psychological preferences	Computer report of four-letter type; focused on the fourth letter of J versus P and their importance in communicating and learning
Beliefs Questionnaire	32 questions; Likert-style responses included 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree)	Participants' self-report on questions related to overall course content impact and also with open-ended questions
Observations	Observations regarding the way participants respond individually and in relation to others in a cooperative learning setting	Instructor and peer ratings are classified to identify strengths and weaknesses
Semi-Structured Interviews	Researcher notes and transcription of audio recordings of semi-structured interview questions	Eight participants from the experimental and control groups were telephone interviewed

Socio-Demographic questionnaire. The socio-demographic Internet questionnaire (Appendix D), was designed to capture demographic data from the participants on gender, major, year in college, specific name of previous courses completed that addressed the topics of human factors and crew resource management. In addition, to provide a more robust data set, it helped determine whether the participant was working or had worked in any facet of military/aviation industry prior to course enrollment and what aviation ratings the participant held.

The eight-question survey was approved by OU's Aviation Manager (who also served as the CRM Instructor for the two courses taught as part of this experiment) for construct validity by examining the questions and their intended purpose (Creswell, 2003). Questions one and two yielded name and gender. Question three asked participants to identify the degree they were seeking and Question four asked what year they were in during the semester under study. Question five asked participants to self-report on the names of other courses completed on the subject of crew resource management (CRM) or human factors. Questions six and seven asked participants to self-report whether they were now working or had ever worked in any facet of the aviation industry prior to this course. If they answered "Yes" to Question six, they were then asked to briefly describe number of years, employment, position(s) held, and whether they used CRM or human factors practices. Question eight captured participant's aviation pilot rating(s). These data served as a supplement to the participant interview data set. Consistencies and inconsistencies among participants regarding ratings served also as starting points for further investigation.

GPA. Participant's permission was requested on the IRB approved Permission to Release Education Record Information (Appendix E) to retrieve their latest grade point average. The researcher contacted the educational institutions' Academic Records department once all the forms were collected and, at the department's request, all copies were scanned and emailed to the University Academic Transcription Clerk for processing. The researcher sent a list of students with ID numbers in an *Excel* spreadsheet and the clerk filled in the column entitled GPA. This data confirmed that GPA consistencies were clear among participants.

The Case Study Instrument. Designed by the researcher with input from the CRM instructor, the case study instrument is based on items from an existing case study assignment in the traditional CRM course. The original items were updated for this experiment with adherence to Bloom's Revised Taxonomy (Anderson, 2005; Bloom, 1956) and adapted based on several studies using Bloom's Taxonomy in a similar case-based and scaffolded format (Athanassiou, et al., 2003; Chowdhury, 2004; Crowe, Dirks, & Wenderoth, 2008; Ferguson, 2002; Plack et al., 2007; Valcke, De Wever, Zhu, & Deed, 2009; Zydney, 2008). In these studies, across various disciplines, the six levels of the taxonomy were designed to help students enhance their study skills and metacognition by developing questioning and problem solving prompts to navigate students through the assignment in order to move from lower to higher order thinking tasks and complete the assignment. In the current study, the six levels were used as the pre- and posttest items.

The idea for the Case Study Instrument was conceived when the researcher was introduced to the Individual Student Case Studies course assignment (Appendix F) as part of CRM syllabus in 2004. The assignment was developed by College of Aviation staff for students to analyze an aviation accident. Each accident narrative is fairly technical and complicated in that several variables are happening at the same time, thus their use as course materials reflects and demonstrates how communication and decision-making skills are important aspects in CRM training.

The CRM Instructor indicated that the original questions were not developed with respect to rank, order, or hierarchy and were not explicitly taught or scaffolded as instructional principles during the CRM instruction. As CRM is considered a required and capstone course, the intent of the assignment was that a student would present an argumentative essay to emphasize what could have been done from a human factors standpoint to have a more successful outcome. The content of the questions reflected both knowledge, or lower order thinking, and problem solving, described as higher order thinking (Leou, Abder, Riordan, & Zoller, 2006; Zoller, 1993).

Because the questions reflected the general theoretical framework of Bloom's Taxonomy, the researcher organized the original questions on the Case Study Instrument and updated the content to explicitly match the associated levels of Bloom's Taxonomy (Appendix G). As dynamic and interrelated as the different levels are, the revised six items then were reviewed by three educational aviation experts to validate content.

The researcher also confirmed and reviewed the literature for research efforts to systematically apply Bloom's Revised Taxonomy classification of the cognitive domain to metacognition of the process of higher order thinking and discovered many applications (Chowdhury, 2004; Crowe, et al., 2008; Jansen, Booth, & Smith, 2009;

King, 1990; Larkin & Burton, 2008; Montes, et al., 2009; Morrone, Harkness, D'Ambrosio, & Caulfield, 2004; Nkanginieme, 1997; Palmer & Devitt, 2007; Swart, 2010; Valcke, et al., 2009; Wong & Day, 2009). The Case Study Instrument items were thus adapted by the researcher based on research with Bloom's Revised Taxonomy (Clauss & Geedey, 2010; Granello, 2000, 2001; Larkin & Burton, 2008) as shown in Table 3.5 and in Appendix G:

Table 3.5
Case Study Instrument Questions

	Case Study Instrument Questions 1-6	Order
1	Present the facts/circumstances of the accident.	Lower order thinking
2	Paraphrase what happened in your own words; provide a brief summary.	Lower order thinking
3	Given prior knowledge and the evidence provided, state the possible and/or probable cause(s) that the NTSB determined of this accident.	Lower order / Higher order
4	Identify the specific human factors related to the causes(s) of this accident.	Higher order thinking
5	Evaluate/critique this pilot's actions in terms of the degree to which error(s) could have been avoided.	Higher order thinking
6	Given the combination of human factors presented in this case, create rules (i.e., rules of thumb, new procedures or methods) for yourself and fellow pilots.	Higher order thinking

Previous studies that hypothesized weighting constructs for the six items based on Bloom's Taxonomy, both the original and revised versions, were reviewed and consulted for scoring (Athanassiou, et al., 2003; Clauss & Geedey, 2010; Crowe, et al., 2008; Zohar & Dori, 2003; Zoller, Dori, & Lubezky, 2002). The definitions of the higher order thinking levels in previous studies were consistent in definition but lacked consistency in item weighting across the studies. Therefore, a weighting system, described below, was developed and validated by the researcher and a statistics expert in conjunction with an educational psychologist.

To create a composite score for the pre- and posttest accident cases (Case Study 1, Appendix H), weighted values were assigned to each item and a composite score was determined. Participant responses were coded to assign lower scores to questions 1 and 2 and incrementally higher scores to questions 3 through 6 (Athanassiou, et al., 2003; Oliver, Dobele, Greber, & Roberts, 2004). This weighted values system is consistent with Miller (1989) who computed a system using the Florida Taxonomy of Cognitive Behavior (FTCB) which is consistent with the hierarchical nature of Bloom's Taxonomy. Other studies of the FTCB and Bloom's Taxonomy included a similar weighted system which suggests that the subsequent level of cognition receive a higher cognitive weight than its preceding level (Athanassiou, et al., 2003; Ball & Garton, 2005; Clauss & Geedey, 2010; Rover, Mercado, Zhang, Shelley, & Helvick, 2008). For this study, the cognitive weighting values attributed to each Bloom's Revised Level were: remember = .5; understand = 1.5; apply = 3.0; analyze = 4.0, evaluate = 5.0, create = 6.0.

In addition, to increase objectivity and decrease subjectivity, a National Transportation Safety Board (NTSB) Rating Sheet or a Rater Rubric (see Appendix I) was devised to capture varying degrees of responses to each item by each participant. The Accident Report and Guidelines and specific answers per scenario were provided to the rater as a Case Study Answer Key (see NTSB Case Study 1 Answer Key in Appendix J) and it was their responsibility to rate each participant's response to each of the six items on the pretest and posttest. The rater scores ranged from 0 - Unacceptable, 1 - Needs Improvement, 2 - Acceptable, or 3 – Exemplary. Each rater read and rated each of the six questions per case study.

Case study scores were calculated by multiplying the point value of each cognitive level by its respective item weight. In order to calculate a total weighted score, the values were summed across each of the six cognitive levels. The maximum weighted score for all six questions at an exemplary level that could be attained was 60. For example, if a participant were to be ranked a 3-Exemplary on each of the six questions using the scoring evaluation level of cognition his or her total cognitive value would be 60 as follows:

$$\textit{Total Score} = .5*3\ Q1 + 1.5*3\ Q2 + 3*3\ Q3 + 4*3\ Q4 + 5*3\ Q5 + 6*3\ Q6 = 60$$

This weighted average ensured that the first two questions considered lower order thinking were weighted lower, while the last four were incrementally weighted more. The researcher, CRM Instructor, and a third rater all individually scored 60 accident case reports (30 individual pretest cases and 30 individual posttest cases). Inter-rater reliability was assessed and, when differences were noted, scoring was negotiated among the raters. Inter-rater reliability (IRR) was calculated using the Pearson correlation coefficient. Before agreement the IRR coefficient was .454 and after agreement the IRR coefficient was .70.

The Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994). MAI is a self-report survey that contains 52 statements (Appendix K). Designed for use with adult populations, each statement is student rated and higher scores correspond to greater metacognitive knowledge and greater metacognitive regulation. The assessment is designed to measure knowledge of cognition and regulation of cognition. Knowledge of cognition is divided into declarative knowledge, procedural knowledge, and conditional knowledge (Batha & Carroll, 2007; Cromley, 2005; Nietfeld, et al., 2005; Palincsar, 1986a; Schunk, 2008; Sternberg, 1998; Vadhan & Stander, 1994; Young & Fry, 2008). Regulation of cognition is categorized according to planning, organizing and managing information, monitoring, debugging, and evaluation of performance. Schraw's instrument has been used extensively by other researchers (Schraw, 2009).

Reliability estimates (alphas) of the MAI are acceptably high for the two factors: Knowledge of Cognition: .79; Regulation of Cognition: .84 In the research for this study alpha coefficients were MAI-pre: .754 and MAI-post: .749. The MAI addresses various aspects of metacognition and also can be used to obtain scores for individual areas of metacognition, such as monitoring, planning, and comprehension. Internal consistency statistics range from r = .90-.95 (Dennison, 1997). The MAI has been found to have strong predictive validity for test performance and self-monitoring in academic tasks. Subsequent studies with the MAI have supported these findings, including a test-retest reliability of .85.

The Myers-Briggs Type Indicator® (MBTI) was developed by Isabel Briggs Myers (Myers, 1998; Myers, et al., 1998; Myers & Myers, 1980; Quenk, et al., 2001), based on the theories of Carl Gustav Jung. The MBTI consists of 94 items that force respondents to choose between one of two answers that reflect the two poles for each specific index (E-I, S-N, T-F, and J-P). In 1998, an updated version of the MBTI, called Form M, was released that has psychometrically enhanced scoring (Appendix L). The Form M scoring uses item response theory and a preference clarity index to provide measurement precision and to gauge the individual's preference clarity. Salter, Forney, et al. (2005) have observed that researchers who dismiss the MBTI for research may be guilty of applying data from the longstanding previous version, MBTI Form G, when discussing type validity and reliability. The MBTI is in a wide variety of organizations to include education, career counseling, and professional development. It is available worldwide in 21 validated translations. According to Myers, the basic use of the instrument was to offer practical and useful information about patterns of perception and judgment that she hoped would lead to the constructive use of differences (Myers & Myers, 1980).

The psychological reality of the MBTI dimensions becomes especially apparent to the taker of the MBTI when it is interpreted in light of the descriptions provided by Myers (Myers, et al., 1998). “The parallels between the descriptions of the individual and the individual’s own self-perceptions are nothing short of uncanny to some clients on first assessment” (Carlson, 1989, p. 67). The point of this mention is clearly not that this serves to empirically validate the test. However, from the standpoint of both the user and the taker, the credibility of the test is greatly enhanced.

With respect to the empirical issue of reliability, test-retest intervals from five weeks to 21 months, MBTI reliability coefficients (Myers, et al., 1998) range from 0.73 to 0.83 for E-I, 0.69 to 0.87 for S-N, 0.56 to 0.82 for T-F, and 0.60 to 0.87 for J-P. Phi coefficient estimates measuring internal consistency range from 0.55 to 0.65 (E-I), 0.64 to 0.73 (S-N), 0.43 to 0.75 (T-F), and 0.58 to 0.84 (J-P). Test-retest reliability estimates for the MBTI Form M scales at four weeks are .83 to .97, with 65% of respondents choosing the same four-letter whole type (Myers, et al., 1998, p. 163). As a strong argument for construct validity, examination of data on individual scales validates the behaviors and attitudes that the Myers Briggs Type Indicator was designed to capture (Jung, 1971; Myers, et al., 1998; Quenk, et al., 2001).

Concerning the validity of the MBTI, the MBTI Manual (Myers, et al., 1998, p. 9.1-9.70) contains over 100 studies that contribute to the development and validation of the tool. When the exploratory and confirmatory factor analytic results are viewed together, there is strong support for the construct validity of the MBTI. There have been numerous validation studies conducted on the MBTI. Many of these studies are produced by the Center for the Application of Psychological Type and the Journal of Psychological Type. Regarding the reliability of the MBTI, on retest, 75% to 90% of people tend to come out with the same score on three-fourths of the variables.

Continuous scores on the MBTI are correlated with the Big Five personality factors and the correlations are substantial. Correlations between the MBTI and the NEO-Personality Inventory (PI) and Strong Interest Inventory range from .57 to .86. As a form of construct validity referred to many times in this study, MBTI type table distributions are primary. To compare one group with another, the Association for Psychological Type accepted an analysis tool, known as the Selection Ratio Type Table (SRTT) (Myers & McCaulley, 1985). Analytic techniques such as using arrays to display the data, creating displays, tabulating the frequency of events, ordering the information, and other methods have been shown to be effective for describing a population of interest (Miles & Huberman, 1994; Yin, 1994). Type table distributions are provided through this study in a way that will not bias the results.

Self-selection Ratios (SSR) were calculated for each type to take into account the relative frequencies of type in the sample of interest as well as the general population: SSR equals the % of a type in sample population. The SSR is also referred to as an Index of Attraction (Myers & McCaulley, 1985). The Chi-square method was used to test whether the Type Table Distribution of the sample under review differs from the base population. SSRs greater than 1.00 mean that more people of that type are attending the CRM class than those enrolled in college in the base population. SSRs less than 1.00 means a lower proportion of individuals of that type are in the CRM class than are in the general population. For the current study, SSRs around 1.00 mean nearly equal proportions are found in the base population and in the sample (Myers, et al., 1998, Table 12.12, p. 298). Evidence to support the construct validity of the MBTI based on type table distributions is abundant and compelling as data show that the distribution of types across occupations such as in aviation generally follows theoretical predictions.

The Beliefs Questionnaire was administered via the Internet after the course intervention was completed and collected information about the overall impact of the course for participants in both the experimental and control groups. The Beliefs Questionnaire (Appendix M) was used to quantitatively answer research questions 5 and 6. It consisted of 32 five-point bipolar probability items. Questions 1 through 11 referred to student's beliefs regarding the Case Study Instrument. Questions 12 through 25 referred to the participants' beliefs regarding MBTI personality type and behaviors. Questions 26 through 32 referred to the content and pacing of the overall impact of the course module for participants in both the experimental and control groups. Content validity was assured in the following manner: content was developed by the researcher, a university-level CRM instructor. Using Cronbach's Alpha, a reliability coefficient of

.79 was attained. Upon completion, the questionnaire was evaluated by the CRM co-instructor and validated by two educational psychology faculty and two professional pilots.

Observations. Getting a snapshot of what was happening in each classroom was best achieved by observing individual interactions and team exercises. The classic form of qualitative data collection is observation of participants in the context of a natural scene. Creswell (1998) notes that researchers observe and should record phenomena of interest in the classroom environment to draw information not obtainable from interviews. Patton (2002) confirms that observation provides the researcher with a powerful qualitative tool to see things that the participants cannot see or may be unwilling to discuss and can use the knowledge provided in the context in which the observation occurred to help lead participants to deeper understandings.

During this study, classroom observations began immediately on day one and they consisted of approximately 12 seventy-five minute sessions. Participants also were videotaped during selected team exercises, allowing the researcher and CRM instructor to make observations about the way participants used the scaffolding exercises and also how they prompted one another when using the scenario-based Case Study Instrument in group exercises. Glaser and Strauss' idea of a "slice of data" (Glaser & Strauss, 1967) was a beginning point. For this experiment, examples of phenomena observed include student facial expressions during group social interaction and while listening to instruction, body language during instruction and activities, and so forth. Gathering more in-depth data over the instructional period of 75 minutes provided a richer data set and a more complete picture of participants' behaviors. Any intangible clues that provided insight into what the students were thinking or feeling was noted. The researcher also noted students who interacted with others when given a choice and the nature of those interactions. These participant observations generated insights and better understanding of the development of the higher order thinking skills under study. The benefit of this prolonged engagement allowed patterns to emerge in the data (Patton, 2002).

Semi-structured interview protocol (Appendix N) was developed in consultation with the CRM Instructor and a fellow pilot who had taught CRM at Cessna to capture qualitative data on participant's beliefs and attitudes. Building on the Beliefs Questionnaire results, interviews with selected participants were conducted in order to reveal underlying beliefs and attitudes that shaped student learning. The sample for the participant interviews was selected from the 30 students who were part of the population observed over the course of the two semesters. The interview data set consisted of eight students, four representing the fall 2010 semester and four representing the spring 2011 semester. These eight participants agreed to be interviewed regarding their course experiences at the conclusion of the experiment.

The eight were purposely selected to represent participants of equal number of J and P preferences each semester. Interviews were structured to last between 15 and 45 minutes and were conducted by telephone using a *LiveScribe* pen to capture audio and interview notes. Interview participants were advised that the session would be recorded. The semi-structured interview was developed with open-ended questions that Patton (2002) describes as including opinion/values questions, feeling questions, knowledge questions, and background/demographic questions designed to address the purpose of the research. The goal was to identify rich trends and patterns in the students' perceptions, team relationship effectiveness**,** and tracking changes in individual students' self-described attitudes toward self-regulation.

The interview was designed to capture participant experiences that influenced their beliefs and attitudes toward learning about human factors in an aviation course. The influences included but were not limited to expectations regarding use, actions, and performance by using the case study instrument to analyze accidents, self-awareness beliefs, and the value of working in cooperative groups. The questions were designed to spark conversations. Therefore, additional clarifications and changes in questioning protocol occurred during the interviews when further exploration or explanation was warranted.

The first two questions captured which aspects of the course produced the greatest and the least learning. Questions three and four captured specifics about prior CRM knowledge that participant's had when they started the course. Question five and its sub-questions captured specifics about which concepts may have been more challenging and why. Question six probed for which CRM practices they learned that could reduce pilot error. Questions seven, eight, nine, ten and eleven and their sub-questions captured specifics about the use and application of the accident cases and the Case Study Instrument. Questions eleven and twelve captured the participant's beliefs about personality type as a CRM human factors topic, and self-awareness as it relates to the role of a pilot. Questions thirteen and fourteen captured participants' attitudes and beliefs when working on the exercises in cooperative groups.

An Interview Guide was used to ensure that basically the same information was collected from each person yet left the researcher free to probe and explore based on responses. The interview guide made good use of limited interview time and made the collection more systematic and comprehensive. It also served to keep the interactions focused, which several of the interviewees commented on affirmatively.

Credibility is based on the validity and reliability of the instrument or instruments used and the internal validity of the study. Credibility is supported by prolonged engagement, persistent observation, and triangulation (Lincoln & Guba, 1985). As a form of prolonged engagement and persistent observation, the study was embedded within the structure of an existing college course called Crew Resource Management and delivered during two consecutive semesters. Each treatment was conducted over a continuous 12-classroom-period timeframe over a period of two and one-half months. Triangulation of the observations, interviews, and the results of the Beliefs Questionnaire helped support the trustworthiness of the findings.

Research Design

The researcher used both quantitative and qualitative methods to provide a rich comprehensive view in terms of how the experimental materials influenced students' approaches to scenario-based instruction during and after individual and group experimental processes. This mixed methods design was approached in an explanatory manner.

A quasi experimental pretest / post-test with control group design was utilized for the quantitative research questions. Quasi experimental designs are utilized when random assignments of participants are impossible (Creswell, 2008). This research used a variety of qualitative methods within the context of an exploratory multi-case study. As suggested by Yin (2009), the case study design was useful because there was little or no control over the behavioral events in the classroom under study. A case study design allowed the researcher to convey meaningful characteristics of the participant's reactions to the training at multiple levels. Important at each level were examination of the treatment from performance scores, observable actions, and the perspective of the participants. Also, several of the research questions required an in-depth description of the social phenomenon in the classroom.

Experimental Study

The experimental study was conducted to answer the research questions regarding the effect on the pre and posttest Case Study Questionnaire of the metacognitive framework – a scaffolding device drawn from scenario based learning using Bloom's taxonomy and combined with MBTI type – as an instructional technique to improve aviation students' higher order thinking skills, herein referred to as aeronautical decision making training.

Participants in both groups took the pretest and posttest case studies but the experiential and scaffolded aeronautical decision making treatment was only administered to the experimental group. The control group was provided with a traditional FAA approved course content that was primarily instructor led. All participants in the study attended the same number of classes and studied similar topics. The independent variable for all questions was the experimental condition – control or experimental. Because MBTI type was not manipulated, it was treated as a quasi-independent variable.

The syllabus of the aeronautical decision making training components (Appendix O) consisted of 12 learning sessions, delivered in 75-minute class sessions twice per week for six weeks that included reading, self-study, cooperative learning activities, guided discussions, and reflective exercises. Learning outcomes and assessment strategies were stated at the beginning of the course.

All participants in the study were provided with information on higher order thinking initiatives as reflected in both Bloom's Taxonomy and metacognitive principles as part of the course content. These topics are appropriate for crew resource management training. The control group learned about these topics in an instructor led classroom while the experimental group experienced these theories as tools and exercises in decision making while alone and in cooperative groups.

The experimental group practiced monitoring their behavior through scaffold exercises while the control group read about how other pilots self-regulate by studying chapters and pages in the assigned reading. Because higher order thinking in crew resource management training is based on communication, participants in the experimental training course received additional training in that they were taught to apply their questioning skills based on the Case Study questionnaire and their knowledge of higher order thinking and metacognition in a learning context by using metacognitive awareness and psychological type. This is an example of what Brown and Palinscar (1982) identified as "informed strategy training." That is, informing the participants of the reason for using the strategies and helping them see the relationship between strategy use and improved learning. In order to integrate the concepts of Bloom's taxonomy and the instructional scaffoldings, the experimental course necessitated a high level of participation, which was manifested through working together and alone, proposing answers to questions, and reflecting on personal communication experiences conducted during the training periods with regard to aeronautical decision making.

The primary dependent variable for Research Questions one and two was participant scores on the pre and posttest Case Study Questionnaire. To establish the parameters that defined the dependent variable, the scoring was based in part on Bloom's Taxonomy developed by Benjamin Bloom (Bloom, 1956) and updated by Anderson and Krathwohl (2001).

Research question three evaluated the relationship between the MBTI and MAI. Research question 4 examined participant responses on the Belief Questionnaire to identify if experimental group participants would report more positive beliefs about aeronautical decision making tools than the control group participants. Research question 5 examined whether participants' psychological type would further impact those positive beliefs. The following variables were used as covariates: GPA, number of human factors related classes taken, prior experience in aviation, and year in school. A summary of the two treatment conditions is presented in Table 3.6.

Table 3.6
Summary of Treatment Conditions

Group	Wk 1 1&2		Wk 2 3&4		Wk 3 5&6	
	Consent MAI MBTI Socio-Demo	**PRETEST;** accident video; CRM intro	MBTI Intro Functions and Attitudes; self-assessment; Provide MBTI Profiles	Intro to ADM; ADM concepts and facts re: crew as groups	Practice with Bloom's and NTSB Reports; Practice HOTS, Type, and CSI	ADM Checklists; Communication; leader / follower; nonverbal communication
1	X	X	X		X	
2	X	X		X		X

Group	Wk 4 7&8		Wk 5 9&10	Wk 6 11&12	
	Small coop groups practice with CSI and MBTI, HOTS, MAI, and Bloom's; test ADM concepts	ADM concepts; Assertive /aggressive; Impact on decisions; test ADM concepts	All Teams present accident reports; 3-4 groups per class; assess team differences	**POSTTEST;** Summarize ADM concepts to date; Debrief experiment	Researcher provides Treatment for Control Group
1	X		X	X	X
2		X	X	X	X

Key Terms in Table 3.6:

Group 1 = Experimental; Group 2 = Control

MAI – Metacognitive Awareness Inventory

MBTI – Myers-Briggs Type Indicator

CRM – Crew Resource Management

ADM – Aeronautical Decision-Making

HOTS – Higher order thinking skills

CSI – Case Study Instrument

Note: Cross-reference Table 3.6 to Appendix O, Crew Resource Management (CRM) Syllabus, for details of treatment condition.

Experimental condition: The experimental group received aeronautical decision making training, which scaffolded instruction to monitor, engage, and regulate higher order thinking using authentic accident reports evaluated using a Case Study Instrument based on Bloom's revised taxonomy and validation of individual MAI results and MBTI preferences while working on exercises in cooperative groups settings. Cooperative group exercise(s) played a prominent role in the experimental condition and the concept was taught but not practiced in the control condition. For this research, experimental participants were introduced to the concept of decision-making explicitly using the accident reports with the Case Study Instrument to practice cooperative engagement. Participants regularly met in pre-assigned groups and the researcher scaffolded the steps to effective cooperative engagement allowing shared leadership to emerge as participants discussed their responses. How their own awareness of their thinking, their metacognitive approach, impacted their teammate's equally legitimate but perhaps different view of the accident case was a learning process advocated from the start.

Control condition: Treatment for the control group was consistent with instructor led crew resource management curriculum approved by the FAA, and focused on issues of human factors driven by workbook text and exercises from the FAA recommended curricula. In addition to the coverage of standard aeronautical decision making concepts, students received training on aviation designed leadership-followership terminology and concepts reflective of human factors topics to include non-verbal and assertive communication training. They also participated in two individual accident report evaluations using the Case Study Instrument, one pretest and one posttest, and received the same instructions as the experimental group except the dissemination of information was predominantly written and implicit. The concept of “cooperative groups as crews” concept was taught but not practiced in the control condition. The control group was assigned to work on only one group exercise during the 12-week module as this was reflective of the traditional model of the course implementation. Each participant was pre-assigned to a group by the researcher and they were limited, as were the experimental groups participants, to the instructions provided on the course group case study exercise (Appendix P).

Internal Validity

In an experimental study the question of whether the observed results are a function of the treatment depends on the experiment’s ability to control extraneous variables that might affect the outcomes. In order to increase internal validity for this study, criteria used here are based on those outlined and recommended by Campbell and Stanley (1963).

Researcher as Participant Observer

The qualitative analysis was approached from an emic perspective. The researcher’s goal was to determine how the treatment conditions’ cognitive tools impacted the participants’ abilities to learn, as well as to understand how they perceived themselves and their ability to use higher order thinking skills in an aviation course. With experience in a variety of psychological instruments and group processes, the researcher has earned a reputation for engaging, high impact instructional events.

From the start, this study called for the researcher to play a key part within the research process. Engagement with the ‘researcher as participant observer’ was an underlying assumption of this study and an acceptable research practice (Davis, 2009). The researcher was mindful that integral parts of the research design were offered in both the classroom participation and the case study analysis. Specifically, the researcher sought to help participants improve their problem solving processes using the Case Study Instrument and improve their perceptions of themselves as cooperative team (crew) members by reflecting on their cognitive preferences as identified through psychological self-assessments and feedback.

While participant observation was historically associated with a form of research in which the researcher resides for extended periods of time in a small community, it can also transpire in classrooms interacting with specific types of people, such as the aviation pilots in this research study.

To ensure the integrity of the study as it regarded the Participant Observer roles played by both the Researcher and the CRM Instructor, the researcher made mental and physical notes to constantly remind herself and the CRM Instructor that they had more than one role and had to perform in a variety of statuses and roles. The CRM Instructor was aware of his changing roles as a commercial pilot, former military crew member, CRM Instructor, and director at the Department of Aviation under study. Both researcher and CRM Instructor were especially sensitive to differences of age, gender, and culture that had the potential to raise ethical issues during the course of Participant Observation. Both discussed potential clashes in ethical principles and were mindful of their changing roles and relationships during the study.

The researcher participated as an instructor, train-the-trainer, interviewer, fellow pilot, and participant observer. The primary qualitative research instrument was the researcher and, as such, the researcher acknowledged that her experiences, personality preferences, and long held beliefs about the value of higher order thinking in flight instruction – and with regard to crew resource management, in particular, were relevant to the study both as advantages and potential obstacles. The researcher had extensive experience as an adult education instructor, a private pilot, an aviation human factors instructor, an MBTI expert practitioner, an executive coach, and a business leader, and has 20 plus years delivering self-awareness programs using experiential learning formats. All of this experience has the potential to impact the methodology and the data collected. Sensitive to the impacts of a psychological filter and years of studying and teaching the MBTI, the researcher relied on prior instructional design knowledge, facilitation expertise, and human factors training, in delivering the treatment.

One of the most profound challenges as a novice qualitative researcher was the transformational change that occurred while evaluating the data. As the researcher moved from initial review of the interviews, survey data, classroom observation notes, and personal reflections, the discovery that analysis and cross analysis could continue to reveal and reinforce ideas and beliefs of the study was enlightening. Participant responses revealed consistencies and similarities, as well as inconsistencies and this, too, added strength to the findings. Many times after reading and rereading, the researcher felt saturated only to discover upon evaluating the data again that themes emerged. The qualitative study process was like learning a new language.

Another challenge was a concern that the researcher might be driving the very discoveries being sought. To start looking for themes by using the Literature Review concepts and sequence felt contrived and inauthentic. However, the statement of the problem that drove this research and the development of the treatment helped confirm the themes and support the additional findings. The process of getting to know the data meant that the researcher read and reread text and listened to audiotaped recordings multiple times. Writing down impressions of the text and tapes was the first step. Constant evaluation of how any of the interpretation of the data might be biased was foremost in the researcher's mind.

At times, reminders were sent to some participants to complete surveys, attend class, or complete cases studies when their attendance was not possible. The attention that was given to the data under these circumstances was questionable as participants may not have addressed the assignment in the same way they would have if they had attended the class or appropriated sufficient time and attention to completing the assignment.

It was important to the researcher to keep the purpose of the evaluation in mind at all times. To this end, one way was to post a note on the computer where the researcher would see the questions under study as a constant reminder. A quick glance at the questions often helped to save the researcher valuable time and refocus the analysis.

One area of rich interest was conducting the content analysis of the text and narrative data that came from the open-ended questions and written comments on questionnaires, responses to the case studies, individual interviews, and descriptive accounts from group discussion notes, observations from field note taking, personal journal insights, and stories from personal accounts of experiences in people's own words.

Throughout the process, the researcher continued getting feedback from colleagues in aviation, past student participants, and the CRM instructor. One fellow aviator reviewed the data independently followed by engaging with the researcher to review and discuss the data and their meaning as well as confirming major conclusions. This analysis resulted in greater confidence of the data by the researcher. Avoiding generalization was a constant threat to the data analysis. Realizing that reviewing the data was for clarification, understanding, and explanation kept the focus on each individual as a case and helped limit generalization.

The Instructors

The CRM instructor and researcher agreed that classroom times would be approached as a laboratory event in which all participants were reminded to constantly and overtly observe and monitor the way each one interacted with one another as well as their approach to the course materials, especially during experiential exercises. Each individual was responsible for confronting questionable issues in a way that could lead to constructive dialogue to reach resolution or to modify behavior. Overtly reminding participants of this process up front established a mindset for the remainder of the workshop and permitted the instructors to deal with discomfort if and as it emerged in the classroom. The expertise of the researcher to consistently observe relationships in the classroom became an opportunity to discuss and appreciate various approaches/reactions to the same accident case. This was one reason why it is important that instructors receive training on how to lead, perceive misunderstandings, and help clarify possible other ways to interpret and make meaning of the accident case study from a human factors standpoint. While the CRM instructor was not equipped to provide the same type of expert modeling as the researcher which was required by the experimental design, attempts to mitigate differences between the two were made by ensuring that briefing occurred before each class and debriefing occurred on the same day right after each class.

It also was necessary to recognize that the treatment needed to be sensitive to the tension between controlling the learning experience and allowing the students to blunder through an interpersonal experience with another person or with the researcher and CRM instructor. A balance was necessary but finding that balance was a challenge both semesters that the CRM course was offered. As the researcher taught the experimental condition, vigilance was maintained throughout the course to spontaneously challenge, encourage, applaud, and critique the participants. One strategy was keeping open channels of communication between instructors and students at all times, especially outside the classroom and any pre-scheduled time. However, participants in the experimental condition delivered by the CRM instructor often received reactions/responses to the MBTI treatment second hand after the researcher and instructor had a chance to debrief. Often, this meant that providing a reflection of learning in the immediate moment for that individual and classmates was lost.

The researcher and CRM Instructor, when solo or instructing together, discussed and acted upon their MBTI types and used their different teaching strategies as a laboratory to assist in participant engagement and learning. The instructional differences also were reflected as they overtly discussed their delivery style differences using type language to describe their approaches to the case study instrument, accident reports, and cooperative learning.

Subject Selection

Subject selection introduced a threat to validity because the variable of a participant's psychological type was a variable of the experimental treatment. Students were assigned by the researcher to the conditions of control and experimental based on their MBTI results. Since MBTI Perceiving types and females were in the minority, the researcher assigned participants so that each condition had an equal number of Perceiving (P) types and an equal number of females. The Judging (J) males were blindly and evenly split between the two conditions. To reduce the bias introduced through subject selection, the researcher ensured that all participants were included in every exercise and that no one received special privileges due to the minority differences introduced.

Mortality

Mortality issues posed a threat during the experiment. Initially, 32 participants consented to the study, completed the consent forms, and were assigned to the control group. During the fall semester of 2010, two students were not able to complete the course. One student stopped attending the course after the team presentations session. He had been ill for two previous sessions and reported health problems by email but did not officially drop the course or claim an incomplete. The other student attended most of the classes but provided incomplete and late paperwork even after multiple requests to submit it. The fall semester control group originally consisted of nine students because a new student unexpectedly enrolled after the first class. Thus, omitting the two students from the control group left seven students in the control group, which matched the number of participants in the experimental condition. A final of N=30 remained for the analysis (15 in the control group and 15 in the experimental group.)

Contamination

To minimize contamination due to interaction between the two groups of participants, the researcher and instructor told the students not to discuss the class content and exercises with anyone else during the course of the next six weeks. Because all the individuals who participated in the study typically see one another on a daily basis, contamination could have potentially posed a large threat to internal validity. However, both the researcher and the instructor had the same type of contact with the participants and used repeated opportunities to remind them not to discuss the experiments outside of their assigned class section. Absolute certainty to a lack of contamination is not possible but the researcher and the CRM Instructor understood the importance of why the participants should not discuss their role or the specifics of the experiment.

History effect

History can be a threat when the treatment period is very long or when significant events elapse between the treatment and posttest. For the present study the period of data collection was six weeks and the posttest was administered during week five thereby controlling for history effects.

Maturation

Maturation refers to any changes in the participant's mental or physical state over time. Maturation was controlled for by the short data collection timeframe and administering the posttest immediately following the treatment.

Experimenter Bias

In any study it is possible that expectations on the part of the researcher could be transmitted to the participants, another instructor, or raters conducting and scoring the experiments. To reduce bias and error, the researcher taught the experimental condition during the fall of 2010 and the CRM instructor taught the experimental condition during the spring of 2011. Ensuring that the CRM instructor could assist students in validating their best-fit MBTI profile was important. A complete description of the researcher and CRM Instructor aviation background and training credentials and a description of the Train the Trainer program that was conducted can be found in Appendix Q.

In addition, after class each day of the experimental condition of the spring semester during which the CRM Instructor was teaching the experimental condition, the CRM Instructor was interviewed by the researcher and audio recorded to collect supporting evidence of the impact of the intervention and confirm the style of instruction being used so that it closely matched the fall intervention used by the researcher. In cases when the evidence and careful questioning concluded that a key piece of data was not discussed, the CRM Instructor noted it and presented the data at the next class for consistency. This also further triangulated evidence about the instructor style and content.

Using different instructors for the experimental conditions was not possible because there was only one CRM trained instructor in the College of Aviation program. Therefore, the researcher and CRM instructor who administered the tests also scored the tests. In addition, one outside coder who was a certified flight instructor was provided training on the use of the treatment and case study tools. The three coders scored the open-response items on each participant's Case Study Instrument. To address issues related to intercoder reliability, the researcher trained the coders regarding the case study rubric and the use of the answer keys, as well as the definitions of the six questions, and every coder understood the criteria being used. Participant names were replaced by identification numbers and none of the three coders knew which participants they were scoring or whether the participant was in the control or experimental conditions. To further minimize potential bias, the researcher did not discuss the weighting for the higher order thinking levels to ensure that the other two raters were not influenced to review those questions differently from the others.

Procedures

Students were briefed on the study and provided Consent Forms to sign. Each student completed the MBTI and the MAI instruments with paper and pencil in class. Completion time for all forms was approximately 40 minutes. Immediately after class, assessments were scored by the researcher and participants were assigned to the conditions of control or experimental. The group assignment was made with the purpose of making the classes as similar as possible in terms of overall group-type makeup.

The researcher provided the CRM Instructor with a list of the participants' group assignments and the notice was posted on the Desire to Learn (D2L) Internet hosted course management system. This D2L tool allowed participants' to access to syllabi, readings, multi-media files, electronic drop boxes, online quizzes, email, grading, student progress reports, and project files. The notice on D2L specified there would be two sections of the class meeting for a six week period, two days a week, in separate locations on campus. An email also was sent to indicate the classroom location where the student should report for the next eleven sessions.

During the second class, students in the control and experimental condition were administered the pretest Case Study Instrument and accident report. Participants were allowed 30 minutes to complete the exercise. All students received the same accident report.

Participants in the both conditions were introduced to Bloom's Taxonomy and the concepts of lower order thinking and higher order thinking as the instructor reviewed the correct answers to the Pretest case study questions. In the experiential treatment, the instructor explicitly used the pretest results to boost confidence and to describe the lower order thinking tasks that participants could perform with little to no assistance versus the higher order thinking questions which may have provided them more problems.

Participants in the experimental condition were then provided with a new accident case study and a list of statements and asked to supply the cognitive level that was referred to using Bloom's Taxonomy terms, first on their own. They were then assigned to work with another person to compare and discuss responses until level agreement was reached.

The instructor discussed, modeled, and demonstrated the value of metacognition and its relationship to self-regulation and learning outcomes in aviation as a strategy to scaffold higher order thinking. Students were divided into pairs and groups to solve accident reports using the Case Study Instrument. Students also were assigned to find an accident report and be prepared to provide a two-minute brief in class using the Case Study Instrument as a guide to learning.

The principal goal at this level was to help participants gain a conceptual understanding of Bloom's Taxonomy to enhance their understanding of the accident report and define the difference between lower order thinking and higher order thinking and at what levels these tended to occur according to theory. At this stage the instructor reinforced the learning by keeping the three concepts – metacognition, higher order thinking, and self-awareness – constantly in the forefront.

As a scaffolding strategy for heightened self-awareness and better self-regulation, participants were introduced to the Myers-Briggs Type Indicator. Having the participants' MBTI results ahead of time allowed the researcher to structure exercises, fine tune the aeronautical decision making training design, and make assignments to groups based on the type preference J and P. From the instructors' modeling openness by discussing their own teaching type and higher order thinking strategies, to highlighting differences through an experiential exercise, to repeating the basic point to be learned about the accident report or a concept on metacognition, four key concepts were reinforced: higher order thinking, metacognition, self-awareness, and cooperative group learning.

A main goal was to introduce Jung's theoretical constructs in an experiential manner allowing the participants to validate their preferences. The computerized MBTI profiles were returned to the participants with a four-letter type. Participants compared their self-assessment to the computerized profile and, if there were differences, a best-fit four-letter type was suggested by the Instructor for further validation and exploration. The goal of MBTI validation is whole type (that is, all four letters rather than only one letter or any other combination). The participants received written profiles of their type and were assigned to continue the validation process. The instructor then assigned an accident report and asked the students to reflect on the questions that cause them challenges and discussed Bloom's hierarchy in light of MBTI type.

In order to conduct experiential learning building on scaffolding higher order thinking, NTSB cases were assigned to the experimental group to address aeronautical decision making training concepts while in cooperative teams. Team members who validated their types used name tags to identify their preferences and talk aloud using objective psychological type language to discuss their self-awareness in their construction of understanding. At this stage the role of the instructor shifted and specific exercises and strategies that allowed the participants to begin to demonstrate fluency in the language of higher order thinking, metacognition, and personality type preferences. The instructor monitored the participant's use of various new strategies while they worked in groups to ensure the strategies were helpful, appropriate, and focused on resolving the case.

The aeronautical decision making training continued until fading of the strategies was obvious and a whole group case study was provided that lasted the entire class session and allowed participants to clearly see what they had learned that could now be used on their own without scaffolding.

During the final aeronautical decision making training session, participants were given the posttest and 30 minutes to complete the exercise. All students received the same posttest NTSB report, which was a different report than for the pretest, and the same scoring measures were repeated for the posttest.

After the intervention was completed, students in the control group participated in an identical aeronautical decision making training short course to reduce possible adverse effects of their not receiving training should the treatment prove beneficial. The experimental group received a workshop of the specific models of aeronautical decision making and the assertiveness training module that the control group had received.

Data Analysis

Quantitative data were analyzed first, followed by qualitative data. The following section describes the data analysis procedures for the quantitative and qualitative data.

Quantitative Data

The quantitative data served to provide a summary of the overall trends and tendencies that occurred regarding the pre- and posttest case study results during the experiment. In the initial stages of data collection, all information sources were manually organized and recorded by theme into a spreadsheet to keep track of the process and ensure the data was being collected from each participant in an accurate and timely manner.

The data were analyzed using the SPSS statistical software package. To determine whether the two conditions were initially equivalent, a one-way ANOVA was performed to compare the pretest scores. Four split plot ANOVAs were conducted to evaluate whether there was a main effect for the treatment group, a main effect for type, and a main effect for time for higher order thinking skills as reflected in Bloom's level 4, 5, and 6 and the MAI. The independent variables were treatment group (treatment, control) and type (J, P). The repeated measure was time (pre-test posttest). Treatment group and Type were between- subject factors. Time was a within-subject factor. The dependent variables were accident report scores from Bloom's Levels 4 through 6, respectively. For the MAI, the dependent variables were the MAI pre- and post-assessment scores.

In a separate analysis, each item on the Belief Questionnaire, reflected in research questions 4 and 5, was also treated as a dependent variable to determine whether Beliefs Scores differed across experimental condition. Three separate categories of items were first created to analyze the responses. Separate ANOVA and MANOVA analyses were conducted for the Beliefs Questionnaire items.

Finally, quantitative data of the psychological profile of the 30 participants was treated descriptively with percentages and totals tallied and presented in tables. In addition, the sample of 30 was compared to a National Representative General

Population of College Students. Simple descriptive comparison of the raw data was made with no statement regarding significance.

Qualitative Data

Following a case study method, the data collected through socio-demographic surveys, pre- and post-test results, classroom observations, semi-structured interviews of key informants, participant's Beliefs Questionnaire, researcher/CRM instructor field notes, and researcher experiences and reflections, was explicated and illustrated by a thematic analysis. The combination of how the researcher analyzed the results and the participants' perceptions, experiences, and personal realities concerning their self-awareness and higher order thinking improvement were the primary research data (Creswell, 1998).

The qualitative data provided an in-depth exploration of the classroom module and its impact on participants' beliefs, attitudes, and practices (Creswell, 2008). Driven by the framework of the experimental treatment, the qualitative data, which included observation notes, interview recordings, and the Beliefs Questionnaire responses, were initially coded into these themes: authentic learning, higher order thinking, self-awareness, and cooperative groups, and then the researcher examined the interrelationships of the themes. Once the basic data had been collected, organized and manually reviewed, all text, spreadsheet, and MP3 files were imported into NVivo 9. In order to increase reliability, an extensive case study database was established to archive researcher notes, protocols, timelines, artifacts, and coded data.

Qualitative data sources included key informant interviews, CRM Instructor notes, researcher field notes and journal reflections, and participant survey data.

Additionally, since 2003 the researcher accumulated memos on scraps of paper, on page margins, in computer files, and on the backs of lecture handouts as evidence of the ongoing mental processes associated with interest in the aviation study as both a participant and researcher. Many of the notes were written concerning what different students said, what their words meant in that situation, similarities or difference among the participants' perspectives.

Field notes were consistently recorded before, during, and after each class in a journal when the researcher taught both the experimental and control conditions. When the CRM instructor taught the experimental condition, in order to capture accurate data, the class was videotaped and an interview was conducted with the CRM Instructor each day after class. The interview notes were records of researcher and CRM Instructor reflections about the surroundings, interruptions, timeframe, and other information as it occurred. These notes were typed into a Word document for cross reference and reinforcement of participant responses.

Audio recordings of key informant semi-structured interviews were transcribed verbatim within seventy-two hours into a Word document, one file per student**.** Each student's name was number coded and the code number was used to reference the participant's data for scoring purposes. Audio recordings were reviewed multiple times to make sure the codes were specific, and to check whether themes continued through subsequent interviews. Later, some early coded passages were re-coded to be more specific to the themes.

Writing down impressions of the text and tapes was the first step. Constant evaluation of how any of the data might be biased was foremost in the researcher's mind. The content analysis of the data was conducted on the text and narrative data that came from the open-ended questions and written comments on questionnaires, responses to the case studies, individual interviews, descriptive accounts from group discussion notes, observations from field note taking, personal journal insights, and stories from personal accounts of experiences in people's own words.

While participant quotations used in this analysis were valuable to support the interpretation, the researcher was careful to not use quotes out of context to make a point. Quotations were used to give examples of a typical response relationship to a certain topic. Confidentiality and anonymity were also concerns when using quotes because the purposive sample was small. Therefore, the consequences of including certain quotes were carefully evaluated. In addition, the use of quotes demonstrated a balanced viewpoint by also including disagreeable and inconsistent responses. To mitigate the constant threat of generalization during data analysis, for example, the researcher focused on each participant, as a unique case, for clarification, understanding, and explanation.

Throughout the process, the researcher continued getting feedback from colleagues in aviation, past student participants, and the CRM instructor. Lincoln and Guba (1985) recommended that qualitative results be evaluated using the standard of "trustworthiness," through credibility and confirmability. In this study, credibility was gained by having three instructors examine a relatively large number of interviews and classroom discussions, thus providing triangulation of data source. The use of multiple raters and instructors engaged in the research and analysis increased confirmability of the data. Other qualitative techniques used included prolonged engagement, persistent engagement, member checks, peer debriefings, and an audit trail. Persistent engagement allowed anomalies to be accounted for and explained.

Summary

This chapter focused on establishing methods for collecting data on case study results and participant beliefs, attitudes, and practices. The methods were framed by the reflective practice model to improve higher order thinking outlined in chapter two. Central to designing the methods for this study was the use of existing instruments and those created by the CRM Instructor and modified by the researcher. These tools allowed the capture of quantitative data used to answer research questions one, two, three, four, and five and additional exploratory answers to questions four and five through qualitative analysis of participant beliefs. Analysis of this data follows in chapter four.

CHAPTER FOUR: RESULTS

This chapter reports the results of a quasi-experimental pretest / post-test control group design used for the quantitative research questions as well as results of the qualitative case study approach. This explanatory approach, mixed method design provides a comprehensive view in terms of how the experimental approach influenced students' higher order thinking skills as evidenced during and after individual and group experimental processes.

Study findings are presented in several sections. First, quantitative results are reported for the research questions. Second, a descriptive statistical review of the participants by MBTI personality type is presented. Finally, qualitative analysis is presented pursuant to an explanatory approach to the research questions.

Quantitative Results

Analysis of the Covariates

A correlation analysis was done to determine which covariates, if any, correlated with Bloom's levels 4-6. Possible covariates for this study were identified as GPA, number of prior human factors courses taken by the participants, number of years of prior aviation-related work experience that exposed the participants to crew resource management techniques, and the college grade level (junior or senior). No correlations were found and each covariate was eliminated sequentially from consideration. Additionally, none of the univariate tests resulted in significant differences.

Participants' Higher Order Thinking Skills

Three split plot ANOVAs were conducted to evaluate whether there was a main effect for the treatment group, a main effect for type, and a main effect for time as reflected in Bloom's level 4, 5, and 6. The independent variables were treatment group (experimental, control) and type (J, P). The repeated measure was time (pre-test posttest). Treatment group and Type were between- subject factors. Time was a within-subject factor. The dependent variables were accident report scores from Bloom's Levels 4 through 6, respectively.

Means and other descriptive statistics can be found in Table 4.1. ANOVA statistics can be found in Table 4.2. The results for the ANOVAs indicated that the interaction between time and treatment on Bloom's Level 4 (Analyze) was significant, [$F(1,26) = 4.486$, $p=.044$].

Table 4.1
Analysis of Variance of Pre and Post Experimental Tests by Treatment Group

Descriptive Statistics

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound
PreTest Total	E	15	29.77	8.681	2.241	24.96	34.57
	C	15	25.33	9.178	2.370	20.25	30.42
	Total	30	27.55	9.062	1.655	24.17	30.93
Posttest Total	E	15	33.03	9.628	2.486	27.70	38.37
	C	15	30.87	5.881	1.519	27.61	34.12
	Total	30	31.95	7.916	1.445	28.99	34.91

Table 4.2
Results for 2 (group) by 2 (type) by 2 (time) on Bloom's Level 4, 5 and 6 - Split Plot Analyses of Variance (ANOVAs)

		df	F	p	Partial Eta Squared
Bloom's Level 4					
Group main effect		1	.153	.699	.006
Type main effect		1	.071	.792	.003
Time main effect		1	4.486	.044	.147
	Group x time	1	.196	.662	.007
	Type x time	1	.066	.800	.003
	Group x Type x time	1	2.016	.168	.072
Bloom's Level 5					
Group main effect		1	.000	.985	.000
Type main effect		1	.110	.743	.004
Time main effect		1	1.399	.248	.051
	Group x time	1	.765	.390	.029
	Type x time	1	1.399	.248	.051
	Group x Type x time	1	.765	.390	.029
Bloom's Level 6					
Group main effect		1	.866	.361	.032
Type main effect		1	.963	.335	.036
Time main effect		1	.401	.532	.015
	Group x time	1	.085	.774	.003
	Type x time	1	.401	.532	.015
	Group x Type x time	1	.085	.774	.003

$p<.05$

Participant's MBTI J/P preference and MAI scores

Next, the relationship between treatment group, J/P personality type and MAI scores was investigated in research question 3. A split plot ANOVA was conducted to evaluate whether there was a main effect for the treatment group, main effect for type, a main effect for time for MAI scores. The independent variables were the group (treatment, control) and type (J, P). The repeated measure was time (pre-experiment MAI assessment score, post-experiment MAI assessment score). The treatment group and type were between- subject factors. Time was a within-subject factor. The dependent variables were the MAI before and after scores. There were no significant differences found as shown in Table 4.3 (descriptive statistics) and Table 4.4 (results).

Table 4.3
Analysis of Variance of Pre and Post MAI Scores by MBTI J/P Preference

Descriptive Statistics

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound
MAI_Before	P	11	39.36	5.464	1.647	35.69	43.03
	J	19	41.11	5.830	1.337	38.30	43.92
	Total	30	40.47	5.667	1.035	38.35	42.58
MAI_After	P	11	40.36	5.784	1.744	36.48	44.25
	J	19	43.74	5.130	1.177	41.26	46.21
	Total	30	42.50	5.532	1.010	40.43	44.57

Table 4.4
Results for 2 (group) by 2 (type) by 2 (time) Split Plot Analysis of Variances (ANOVAs) of MAI Before and After Scores

		df	F	p	Partial Eta Squared
Group main effect		1	.105	.749	.004
Type main effect		1	1.420	.244	.052
Time main effect		1	12.017	.002	.316
	Group x time	1	.259	.615	.010
	Type x time	1	2.529	.124	.089
	Group x Type x time	1	.025	.875	.001

Participant's Beliefs

Finally, ANOVAs were conducted to test for mean differences on the Beliefs Questionnaire items in research questions 4 and 5. The 32-item Beliefs Questionnaire return rate was 100% (Appendix R). The questions were divided into three categories and results are displayed as descriptive data in Tables 4.5, 4.6, and 4.7.

Table 4.5 contains mean responses for items 1-11 regarding the Case Study Instrument (CSI) with mean responses ranging from 2.7 to 4.93. There were no significant differences in means between the experimental and control conditions.

Table 4.5

Mean Responses to Beliefs Questionnaire regarding the Case Study Instrument (CSI)

#	Item	Exp	Control	F	Sig
1	Using CSI to learn about HOTS was beneficial.	4.13	4.2	.042	.839
2	I found it difficult to create new rules of thumb.	3.53	3.47	.026	.872
3	I will think more about accident errors.	4.33	4.33	.000	1.0
4	Aviation courses with CSI better than without.	4.2	4.27	.070	.793
5	I enjoyed figuring out answers to all CSI questions.	3.93	4.2	.974	.332
6	I was more interested in the accident than the CSI.	3.07	2.7	.532	.472
7	Using CSI helped me identify where I got stuck.	3.53	3.4	.193	.664
8	CSI levels helped me know how to ask for help.	3.13	3.33	.441	.512
9	I will use the CSI to help me in other courses.	3.2	3.07	.175	.679
10	Judgment, decision making are important.	4.93	4.73	2.172	.152
11	My interest in accident reports has increased.	4.33	4.33	.000	1.0

Table 4.6 contains mean responses for Items 12 - 25, ranging from 2.67 to 4.47. There were no significant differences in means between the results experimental and control conditions.

Table 4.6
Mean Responses to Beliefs Questionnaire About Self-Awareness

#	Item	Exp	Control	F	Sig
12	I learned a lot about myself.	4.13	4.07	.064	.803
13	I learned how to interact with others more effectively.	3.67	3.80	.211	.650
14	I expect some of my behaviors to change.	3.33	3.60	.651	.426
15	I learned more about my classmate's personality.	4.20	4.27	.175	.679
16	I understand how my preferences can affect others.	4.33	4.33	.000	1.0
17	I'm aware personality affects crew communication.	4.47	4.47	.000	1.0
18	I'm aware of how I think because of this module.	4.00	4.00	.000	1.0
19	I understand myself better in relation to others.	3.87	3.93	.108	.745
20	Improved self-awareness helped me use the CSI.	3.00	3.13	.157	.695
21	With CSI, I thought about communication type.	2.67	2.73	.033	.857
22	Team exercises should be part of aviation courses.	4.00	3.73	.516	.478
23	I will change some of my behaviors.	4.07	4.13	.108	.745
24	I would take a refresher course if offered.	3.80	3.73	.048	.828
25	People in my life … value of preferences	4.07	4.13	.045	.833

Table 4.7 contains mean responses for Items 26 - 32, ranging from 2.67 to 4.47. There were two significant differences in means between the experimental and control conditions for Item 30 and Item 31. Item 30 was reverse coded since the textbook was used frequently in the control group. There were two significant differences in means between the experimental and control conditions for Item 30 and Item 31. These results were expected as the control group was not provided the same level of support and scaffolding in group dynamics as the experimental treatment. The mean response to Item 31: "I learned the value of NTSB reports," was favorable to both groups and significantly higher for the control condition, which did not have extensive exposure to accident reports or in-class group support.

Table 4.7
Mean Responses to Beliefs Questionnaire regarding Overall Module

#	Item	Exp	Control	F	Sig
26	I learned a lot from this module.	4.00	4.13	.272	.606
27	Too much time was dedicated to this module.	3.93	3.60	1.036	.318
28	More time should have been devoted to this module.	3.13	3.13	.000	1.0
29	I thought pace of instructor guidance was just right.	3.80	4.07	.974	.332
30	Textbook helped me learn more about these topics.	2.40	3.60	14.264	**.001 *****
31	I learned the value of NTSB reports.	4.27	4.67	4.065	**.053 ***
32	I will pay more attention to NTSB reports to learn.	4.33	4.33	.000	1.0

* $p < .05$; **$p < .01$; ***$p < .001$

A MANOVA was conducted to examine whether there were any differences in beliefs across group conditions and across J/P types. Table 4.8 presents only the statistically significant results of MANOVA, showing descriptive statistics as well as the overall differences by group and MBTI J/P type preferences. Each of the 32-items by the three categories previously described was treated as a dependent variable and the nine items in Table 4.8 represent those items with statistical significance.

Four responses (1, 11, 20, and 23) that were analyzed together for control participants who reported a preference for P are significant for this study and are represented by “C-P’s” after the item description. Unexpectedly, several of the results indicated that participants in the control condition who validated an MBTI preference for P reported significantly positive beliefs of using the case study instrument with the accident reports compared to the J participants in the control condition and compared to all participants in the experimental treatment. Also, only P’s in the control condition reported significantly more positive beliefs that they will change some of their behaviors.

Five responses (9, 19, 21, 24, and 25) that were analyzed together for experimental participants who reported a preference for J are significant for this study and are represented by "E-J's" after the item description. This indicated that, concerning these five beliefs items, J participants in the experimental condition reported significantly more positive beliefs about their learning and the future use of the concepts compared to P's in the experimental condition for Items 19, 21, 24, and 25, and compared to all participants in the control condition.

Table 4.8
Multivariate Analysis of Variance by Group MBTI J/P – Significant Responses Only*

	Dependent Variable	**Type III SS**	**F**	**Sig.**	**Observed Powerb**
1	Using CSI to learn about higher order thinking was beneficial. (C – Ps)	4.188	6.298	**.019****	.676
9	I will use the CSI to help me in other courses. (E – Js)	3.128	4.538	**.043***	.536
11	My interest in accident reports has increased. (C – Ps)	1.928	5.748	**.024***	.636
19	I understand myself better in relation to others. (E – Js)	2.137	10.504	**.003****	.877
20	Improved self-awareness helped me use the CSI. (C – Ps)	7.552	12.204	**.002****	.920
21	When answering CSI, I thought about communication style. (E – Js)	7.234	9.888	**.004****	.857
23	I will change some of my behaviors. (C - P's)	1.848	7.244	**.012****	.736
24	I would take a refresher course if offered. (E – Js)	3.128	5.109	**.032***	.586
25	I wish important people in my life understood the value of personality preferences. (E – Js)	3.077	4.724	**.039***	.553

This concludes the quantitative analysis of the five research questions of this study. A discussion of these results is presented in chapter five. To transition to the qualitative findings, it is important to build a foundation using the descriptive statistics of the participants regarding the Myers-Briggs Type Indicator (MBTI), which was the tool used in this study for scaffolding self-awareness.

MBTI Descriptive Statistics

The following descriptive statistics provide the results of the class makeup of the aviation participants under study in terms of MBTI types. For purposes of comparison and in a way that will not bias the results, first a type table description of the population of interest, the Collegiate Aviation Participants in CRM Fall 2010 and Spring 2011, is provided in Figure 4.1.

	SENSING		INTUITION		
	Thinking	Feeling	Feeling	Thinking	
INTROVERSION	ISTJ N = 8 F = 1 M = 7 25.0% SSR = 2.63	ISFJ N = 2 F = 1 M = 1 6.0% SSR = .69	INFJ N = 0 F = 0 M = 0 0.0% SSR = 0	INTJ N = 3 F = 0 M = 3 9.0% SSR = 2.45	Judging
INTROVERSION	ISTP N = 3 F = 1 M = 2 9.0% SSR = 2.00	ISFP N = 0 F = 0 M = 0 0.0% SSR = 0	INFP N = 2 F = 0 M = 2 6.0% SSR = 1.08	INTP N = 2 F = 0 M = 2 6.0% SSR = 1.42	Perceiving
EXTRAVERSION	ESTP N = 1 F = 0 M = 1 3.0% SSR = .64	ESFP N = 0 F = 0 M = 0 0.0% SSR = 0	ENFP N = 4 F = 0 M = 4 12.5% SSR = 1.36	ENTP N = 0 F = 0 M = 0 0.0% SSR = 0	Perceiving
EXTRAVERSION	ESTJ N = 3 F = 0 M = 3 9.0% SSR = .85	ESFJ N = 2 F = 1 M = 1 6.0% SSR = .56	ENFJ N = 0 F = 0 M = 0 0.0% SSR = 0	ENTJ N = 2 F = 0 M = 2 6.0% SSR = 1.35	Judging

N = 32
F = 4
M = 28

		N	%
Eight Preferences	E	12	37.5
	I	20	62.5
	S	19	60.0
	N	13	40.0
	T	22	68.7
	F	10	31.2
	J	20	62.5
	P	12	37.5

Attitude Pairs	IJ	13	40.6
	IP	7	21.8
	EP	5	15.6
	EJ	7	21.8
Function Pairs	ST	15	46.8
	SF	4	12.5
	NF	6	18.7
	NT	7	21.8
Perception and External Orientation	SJ	15	46.8
	SP	4	12.5
	NP	8	25.0
	NJ	5	15.6
Judging and External Orientation	TJ	16	50.0
	TP	6	18.7
	FP	6	18.7
	FJ	4	12.5
Energy and Perception	IN	7	21.8
	EN	6	18.7
	IS	13	40.6
	ES	6	18.7
Energy and Judgment	ET	6	18.7
	EF	6	18.7
	IF	4	12.5
	IT	16	50.0

Figure 4.1 Type Table of Collegiate Aviation Students in CRM
Fall 2010 and Spring 2011

A Type Distribution of Traditional Age College Students as the base population is represented in Figure 4.2 for comparison with the Type Table of the population of interest or the sample population in Figure 4.1. Students of all psychological types enroll in CRM aviation courses and these data show that for the two semesters included in this study, ISTJ was the most common type enrolled at a total of 8 out of 30 or 25% of the class.

To determine whether the Type Table Distribution of Collegiate Aviation Students enrolled in CRM in this study as shown in Figure 4.1 differs significantly from the MBTI Traditional Age College Students Male and Female base population in Figure 4.2, Self-Selection Ratios (SSR) or indices of attraction were calculated for each of the 16 types to take into account the relative frequencies of type.

	SENSING		INTUITION		
	Thinking	Feeling	Feeling	Thinking	
INTROVERSION — Judging	ISTJ N = 2573 9.47%	ISFJ N = 2352 8.66%	INFJ N = 885 3.26%	INTJ N = 997 3.67%	
INTROVERSION — Perceiving	ISTP N = 1216 4.48%	ISFP N = 1351 4.97%	INFP N = 1495 5.51%	INTP N = 1142 4.21%	
EXTRAVERSION — Perceiving	ESTP N = 1257 4.63%	ESFP N = 1767 6.51%	ENFP N = 2496 9.19%	ENTP N = 1363 5.02%	
EXTRAVERSION — Judging	ESTJ N = 2879 10.60%	ESFJ N = 2875 10.59%	ENFJ N = 1309 4.82%	ENTJ N = 1199 4.42%	

Eight Preferences

	N	%
E	15145	55.77
I	12011	44.23
S	16270	59.91
N	10886	40.09
T	12626	46.49
F	14530	53.51
J	15069	55.49
P	12087	44.51

Attitude Pairs	IJ	6807	25.07
	IP	5204	19.16
	EP	6883	25.35
	EJ	8262	30.42
Function Pairs	ST	7925	29.18
	SF	8345	30.73
	NF	6185	22.78
	NT	4701	17.31
Perception and External Orientation	SJ	10679	39.32
	SP	5591	20.59
	NP	6496	23.92
	NJ	4390	16.17
Judging and External Orientation	TJ	7648	28.16
	TP	4978	18.33
	FP	7109	26.18
	FJ	7421	27.33
Energy and Perception	IN	4519	16.64
	EN	6367	23.45
	IS	7492	27.59
	ES	8778	32.32
Energy and Judgment	ET	6698	24.66
	EF	8447	31.11
	IF	6083	22.40
	IT	5928	21.83

Figure 4.2 Type Table of MBTI Traditional Age College Students
N=27156 *(F=14,519, M=12,637)*

For example, to calculate the SSR for the 25% of ISTJ types in the class for this study found in the upper left of Figure 4.1, the 25% is divided by the 9.47% base population percent of traditional college student ISTJs shown in Figure 4.2 which equals an ISTJ SSR of 2.63. SSRs greater than 1.00 mean that more people of that type are attending the CRM class than those enrolled in college in the base population. In this case, results show that ISTJ types are represented at 2.63 times more in the aviation crew resource management course than ISTJs are represented in the base college population. SSRs less than 1.00 means a lower proportion of individuals of that type are in the CRM class than are in the general population. SSRs around 1.00 mean nearly equal proportions are found in the base population and in the sample (Myers, et al., 1998, Table 12.12, p. 298). The SSR of the ISTJ Group Type for this study was 2.63 which mean that over two and one-half times as many of these types were attracted to this collegiate aviation course program than in the general population of traditional college students. These data show the ISTJ type (25%) was the most common enrolled in the class under study. Other types in the class who shared the Sensing (S) and Judging (J) combination of preferences made up 46.8% of the class. These results will be discussed in Chapter 5.

Qualitative Results

In addition to a quantitative perspective in addressing the research questions, qualitative interpretation is also important. Chapter three outlined the methods that were used to collect and analyze the quantitative data to answer the five research questions and the explanatory qualitative data which emerged from the classroom observations, interview recordings, and Beliefs Questionnaire responses.

There was rich qualitative evidence that the combined use of the MBTI as a psychological self-awareness assessment, authentic case studies, a case study instrument based on Bloom's Taxonomy, and working in cooperative groups on exercises with instructional scaffoldings improved participants' higher order thinking skills from the initial to the final observations. Patterns of use and participant beliefs about the use of the tools, media, and strategies of the aeronautical decision-making were most strongly influenced by four educational psychology factors: self-awareness, authentic learning, higher order thinking, and cooperative groups. All qualitative sources were coded into these four themes and were identified as the primary influences in the experimental module's successes and limitations. In the remainder of this chapter, qualitative evidence regarding each of these factors is provided with a discussion to follow in chapter five. Responses of the 30 participants were coded by numbers 1-30 to protect their identity. Participants will be referred to by their identification number throughout this chapter. If more than one participant is referenced by a sentiment or observation, each individual participant's number will be in parentheses separated by a comma. The next section reflects on participant's metacognitive awareness as they engaged in the scaffolded instructional approach to improve higher order thinking.

Self-Awareness

One of the goals of the aviation course under study was for participants to learn to appreciate the benefits of their own natural preference for either J or P as well as understand the less preferred of the pair as their blind spot or a less preferred cognitive function. The researcher consistently reminded participants that each day the classroom became a laboratory filled with different personalities who could be both observed and engaged in order to learn both the challenges and the values of working with someone who naturally had preferences that may be opposite of their own. An underlying objective was for each participant to learn not merely to tolerate a person with a different way of problem solving but to learn to appreciate and choose to team with that person because of the differences and not in spite of their differences.

The researcher's ability to model openness by discussing her cognitive learning and teaching style using the MBTI descriptors and presenting lower order and higher order thinking strategies by highlighting differences through experiential exercises supported three educational concepts that were consistently reinforced: higher order thinking, metacognition, and self-awareness using the MBTI with particular attention to the influence of the last letter of type, J or P. Participants also were encouraged to listen to how others approached the accident report and why their approach might be reflective of their J attitude of closure or P attitude of continued data gathering.

Many participants expressed a desire for others to know more about personality type so they could communicate more effectively or, as some expressed, "so they would understand me better." The presentation to the experimental class of the MBTI profile of aviation students helped to emphasize the higher percent of J types as a population that are attracted to aviation and how that culture of aviation is a J type. In contrast, the presentation explained how vital it is to expand opportunities for learning and especially higher order thinking by teaching to and practicing a more open, flexible, and probing P model in aviation so that all types can better understand the value of different cognitive preferences of aeronautical decision making.

The J/P dichotomy in particular gave expression to participant's decision-making process. For example, participants identified as J types (01, 05, 06, and 07) volunteered during one exercise review that knowing their J preference tendency "to close on data too quickly" was insightful. They also voiced self-awareness that they could use metacognition to stop, self-correct, and choose a P approach to stay open and help with generating new data. One P type participant hearing this jokingly responded, "Yeah, when I do it, they call it procrastination." The researcher used the opportunity to discuss the liability of either approach. Too much judgment without perception or openness to new data can be prejudice. Too much openness or perception with no judgment can be procrastination.

As a scaffolding strategy for heightened self-awareness, metacognition, and better self-regulation, participants were introduced to the Myers-Briggs Type Indicator (MBTI). Having the participants' MBTI results ahead of time allowed the researcher to structure exercises, fine tune the training design, and make assignments of participants to pairs and groups based on type preferences. The findings regarding self-awareness support those reported by (Beckham, 2009; Dollar & Schroeder, 2004; Huitt, 1992; Psychometrics, 2007; Quenk, 2009; Salas, Rhodenizer, & Bowers, 2000; Salter, Evans, & Forney, 2006; Wiggins & Parker, 1998; Zimmerman, 2002).

A majority (66%) of participants were validating J preferences for structure and closure and, the researcher and CRM Instructor observed them on multiple occasions exhibiting an all work, no-play attitude in the classroom. Also, a majority (66%) reported a preference for Introversion and the researcher and CRM Instructor, both Extraverts, frequently discussed after each class, how silence and an absence of body language needed to be discussed and made overt in the classroom to both encourage the Introverts to speak more and to encourage the Extraverts to listen more. Both the researcher and CRM Instructor discussed a constant need to reinforce these facts about the classroom culture and adapt their delivery accordingly with the researcher's expert advice from working knowledge and past experience.

The researcher and CRM Instructor provided examples of meaningful J and P style questioning prompts as a scaffolded strategy with the goal that it would lead to deeper understanding, reflection, and positive action on each participant's part as they worked in cooperative groups. To go beyond the case study content and help students develop intellectual maturity, learning skills, and self-awareness so they can function better as independent learners and also as effective and respectful future crew members was a goal in all the experimental classroom presentations. The motive was not just to present content but to uncover the content in a way that motivated the participants as they each recognized how they, as a J or a P, encountered the content and one another while working with the content.

In a group exercise taught and observed by the researcher, participants were separated into groups according to their preference clarity for J and P and were given the assignment, "Using the flipchart, work together and provide a response to the following, "How to make a trip happen. You have 10 minutes to complete this assignment." Without the researcher telling the participants which group had the members whose last letter was J or P, the groups were instructed to work on the exercise together. The researcher observed the serious, directive, and structured-oriented approach of the self-identified Js, and the fun, non-directive, option-oriented approach of the Ps who were located at a flipchart across the room from the Js.

During this class exercise, the researcher and CRM Instructor noted similarities in the way participants in the same group, the Js, reacted to the directions in a similar manner and yet how different it was from the opposite group's approach, the Ps. Once the time was completed, the instructor led a debriefing session, first around the J chart asking all participants, "How do J types see the issue? How are differences an advantage and how are they a stumbling block when working on an accident report together?" Then gathered around the P group's flipchart, the researcher repeated the questions, "How do P types see the same issue? What specific J or P behaviors either facilitate case study resolution or block resolution?"

A goal was that each would honor the other's differences, especially as it relates to the worldview of J and P preferences. The researcher promoted the use of the phrase "the gift of perception" to encourage participants to share their thoughts with the opposite group. For example, Js began to see and hear how structured and directive they were in their tone and mannerisms. As Ps became more self-aware, they were encouraged to view the classroom as less structured. Typical structured classrooms "can make the perceptive types feel imprisoned, with the result that they spend energy needed for study trying to get freedom. More flexible classrooms are naturally more suited to these students" (McCaulley & Natter, 1974).

The participants were observed to be highly engaged as they were all standing in their respective groups of J or P, alert and focused on the researcher, and highly interested in the major differences between the team reports on the flipcharts as reflected in the many nonverbal gestures and expressions on their faces. It became quickly evident how the J/P dichotomy highlights those observable differences in others' behaviors that can be irritating when one is dealing with someone of the opposite preference. Many saw the differences between the two poles of each dichotomy and were decisive about their preferences. The differences were so noteworthy that Participant 06, a J, asked the researcher about the P group, "Did you give them different directions?"

Another participant, 09, emailed the researcher that same evening after the exercise and asked to have a different MBTI profile sent to him for validation. He claimed that the exercise really brought his type to light for him. After receiving the requested profile, he wrote, "Thank you very much for sending this to me. After we had the discussions in class and I read over the INFP profile, it was pretty clear INFP is a much more accurate description of me. Thank you much for your interesting discussions and CRM insights."

The researcher and CRM instructor understood that a major goal was to heighten awareness of personal blind spots in communicating information to team members. After the initial introduction to MBTI type and as part of the learning strategy, participants often wore name tags with their MBTI types and were encouraged to probe others for their understanding of the accident with attention to their outer world orientation – J or P. As students became engaged in learning MBTI terms and experiential exercises, they were observed to be seriously paying attention to the accident reports and using that knowledge to help process information in their teams. The researcher noted that participants quickly made connections with the J and P observed behaviors especially as they were divided into two groups by J and P and were able to recognize the different ways the two groups approached the same problem.

Participant 15, in both understanding himself and appreciating those who are different, reflected in conversation with the researcher,

> It's important how you communicate, how someone else is approaching the situation, how they are breaking it down. Although I won't break down all the details and memorize all the facts there may be someone who is going to and I can better communicate what I need to get done as either a leader or a follower – I can work more effectively and efficiently by getting to their level and giving them every fact or detail they need, give them what they need.

Participant 30, planning career as a commercial pilot, responded, "So when you're in the cockpit getting a feel for what kind of personality type the person you're flying with has, your understanding of yourself, your personality type, can make for a more functional crew." Participant 14, upon validating his J type by reading his profile, responded voluntarily to the researcher: "Wow, that's me, by far. I do remember reading the INTJ profile and being really entertained that how true it was. I just sat and laughed the whole time during the exercise and then reading this because it sounded like a story about me."

Based on the researcher's experiences with INTJs, this participants' response is significant and noteworthy because INTJs are an extremely private type and their constant expectation of reasonability versus sociability is a challenge when scaffolding self-awareness. INTJs tend to have little patience with any form of surface conformism such as type-talking or monitoring oneself and others inter- and intrapersonally. INTJs comprise less than 4% of U.S. college students (Figure 4.2). They tend to seek and enjoy freedom from the constraints of any sentiments. In contrast, when the MBTI is presented logically by an expert who translates MBTI type as a specialized knowledge system or tool that can help INTJs improve their intellect and their aviation crew relationships, INTJs listen, learn, and often become the strongest advocates of the tool for self-awareness. The INTJ profile becomes a logical framework for self-understanding and self-monitoring as well as an asset in the metacognitive arena for "thinking about how they think," especially when working with others.

The researcher and CRM Instructor noted one participant (20) who was selected to be interviewed because both experienced Participant 20 as the most socially reserved and detached member. Not surprising to the researcher, when Participant 20 was one-on-one, he was talkative and appreciative of the J and P differences data. He had the shortest interview, 13 minutes compared to the average interview of 40 minutes. When asked, "I'm curious about what you learned about yourself," Participant 20 reflected on his J type,

> I learned about the perceiving and judging and how that contributed to a lot of factors that could have prevented misunderstanding myself. Factors you need to recognize because everybody is going to be handling situations differently so if you recognize in advance, it will help make a safer cockpit environment.

It was observed with frequency that individuals who preferred a Judging attitude were organized, structured, effectively worked within schedules, and began tasks sufficiently early so that deadlines could be comfortably met. These J types, observed to be operating in this systematic manner without conscious effort, were often frustrated when decision making was delayed, when team members did not have a plan, and when they could not control interruptions and diversions from the task at hand. Unfortunately, they often came to closure too quickly and often ignored others' contributions because they had already decided and moved on, ignoring valuable data.

Participant 15, a P type, was assigned to work with two Js and reported,

> I was intrigued that the group members approached the case study more simplistic. They just wanted to divide up the questions. It was very simplistic. I wanted to talk about the whole case and then review all the questions together as a whole. I thought each contained valuable points. I was intrigued that they didn't care about my point of view; I wasn't offended. They wanted it less dense, more simplistic, and over – that's the way they wanted it.

When a Perceiving attitude, such as Participant 15 just reported above, is in operation, there is a desire to stay in a data gathering mode before coming to a conclusion. The participants who preferred a P attitude were observed to be operating in a flexible, adaptable, and spontaneous manner without conscious effort. This was manifest especially in the dynamics of team work as P's were comfortably pressure-prompted, welcoming any stimulation which appeared to inspire new energy and additional useful information.

An example of an exercise that highlighted the differences when Js and Ps were working together to diagnose an accident case study was, "Ask Js to write three open-ended questions about Ps; Ask Ps to write three closed statements/judgments about Js." The J's would write questions such as, "Are Ps ever really done with analyzing an accident?" This is not an open-ended question; it is a judgment in a Yes or No question form. The Ps responses to the exercise included statements such as, "Js speak with such a serious tone." This statement is not a judgment; it is an accurate observation of how Js speak.

The exercise demonstrated that Js, even when they were consciously trying to exercise their P function by asking open-ended questions, were really directive. P's while working to be directive by consciously using their J function to make closed judgments/statements, were really being open-ended. This result is consistent with assertions by Kroger, Thuesen, & Rutledge, (2002).

The researcher regularly used participants' comments, statements, and questions to point out these J-P differences to the participants, encouraging push back, self-reflection, and clarification of concepts in the moment. The most obvious stage of self-awareness was reached when most Js could articulate their frustrations with their own need for closure as they began to consciously listen to what they were saying, that is, what they were extraverting, as they heard their expressions as serious, declarative, controlling, directive, and often negative.

Js often raise a question for which they already have an answer and only wish to have it confirmed and closed. This is in stark and consistent contrast to P classmates, whose expressions were found to be replete with options, inquisitive, probing, and inviting. What is important to P's is keeping the discussion open and gathering more data. Both types declared frustration with each other's type in group settings. The Js were frustrated that Ps tended to procrastinate while the Ps were frustrated that Js tended to be closed or prejudiced toward new data.

Students began to use the type language and several (06, 07, 08, 09, 10, 15, 18, 21, 28, and 31) told the researcher voluntarily after class through face to face discussion and emails how thankful they were about understanding themselves better. Conversely, not all participants were as engaged or enthusiastic. Participant 23, a P in the experimental group with the CRM Instructor, was observed on numerous occasions by the researcher on videotape to be a loner and not engaged with his teammates. In the open-ended Beliefs Questionnaire he responded,

> I am surprised it takes something like the MBTI to make people aware of themselves. I feel like the MBTI results should be pretty obvious if you've ever tried to understand yourself. I believe it does help understand other types of people and can be a good leadership tool to get to know the people you will be leading.

Team members voluntarily validated their types using nametags to identify their preferences and talking aloud using type language to discuss their self-awareness in their construction of understanding. At the final stage in the experimental treatment, the role of the instructor shifted and specific instructions faded as exercises and strategies allowed the participants to begin to demonstrate fluency in the language of higher order thinking, metacognition, and personality type preferences. The instructor monitored the participants' use of various new strategies while they worked in groups to ensure the strategies were helpful, appropriate, and focused on resolving the case.

The participants were observed to continually use objective type language, without explicit prompting, and to organize information into categories based on Bloom's taxonomy as evidenced in the case study instrument. They also were able to describe to peers and the instructor where they needed more assistance and some could even explain cognitively why, based on MBTI J or P preferences.

These classroom observations and interview responses supported the quantitative findings of the Beliefs Questionnaire statements regarding self-awareness as displayed in Appendix R, page 2.

Questionnaire data. Participants were asked to respond to the statement, “I learned a lot about myself.” A majority of participants (86.7%) agreed (60.0%) or strongly agreed (26.7%). Results of participants’ responses to the statement, “I understand more about how my personality can affect others in CRM” revealed all participants (100.0%) agreed (66.7%) or strongly agreed (33.3%). Focused on capturing beliefs about whether they will initiate changed behaviors, participants were asked to respond to the statement, “I will change some of my behaviors.” A majority of participants (90.0%) agreed (70.0%) or strongly agreed (20.0%).

Participant comments, questionnaire responses, and observations of heightened self-awareness support the endorsement of interviewed participants for the understanding their outer world preference of P or J in relationship to others as well as the importance in how they tend to approach the Case Study Instrument based on Bloom’s hierarchy used in conjunction with the NTSB accident reports to positively impact classroom instruction for CRM and improve higher order thinking skills.

Authentic Learning

Data from classroom observations, interviews, and Beliefs Questionnaire responses indicated a pattern of improvement in participants’ knowledge of CRM practices and higher order thinking skills. Participants also provided evidence through their responses to the interviews, classroom observations, and survey responses that they will transfer new knowledge to other courses and to their professional career development in aviation. This section provides results on the theme of authentic learning as experienced through the use of actual accident case studies available from the National Transportation Safety Board, which were instrumental in participant's higher order thinking skills improvement.

Using the case study instrument with an accident report, participants improved their case study problem solving skills by participating in a combination of authentic tasks, social interaction, and collaboration in context. The experimental course provided scaffolding to move students beyond their comfort zones to expand cognitive skills in communicating and problem solving using the case studies. The findings regarding authentic learning support those reported by Brown, Collins, & Dugaid (1989), Collins (1988), Greeno (1998), Lave & Wenger (1991), and Schell & Black (1997) that many participants improve learning through the use of authentic activities that are open to interpretation, requiring students to identify for themselves the tasks and subtasks needed to complete the major task.

Authentic accident reports from the NTSB were used to demonstrate how participants could improve various skills to include communication, higher order thinking, self-awareness metacognition, and cooperative learning. Accident reports selected by the researcher contained examples of poor pilot judgment that allowed the researcher and CRM instructor to introduce cognition and higher order thinking to the experimental condition as instrumental in making good judgments through aeronautical decision-making about likely accident human factors (Flavell, 1979). However, both treatments used authentic cases as an important part of the curriculum, therefore both treatment groups had a level of authenticity that is higher than found in a typical aviation course.

Classroom observations. As the researcher opened the class on day one to teach the participants how to scan accident reports and search specifically for human factors, many examples of participants' lack of higher order thinking skills and improvement in higher order thinking skills were observed in the classroom. In one instance, on day two of the CRM module, Participant 31 was so involved in listening to the researcher that he exclaimed, "Airplane crashes fascinate me." With that spontaneous response, the researcher asked for a show of hands of the participants who used the NTSB database to research accidents. Only Participant 18 raised his hand.

The researcher and CRM Instructor met together after class and noted that the majority of students (96.6%) had never read an official NTSB accident report. This observation was alarming because a majority of the participants (86.6%) possessed advanced pilot certifications, were juniors or seniors in college, and the NTSB reports were widely disseminated to heighten awareness of safety and risk factors. The CRM Instructor recounted the many safety resources offered in this university program as well as hallway and classroom postings and regular seminars. In his mind, the NTSB databases were assumed to be a common part of pilot's reading materials, if not reference materials.

The researcher and CRM instructor continued to observe and note that participants were engaged whenever the accident cases were discussed throughout the course. Engagement was evidenced by participant's eye contact with the researcher, leaning forward body movement as they were listening, voluntary discussion patterns, and intelligent probing questions to discern details of the accident and the human factors. The researcher and CRM instructor were in total agreement that each student in both groups manifested a physiological and intellectual reaction to any authentic case study used during the duration of the module. For the experimental group, participants used the case study instrument on eleven different occasions as part of the curriculum. This included case study test, group projects, classroom case study discussions, and homework assignments. For the control group, the case study instrument was used three times with no scaffolding or explanations. It was used for the pretest, as a group project, and for the posttest.

An observation by the researcher of seven participants (01, 02, 03, 05, 06, 07, and 08) provided affirming evidence of their becoming more capable of self-monitoring and self-regulating their progress in problem solving and attending to higher order thinking through authentic learning. Specifically, the researcher commenced teaching on the topic of metacognition, forgetting that the participants had been assigned to research an accident, prepare to deliver a two-minute oral report, and hand in a one-page synopsis using the case study instrument. Participant 06 raised his hand, interrupting the researcher, and asked, “When are we going to present our accident cases?” The researcher asked for a quick show of hands for who was ready to present and observed that each participant (01, 02, 03, 05, 06, 07, and 08) raised their hand and had their cases out on their desk.

The researcher acknowledged the oversight, turned on the stopwatch, and allowed the much anticipated accident reports to begin. All seven participants presented a valid accident case and delivered their findings using the assigned format of the case study instrument based on Bloom’s Taxonomy. Each participant not only stayed within the allotted two minutes but focused exclusively on the human factors in the accident.

Participant 01 summed up the exercise when he added, “The best part of each of our accident reports is that you can see a clear human chain of events in each one.”

The participants’ confidence in their use of the case study instrument, preparation to stay on time and task, and clear attention to appropriate human factors, showed self-regulation and the utility of the authentic case study approach for this group of aviators, and supported the findings of Brown, et al. (1989), Collins, Brown, and Holum (1991), Greeno (1998), and Robertson (2005). The trend of the participants using the accident reports through voluntary classroom storytelling, a reference during a group exercise, or calling to mind an accident as an example of lessons learned was noted and openly discussed. It was especially apparent during the semi-structured interviews of the eight participants (05, 07, 14, 15, 18, 20, 24, and 30) interviewed.

Semi-structured interviews. When asked, “What produced the most learning?” from the Interview Guide sheet, all eight (05, 07, 14, 15, 18, 20, 24, and 30) participants interviewed (100%), representing both treatment groups, answered the same – the National Transportation Safety Board (NTSB) accidents case studies. In particular, the aeronautical decision-making module helped them learn how and where to seek out the NTSB human factors data and use it to make new discoveries and create new rules of thumb for themselves and others. Three participants (14, 24, and 07) expressed surprise at the amount of time they spent accessing the data and the amount of information they received. The interviews provided clear indication that participants were transferring their knowledge and higher order thinking skills to these well-researched technical reports of authentic accidents. Participant 14 responded, “Anything to do with the NTSB stuff was very valuable; I was kind of surprised how into it I got; like I spent way too much time looking into it than I really needed to which is not a bad thing." Participant 24 described his experience, "You learn techniques and how you know how certain accidents broke down; I actually liked it. You can actually learn a lot from accidents."

Participant 07 exclaimed,

> I think the absolute greatest thing from the reports is actually getting online looking for them, bringing them to class and I mean you may only bring 5 to 6 to class but I've read thirty of them on my own and then heard thirty other people, you know, throughout the semester and, you know, it's just well rounded; your ideas and thought of little accidents and the little thing that you may find yourself in stuck in a situation … oh, it looks like I may have a little sleet on the wings … and then all of a sudden that story pops up into your mind and then oh, you know wait a second and say, let's stop this before anything happens. And it can happen to you.

Three participants (18, 15, 20, and 30) put themselves in the accident pilot shoes and experienced various reactions. Participant 18 shared his belief that he would not have made many of the same mistakes,

> It's very interesting for me to see the special circumstances that come around with different incidents and accidents because I don't think that I would have made a lot of those errors that led to some of the accidents that we looked at. I think personally that I would have been able to get around them or step things up in a way that I wouldn't have had to risk – but because of the conditions both physically and mentally and just the circumstances that surround the aviator and the situation are so common and easy and real.

Participant 20 learned how reading these reports would make him a better pilot,

> They make you a better pilot 'cause you're learning from other people's mistakes I think and you need that information to make yourself a better pilot and it's just some interesting read too, I think so. I would say it's like in law offices like all the case studies and stuff like that you get a greater understanding using NTSB reporting stuff like that.

Participant 15 seemed to sympathize that even an experienced plot can overlook something,

> Analyzing the accidents that we studied was the best. How an experienced pilot can overlook or breakdown communication something incredibly simplistic; going through and seeing what pilots did and being able to correlate it to what you see when you're flying and you experience it as your own.

Participant 30 agreed that the accidents became a learning tool for him,

> I think you can learn a lot definitely from looking at accident reports. I enjoy reading them myself because after reading one of them I really think about the human factors that were involved with that or any other factors that were involved when I get up and fly. You know that stuff usually sticks with me and I use that as a learning tool to just remember what to do in certain situations that led up to certain accidents so that I'll be sure to not make the same mistakes.

Two more practical angles were added in the optional open-ended responses of the Beliefs Questionnaire by Participant 23, who was also an active U. S. Air Force ROTC student,

> Case studies are basically "chair flights" of possible situations and can help develop courses of actions to situations that require quick action before the event ever presents itself. The tragic outcome of many of the case studies hits home to many pilots and air traffic controller which leaves an impression.

Participant 32 indicated that she liked the accident reports but found the case study instrument tedious.

> I like learning about the crashes and accidents; don't bore me with weather details at the time of the accident or what the pilot ate before he left; I want the summary and conclusion and I can determine the lessons learned quickly.

These interview responses supported the quantitative findings of the Beliefs Questionnaire statements regarding authentic learning that showed that, for both treatment groups, use of the accident reports improved participants' learning.

Questionnaire data: Responses to the item, “My interest in accident reports has increased,” revealed that a majority of participants (93.4%) agreed (56.7%) or strongly agreed (36.7%). Responses to the statement, “I learned the value of NTSB reports,” revealed that all but one participant (96.5%) agreed (51.7%) or strongly agreed (44.8%). Regarding the statement, “I will pay more attention to NTSB reports in order to learn,” all but one participant (96.6%) agreed (63.3%) or strongly agreed (33.3%). Supportive of the value of learning from the accident reports, Participant 07 added,

> You can’t preach safety all the time too much or people start drowning it out but if there’s an accident, they’re going to bring it up in your weekly stand up meetings and it just makes you really think and makes everyone aware of what’s going on.

These participant comments, questionnaire responses, and observations support the endorsement of interviewed participants regarding the importance of accident reports as authentic case studies to positively impact classroom instruction for CRM. The next section reflects on the interdependency of the case study instrument, based on Bloom’s hierarchy, to help student’s improve their higher order thinking.

Higher Order Thinking

The presence of a tool in the classroom that provided guidance to assess the accident cases and was scaffolded in such a way that participants understood that as they moved from question one to question six of the case study instrument, the learning moved from lower order to higher order, from easier to more complex. A few participants recalled hearing about Bloom’s Taxonomy but after some probing by the researcher, not one participant could remember exactly when or where. Two participants (05 and 18) who had earned their certified flight instructor credential, recalled the *PowerPoint* visual that the researcher displayed of a page from the Aviation

Instructor's Handbook (FAA, 2008a, p. 2-4) but they could not define the use of it or recall any application of it. For all participants, the CRM module was their first exposure to the concepts of lower order and higher order thinking in aviation and as described in research (Ball & Garton, 2005; Barak, Ben-Chaim, & Zoller, 2007; Bloom, 1956; Callister, 2010; Cochram, Conklin, & Modin, 2007; Facione & Facione, 2007; Halpern & Hakel, 2003; Krathwohl, 2002; Mayer, 2002; Miller, 1990; Robertson, 2005; Van Merrienboer, Kester, & Paas, 2006; Zohar & Dori, 2003; Zoller, 1993; Zydney, 2008).

The case study instrument was presented as a scaffolding device (Palincsar & Brown, 1987) to help participants consider varying levels of inquiry while studying the accident reports. This instrument allowed the researcher and CRM Instructor as well as peer team members to observe participants' understanding and misconceptions during problem solving and provide timely feedback to facilitate answering all the questions. Although the case study instrument helped students appreciate more fully the wide range of cognitive activities involved, it also functioned to help students appreciate the complex conceptual activity an accident case analysis can demand. Participant 05 shared an example,

> It was something that I kind of thought about and thought of automatically whenever I sit down in the steps and kind of made us more of a thorough set of activities. It was just never deliberate act before so using that and those six questions were more overt.

When asked to think about his future as a career pilot, Participant 07 replied,

> Yes, it was helpful. We will actually have to build a case or defend an NTSB investigation in our career so something you have to put everything together and you don't know the results or the end story and I think that if you were building it that way (using the questions) it would be absolutely perfect.

Upon completing the pretest case study, Participant 15, who did not have prior experiences with any NTSB accident report or a tool like the case study instrument to guide the exploration of the accident, recalled how he had taken many courses in philosophy, which he believed helped him think about how to approach the accident,

> At first, I tried to extrapolate too much and I didn't understand the concept and what we were supposed to do. I liked the gathering facts and then reviewing the other pieces. Trying to extrapolate a lot. I got many wrong. Wow, I was unsure but then the second case test – then I understood; I used the questionnaire to approach each case after that.

Participant 18 provided multiple examples of the positive impact that the guiding statements on the case study instrument had on improving his learning.

> The questions all formed kind of one component, one little piece of what it takes to look at that NTSB paragraph in a rounded and full way between the six and what is interesting is that they are all different enough, unique enough and have their own little twist enough that you kind of take that little piece of overlap and look at it from a little bit of a different side. I'm trying to paint a visual here that basically six parts come together to form a good way to look into it so I think they're crafted well.

As reflected in the increasing complexity of the questions, questions five and six represented higher order thinking in the participant's cognitive skills required to evaluate the data (question five) and create new information as a result of analyzing the case (Question six). Participant 20 added,

> I thought it was cool because it made you really think about in-depth about what was going on maybe it wasn't just the crash and that was it, it was like why do you think of the factor that were related to this, you know? It makes you think a little bit harder about the fact that it's not just about that. I don't know that underlying factors of the last two questions. I had to think a lot more on those.

It was observed by the researcher that some of the young male students, especially STJs, were reluctant to engage in probing discussions possibly because they may be viewed as weak or exhibiting followership rather than leadership behaviors. When three STJ participants (05, 24, and 25) working together on an accident report heard the researcher deliver the official NTSB findings on the case, their body language conveyed an attitude that they were done as one closed his notebook and another started to put the accident case study papers away. When the researcher recommended that the groups continue their discussion of task six in the Case Study Instrument which represented the highest order of thinking, the three STJ participants were recorded by the researcher in their small group looking at one another frustrated while one of them was saying, “I thought we were done” and the other two shook their heads saying, “Me too.” The strength of J types is focusing on getting the task at hand completed and checked off. The researcher approached the three and reminded them that improving higher order thinking requires time, exploration, probing questions, and a focus on generating new ways or lessons learned to create heuristics or rules of thumb to help avoid a similar accident in the future.

Participant 30 provided a different view of the utility of the case study questions when prompted, “Tell me about the way you approached the case study instrument.”

> I’ve done certain exercises where I mean I don’t remember the specific class but I mean I’ve learned how to usually go through those steps and I think even when I was in high school they taught us the higher order thinking and all that.

The general question-asking and answering structure served a metacognitive purpose in helping participants monitor and regulate their understanding of the case study and even going beyond that to construct new knowledge. In the experimental group, the researcher witnessed peer scaffolding as team members asked one another questions such as “What made you think of that? Or “How can you prove that?

“Repeatedly “thinking about their thinking” in this way presumably promotes students’ awareness of their thinking processes, which may further improve their thinking and learning” (King, 2002, p. 38). This peer scaffolding displayed positive effects among team members as they interacted with various strategies, including these question prompts, in order to maximize learning benefits.

As students began to understand the concepts of lower order thinking and higher order thinking and began to relate the questions in the case study to each level, they could discuss the concept intellectually and chose to do so with more frequency in each class session. During the course of a team based accident report, Participant 29 created an impressive *PowerPoint* presentation on a scholarly concept of higher order thinking in aviation. He referred to the FAA research on higher order thinking introduced by the researcher on the first day of class. He emphasized that the concept of higher order thinking was an important factor to the FAA and found complimentary educational research sources to support that focus (Bloom, 1956; Chidester, et al., 1991; Robertson, 2003).

During the presentation he also referred to the term metacognition and used the real life story of “Landing on the Hudson” when a commercial pilot famously used all his skills to land a commercial aircraft on the Hudson River in New York in January, 2010. A dramatic and well-publicized accident, Captain Sullenberger revived the use of the term metacognition in the aviation community when asked to describe his thinking during those few minutes of decision making. The captain’s response, presented as a 30-minute lesson to the experimental group, left a great impression on Participant 29 and the entire class as the researcher observed the students on several occasions when working in groups together voluntarily using the word metacognition and using it correctly. Participant 29 went on to describe lower order and higher order thinking as defined by Bloom's hierarchy and as reflected in the Case Study Instrument. Finally, he (Participant 29) tied it all together as he discussed the function of higher order thinking in problem solving using the NTSB accident reports.

Participant 05 commented about the positive changes the Case Study Instrument questions had on his CRM practices. He reflected on his past practices in flight training and how the questions made him more aware. "It was something that I kind of thought about before whenever I went through a problem and kind of made us more aware of activities. It was just that using those six questions was more overt."

Participant 07 during the interview added, "It was helpful. The questions were first trying to build the framework and then go into the details a little bit at a time." Participant 14 identified its value in helping him to focus, "Yeah, they definitely helped to think of things that I should be looking for. It took more time at first but it helped. Remember, I was specifically one of the last persons to finish the test."

One more experienced participant, 19, said,

> I had never seen this approach before. It helped breaking down the factors of the case. The questions really made me think. I thought the first two questions were redundant. I think of facts as a summary. I always summarize.

Participant 24 expressed his interest in the way the questions got increasingly more challenging and caused more positive interaction among the students and with the researcher.

> Basically it was just work with your personal opinion and work your way up with until you get to an answer and then you get to a general rule of thumb. You have to fill out the blanks and then go on to the next one but I thought that you really kicked it up and kind of made us interact with you and each other as well and I liked that. You don't get that a whole lot in most of the classes.

Negative responses implied that participant's expectations were not met by some of the opportunities provided. Two participants (23 and 12), who were part of the experimental class in the Spring of 2011 with the CRM Instructor, raised concerns that they did not have a satisfactory experience using the Case Study Instrument and stated,

> For me, reading about accidents is what interests me, therefore it is natural for me to zone in on select features instead of taking an academic or broad view of the report by using that instrument. I think the only question really focused on by my group was, "What do you think happened in this case?" We skipped all the other questions and just ended up talking about the accident in general.

Participant 12 commented, "The NTSB case studies were not effectively woven into the instrument." The researcher noted these two participants' comments on the open-ended Beliefs Questionnaire responses as they attended the experimental group during the semester that she taught the control group.

Overall, the interview responses and classroom observations supported the quantitative findings of the Beliefs Questionnaire statements regarding use of the case study instrument and higher order thinking improvement is displayed in Appendix R, page 1. The results showed that the participants in both groups responded favorably when asked about their experiences using the case study instrument as a device to better understand the accident reports.

Questionnaire data. For the item, “Using the CSI to learn about higher order thinking was beneficial,” a majority of participants (83.4%) agreed (46.7%) or strongly agreed (36.7%). Responding to the statement, “Aviation courses that use the CSI are better than those that do not,” a majority of participants (86.6%) agreed (53.3%) or strongly agreed (33.3%). Participants’ responses to an item focused on capturing their beliefs about question six on the Case Study Instrument that was representative of Bloom’s revised hierarchy level, create, considered the most complex, “I found it easy to create new rules of thumb,” showed that a majority (66.6%) disagreed (53.3%) or strongly disagreed (13.3%). In other words, participants were reflecting that it was more difficult to generate/create new information, which was an indication that their higher order thinking skills were engaged in the process. Only 5 of the 30 participants (16.7%) agreed or strongly agreed that creating new rules of thumb was easy. When asked to respond to the statement, “I enjoyed figuring out answers to all CSI questions,” a majority of participants (83.4%) agreed (56.7%) or strongly agreed (26.7%). Another statement designed to capture participant beliefs about their awareness of how they think, “I am more aware of how I think because of this module,” revealed a majority of participants (80.0%) agreed (53.3%) or strongly agreed (26.7%).

These participant comments, questionnaire responses, and observations support the endorsement of interviewed participants from both treatment groups for the importance of the case study instrument based on Bloom’s hierarchy used in conjunction with the NTSB accident reports to positively impact classroom instruction for CRM. The next section reflects on how each participant used the instructional information in cooperative groups for effective crew resource management.

Cooperative Groups

Participants discovered that by working together they learned to appreciate and strengthen both their basic interpersonal communication skills and their academic CRM proficiency. The cooperative learning of the experimental condition was different than most strategies that aviation students encountered in their core courses as it was explicitly and socially constructed. Just as we provide aviation students with knowledge of stick and rudder, maneuvering, or glass cockpit vocabulary, we also must lead them to learn why and how to work better together as crews. “Perhaps the major psychological problem of our time is that of developing the human capacity to value human differences” (Pearman & Albritton, 1997, p.139).

There will always be external factors that complicate the dynamics of any classroom but by agreeing to learn how to learn cooperatively, the participants engaged in human factors management. Designing a classroom environment that supports cooperative learning proved to be initially difficult because students were accustomed to aviation teaching that includes high instructor control, which is contrary to the structure of student-centered approach of cooperative learning.

In response to “Tell me about working in teams,” Participant 05, with a clear and validated preference for J, evidenced developing metacognition when he responded,

> When I would have an idea or when they would, it just wouldn’t mesh and a lot of times I just wouldn’t have a lot of patience to sit there and work it out and understand that yea they have different styles of thinking and even though it makes perfect sense to me it’s a fact they see it different way maybe well I just wouldn’t step back long enough to see it a different way.

Participants in the experimental condition were regularly assigned to work in cooperative or group learning to maximize their own and each other’s learning.

Participant 18's J perspective on cooperative learning emphasizes her new found knowledge of herself while working with others.

> Having that as a learning tool was cool but really the principle tool right there was for me to learn was the ability to kind of step outside myself and objectively look at how I'm interacting with other people and really the listening aspect of that on how they interact back with me that I might not have even seen that they were hesitant, you know.

Cooperative learning exercises encouraged self-awareness, metacognitive development, and higher order thinking in understanding and self-validating the last two of the four MBTI dichotomies. Participants were asked to self-assess a four letter MBTI type based on the experiential exercise and instructor descriptions of the dichotomies. An important concept was that of socio-cognitive conflict which existed in the experimental condition when the design of the Case Study questions prompted students to express differing points of view which often created what Piaget called cognitive dissonance and neo Piagetians call socio-cognitive conflict (King, 2002). A social construction of knowledge occurred when students were placed in cooperative groups with members of a different type and the interaction that ensued required them to confront differences in their understanding as well as hear one another's differing attitudes, values, or perspectives on the case study. Through small group case study discussion, participants were observed reformulating their own thinking and altering their approaches. Helping the students by explicitly reminding them to pay attention to their last letter of type and their fellow team members' last letter of type, J or P, helped to expose and reconcile differences in approach and understanding to decision-making with the accident report and helped to control the direction of the discussion so all contributions were valued.

For example, when asked by the researcher during the telephone interview about how the team approached their group exercise, Participant 30, a J type, working with two other J types replied,

> We sat down and kind of brainstormed how we wanted to present the explanations in class and from there we decided that we would split up the parts that we had talked about and then once we established that we were on our own doing the research, we got back together and we met once right before we presented and just kind of went though it real fast. We worked real well as a team.

Participant 20, another J, responded, “It was good and bad; at the first we were all kind of going about how to do it but once we got a plan established it was good use of time after that.”

As Participant 15 commented during the interview when asked about working in groups,

> As a P, it’s just a different plane – an alternate universe, a different plane where I need to negotiate and express myself to them in their language as opposed to expecting them to come to my language. I think of it as we’re all just speaking completely different languages from different countries.

Coupled with the use of the Case Study Instrument and knowledge of type, interacting with peers in cooperative groups proved to be a new experience and improved metacognitive processes showed that a struggle once latent was now overt and could be dealt with more effectively. The experimental group practiced monitoring their behavior in groups through instructor coaching and extensive peer interaction while the control group primarily read about how other pilots self-regulate in crews by studying chapters and specific pages in the assigned text. To reinforce the content that was read by the control group, the researcher/CRM instructor would then highlight the definitions and concepts in the reading and present data to the control group through a lecture with *PowerPoint* slides.

After class each day, as the researcher and CRM Instructor compared notes and discussed, they agreed that there was not one instance where a control group participant engaged their peer during the course of any class regarding the content. There was minimal voluntary public interaction during the class with the researcher/CRM Instructor in the form of a question or to add data to clarify a point. However, it was evident in the experimental group that explicit support for peer interaction through modeling and encouraging dialogue was occurring during each class, with greater frequency after week three. The scaffolding of cooperative learning resulted in an active and experiential classroom environment that encouraged the students to interact with their peers using the Case Study Instrument as a guide to the improvement of their higher order thinking.

"Practice involves making metacognitive processes explicit by critiquing and correcting, which benefits from a team context" (Kanki, et al., 2010, p. 170). Participant 24 commented:

> I learned how other personalities are more affected by my personality and vice versa; how breaking down certain personalities or attitudes that people present even anger in any of those accidents or it could be the way you take the positive side of it and you say their personality type – how could I deal with them and whoever my crew members are.

Effective teamwork is essential to maintaining a positive crew climate that contributes to problem assessment and aeronautical decision making.

Classroom Observations. It was observed by the researcher and CRM Instructor that the most effective teams were reflective. Specific ways that they were reflective included: they checked their assumptions by talking with one another, questioned missing information, considered what might have gone wrong, how likely it was, how serious it could be, and they created new information for other aviators to learn from their findings (Kanki, et al., 2010, p. 167).

J's need for closure and control make them seem like poor crew mates or team players. And the P types' seemingly incessant need to generate alternatives and "fly by the seat of their pants" make them appear to be less committed to the team's goals (Kroeger, et al., 2002, p. 187). For example, Judgers score significantly higher than Perceivers on order, while Perceivers score significantly higher on change (Quenk, et al., 2001).

Another strategy was used when the researcher scaffolded an exercise to better communicate with the goal of teaching students how to ask for clarification. Participants were assigned a partner, preselected by the researcher based on type, and moved their chairs so they were sitting back to back. One of the pair was given a blank sheet of paper and was called participant A and the other in the pair was given a sheet, face down, with a figure on it made entirely of shapes and was called participant B. It was observed from the start to both the researcher and CRM instructor that the participants did not normally engage in experiential learning exercises with others in a class, as their initial response was awkward and self-conscious. The directions were: Participant B may flip over your sheet of paper and must give instructions to Participant A, sitting with their back to them, on how to replicate the drawing they were now looking at. Participant A was not allowed to see the drawing and they had five minutes to complete the exercise together. The goal of the exercise was to demonstrate communications skills. Carefully observing the J types, they were clearly not comfortable, as if it were wrong to be doing this exercise in class and they exhibited a serious approach. P's reflected briefly on the instructions and then just jumped into enjoyment of the exercise, not seeing structure and not confined by the time limitation.

In the semi-structured interview, several participants (06, 07, 24, and 30) reacted positively to the exercise. Participant 24, a J type, shared this report of the experience,

> What made it a lot easier to learn was actually engaging in it and actually seeing type. In other words when we were doing those exercises in class and we sat back-to-back and draw the pictures and then had to communicate with our partners, it actually helped me see how precise or certain techniques made me have to think about my personality versus how does this person think. I learned more about how to learn how other personalities are more affected by my personality and vice versa. That really opened my eyes.

In another classroom observation by the researcher, Participant 18, a J who was assigned to a group with two P participants, reflected,

> I was the automatic head of the triangle as there were three of us in my group and they were, well it was kind of … it was this ..., well I don't want to use the word hierarchy but I was automatically the lead.

In another group exercise, students in both the experimental and control groups were assigned to teams and given an accident report to work on together with the goal of making a group presentation. In this exercise given to both the control and experimental groups, different types of instructions were given that impacted the results. The researcher encouraged the CRM Instructor to change the standard operating procedures of the courses' Case Study assignment from the way it had been institutionalized to date (see Appendix F) as an individual report. The Instructor agreed and the assignment was updated by the researcher to reflect Bloom's Revised Hierarchy specifically and it was distributed to all students in both treatments. The researcher randomly assigned students to groups and sent the list to the Instructor for approval. The Instructor then posted the groups to D2L where the students learned of their team members. The differences in instruction between the two treatments are contrasted below.

The researcher/CRM Instructor (depending on semester) worked actively among the experimental group teams, clarifying assignments, offering encouragement, reinforcing positive instances of cooperative behavior, modeling behaviors, clarifying task expectations, stimulating dialogue, and issuing timely questions designed to promote higher-order thinking. The instructor also modeled cooperative behaviors by interacting with students by name in a much more personal and informal manner than the instructor in the traditional lecture format. This process is consistent with previous research indicating the importance of scaffolding group collaboration (Gillies, 2006; Lave & Wenger, 1991; Nussbaum, et al., 2009).

The researcher/CRM Instructor (depending on semester) provided no overt or explicit guidance to the teams in the control group on how to work in or as teams. They were "thrown together" as many college course team assignments, unfortunately, are expected to function. The instructor asked if there were any questions and occasionally reminded teams of the timeframe for the presentations both in class and for individuals to see on D2L. All teams in both treatments were limited to the same timeframes for the presentations.

Observations by both the researcher and CRM Instructor showed that the experimental class had been participating regularly in cooperative team activities by the time of this project assignment as evidenced by their easily working with their team members practicing social skills strategies and identifying the tasks to be performed. In all cases with the experimental teams, members introduced one another, were at ease with the flow, had practiced their roles whereas the majority of participants in the control group teams reported simply divvying up the case report questions and working independently, often not even remembering their team members' names. The instructors observed, in one case, negative reactions to other team members who did not pull their load and were guilty of social loafing but clearly had learned no formal group processing social strategies to handle their negative reactions.

Another great example of cooperative groups processing in the experimental class was when all the participants were assigned to teams to work on a case study called Winter Survival. The exercise reflected experiential problem solving using the tools of decision making in a cooperative group setting where there was an expert's ranking resolution from the United States Army as a benchmark at the end. During this exercise, aimed at effective communications and teambuilding, the researcher would stop the group at times when it was observed that they were not making progress or were not working well together as evidenced by body language to help them "think about their thinking" or metacognition and asked questions such as: "What is going well? What could you have done differently? What should you do next time? What would work better? How does this relate to your previous experiences and to future learning activities?" The researcher would make explicit that what she was doing as part of the group process was a means of scaffolding the group's decision making by stopping and asking those questions. It was modeling for participants how to stop themselves and self-monitor in order to reflect on their though process, to encourage shared leadership of the practices of the group's processing. They were encouraged to stop and change course if necessary in considering what to do next.

The outcome of experiential approaches to learning about aeronautical decision making was primarily about working cooperatively to explore optional ways to address problems and exercising their higher order thinking skills by creating new advice/information/rules of thumb for themselves and for fellow pilots to help avoid a similar accident in the future. For most J types, this process conflicted with their comfort of being quick and decisive individual contributors as the researcher probed and J participants volunteered their reactions during class exercises. Also, more J participants than P types reported stress when participating in group exercises and in any exercises where the outcomes were uncertain, took longer, or had vague directions.

Students need to be explicitly taught rules for communicating in groups that may differ from the aviation classroom rules with which they are familiar including, "Is it okay to speak without raising my hand?" and "Is it okay to push back on another's view of an accident or is that considered arrogant?" Cooperative group norms are very different from the competitive and individualistic aviation classroom environment that students were accustomed to, so it was important to give them the opportunity to not only become acclimated to a new way of behaving but for some types, to give them permission to act in such a way. The researcher and CRM Instructor modeled and provided authentic reasons for participating in cooperative tasks; that is, providing tasks that the students could not complete independently either because of the nature of the activity or because of how much time they were allotted to complete the assignment (Johnson & Johnson, 1994).

It was observed by both the researcher and CRM Instructor that J type participants were consistently surprised and unsure of what to do when spontaneous team exercises were announced. As their names were called to join others in a group activity, their reactions, which were videotaped, ranged from raising their hands to ask the researcher to repeat the instructions, to whispering to a classmate “What are we doing?”, to displaying a look of vulnerability and fear moving from their physical space to other areas of the room with others. The researcher, expecting these reactions in advance, used the opportunity to discuss discomfort, type, and learning.

Js seemed more at ease once these facts were overt and sentiments were shared by others like them. Also, several J’s (Participants 01, 05, 07, 10, 18, 21, 25, and 30) made time to talk to the researcher face to face about how much they were learning about themselves but, more importantly, how they could see (some for the first time in their lives) that they approached tasks so differently than their P type fellow aviators. As the J type researcher reflected on her own transformational experience when she learned about the pathways and pitfalls of teaching to and learning from J and P types, it impacted the development of all subsequent learning deliverables and motivated her to ensure an all-inclusive explicit design for both types approach to learning, as reflected in the experimental treatment.

Aeronautical decision making relies not only on logic but on the effective combination of logic, interpersonal dynamics, and cooperative learning. As many of the participant interviews revealed, this was a difficult task, particularly for J types because it is not predictable and could not be controlled. In addition, the J dominant aviation culture tends to want to “check the aeronautical decision making training box” to indicate completion of that task in class, believing that attendance will convey needed non-technical skills such as leadership/followership, cockpit communication, assertiveness, or other human factors topics. Many Js, and especially STJs, approach all of life as though they going through a pre-flight checklist before takeoff. There is comfort in having a tried and true system that gives specific, tangible instructions about what to do in a given situation. The challenge is that having skillful conversations by learning about oneself through self-awareness strategies and learning about how to be in community through cooperative learning takes time and tools that are less familiar and less comfortable for the STJs.

Regarding effective processes to augment students' abilities to understand the emotional and logical gaps in communication in the present-day aviation crew environment, the rationale behind scaffolding self-awareness by instructing participants about their last letter of type, J or P, was to allow them to view their approach, as well as others' approaches, to aeronautical decision-making as a conceptual cooperative team-based tool in a cognitive-constructivist environment. Unfortunately, most content is conveyed in an instructor-led environment through a logical process or checklist as a filter for the culture of aviation – the culture of safety.

Participant 07, not only a clear J type but one with extensive military experience, reported,

> In the Air Force we did a lot of CRM training and every mission we have our hour long briefings before we left home station and when you look back on it that is what brought the crew together and gave everybody an understanding of what was expected and what was going to happen on the mission and now knowing the theory behind it makes sense.

P participants (02, 08, 09, 15, 20, 28, 31, and 32) enjoyed the spontaneous exercises with no adverse physiological reaction observed on videotape. As expected by the researcher, most P types appeared natural in approaching each exercise, although two introverted P types (Participants 08 and 32) moved with less enthusiasm than their fellow Ps towards their group members to participate in the exercises.

Perceptive types craved the choices of exercise formats offered for the cooperative exercises and their spontaneous questions were evidence of their engagement. The researcher noted the participant types with a combination of N and P preferences (Participants 04, 08, 09, 15, 23, 28, and 31) worked to understand the task with others at a deeper level as evidenced by their probing questions of one another about the accident. P types need opportunity to be spontaneous and freewheeling, to follow their curiosity (Kroeger, et al., 2002). The researcher and CRM instructor were constantly alert to this, especially the CRM instructor who shared the two preferences (N and P) with the minority of P students and encouraged P participants to explore and find new facts or possibilities to use. Prior to this module treatment, the NP instructor delivered the class in an instructor-led lecture mode.

The researcher, who shared two preferences (S and J) with the majority of group type participants (01, 03, 05, 07, 11, 12, 17, 19, 21, 22, 24, 25, 27, and 30), was aware of the constant and interesting clashes that occurred as P types felt the push of the Js at times for a more tightly scripted agenda. The researcher and instructor were quick to remind participants that much of the necessary self-reflective and higher order thinking theoretical model is more of a P style model rather than a J style model. Thus, learning how to probe, ask questions, remain open, and reflective is an important part of CRM inquiry and higher order thinking.

Student interviews and responses to the Beliefs Questionnaire supported the researcher's observations that practicing the skills of team building and paying attention to others' J or P preference caused impatience and frustration in many, most notably those whose preference for orienting to their world while extraverting (talking) was J. In other words, their need for closure and order superseded their need for relationship and for listening in the moment.

When asked, "I'm curious about what you learned about yourself," Participant 30 discussed the class exercises:

> I learned more about my own personality type from just the simple exercise you did of having different people stand on either side of the room just by certain letter. I'm a very visual person so that was a visual example of the differences of people that we have in your course and so having that as a learning tool was cool but really the principle tool right there was the ability to step outside myself and objectively look at how I'm interacting with other people and really the listening aspect of that on how they're interact back with me. Before this, I might not have even seen that they were hesitant, you know. It was powerful.

Specifically, participants were trained to appreciate and capitalize on differences in communication and MBTI information processing styles within their groups. As students were introduced to the ADM concepts and discovering new ways to express themselves, it was clear that many were not comfortable and felt it a great risk to express their personal feelings about issues in front of others. This is a delicate subject for many organizations, especially ones with strict hierarchies as in aviation, so appropriate communication techniques were scaffolded so that students understood how to give and receive feedback and that the questioning of authority, in this case the researcher or CRM Instructor, was not seen as threatening.

For instance, on one occasion, Participant 05, who possessed advanced aviation credentials chose not to participate while in a team activity. This participant consistently scored high on the case studies and was active in individual exercises but on one occasion when assigned to lead a team activity, he joined the group but refused to participate with the three other members. On this occasion the teams were assigned with type-alike J or type-alike P participants. In the team with Participant 05, the four members all shared J preferences. Persistent engagement with Participant 05 as well as a private discussion off site from the classroom revealed that while the he was competent in a one-to-one approach, he was insecure and uncertain of how to interject himself into a small group exercise and lead them. He reported that publicly leading the group was harder than he imagined so his reaction was to withdraw.

This was just one of many examples where an experiential classroom with cooperative learning allows the participant to fail and to learn from the experience. After class, the researcher met with Participant 05 and helped bridge the gap by providing feedback, listening, and discussing his options.

> You know when we were working as a group it kind of tries your patience and you’re kind of like, yeah, that makes sense but it’s not the way I see it and it’s kind of a more patience thing with me in not trying to talk things out and just, does that makes sense? I’ve really improved over going through this course in meshing with the other personalities and learning how to do that and I think as part of aviation, I think was the biggest struggle for me and I’m still improving.

As demonstrated through this example, most of the students, even the most experienced as Participant 05, appeared to possess declarative knowledge of strategies and concepts of CRM but lacked the maturity and social skills to take their own knowledge to the next step of communicating more effectively with others in classroom exercises. Most participants started out the module being focused on themselves. Curious from classroom observations during one class period, the researcher privately asked one participant, “What did you learn today about working with others?” Participant 32, a P type, agreed to be audio recorded and provided a quick objective response,

> Two main things really, the way I think so inwardly and say very little. I’m a classic introverted type. I’m good at establishing boundaries. I read body language. I like learning about behavior patterns. You’re going to meet people that you may spend six to eight hours with and never see again. You only have about ten minutes to establish your cockpit environment and establish rapport. You should be careful with boundaries.

Participant 07, a J type, discussed his discomfort in a cooperative exercise,

> Personally I don’t like working in group projects. I like control; I didn’t want to be paired up and then I ended up being paired up with those people; so it was kind of like awful, really; but I think that’s a personality clash not a project clash.

Helping to link students to others through ongoing interactions helps student develop their identity and discover their voice to transfer the learning to other academic and social experiences. Participant 30, a female military pilot participant, exclaimed,

> I feel like I’ll have a whole new opportunity now with strangers at boot camp this summer who I can start fresh with and practice new behaviors. I want to come across with a more assertive style and I realize that I can put some new ideas into practice.

Participant 14, a J type, admitted, “Not the CRM concepts but thinking about how to implement them with a group in the future, as in decision-making for a crew, that intimidates me and scares me a little bit.” Participant 18, a J type, added,

> I think working in teams is one of the most important components to CRM because it's super important to define the way to reach a common ground on how things are going to be done and that's what CRM is to me. It's a way to get everyone to bringing out their thoughts and get it on the table looking at them all together and then figuring out the best way to get to the goal and making sure everyone feels like they're doing it their right way and has a say in it. That's where personality type comes in.

Participant 32, a P type teamed with Participant 18, a J type, responded:

> I think about things; I listen and then think but don't always talk. It's very challenging for me as an Introvert and a P type dealing with an Extravert who is a J, like [Participant 18]. We think about things so differently; we work well together but very different ways. He can read a case study for three hours; I want the highlights. I want only the lessons learned and he likes to think about it and analyze it; I like the three minutes version; he likes the three hours version; I like things concise. I tend to be blunt but I see it as being fast. It's like a teeter tooter; a division of power; checks and balance; I used to think that it was a 90/10 relationship with the PIC (pilot in command) and FO (first officer) now, after being in teams here, I see it as 60/40 – mostly level.

Cooperative learning groups were reported by many participants as a collaborative and supportive network that helped them improve communication and share different versions of the same accident report with each other since trying to create rules of thumb was often time consuming. Participant 31 volunteered one day after a group exercise, "This class and your group work design were very relevant and a lot more fun than the other aviation classes I have to take. I don't mind any of them but I enjoy yours more."

In another team project assignment, students in both the experimental and control groups were assigned to teams and given an accident report to work on together with the goal of making a group presentation. The control group was not given any explicit directions on how to work together in groups and was only given the Case Study Instrument as their guide with the requirement to respond to all six tasks through a classroom presentation format. All teams were limited to 10 minutes for the presentation and 5 minutes to respond to questions and answers. The experimental class had been participating in multiple team activities by the time of this project assignment, and while the instructions given for this group exercise were the same as for the control group, participants in the experimental group teams quickly moved to form their teams practicing social skills strategies and identifying the tasks to be performed as a team.

On the day of the presentations, the researcher and CRM Instructor compared notes and agreed that the participants in the experimental module exhibited more interpersonal interface introducing one another by name, making personal references to each other's habits, voluntarily calling out their J and P type preference indicators, and projecting social acceptance of the team as a whole. These behaviors were in sharp contrast to team presentations of the self-directed control groups in which more tense moments among the members were observed to include confusion about the process and order, blame, and more individualistic final presentations than cooperative group effort. For example, in one case, three members reported the way their process to complete the presentation worked. They met once after class and one person said they should break the case up using the six questions and each one took two questions.

On the day of the presentation, as the researcher and CRM Instructor observed this groups' presentation, they agreed that it was like watching three independent presentations. No teamwork was evident and when it was time for questions, the researcher noted that Participant 14 on this team could not recall his teammate's names nor could they collectively discuss the entire accident as they had divided it up and exclusively addressed those questions. It was evident that the experimental treatments' teams had an advantage by receiving instructional scaffolding strategies for learning how to build effective relationships with others and how to improve their collective study habits for delivering effective presentations.

Even so, Beliefs Questionnaire statements regarding cooperative learning demonstrate that the majority of all participants improved in their ability to work together and increased their learning.

Questionnaire data. Participants were asked to respond to the statement, “I am more aware of how personality affects crew communication” and all participants (100.0%) agreed (56.7%) or strongly agreed (43.3%). Participants were asked to respond to the statement, “I learned more about my classmates’ personality preferences. Results showed all (100.0%) agreed (76.7%) or strongly agreed (23.3%). Another question captured participant’s self-rating of their ability to connect with others in a healthy crew resource management manner. Asked, “How would you rate yourself in terms of your ability to establish rapport and maintain healthy CRM relationships with others?” A majority of participants (83.3%) rated themselves as above average (73.3%) or superior (10.0%) in relationship building.

Cooperative learning communities help transfer learned strategies (Felder & Brent, 1994). This concept is not practiced in aviation courses and specifically in crew resources management where course content is most natural for it to occur. Humanizing the learning environment was essential to a successful CRM course.

The goal of the experimental condition was to strengthen social and intellectual connections between students and build a sense of community among participants. As demonstrated through the team presentations and classroom discussions, most of the students appeared to possess declarative knowledge of strategies but lacked the maturity and social skills to take their own knowledge to higher levels of problem solving such as evaluation and creating new information, that is, lessons learned that might help fellow pilots.

Additional Findings

In addition to the four educational psychology factors identified in the analysis of the interviews, classrooms observations, and surveys related to the research questions, other factors emerged that may have impacted the results, including the use of classroom materials and the impact of other dynamics of personality type.

Course textbook

Analysis of participant responses to the interview question, “What produced the least learning in the course?” revealed minimal expectations for the required textbook. The researcher noted the correlation with reported dissatisfaction of Item 30 of the Beliefs Questionnaire “The text book helped me learn more about the topics,” in which 20 of the participants disagreed and it produced a significant finding ($p<.001$) of this study. Participant 07 who admitted to an appreciation of reading scholarly materials, admitted,

> The book was written in such a way that it was just didn’t catch me to learn information so yes, I learned information for the test but when it actually came down to what I retained and learned? It was not the book, it’s gonna be the discussions. What we talked about in class and the actual CRM aspects of human factors was important rather than the theories and where they came from. That would be the least that I took away from this class.

Both the researcher and CRM Instructor noted on multiple occasions that one or two of the students used the book and that, by the fourth week, three had still not purchased the book, relying on reading portions that were available on *Amazon.com.* Overall, in response to the item, “The textbook helped me learn more about these topics,” ten participants (33.4%) responded Agree (26.7%) and Strongly Agree (6.7%). These participants were members of the control groups that used the textbook under instructor direction. Seven of the eight participants responded Disagree (26.7%) and the two participants who responded Strongly Disagree (6.7%) were in the experimental treatment which focused more on class group work than following the textbook in each class. 10 participants (33.3%) chose to respond neutral regarding the textbook.

Research on other facets of Psychological Type

During many of the experiential class exercises, concepts such as metacognition, higher order thinking, and elements of Bloom’s Taxonomy appeared to be easier for some students to grasp than others, as evidenced by observations and interview comments by participants. It was noted by the researcher and discussed with the CRM Instructor, who agreed, that the common type preference of those participants was highly correlated with a different dichotomy of the MBTI than the J-P dichotomy under study. This other dimension is the second pair of letters or dichotomy of the MBTI called the perceiving function and represented by the opposite psychological preferences for Sensing(S) or Intuition (N).

During the class, the researcher would probe for an understanding of where one’s mind started in attending to the six questions on the Case Study Instrument as they read the accident report. The help offered could take the form of an instructional scaffolding of the MBTI perceiving dichotomy of S or N. For example, the researcher notes frequently that the twelve participants (40%) with a data-gathering preference for Intuition, represented by the letter N, were more curious, made more affirmative statements of learning, were more interested in the concepts of metacognition as evidenced by their questions, and generated more possibilities with the accident reports as a form of deep learning strategies than the surface or rote tendencies of their S team members when working in cooperative groups. The researcher noted that N's in the study conveyed a relief of better understanding their fellow aviators with a S preference who did not seem as interested in generating possibilities and staying open to discuss the reports and findings as they did.

This data gathering function of Intuition was noticeably different than that of the 17 participants (60%) with Sensing as a data gathering preference, represented by the letter S, who asked questions of fact, details, length of course, and most frequently, "Is this in the test?" An example of the S data gathering mode's blind spot was evidenced during instructor probing of "Let's hear your ideas about this" or "Come up with original ideas about how what you learned will help you next time you fly" as these were primarily answered by N students.

In closing this chapter, the perspectives of the participants suggest they not only learned a new methodology for using their higher order thinking skills in resolving accident cases and creating new information to use in future flight scenarios but they achieved heightened self-awareness as a member of a cooperative community of aviation learners.

CHAPTER 5: DISCUSSION

Introduction

What began as a study of introducing a scaffolding approach to teach higher order thinking in aeronautical decision making became a study of the process of changing participant's beliefs and practices for strengthening social and intellectual connections as well as building a sense of community among fellow aviators in the pursuit of improvements in higher order thinking skills. As such, the analysis of the transforming power of classroom community building has implications for those involved in curriculum improvement efforts, whether they are teachers, administrators, or outside consultants.

The business of instructors is to provide the kind of classroom experiences that will help develop true disciplined thought in each individual (Dewey, 1938). Myers (1998) believed people were innately different and developed a framework for explaining normal differences in how people think and act and to make constructive use of differences. She dedicated most of her working life to making the psychological type theory of Carl Jung practical, believing that the methodical study of personality differences would provide useful and practical insights into how people learn, communicate, develop, and change. The researcher approached the participants in this way – knowing they were all very different in the way they learned and the way they interacted with others so that the various objective scaffolding frameworks strategies provided in this study were introduced as tools offered in an atmosphere of respect and honesty both in groups and during individual conversations held with the researcher. The new shared terminology allowed participants to express their hopes and concerns as the researcher discussed individualized learning strategies for each participant demonstrating that all type preference combinations were pathways to excellence.

Before discussing the quantitative and qualitative results, the researcher discovered what Miles and Huberman (1994) described as “the sneaky feeling that, in fact, reasonable conclusions are out there somewhere” (p. 262). Multiple examples of the success of community building were apparent during and after the experiment to include that the researcher offered career advice to former participants and continues to meet regularly with them, fly with them, and host family events for them as part of the aviation community that commenced with this experiment. Specific other examples follow.

Two participants requested that the researcher speak to the Reserve Officers' Training Corps (ROTC) class of 2011 to provide evidence of improved communication, higher order thinking skills, and personal impact training by using the tools they experienced in class. The requests from the participants were specific and doable and demonstrated that they had decided how they would apply their case study instrument and type knowledge in ROTC. They just needed scaffolding from the researcher as they worked to implement the knowledge. Several other participants requested that the researcher help them discuss their type preference for improved personal impact in job interviews as well as communication improvements with faculty, friends, and family members. The majority of participants who were also certified flight instructors (or preparing to be) voiced strong opinions that the knowledge gained in the experiment would help them teach others to fly and would improve their higher order thinking in the cockpit.

As further confirmation of the development of strong aviation community ties and of knowledge transfer, at two Aviation College graduation dinners in the fall of 2010 and the spring of 2011, when the researcher was introduced by students to their parents, comments such as “better understanding myself” by describing their type preferences and how their awareness of Bloom’s levels helped describe where they may be stuck in learning were voiced. Also, several students began submitting aviation accident cases and explained why they believed the case should be shared. Many others reported subscribing to the free educational resources available as a result of the value that the CRM Instructor and researcher conveyed about these tools for improved higher order thinking. On the final day that the researcher completed the experimental module (during both semesters) and explained that her class involvement was concluded for the semester, several participants approached her privately and expressed that they were disappointed it was over, would miss her, and valued the expertise offered. As one student wrote in a closing email to the researcher upon hearing that the module was ending:

> It was a wonderful addition to have you join our CRM class and share your incredible knowledge on the MBTI. I have taken the MBTI many times previously and no prior instructor truly helped me understand it as well as you did. You helped me understand the complexities of the J vs. P and the E vs. I in my individual type as I can present different types as I deem necessary for the situation (at home vs. work in your example from class today). Thank you again for your insights and your time. It was truly a pleasure.

Overview of the Findings

The purpose of this study was to examine the impact of a combination of instructional scaffoldings that provide intentional and explicit strategies for supporting development and use of higher order thinking among participants assessing accident reports. Since the scaffoldings are proven contexts for expert-like problem solving and reasoning activities, the hope of this study is that a combination of these models used to teach aeronautical decision making will result in a classroom environment that is meaningful, authentic, and effective for the improvement of higher order thinking. This section presents evidence that supports that hope. The study also explores relationships between participants' responses and their metacognition and psychological type, as hypothesized by Carl Jung and measured by the MBTI, for students working alone and in cooperative groups. Participants comprised a relatively homogenous group of college aviation students enrolled in a junior- to senior-level required course called Crew Resource Management.

The findings related to research questions, from both quantitative and qualitative data sources, are summarized below, followed by a discussion of the practical implications for aviation education and future research. First, the discussion of higher order thinking skills as reflected in research questions 1 and 2 is presented.

1. Are there significant differences in higher order thinking skills between experimental and control groups? 2. Is there a significant interaction between experimental condition and MBTI type? In other words, does the rate of improvement in higher order thinking across experimental conditions depend on whether the individual is a J or a P?

Higher order thinking skills were assessed by a participant's ability to answer all case study questions on the pre- and posttest. The research focused on how participants applied the learning after reading the accident facts and how they would understand, infer, and connect the facts to the human factors of the case by analyzing, evaluating, and creating new rules or novel ideas to apply lessons learned to future decision making. Although not significant, it is important to note that the sample size (N=30) was inadequate to be conclusive. In the experimental module, the objective was to develop and enhance aeronautical decision making as evidenced by significant improvement in posttest scores by the experimental group on those questions designated as representing higher order thinking skills (questions four, five, and six of the Case Study Instrument).

Participants in both groups performed comparably on the pretest, overall answering more of the lower order thinking questions (questions one two, and three) than the higher order thinking questions (four, five, and six). This was the participants' first exposure to the NTSB accident report format, so it is possible that many of them did not recognize or note the critical facts in question one that were necessary to respond to the higher order thinking questions that followed. During class, as a part of the instructional strategy of lower order to higher order thinking, the researcher used sample accident reports to draw participants' attention to the basic facts in the case in order to demonstrate the importance of accurate evidence that would lead to making a correct evaluation of the accident as well as create new ideas or rules of thumb to avoid a similar situation in the future.

Overall, J types improved more on posttest scores for the higher order thinking questions numbered four through six than did P types but results show no significant differences by J or P preference within either treatment group. Several patterns on the posttests of both the Js and Ps are worth noting and warrant further research related to this question. P types' mean responses on the six questions overall were higher than those of J types. However, J types gain scores were higher on two of the three higher order thinking questions, five and six, than were the P types gain scores. This could be a reflection of the high need for closure of the J types and thus moving ahead to finish the task by ensuring that each question had an answer.

P types demonstrated a zero gain score on their responses to questions five and six. Only one P participant in the experimental group improved in score, from a pretest score of 1 to a posttest score of 2. The other P types either scored the same and thus showed no gain, answered incorrectly, or wrote in only one answer. However, none of the P participants left any questions blank. Some responses were not well thought out or were incorrect. Of the twenty J types, seven or 35% showed improvement from a pretest score of 1 on question six to a posttest score of 3. Two of the J types improved from a score of 2 to a score of 3 on questions six. Three J participants went from a pretest score of 1 to a posttest of 0. The others' scores from pretest to posttest remained the same or the differences were within one point. Thus, the range of scores from 0-3 was limited and could have inhibited significant differences.

Since the posttest item weighting was developed according to Bloom's Taxonomy, analysis of variance of the gain scores was calculated individually for each of the six questions on the Case Study Instrument. Higher order thinking skills involve analysis, evaluation, and creation of new information, as described in Bloom's hierarchy, and optimal weights were applied to each question incrementally in a manner consistent with previous studies and the scoring rubric design was also based on a similar model used in these studies (Athanassiou, et al., 2003; Crowe, et al., 2008;

Scott, 2003) but had not previously been tested with a group of aviation students. Future research may seek to verify these results.

The highest and most consistent scores occurred on questions one and two. The participants in this study modeled more successful lower levels of thinking in their verbal discourse and case study responses than higher order thinking responses. This is consistent with previous research indicating that students in college classrooms primarily learn at the knowledge and comprehension levels of cognition (Ball & Garton, 2005). A significant increase in gain scores for the experimental group was expected on the higher order thinking questions of the case study instrument, which were numbered as question four, five, and six. For the scores on those questions on the posttest to be equal to or lower than the pretest scores was surprising. Possible reasons and contributory influences follow.

The curriculum of both groups offered similar aeronautical decision making topics, and both groups had at least a degree of authenticity introduced via the case studies and the Case Study Instrument. Although the experimental condition clearly provided more authenticity, more scaffolding and peer support, and more use of the case study instrument, the inclusion of even small amounts of those factors in the control condition may have been a possible deterrent to significant differences between the groups. Above a certain level of scaffolding and fading, no further increase in the effect of the Case Study Instrument was observed. Prolonged use of the instrument above that which may have been needed may have caused other undesired course response effects, such as not taking the posttest seriously. The researcher and instructor noted consistently that use of the accident cases in any manner in both groups continued to cause an increased positive response as new and different accidents were introduced and did not appear to have a saturation effect.

Regarding the six-weeks' time constraints of the experimental module, research demonstrates that not only is engaging students in higher order thinking complex and challenging but determining the evidence that it has actually occurred is even more problematic (Nentl & Zietlow, 2008). Other studies have discovered that the not having enough time during an entire semester (Athanassiou, et al., 2003; Betts, 2008) or even an entire year is enough (Crowe, et al., 2008) to help students develop higher order thinking skills that require deep conceptual understanding. Students often have difficulty performing at these higher levels and it takes considerable time and effort to increase student engagement in the learning process (Bransford, et al., 2000; Facione, et al., 1993; Halpern & Hakel, 2002; Zoller, 1993).

The test timeframe of thirty minutes to complete the six questions may have also been problematic. However, the researcher and CRM Instructor both monitored for completion times and neither noticed body language indicating that the time was inadequate nor did either receive requests for more time. The thirty minutes appeared sufficient and the majority completed the tests ahead of time. Of great interest on the posttest for the experimental group as observed by both the researcher and CRM Instructor was that participants took even less time to complete the posttest.

Perhaps if participants had more exposure and modeling of the conceptual differences between deep and surface learning and the correlation of these concepts to the six levels of Bloom's Taxonomy, it may have helped transfer their learning to the development of all responses. Also, studies show that developing deep learning (identified as Case Study items four, five, and six) over surface, rote learning (such as items one and two) may be improved through a reminder of the value of the higher order thinking concept and increased time devoted to exploration of the higher order thinking concepts (Marshall & Horton, 2011). As an example, responses to question six, “Given the combination of human factors presented in this case, create rules (that is, rules of thumb, new procedures or methods) for yourself and fellow pilots,” were awarded a score of 3 for providing three or more new rules or new ideas to avoid a similar accident in the future. Only two participants in the experimental study scored a 3 for providing three or more new rules/ideas. A likely explanation may be that the novelty of the exercises wore thin and the drive was to finish the exercise. Also, there may have been concerns that the researcher’s project was coming to an end and it may have created an environment of submission to the research project or to the researcher’s wishes rather than one of demonstrating knowledge by completion of the posttest.

Another possibility was participant over exposure to the case study instrument by the time of posttest that caused some to be less serious about the responses and for others to not complete it. The control group participants, who had less explicit and repetitious exposure to accident reports and the Instrument, spent considerably more classroom time answering the posttest questions. This history and maturation effect could have been a distraction to the experimental students and contributed to a less than expected effort on the posttest. As Larkin (2001) suggested, “Avoid boredom. Once a skill is learned, don’t overwork it.” It was not apparent that any participant perceived the posttest task to be difficult. As the researcher and CRM instructor observed, everyone turned in their test on time and no one appeared to be exerting effort to meet the posttest deadline.

Instructional scaffoldings provided to the experimental groups included the instructor modeling how to explicitly use the accident reports in conjunction with the six questions of Bloom’s as practiced on multiple accident reports alone and in groups throughout the six weeks. The control group was provided with the same pre and posttest accident report and the Case Study Instrument. However, their instruction on aeronautical decision making did not explicitly teach the tool, was instructor-led, and heavily used reading of aeronautical decision making theories and examples from the class required book published in 2010 called “Crew Resource Management” (Kanki, et al., 2010). Theories included references to Bloom’s taxonomy, various commercial accidents with worked out problems, and multiple acronyms for decision systems detailed in chapter two. Qualitative results indicated that both treatment groups benefited from the introduction of the Case Study Instrument and the accident reports as a form of scaffolding. The participants in the experimental group received explicit, frequent, and experiential engagement with the Case Study Instrument. The control group members demonstrated their interest and enthusiasm on their brief introduction to the Case Study Instrument and accident reports as they asked questions during the class section on accident investigation and human factors topics. The implicit scaffolding of the Case Study Instrument to the control group may have mitigated possible differences between the two conditions.

Qualitative results confirmed that the use of the Case Study Instrument based on Bloom’s hierarchy as a device to study and problem solve the accident report was helpful and positively impacted participant's beliefs, attitudes, and interviews. The results were that this practice influenced a positive change in learning about human factors and the elements of higher order thinking. The Case Study Instrument based on Bloom's hierarchy of six levels helped both J and P types but especially the J's resist closure and continue to probe, especially as they moved to item number six of the case study instrument, "Given the combination of human factors presented in this case, create rules (i.e., rules of thumb, new procedures or methods) for yourself and fellow pilots." For J-type participants, it was observed that reopening the accident after having completed the evaluation in question five, "Evaluate/critique this pilot's actions in terms of the degree to which error(s) could have been avoided," was frustrating, as they presumed question five to be the final next step in their thinking about the case.

As this study assessed achievement of improvement in higher order thinking skills through the use of the Case Study Questionnaire responses, which were largely based on Bloom's Revised Taxonomy, it may be useful to introduce other tools that measure changes in critical thinking steps, such as the Watson-Glaser Critical Thinking Appraisal or peer researched rubrics that can be adapted to assess participants' improvement. Other analytic rubrics using terms from the revised Bloom's Hierarchy to evaluate the participants' levels of thinking also could be useful.

Participant interviews, Beliefs Questionnaire responses, and classroom observations demonstrated that participants were engaged with the tool and did use the six questions to start with the lower order thinking and move to the higher order thinking ultimately culminating in time spent generating new thinking, creating new ideas, drawing upon prior knowledge to think critically and derive heuristics for future flight and fellow pilots. Some reported that the best help they received was when the researcher invited a high time pilot into the class to comment and elaborate on accident cases and prompt more scenarios that helped the students to think more critically about what they could do when they encountered similar circumstances in the future.

While the focus on the accident reports led participants to generate valuable data and to discern the expert's opinion on probable cause, qualitative results showed that when using the accident reports, participants learned about the topic of human factors in CRM in a manner consistent with the expectations of the research. Interview data revealed that the participants in both treatment conditions unanimously rated the inclusion of these reports as providing them with the most learning that they experienced in the module. Several indicated they were excited about the use of the accident reports and had made it a goal to leverage the new learning and transfer this knowledge to other courses and aviation activities as well as to their current and future flight students as many were certified flight instructors for the university aviation program. As their understanding of the value of reviewing accident reports increased, participants spoke in their interviews about the desire to use more interactive and student-centered activities like this for when they would be teaching their students, as certified flight instructors.

Some participants reported that the best help received was when the researcher or Instructor as experts explicitly commented and elaborated on the accident cases and prompted more scenarios that caused them to quickly make association and applications while thinking critically. Several participants mentioned that making time for this expertise of the researcher and instructor in a cooperative team setting served as another excellent resource for them to gauge their progress, reflect on their ideas, and learn from others.

Many educational studies support the notion that instructional scaffoldings improve higher order thinking (Anderson & Krathwohl, 2001; Brown, et al., 1989; Ennis, 1993; Facione & Facione, 2007; Granello, 2001; Halpern & Hakel, 2003; Jonassen, 2003b; Lave & Wenger, 1991; Myers, et al., 1998; Palincsar & Herrenkohl, 2002; Reigeluth & Moore, 1999; Zimmerman & Paulsen, 1995; Zohar & Dori, 2003). The qualitative evidence of the current study showed that a combination of instructional scaffoldings to teach aeronautical decision helped improve higher order thinking skills of participants' in both groups. In retrospect, this is not surprising because authenticity and scaffolding were present to some degree in both treatment settings through the use of authentic accident cases and the structured case study instrument. In addition, notable dynamics, new understandings, and phenomena emerged which will be presented and discussed later in this chapter.

3. *Does MBTI J/P preference significantly correlate with metacognitive awareness (MAI) scores?*

There was an expectation that those participants with a preference for J would score higher than P types on the pre- and post-administration for the MAI questions under the Regulation of Cognition categories that included Information Management Strategies and Planning, both hallmarks of a judging orientation to structure and order. However, Ps answered "true" to the MAI questions under these same categories as consistently as J's did.

The MAI may have not have been the ideal tool because pilots tend to want to project a high sense of awareness about how they think and the aviation culture places great value on a preference for structure and order, which are implied in the MAI questions but are not what metacognition is by definition. Other tools that may be used in a future study include The Higher Order Thinking Awareness Survey (Robertson, et al., 2006) which is a modified version of the Schraw & Dennison (1994) survey or The Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich and Garcia (1991). Also, a combination of tests to control for intellectual ability would help determine whether or not preexisting differences existed between the groups and provide more confidence in comparison.

The researcher did not find the MAI results to be useful to this study for two reasons: (1) the pre- and post-self-test MAI scores for both Js and Ps were 90-95% "True," indicating a ceiling effect as the highest scores possible when adding up the points for the "True" answers was reached in many cases and (2) there was no correlation to the J-P scale of the MBTI to the MAI Regulation of Cognition categories that included Information Management Strategies and Planning regarding structure, order, and closure as also defined by the J preferences of the J-P scale.

Compared to the MBTI questionnaire, the face validity of the MAI instrument was weak and participants may have not paid serious attention to it. One reflection of lack of attention was shown when the researcher collected the scoring sheets for the MAI's 52 questions after class in the fall semester. The sheet was a double-sided *Word* document with the MAI statements 1-25 numbered down the left on side one and statements 26-52 on side two. Two column headers to the right of the MAI statements were titled True or False for participants to put a check mark under True or False. When the results were collected, seven of the fifteen students did not complete the reverse side of the document and the researcher had to track them down at the next class to complete statements 26-52. Perhaps the format of the True and False statements led some to simply mark the True column as an indication of their beliefs of metacognitive awareness. In addition, their failure to turn the sheet over may have indicated expediency, boredom, or lack of interest or attention.

Further, few students are self-aware, metacognitively astute, and self-regulated (Pintrich, 2002; Zimmerman, 2002) and the MAI may not have been the best tool for evaluating their metacognition. Schraw and Dennison’s (1994) studies have reported inconsistent results from one study to another, as discussed in chapter two. In addition, most of Schraw and Dennison’s studies using the MAI with college student populations were “traditional samples” of psychology students while the results with “nontraditional samples,” such as medical students, could not be said to support the view that metacognition increases due to education. Thus, as reflected in chapter two, self-reports may not be the best way to measure metacognition.

Both J and P aviation students understand that the discipline and culture of aviation requires the attributes of metacognition for success and thus they may have quickly identified the pattern of True/False questions and answered “true” to most of the questions on both administrations of the MAI. In addition, the MAI was administered along with three other forms/assessments within the same class hour on the same day, raising the possibility that test saturation may have occurred. In addition, numerous factors can produce unreliability in metacognitive performance (Kelemen, Frost, & Weaver III, 2008). The present findings are consistent with other studies of unreliability in metacognitive performance among students. Schraw et al. (1995) found that overconfident participants tended to remain so over time and across tasks.

Other studies show that participants with higher metacognitive ability had a preference for tasks with clear instructions that involve ambiguity and novelty, in other words challenging tasks. In Batha and Carroll's (2007) study, results suggested that students with high metacognitive ability tend to prefer a mastery approach and strive to improve their understanding. Students who were given a form of metacognitive instruction outperformed others on decision-making tasks. However the students whose metacognition was above average performed worse after instruction. This suggests that not all participants benefit from metacognitive instruction, and more replications of success are needed.

To be effective, aeronautical decision-making must encourage free and open classrooms inviting curiosity, reflective thinking, and inquiry (P-types). For example, since there are more J types in this study as well as in aviation, the researcher and CRM Instructor closely observed the group with the expectation that certain exercises would contribute to anxiety to J types because of the less structured approach of the CRM module. By overtly identifying J types' blind spots and introducing P types' pathways to learning, the participants began the process of broadening their perspective on the cognitive issues of producing significant improvement in their metacognitive skills.

This improvement was observed during many of the classroom exercises. Teaching low-time pilots to use a more open or P style, which is flexible and inquiry-based, as a filter required a process of enculturation so that they could engage in a new way. Structuring cooperative and experiential activities was an invitation to learn not only from the accident content but to use the self-awareness tools of J-P to gain insights from their own understanding of the accident as well as reflecting on the researcher's/instructor's insights and their peers' understanding.

Qualitative results confirmed that scaffolding a form of self-awareness into the CRM instruction through the use of the MAI concepts and the MBTI construct, with particular attention to the last letter of type as J or P, encouraged and influenced all the participants but especially those in the experimental treatment who had a longer and more controlled exposure to the strategies of self-awareness. It caused participants to monitor their responses to the accident report and use of the case study instrument and to try other options individually or while in teams. It also challenged them to be aware of the structured J type preference norm prevalent in aviation training and be mindful and appreciative of P types especially when participating in cooperative group exercises. Next, the discussion of participant beliefs as reflected in research questions 4 and 5 is presented.

4. *Will participants in the experimental group report more positive beliefs regarding higher order thinking and the case study questionnaire, personality and self-awareness as well as cooperative learning, and overall module, than those in the control group? 5. Will there be a significant interaction between the experimental condition and MBTI J/P type on positive beliefs post treatment?*

Comparing the results between the control and experimental groups as well as those with a preference for J and for P showed little distinction regarding positive beliefs. It was expected that those who participated in the experimental module for the entire period of twelve class sessions would report significantly more positive beliefs. Several variables may explain why this expectation was not met. The goal was to receive Beliefs Questionnaire feedback on the six-week module from both the control and experimental group participants prior to delivering an accelerated version of the experimental module to the control group.

Participants were sent a link to the Beliefs Questionnaire after the final class of the research study. All participants from the first semester's control group completed the questionnaire prior to experimental class. During the second semester, however, after completion of the control version of the module and by the date when the control group was to begin receiving the follow-up accelerated experimental module components, four of the eight participants (50%) had not completed the Beliefs Questionnaire. The researcher sent multiple emails to the participants as reminders and eventually did receive a 100% return. However, four of the surveys from the second semester control group were submitted after this section of the control group had already begun receiving the accelerated version of the Experimental module. Therefore, the lack of distinction between the two groups' beliefs results may be, at least in part, a result of exposure to the follow up treatment.

The mean rating on the Beliefs Questionnaire for the treatment condition was marginally higher for P types than for J's, but the difference is not significant. In addition to the explanation posited regarding the four late survey returns during the second semester, another plausible explanation for the lack of difference may be that J's already are cognitively aware of their need for planning, structure, and closure, and agree that their goals more closely aligned to the process of using the case study instrument so continually being explicitly told to do something that is already natural to them may have distracted them.

On the other hand, for P's, the concept of using the case study instrument as a guide to review the accident reports may have been novel and helpful, so P types may have initially responded better. The P's nature to explore alternatives and options was frequently evidenced in classroom observations causing them to explore various responses to the six tasks rather than coming to conclusions. This is consistent with existing literature (Beckham, 2009; Kroeger, et al., 2002; Lawrence, 1982; McCrae & Costa, 1989; Myers, et al., 1998; Quenk, 2009). Another important reason is that both Js and Ps, as experienced pilots who understand the value of working together in crew situations, also equally benefitted from heightened self-awareness and learning more about the other type.

The longer timeframe and the twice weekly classes held at the same time and in close proximity to the mutual gathering place for flight assignments for six weeks in a row also may have created unnecessary tension for control group participants, perhaps making them feel like outsiders and/or less privileged. In addition, some course participants may have talked to one another more than was originally anticipated and may have contaminated the study. It was discovered that a few members of the control groups discussed the MBTI as evidenced by hearing them talk to one another about being J or P. One control group participant asked the Instructor when they would get their MBTI results and why they were not doing more fun exercises like the other class. This awareness of what was happening in the other section may help account for the similar and very positive responses to the questions by both groups with little to no differences. Thus, the lack of distinction between the two groups' Beliefs Questionnaire results presented in Chapter Four may be explained, at least in part, by contamination.

Next, a brief discussion of the importance of understanding the prevailing MBTI culture in the classroom is followed by the impact of rich qualitative findings that the J and P preference provides. As Kise (2004) explained, "Type gave us a neutral language for discovering the participant's basic educational beliefs. And once they could name those beliefs, they could better apply their higher order thinking skills to examine their accuracy and applicability" (p.193).

STJ Culture

While STJ types are not the focus of this study, it is valuable to understand the majority type and their beliefs as they can negatively impact the delivery of constructivist practices to protect the dominant preferences. As many of the participant interviews revealed, using effective interpersonal communication skills was a difficult task particularly for the STJ types, who seek and value control, because relationship matters are not predictable and cannot be controlled. The rarity of constructivist team tools in the aviation classroom is most likely because data conveyed to a largely STJ culture through an instructor-led checklist oriented process is the trusted filter for the culture of aviation, the culture of safety.

While aviation training reform such a FITS are correctly aimed at improving higher order thinking skills of the students, this is often done without regard to the fact that FITS reform efforts to change teaching without examining the underlying STJ assumptions and beliefs, as well as the societal pressures of each Collegiate Education program, may at best produce only a restructure of efforts rather than a transformation in classroom practices and achievement of improved higher order thinking skills.

The validated psychological type of each participant as compared to the majority of types drawn to aviation in chapter two (Boyd & Brown, 2005; Kutz, et al., 2004; Robertson, et al., 2006; Roen, 1991; Wiggins, 1998; Wiggins & Parker, 1998) provided insights into the challenges of effectively teaching aeronautical decision making in a distinctive J culture. The largest percent of pilot types in the current study was ISTJ. While ISTJs comprise only about 6% of the general population, they comprised 25% of the current study participants and account for approximately 30% of the United States armed forces. This type is found overwhelming in the military: combined Army, Navy, Air Force, and Marines is 55% percent Introverted, 72% Sensing, 90% Thinking, and 80% Judging – ISTJ (Kroeger, et al., 2002). In a study of US Air Force pilots, 50% were STJ pilots and 65% of all pilots were J-types (Roen-Pearson, 1986; Wiggins, 1998; Wiggins & Parker, 1998).

The reason it is important to understand the majority type in a classroom setting is that at the heart of aeronautical decision making are effective processes to augment students' abilities to understand emotional and logical gaps in communication. In the present study this means that understanding students' relational styles and personality traits are critical to effective decision making (FAA, 2008a, Chapter 1, p. 2-6).

J and P Preference Impact

How participants experienced the experimental strategies and why their approach might be reflective of their MBTI preference for a Judging (J) or Perceptive (P) cognitive style was identified as instrumental in the beliefs questionnaire. To enhance a view of the profile of pilots in general, and college students who are pilots, more specifically, it was helpful to compare to MBTI descriptive statistics of the participants in this study to a general population of aviation college students. The class makeup resembled the general class MBTI type for aviation related courses and provided insightful clues and implications for teaching higher order thinking to this type (Wiggins, 1998; Wiggins & Parker, 1998). For example, with the group type and combination of preferences in this research study, there was potential for conflict and discomfort for the minority P types learning in a J type classroom environment regarding course beliefs, expectations, and performance.

Metacognition includes awareness of one's thinking processes, self-monitoring, and application of known steps for thinking (Batha & Carroll, 2007; Flavell, 1979; Palincsar, 1986a; Reeve & Brown, 1984; Sternberg, 1998; Zimmerman, 2002). The value of the last letter of type, J or P, is that it is considered the most observable in the way one interacts in the outer world and thus, if they are made more self-aware of the behaviors that manifest in decision-making when operating in a natural J or P preference, participants have options to choose from that may be better in the moment of decision. Knowing where one naturally starts when a decision is to be made, J or P, and knowing the benefits and liabilities of the self-correcting nature of one's thinking is a powerful metacognitive strategy.

The experimental module was designed to reflect a combination of cognitive and constructivist learning theories and strategies that encourage a free and open classroom environment inviting curiosity, reflective thinking and inquiry, peer workgroups, enhanced social and communication skills, and metacognitive strategies. The combined instructional scaffoldings ensured that Js and Ps benefited equally from various methods employed throughout the semester. The researcher, a validated J-type, checked in regularly with the CRM Instructor, a validated P-type, to monitor that they were in sync with the participants' type preferences, class content structure for both control and experimental, and course presentations.

The MBTI psychological community is replete with studies on the predominance of J-types in instructor roles in the classroom, as well as the J business culture of institutions based on a military model such as the FAA which places a high value on orderliness, checklists, compliance, and safety oriented classroom environments. For example, since there were 66.67% structured J type participants in the experimental group of this study, the researcher and CRM Instructor closely observed J's with the expectation that certain exercises would contribute to anxiety among them because of the less structured approach of the experimental module.

By guiding J participants to self-awareness of their blind spots when participating in experiential learning and cooperative teamwork, they began the process of metacognitive and higher order thinking skills development. For P types, guiding them to understand that in aviation team settings there may likely be an equal number or more of J types in the classroom as well as future aviation teams and it will help Ps to anticipate and be prepared to diffuse potential conflicts with the opposite type J.

Therefore, P types scaffolding included that they should expect an atmosphere of closure may rule and it is the P's responsibility to monitor and manage their participation so that their natural desire to keep the dialogue open or going on longer than most Js may feel comfortable with will not be viewed as resisting the Js need for closure or, worse, being cast as a resistor or procrastinator for delaying a decision. In healthy team functioning, Ps can use the opportunity to describe their necessary cooperative group process of ensuring all data has been examined or all ideas have been explored before coming to closure especially when time is of the essence.

Cooperative Learning Community

Personality differences in cooperative group settings positively impacted team members' relationships. A key finding of this study is related to the use of the MBTI in teams. Myers and McCaulley (1998) wrote, "the basic assumptions underlying using the MBTI with teams remain the same: Knowledge of individual differences will help teams identify the particular talents and gifts that each member brings to his or her task; and this knowledge can help reduce conflict by reframing potential sources of misunderstanding as natural individual differences" (p. 348). Qualitative findings affirmed that cooperative groups served as a channel for professional development, self-awareness, and collaboration. Participants in the experimental treatment demonstrated improved instances of working better together to resolve and discuss human factors and to begin to appreciate more fully the benefits of crew resource management in aviation.

Designing a classroom environment that supported cooperative learning proved to be initially difficult because students were accustomed to aviation teaching that included high instructor control, which is contrary to the structure of cooperative learning. Despite their high confidence for success as a pilot, several participants expressed feelings of incompetence and frustration when working closely with others to problem solve with the accident reports in cooperative groups. Often content to simply complete the assignment on their own and be done with it, many participants persisted as they learned and appreciated their own and others' new behaviors in group settings.

The scaffolding of cooperative learning resulted in an active and experiential classroom environment which encouraged the students to interact with their peers using the Case Study Instrument as a guide to the improvement of their higher order thinking. The Beliefs survey data and the interview responses suggest that cooperative learning:

1. Promoted a team based approach that helped participants become metacognitively aware and also begin to identify potential cockpit challenges which an understanding of J-P communication strategies might help mitigate.
2. Provided practice in cooperative group activities with appropriate instructor scaffolding to positively affect performance, attitude, and group interactions in the aeronautical training environment under study.
3. Ensured that effective small group strategies were employed, which included face-to-face interaction, positive interdependence in decision-making, individual accountability, and assessment of the group functioning (Johnson & Johnson, 1994).
4. Encouraged peer interaction and peer mentoring as the participants began to practice engagement in a crew-like environment modeled by the researcher/CRM Instructor. This practice promoted assertiveness, cooperation,

and collaboration to determine that the case studies were effectively and exhaustively analyzed. It also ensured that each team member contributed to the creation of new information to successfully apply their analysis to new situations without having previously encountered the new situation.

5. Scaffolded cooperative learning techniques while using the authentic case studies and scaffolded self-knowledge of J-P differences that provided the participants with learning strategies to engage one another and learn from one another.

These learning communities incorporated active and collaborative activities intended to promote crew resource success beyond the classroom. Such approaches have been linked with increased academic achievement and promoting openness to personal and interpersonal development, as was evident in the experimental approach and comments in the interviews and the Beliefs Questionnaire responses.

The aforementioned participants' beliefs resulted in self-monitoring and self-correcting and team building behaviors that likely will help transfer self-awareness into other courses, events, relationships, and eventually the participant's career in aviation.

Discussion of Additional Findings

Other factors that emerged that may have impacted interpretation of the results to include the use of the course textbook, the student populations' age and associated preferences, and the impact of other dynamics of personality type are now discussed.

Course Textbook

Analysis of participant responses to the interview question, “What produced the least learning in the course?”, revealed the overwhelming answer, “The assigned book.” On the Beliefs questionnaire, responses to the statement, “The textbook helped me learn more about these topics,” revealed that the control group that used the textbook under instructor direction mostly reported “agreed.”

However, experimental group participants who were assigned to read the same sections but for whom the class exercises also allowed them to experience the topics in class mostly reported “disagreed.” In addition, 10 participants (33.3%) made up of members from both the experimental and control group selected “neutral” regarding the textbook. A major change to the CRM course under this study was that, for the first time in many years, a new textbook was introduced in the fall of 2010. This introduction complicated matters for the researcher and CRM Instructor as all prior reading assignments in the former Course Syllabus could no longer be used and a new pages in the book had to be assigned.

The prior CRM course had been laid out to match the flow and structure of the previous textbook. The CRM Instructor and the researcher worked together to identify appropriate pages from the new textbook into the existing syllabus only to discover how many concepts the new textbook was introducing that neither the CRM Instructor nor the researcher were prepared to address. In hindsight, the commitment to introduce the new 2010 textbook was made before the CRM Instructor had a chance to critically evaluate it and compare it to the previous textbook. Upon closer inspection, it contained a more theoretical approach and very different format than the previous textbook.

Therefore, the expectation that there would be a significant difference between the two groups regarding the use of the textbook has little value to this study.

Millennial Generation Participants

The researcher and CRM Instructor frequently discussed learning habits and styles of the new generation of pilots, referred to as the Millennial generation, and reflected in this college class of aviators, who were observed to reject some of the traditional instructional strategies used in this study. Millennial pilots born between 1981 and 2000, and called so because they were the first to start their careers in the new millennia, tend to have distinct preferences regarding classroom structures and behaviors (Glass, 2007). In stark contrast to previous generations, the Millennial generation is unwilling to dedicate much of their daily life to classroom studies and instead prefer to have more of a balance between classes and their other interests (Smola & Sutton, 2002). Also called the Net Gen, Millennials' attributes include a hopeful outlook and a determined attitude but their continuous partial attention perpetuated by their personal devices means they can react negatively towards any forms of information that appears too time-consuming to absorb. They seem to exhibit a 'study to live,' not 'live to study,' attitude.

Further study is warranted to fully investigate this assertion but many empirical studies indicate this generation's difference (Arum & Roksa, 2011; Bauerlein, 2008; Oblinger, 2003; Twenge, 2006). In cooperative or teamwork settings, these Millennials portrayed a complex combination of relationship, personal growth, and organizational challenges to address their ideal learning environments and workplace preferences which are dominated by desires for greater personal freedoms with less oversight and interventions (Niemczyk & Ulrich, 2009).

Regarding unique attention to the learning preferences of the low-time Millennial pilots who were also students, it was especially important to reinforce that aviation is unique in that it is operationally structured on a vast array of rules, regulations, and time schedules. Psychological type was frequently discussed in light of how the establishment and enforcement of aviation requirements comes not just from management, but also from local, state, and federal governments, as well as from the highly regulated J-type FAA Training Industry Standards. Without these, the industry would not be able to function as effectively, efficiently, and safely as it does. Both J and P Millennial learners and pilots as participants in this research were encouraged to discuss their challenges with the J-type culture of aviation.

As another finding that emerged, the generation of Millennial pilots respected and valued the sophisticated graphic tools of the modern cockpit global positioning systems and noticeably perked up whenever they were discussed in light of accident reports or in general conversation. Their experience with instant access and sound bite data has provided them with unprecedented freedoms on the one hand, and limited access to deep learning strategies on the other hand as evidenced when they were tasked on day one to search for accident reports and none were users of the National Transportation Safety Board archive of investigated accident reports by experts. All participants were able to quickly describe recent “crashes” or literally click on their personal devices and retrieve a recent Internet *YouTube* video sensation of the latest “crash” or pilot foibles posted. It was discovered during probing questions in exercises in both the control and experimental groups by the researcher and the CRM Instructor that most Millennials do not use the available information for learning purposes nor do most take advantage of the plethora of subscriptions and interactive programs offered to them free for educational purposes.

As a generational contrast, both the researcher and CRM Instructor, self-identified as members of the Baby Boomer generation who grew up with reading materials as opposed to computer-based research access, not only subscribe to many well-known and widely publicized Safety Journals and aviation magazines but also continue to subscribe to and attend multiple annual association conferences to further their professional development skills as aviators. Since their freshman year, all the junior and senior level participants in this study were offered the same level of subscriptions and conference attendance opportunities, mostly at no cost for students, but when polled during class, most were aware that resources were offered but did not subscribe, and only two subscribed to many various resources with enthusiasm. The access to these scholarly resources is an area in which instructors of all ages could be taught to model explicit use and appreciation so that Millennial pilots, in particular, have a clear understanding of the benefits of these educational safety and career resources as tools for the continual development of higher order thinking and aviation community building.

Aviation education must use tools that are more relevant to the participants' zone of proximal development (Vygotsky, 1978) and to adjust to the different ways each learn. Part of the challenge inherent in the design of the current study may have been that the pre- and posttest requirement was for Millennial participants to *read* a one-page accident report handout in class and to *hand write* their responses to six linear questions (Brown, et al., 1989; Lave & Wenger, 1991). Thus, both motivations to learn and time to complete may have been factors preventing success.

In 2010, the Airplane Owners and Pilots Association (AOPA) introduced an online multimedia learning portal that was launched after this study was underway. Pilots who are students log into the website with a free membership and may select from a number of interactive accidents report formats, some in which the voice of the pilot talks through an accident scenario they survived. They contain real audio of the Air Traffic Control transcripts and cockpit voice recordings to supplement the learning.

In addition, a step-by-step narrative of the conditions and pictures of the chart and flight path are displayed along with safety tips to reinforce the mistakes made by the pilot along the route. The multimedia format is a valuable new offering and would be worth the time to evaluate how to supplement and or replace the strategies and tools used in this study. The goal of such a treatment would be to foster active processes that move the learner from the basic skills and facts to linking new information with prior knowledge and moving from novice to expert-like decision making (Anderson & Krathwohl, 2001; Bloom, 1956; Kerka, 1992) with the aid of computers as multimedia (Chen, 2006; Chen & Bradshaw, 2007; Jonassen, Carr, & Yueh, 1998; Kauffmann, Ge, Xie, & Chen, 2008; Xie & Bradshaw, 2008).

This supplemental learning environment would be specifically designed around similar instructional scaffoldings allowing students multimedia support in the promotion of higher order thinking in cooperative groups. Such research would involve feedback from the students to measure effectiveness of the combination of tools to promote higher order thinking. A longitudinal study that examines not only the results of this proposed interactive multimedia component would increase confidence by following one of more pilot cohorts through the entire program. A study could be repeated at years one, two, and three to determine whether higher order thinking is improving and whether students are more self-aware in their metacognitive strategies, as well as measuring improvement in their abilities to effectively communicate with fellow pilots when involved in teamwork.

Other Facets of Psychological Type

The ability to create new information, to brainstorm ideas and to suggest alternative courses of action are attributes of higher order thinking, which is affected by another scale of the MBTI, the Perceiving dichotomy, represented by the psychologically opposite preferences of Sensing and Intuition. McClure and Werther (1993) report an exercise in time management and how related team tension was substantially reduced when Sensing types were responsible for analysis of the planning details whereas the Intuitive types were responsible for assessing risk and opportunities inherent in the global strategy. The perspectives of both types were encouraged in teamwork and were integrated into a logical implementation plan.

A future study exploring a combination of the second and fourth scales of the MBTI (S/N and J/P) might illuminate a powerful learning strategy for higher order thinking that focuses on both “where I generally start” in gathering data, S or N approach, and “how I can change in this moment before I decide,” a J or P approach. Based on data from the Center for Applied Psychological Type (CAPT) the majority of undergraduates are sensing students. Between 56% and 72% of over 16,000 freshmen at three state universities validate preference for sensing which closely correlates with the general population of sensing types who represent 70-75% of the population. In the many aviation studies, between 60-72% of students report a preference for Sensing (S). Interestingly, 83% of national merit scholarship finalists and 92% of Rhodes Scholars validate preference for intuition (N). CAPT reported that the majority, 64%, of 2,282 university faculty report a preference for intuition (N), although the proportions in the general population are only 25% reporting a preference for intuition (N) and 75% reporting a preference for sensing (S). Taken together, the four combinations of participants (SJ, SP, NJ, and NP) could provide valuable insights for better self-management and improved higher order thinking skills (Murphy, 1992; Myers, et al., 1998; Palincsar & Herrenkohl, 2002; Robertson, 2003; Zimmerman, 2002; Zohar, 2004).

Implications for Aviation Education

Crew Resource Management training generally is recognized as an effective tool for reducing human error in flight operations. However, the implementation of effective training for commercial aviation has been on the National Transportation Safety Board's "Most Wanted" list of safety improvements since 2004. After analyzing data on commercial accidents over a recent 10-year period, the Federal Aviation Administration published a new rule, that mandates, “Crew Resource Management training for commercial airlines must address the captain’s authority; intra-crew communications; teamwork; managing workload, time, fatigue and stress; and aeronautical decision-making skills” (FAA, 2011, p. 3831).

In order to achieve its overall goal of higher order thinking improvement, a systemic change is called for that will ensure that leadership and faculty have the skills to not only teach higher order thinking strategies but recognize their continuous improvement. The challenge does not entirely rest on the student's inability to improve but on an aviation educational system that has too long perpetuated a "teach to the book/test only" mentality allowing pilots to navigate through some courses such as crew resource management which is considered a "non-technical skills" course with minimal difficulty. Training should also bring about appropriate changes in attitudes and should strive for that unique synthesis between improvement of the individual's heightened self-awareness and promotion of organizational objectives.

When most participants reach this required course in their aviation management, they will have studied many stick and rudder courses that emphasize critical thinking skills development. However, the type of thinking required for manual operation of equipment does not readily appear to transfer to case study analysis and especially the creation of new information (Kanki, et al., 2010; O'Hare, 2003; O'Hare, et al., 2009; O'Hare & Wiggins, 2004; Robertson, 2005). Many of the students are accustomed to responding to faculty with a "tell me what to do" attitude. Although the FITS focus is a learner centered model, many colleges are just beginning to encourage the locus of control to move from the instructor to the student, as presented in the current study. Too often, the culture of aviation has created an environment where instructors tell students what they should know and refer them to the text for further worked out example. Constructivist instructional strategies that involve student centered learning is rarely implemented in the aviation classroom.

This study provides qualitative evidence that participants can be encouraged to think at higher levels of cognition using the revised Bloom's Taxonomy as a probing questions guide through the use of the Case Study Questionnaire to evaluate their performance as they review accident cases. The use of the instructional scaffoldings of this study supports the development of student responsibility and a student-centered cooperative classroom. In addition, aviation faculty can customize the Bloom's questions or use those provided in Appendix G to help students construct knowledge rather than passively receiving it and then translate this new knowledge into active practice, resulting in fewer accidents.

It will take time and continued strong advocacy for cognitive and experiential measures of higher order thinking to take the place of current aviation classroom features and measures based on outdated instructional models. As this current study emphasized, general aviation education describes and escalates the need for improved higher order thinking, but fails to convey the time, expertise, and training hours necessary to deliver research supported and effective strategies to effect that change. The enthusiasm displayed by the majority of participants based on classroom observations, interviews, and the beliefs survey reinforces the need to design and deliver an aviation training program for the diversity of learning styles and preferences within the student population of aviation pilots.

Limitations of the Study

Sample Size. First, it is important to note that this study was an exploratory investigation of a small group of participants. While the limited sample size makes definitive conclusions tenuous at best, this study raises and addresses some important issues and questions and has important implications for aviation education and research regarding it. While it is evident the participants in this study valued the introduction to higher order thinking, additional research with larger numbers of participants is needed.

Study Duration. This study was primarily designed for junior and senior level aviation student participants in a classroom environment. The training period lasted for six continuous weeks and the class was held twice per week for a total of twelve 75-minute sections or a total of 15 hours of contact time with the participants for the researcher. This duration of time may have been insufficient for most of the participants to absorb the information and apply it to the improvement of higher order thinking skills (Kanki, et al., 2010; Marshall & Horton, 2011; Mulenburg, 2010). Evidence of time constraints were provided to the researcher in conversations with some participants after the study who expressed their wishes for more time, while others felt the time provided was sufficient.

Assumptions regarding motivation. Another factor that was not considered as part of this research was the participants' motivation while attending. The researcher made the assumption that since each participant had demonstrated great achievement in aviation by obtaining multiple aircraft credentials and since each had a relatively high GPA, with 3.32 as the class average, and the course was a core requirement, that the motivation to attend was high. However, as the class was underway, many of the participants seemed unmotivated to study and/or participate at times.

Lack of longitudinal data. No follow-up data from these participants was obtained for the purposes of this study. It might be that there were concerns about the experimental methods that this study missed by not asking more questions on the survey. For example, since the accident reports and the Case Study Instrument for the pretest and posttest were provided in paper form and the participants were expected to complete them in written form, it may be useful in the future to ask about reactions to the media.

Limited expertise of a second instructor. As described in the internal validity section of chapter three, at the recommendation of some dissertation committee members to reduce bias and error, the researcher taught the experimental condition during the fall of 2010 and the CRM instructor taught the experimental condition during the spring of 2011. This was not the preferred methodology for the researcher, who was concerned about the specific MBTI expertise of the other instructor. The CRM Instructor had the benefit of learning about the MBTI in the past and, while he valued it and spoke highly of his personal validation of it, he was not a qualified practitioner of the MBTI tool. The researcher attempted to mitigate this concern via train-the-trainer sessions which were conducted for the CRM Instructor during the summer of 2010, with a refresher delivered in December 2010 (Appendix Q). The CRM Instructor had attended FAA approved military Instructor Training courses over ten years prior but was not a formally trained educator. The researcher approached the study with over twenty years of experiential training workshops in human factors topics and was a certified MBTI practitioner.

One of the reasons for the study was to demonstrate the power of the combination of tools by an expert and to help influence the need for aviation instructors to learn more about how to scaffold these tools of the accident reports, the Case Study

Instrument, and cooperative learning to improve higher order thinking skills. By switching treatment groups between the two instructors with different levels of expertise regarding both teaching methods and MBTI depth, some validity concerns may have been addressed, but new concerns were introduced.

A confluence of distracting events may have caused the CRM Instructor to not pay as close attention to the many instructional variables necessary to conduct the experimental condition. Among those factors was the introduction of a new CRM course book that both the researcher and CRM Instructor were using. In addition, the CRM Instructor was trying to learn how to deliver the experimental condition to the spring semester of students while distracted by his daily duties as Director of the College of Aviation. In the future, a certified flight instructor or aviation ground school instructor with and Education degree who can dedicate time to the project, who has a personal stake in the success and outcomes, and who has experience conducting experiential workshops should be a requirement.

Instructor Education. In the future, it would be more effective for the researcher not to be involved in delivering either the control or experimental conditions. Rather, the researcher would teach qualified aviation instructors how to use the instructional scaffoldings effectively as part of a semester-long curriculum. The study would be more consistent as the researcher could remain in the background unobtrusive. The likelihood that the main instructor would continue to facilitate the higher order thinking skills development and content would likely increase because the cognitive skills needed to make good judgments are teachable. In this arrangement, not only would the participants benefit from the consistency of the same instructor but the instructor would become a practitioner of new experiential learning format for higher order thinking and their own professional development. However, for that to be possible, administration must be willing to invest the necessary time, energy, and resources to make curriculum development and instructional design a chief goal.

Because aviation instructors impact this initiative's success, attention must be given to their attitudes and beliefs. Instructors must be clearly briefed about the initiative and enrolled in high quality professional development training to learn how to deliver strategies for skills improvement in an experiential based format. The instructor's attitudes, beliefs, and opinions should be included in the module planning and their concerns openly recognized and addressed. This takes sustained opportunities for professional development, clear and frequent communication, and active engagement with facilitators and instructors as they work to directly impact future classroom practices. In order to scaffold development of self-awareness, metacognition, and higher order thinking in their students, the instructors must be engaged in developing these qualities in themselves.

When the education community better understands how instructors who are successful in challenging students in higher-order thinking spend their time preparing relative to performance indicators, educators will be better able to develop experiences that help instructors transition to more desired instructional patterns (Marshall & Horton, 2011). This understanding may also be extended to flight instruction for one-to-one relationships where nonspecific training practices can give way to more specific flight scenario preparation, guidance, and instruction, helping to refine the development of the aviation instructor's skills and course content for improved higher order thinking and self-awareness as an integral part of flight training.

Instructor Implementation Challenges. There are obvious challenges for the aviation instructor to effectively use the instructional approaches in the current study. 1. It is time consuming upfront to learn this approach and to implement it effectively and there are many implications if time is not invested wisely in instructor development. The full benefits of an instructors' ability to adequately model the desired behaviors of improved higher order thinking by using the accident reports cannot be seen unless the instructors are properly trained. 2. There is potential for misjudging the zone of each participant's proximal development without proper training. This includes the ability of the instructor to thoughtfully identify that area that is just beyond but not too far beyond the participant's abilities, and this varies with psychological type. 3. Instructors must be provided with specific accident report worked examples ahead of time through training so that they may hear how to influence the development of non-technical skills in the aeronautical decision making process. 4. The Aviation Instructor Handbook must be updated to accommodate the combination of instructional scaffoldings and include educational strategies and citations.

Conclusions

The purpose of this research was to examine and compare an experimental approach to the teaching of higher order skills compared to a more typical approach of aeronautical decision making in flight education based on instructor led classroom instructional strategies. The quantitative elements of the study were insufficient to discriminate among the control and experimental groups regarding improvement in higher order thinking skills. Qualitative elements of this research strongly supported patterns of participant beliefs that were most strongly reflected in and influenced by the study's four educational cognitive strategies for improving higher order thinking: metacognition, psychological type for self-awareness, authentic learning, and cooperative groups. These scaffolding strategies were introduced in combination and were identified as the primary influences in the experimental module's successes. The qualitative analysis suggests the participants not only learned how to use the case study instrument to analyze accident cases more effectively but also achieved heightened self-awareness and metacognition for improved self-management. Collected through and derived from rigorous qualitative research, the research has yielded suggestions for a positive impact on future course content.

The experimental module took students out of their comfort zones of experience and habit to teach problem solving and relationship building, both critical human factors in aeronautical decision making. The goal was to introduce and use instructional scaffoldings so that the participants would identify their cognitive preferences and learn to identify possible personal barriers to learning. In this way, participants more quickly became contributing members of groups, crews, and teams that solved problems and generated novel and workable solutions. The self-awareness gained from the MBTI assessment supported problem solving and teambuilding pursuits as an individual and as a member of a team. Various exercises helped to teach individuals about trust-building, communication, assertiveness, and conflict management.

Perhaps if a greater emphasis is placed on studying the human factors that contributed to accidents and understanding human personality type in the context of aeronautical decision making challenges, explicit and meaningful messages will be sent to each crew member as new teams are formed and future challenges are tackled together. These messages would convey that by increasing engagement in the aeronautical decision-making learning process, higher order thinking can be improved, participants' natural preferences and comfort in interacting on teams are both acceptable and able to be mitigated, and strategies can be employed to effectively benefit from using authentic and recent accident reports in cooperative group settings.

Recommendations for Future Research

The research described herein provides suggestions regarding recommendations for future research and practice. Foremost is that of conveying the importance of higher order thinking, complex reasoning, and effective communication with others takes sufficient time to build the case of its importance and centrality to decision making and problem solving. The qualitative results have yielded suggestions for a positive future impact on CRM course content and delivery as well as higher order thinking skills development. The development of such skills is thought to be the core function of a college education and "what many students are not walking away with is something that has long been recognized as invaluable – higher order thinking and reasoning skills" (Arum & Roksa, 2011). Development of such skills may take longer than six weeks to deliver and ensure improved results and then measure consistently improved results.

Accordingly, the following recommendations are offered for policy, practice, and future research:

1. Instructor lesson plans must be revised to specifically include new standardized language and non-technical terms of aeronautical decision making using the combined instructional scaffoldings of this study for students to competently practice in the classroom independently and with team members. Since improvement in higher order thinking skills are to be included in crew resource management with particular attention to aeronautical decision making, clarity on the definition of the higher order thinking as well as understanding of how the mind processes and stores information is needed. Zohar (2004) suggests that to teach for active construction of knowledge, aviation education instructors must understand their roles as mediators of meaningful student learning and of instructional practices that promote higher order thinking skills.
2. Relationship management skills that are needed to teach well in an authentic constructivist learning environment take time to develop. Most instructors today have not been provided adequate professional development training that equips them to provide instructional scaffoldings for humanizing the learning environment. The tools used in combination in this study deserve further research to heighten aviation education instructors' self-awareness for improved self-management in aeronautical decision making. Instructors should receive train-the-trainer support in delivering experiential non-technical skills team exercises. Instructor refresher training could occur before each semester to remind instructors of the value of non-technical skills and effective group

processing. It also should be very clear what ineffective group processing looks like so it can be avoided at all costs. Instructors also should be certified users of the MBTI or other self-awareness tool and be provided regular opportunities to practice their skills with experienced practitioners in the classroom.

3. The absence of an effective instructor training program for aeronautical decision-making is a weak link in the aviation safety chain. Conditions must be created wherein collaborative examination of instructor beliefs can be accomplished and scaffolding provided when instructors are asked to change those beliefs. Exclusive skills acquisition training results in instructors with a metacognitive deficit who know how to teach about aeronautical decision making but do not necessarily know how to integrate authentic and experiential learning based on the student's zone of proximal development into classroom instruction. Specifically, aviation education instructors must be trained how to scaffold thinking activities and help students use higher order thinking skills and to become aware of their patterns of thinking (metacognition). They also must impart how different thinking strategies are required for different problems. Instructors must be able to discern and examine critical or higher order thinking dispositions and abilities as an approach to learning in aviation and transfer this knowledge to their students. Further investigation of the training needs of aviation instructors must be explored and discussed.

4. Aviation educators should ensure that training exercises include a mix of accident reports that address not only commercial or military accidents but also general aviation accidents. Expert modeling of the use of the many databases of

information will become a key to the participant's understanding. The FAA should strongly encourage and seek educational partners to design educationally sound documentation and complimentary multimedia resources for helping instructors use National Transportation Safety Board accident reports as authentic learning to improve aeronautical decision-making skills and higher order thinking skills and heighten metacognitive knowledge development. Encouraging ongoing and open communication of accident errors and near-misses regarding pilot judgment in the cockpit and fostering an atmosphere where fellow pilots are encouraged to voice concerns are other ways that may lead to increased self-awareness, improved communication with others, and overall improved safety systems of the aviation culture.

5. Every institution of aviation education must respond to Millennial pilots' continuous partial attention span to improve higher order thinking skills, as well as to collaborative team outlets to reinforce their sound-bite learning style preferences. The well-designed AOPA web-based interface described earlier should be introduced and used as a low-cost iterative measure for teaching higher order thinking skills improvement using authentic accident reports. For a future study, it would be interesting longitudinally to see whether participants like these pilots develop more use of and appreciation for such resources as they mature. The current study did not account for various levels of technical computer/Internet navigation skills required by the aviation instructor to access and expose participants to the AOPA website safety education and training

programs. There is much to be gained from studying the differences in users and instructors in regard to their acceptance and comfort with multimedia initiatives.

6. Improvements should be made in the instrumentation and procedures used in this study. Since this study used self-report assessments to evaluate the participant's metacognition and self-awareness, there could have been some bias in the responses. Future research should be conducted using a combination of self-assessments and validated tests of requisite intelligence, critical thinking skills, and content knowledge. When surveys are used, participants should be informed regarding the number of items and sections each survey contains so that they can better monitor their progress and completion of each.
7. Feedback surveys or critical incident (Brookfield, 1995) surveys should be a regular practice. College administration, faculty, and aviation instructors should be surveyed regularly to determine whether instructors are incorporating the instructional methods or teaching the elements of crew resource management and aeronautical decision making that the faculty believes they should be teaching (Cassens, 2010). Students should be surveyed regularly for feedback to determine whether they believe they are receiving effective instruction during training. This will help identify any discrepancies between what instructors believe they are teaching and what students feel they are actually learning and practicing.
8. A future longitudinal study is recommended that would generate data that could corroborate or challenge the participant interviews and survey responses that reported higher order thinking and self-awareness improvement and monitor its

engagement and possible improvement in subsequent years of the study.

Questions to explore during the research include: Does improvement in higher order thinking occur? If so, why? If not, why not? Do the four constructs - authentic learning, metacognition, self-awareness, and cooperative learning - work best or are other combinations more appropriate? Why or why not?

Developing a focus on improvement of higher order thinking through self-awareness of learning preferences in the aviation classroom will take time and commitments from all levels of the collegiate organization. It must be a planned and purposeful change that attends to how people communicate and self-manage. It also requires altering the approach to classroom training programs so that individual differences can be recognized and respected. In most cases, this change does not mean rebuilding the aviation training program. Ideally, with the proper guidance, focus, commitment, and time from management, administration, and instructors, the existing content can be repackaged and the instructor population can be retrained.

While this study was designed for aviation students with a specific emphasis on aeronautical decision-making, this study could be adapted and replicated for audiences to more clearly identify the value of improvement in higher order thinking skills as it relates non-technical skills development for members of a technical team. For example, in the summer of 2011 and ongoing since the spring of 2012, the researcher implemented a similar program on mentoring for senior and associate geoscientists. Using a similar combination of instructional scaffoldings as presented in this study, significantly positive survey results on the practices of instructor modeling, scaffolding, and reflection, as well as promoting intentional and exploratory use of higher order thinking strategies among J and P participants for non-technical skills development, are providing early evidence of the success of crew-like interactions in the Geosciences community through effective mentoring partnerships.

In summary, when adult learning is combined with constructivist strategies in an aviation classroom for the improvement of higher order thinking that include self-awareness, metacognition, authentic case studies in a cooperative environment for immediate application, the resulting integrated model of learning can become a potent tool for the development and transfer of aeronautical decision making knowledge. The findings suggest that a module on aeronautical decision making that not only teaches the value and skills of higher order thinking but actively allows the participants to practice independently and with others in a controlled yet student centered environment achieves student satisfaction and improvement.

By the end of the module, participants were more likely to seek out confirmed sources of aviation accident reports, work more collaboratively to create new information, remain metacognitively aware, seek others' views and values in decision making, and were more likely to transfer their learning to practical inflight applications. Most importantly, in the pursuit of becoming proficient, skilled, and safe pilots, the participants will be more likely to reflect on meaningful ways to learn, engage one another, and ponder their educational beliefs for improved higher order thinking.

The meeting of two personalities is like the contact of two chemical substances: if there is any reaction, both are transformed. ~ Carl Jung

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APPENDICES

A - FAA Industry Training Standards Slide (PowerPoint)

B – History of Bloom’s Taxonomy

C – Myers-Briggs Type Indicator® (MBTI) Scales

D - Socio-Demographic Survey

E - GPA – Permission to Release Education Record Information

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I – NTSB Rating Sheet - Case Study 1

J - NTSB Case #1 Answer Key

K - Metacognitive Awareness Inventory (MAI)

L – Myers Briggs Type Indicator (MBTI) Form M

M – Beliefs Questionnaire

N – Semi-Structured Interview Questions

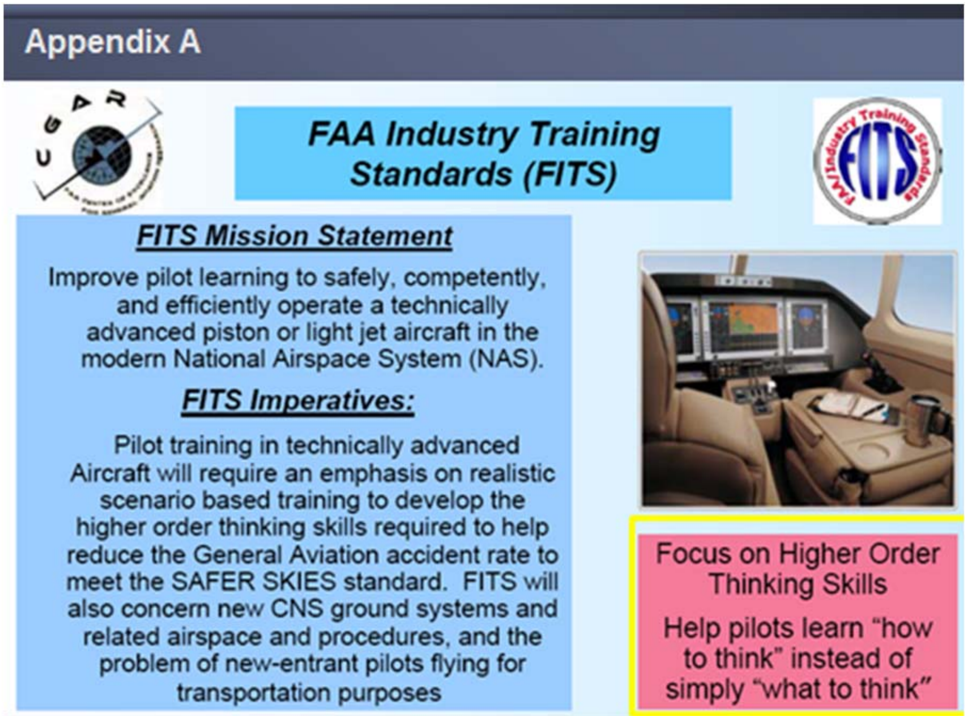
O – Crew Resource Management Course Syllabus

P – Briefing Team Assignments and NTSB Report

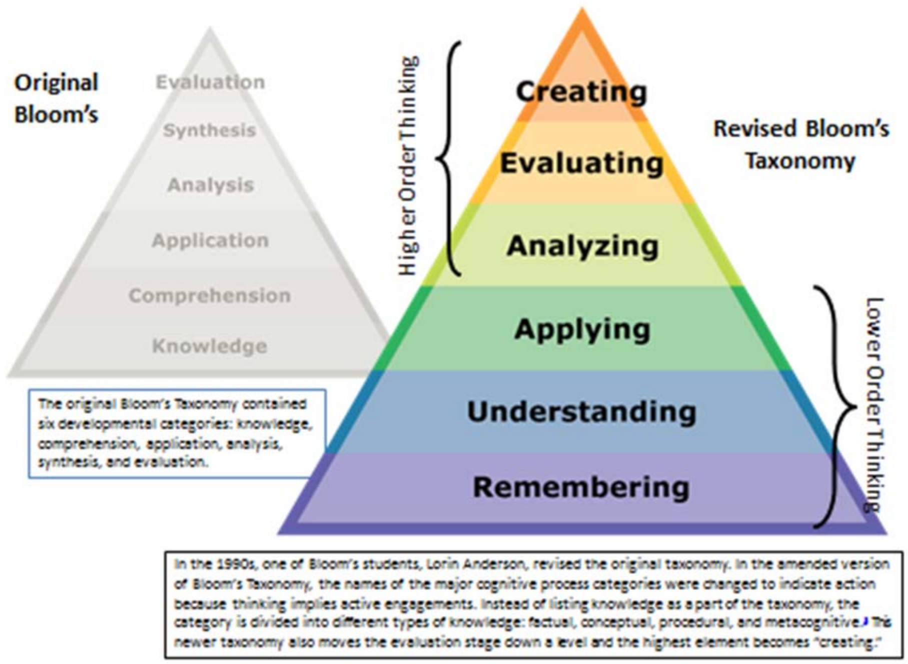
Q – Train the Trainer Narrative

R – Beliefs Questionnaire Responses

Appendix A - FAA Industry Training Standards Slide



Appendix B - Bloom's Taxonomy



Appendix C – Myers-Briggs Type Indicator® (MBTI) Scales

Scale	Descriptions	
E/I - Energy sources - Introversion/ Extraversion	Extraversion (E) – Gain energy from interacting with outer world of people, action and things.	Introversion (I) – Gain energy from inner world of concepts and ideas.
S/N – Data gathering Sensing/ iNtuition	Sensing (S) – Prefer to perceive the immediate, practical facts of experience and life, collecting information through five senses.	Intuition (N) – Prefer to perceive possibilities, patterns and meanings of experience, relying on a sixth sense.
T/F – Decision-making Thinking/Feeling	Thinking (T) – Make decisions objectively and impersonally, seeking clarity by detaching themselves from the problem.	Feeling (F) – Make decisions subjectively and personally, seeking harmony placing themselves within the problem.
J/P – Outer world orientation Judging/Perceiving	Judging (J) – Prefer to live in a decisive, planned, orderly way, aiming to regulate and control events. Often appear closure-oriented, with a focus on a goal.	Perceiving (P) – Prefer to live in a spontaneous flexible way, aiming to understand life and adapt to it. Often appear flexible, open, and non-directive.

Appendix D - Socio-Demographic Survey

1. Name:

2. Gender:

- ◯ Male
- ◯ Female

3. What degree are you seeking:

- ◯ Air Traffic Manager
- ◯ Aviation Management / Non-Flying
- ◯ Aviation Management / Flying
- ◯ Professional Pilot

Other (please specify)

4. What year are you in?

- ◯ Senior
- ◯ Junior
- ◯ Sophomore
- ◯ Freshman

***5. List the names of other courses you have completed that included the subject of crew resource management (CRM) or human factors? If you have not taken any, type "None."**

***6. Are you now working or Have you worked in any facet of the aviation / military / government industry prior to reentering college for this degree?**

- ◯ Yes
- ◯ No

7. If "Yes" to Question 6, please briefly describe # years, employment, position(s)held, and if you used CRM or human factors practices? Otherwise, you may skip this question.

8. Select the ratings you hold:

- ☐ Private pilot
- ☐ Commercial pilot
- ☐ Instrument Rating
- ☐ CFI
- ☐ Multi-engine
- ☐ I'm not a pilot

Appendix E - GPA – Permission to Release Record Information

PERMISSION TO RELEASE EDUCATION RECORD INFORMATION

Students may authorize the release of their education record information to a third party on either a one-time or an on-going basis. Authorizations for release of information on an on-going basis will remain valid for one year following the student's last enrollment at the University of Oklahoma or until canceled in writing by the student at any time. If you have any questions about this policy, please contact the Office of Academic Records at the address below or at (405) 325-4147.

Student's Name: ______________________ Sooner I.D. # ____________________

I authorize release of my information to: Rita Murray, PhD candidate, with an address at:

The University of Oklahoma
Department of Education
Instructional Psychology & Technology

Purpose of the release of information:
You will contribute to a body of knowledge that is studying the development of expertise in aviation. You will not be identified by name. Quality Assurance is provided by IRB.

Please check the appropriate box(es):

- ☐ Please send a copy of my grades at the end of each term to the person names above.
- ☐ Please provide a completed Good Student Discount form to the person named above, upon request.
- ☐ Please provide an official transcript of my academic record upon request to the person named above.
- ☒ Please provide the following specific academic information to the person names above; e.g., GPA information, ACT/SAT scores, etc.
  Cumulative GPA

Please check one:

- ☒ This authorization is valid for this request only.
- ☐ This authorization should remain valid for one year after my last term of enrollment at the University, unless I revoke it before that time.

I understand that I may revoke this consent in writing at any time.

Student's signature: ______________________

Date: ______________________

Office of Academic Records, University of Oklahoma, 1000 Asp Avenue, Norman, OK 73019

Appendix F – Individual Student Case Studies Course Assignment

UNIVERSITY OF OKLAHOMA

You are the lead investigator on a NTSB accident investigation team. You have been called to Washington to brief the Chairman of the NTSB and the Administrator of the FAA.

The following guidelines are to be used in preparing your presentations:

- Plan on a <u>10 minute</u> oral presentation.
- You should some sort of media to present your brief (overhead slides; powerpoint slides, dry erase board, along with a one or two page handout that serves to enhance your presentation.
- Your presentations will be given to the class on the dates indicated on D2L. You must be prepared to present on the **first day** of scheduled presentations

- You should structure your presentation around the following outline:

    - <u>**Present a short summary**</u> of the accident and the circumstances surrounding it
    - <u>**List conclusions/findings**</u> that contributed to accident
    - <u>**What is/are the probable cause(s)**</u> of this accident?
    - Are <u>**there human factors areas related to the causes(s)**</u> of this accident? If so list and discuss them. (may be duplicates of causes/findings above).
    - What <u>**would you recommend as corrective action to ensure that this type accident would not occur again?**</u>

Your grade in this phase will be determined by the thoroughness of your presentation in covering the areas noted above and the <u>professionalism</u> <u>with which you present it.</u> <u>You will need to prepare an outline or summary, or some sort of written material to be handed in the day of your presentation</u>.

Appendix G - Case Study Instrument

AVIA 4423-001 FA09 – Crew Resource Management

NTSB Case Study

Time Limit: 30 minutes

Instructions: Read the attached NTSB accident report. Provide a legible response to each of the six (6) questions below. Use your time wisely.

1. Present the facts/circumstances of the accident.

2. Paraphrase what happened in your own words.

3. Given prior knowledge and the evidence provided, state the probable cause(s) that the NTSB determined of this accident.

4. Identify specific human factors related to the causes(s) of this accident.

5. Evaluate/critique this pilot's actions in terms of the degree to which error(s) could have been avoided.

6. Given the combination of human factors presented in this case, create rules (i.e., rules of thumb, new procedures or methods) for yourself and fellow pilots.

Appendix H – NTSB Accident Case 1

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National Transportation Safety Board
Factual Data Collection Report of Accident

CEN10CA092

Aircraft Reg No: N10401
Most Critial Injury: Minor

Location/Time

Nearest City/Place: Brownstown, IL
Occurrence Date: 01/05/2010
Occurrence Time: 1720 CST

Flight Itinerary

Last Depart. Point: Decatur, IL
Destination: Litchfield, IL

Aircraft Information

Type of Aircraft: Airplane (not Homebuilt)
Make/Model: Cessna / 150L
Serial Number: 15074845
Landing Gear:
Engine Type: Reciprocating
Engine Make/Model: Cont Motor / 0-200A
Aircraft Damage: Substantial
Aircraft Fire: None

Operator Information

Registered Acft Owner: CUVAR PHILIP M
Operator of Aircraft: CUVAR PHILIP M
Operator Address: GRANITE CITY, IL
Reg. Flt. Conducted Under: Part 91: General Aviation

Weather

Condition of Light: Dusk
Wx Cond. at Site: Visual Conditions

First Pilot Information

Cert(s)/Rating(s): Student

Instrument Ratings: None
Medical Cert: Class 3
Date of Last Med. Exam: 04/2008

Flight Time (Hours)

Total All Aircraft: 73
Total Make/Model: 16

Injury Summary

	Fatal	Serious	Minor/None
Crew	0	0	1
Pass	0	0	0

Narrative

""" This investigation is based on information furnished by the Pilot/Operator. Additional details may be found in the Form 6120.1"""

The student pilot stated he was given a clearance to climb out to the west after taking off on the last leg of a three-leg cross country flight. He stated that by the time he was able to turn onto his course heading, he was off his planned route of flight. He stated that the haze and setting sun made it difficult to see, and he was not able to locate his checkpoints to get back on course. The pilot stated that while he was getting help from his flight instructor, the engine experienced fuel exhaustion and he performed an off airport landing. He stated he chose a dark area in the terrain on which to land; however, the field was short and the airplane contacted trees and nosed over during the landing flare. The airplane sustained substantial damage to the wings and fuselage.

Appendix I – NTSB Rating Sheet - Case Study 1

Student Identifier #: ____

Rater Identifier #: ___________________________

Instructions: Case Study is attached for your use in scoring. Upon completion, total the points.

Q	Exemplary 3	Acceptable 2	Needs Improvement 1	Unacceptable 0	Score
1.	Mention at least 20 facts of the case.	Mention at least 15 facts of the case.	Mention at least 7 facts of the case.	No case facts.	
2.	Evidence of thorough understanding reflected in student's paraphrase.	Evidence of good but incomplete paraphrase reflected.	Evidence of poor paraphrasing comprehension and weak summary.	No paraphrasing.	
3.	Reflects correct analysis and excellent ability to state only the NTSB probable cause factors.	Reflects partially correct analysis; good to reasonable ability to state probable cause.	Reflects partially correct analysis but poor ability to state the probable cause.	Incorrect or no probable cause.	
4.	5 or more human factors identified correctly.	Evidence of at least 3 human factors.	1 or 2 human factors identified correctly.	No human factors.	
5.	Evidence of excellent ability to critique and evaluate the case study.	Evidence of good ability to critique and evaluate the case study.	Evidence of very limited ability to critique and evaluate the case study.	No critique.	
6.	Reflects excellent ability to provide 3 or more legitimate "new rules".	Reflects good ability to correctly propose 2 legitimate "new rules."	Reflects limited ability and provides 1 legitimate "new rule."	No new rules or no legitimate rules provided.	
				Total Points =	

Appendix J - NTSB Case #1 Answer Key

Rater Instructions: Students were allowed 30 minutes to complete the following 6-question NTSB case study exercise. Please use this answer key to score each students answers on the attached NTSB Case Study Rating Rater Sheet. The Student's name is hidden and a Student Number Identifier is provided for scoring.

1. **Present the facts/circumstances of the accident.**

   Here are 25 possible facts of the case:

   1) Male student pilot
   2) Accident aircraft - Cessna / 150L
   3) Student pilot was also aircraft owner
   4) Total hours 73
   5) 16 hours in accident aircraft
   6) Accident date was 1/5/10
   7) Accident occurred at 5:20 p.m. (Dusk) (FYI Sunset in IL January is 4:30 p.m.)
   8) Part 91 Operation / training flight
   9) VMC
   10) Held a student certificate for at least two years
   11) Current medical
   12) Last medical was 4/2008
   13) No instrument rating
   14) Last leg of cross country
   15) He was given clearance to climb to West which was not his course heading
   16) Student pilot had trouble with haze and setting sun; could not see checkpoints
   17) He was alone – NTSB Crew total identifies only 1 crew and 0 passengers
   18) He called his CFI on a radio or cell phone to get help
   19) Fuel exhaustion while he was talking with CFI
   20) Off airport landing
   21) He stated he chose a dark area
   22) The field was short
   23) Contacted trees
   24) Nosed over during landing flare
   25) Airplane had substantial damage to wings and fuselage

   Scoring Instructions for Question #1:
   To rate a 3 – mention at least 20 facts
   To rate a 2 – mention at least 15 facts
   To rate a 1 – mention at least 7 facts

2. **Paraphrase what happened in your own words.**

   Use your best judgment to score their answer. It should be a brief statement or two that clearly summarizes the accident.

   Here's an example of an answer that would score a "3- Exemplary.":

Student pilot alone on the last leg of a cross country at dusk, crash lands into trees due to poor time planning, disorientation, and fuel exhaustion.

3. **Given prior knowledge and the evidence provided, state the probable cause(s) that the NTSB determined of this accident.**

   The National Transportation Safety Board determines the probable cause(s) of this accident as follows:

   A total loss of engine power due to fuel exhaustion as a result of the student pilot becoming lost/disoriented in flight.

   Student would receive a score of 3 – Exemplary for the exact and only factors identified by the NTSB above.

   Use the scores of 2, 1, or 0 and the PreTest rating Sheet for guidance on other response.

4. **Identify specific human factors related to the causes(s) of this accident.**

   1) Long-time student pilot flying at or after dark - Accident occurred at 5:20 p.m. (Dusk) (FYI Sunset in IL in January is at 4:30 p.m.)
   2) Did not contact ATC for help
   3) Student pilot had trouble with haze and setting sun and could not see checkpoints
   4) He was alone – Crew total identifies only 1 and 0 passengers
   5) He called his CFI on a radio or cell phone to get help
   6) Fuel exhaustion – poor time management

   Scoring Instructions for #4:
   To rate a 3 – mention 5 or more human factors
   To rate a 2 – mention at least 3 human factors
   To rate a 1 – mention at least 1 human factor

5. **Evaluate/critique this pilot's actions in terms of the degree to which error(s) could have been avoided.**

   Review the students' answer and use your best judgment to score their answer as a 3, 2, 1, or 0 using the scoring descriptions provided.

6. **Given the combination of human factors presented in this case, create rules (i.e., rules of thumb, new procedures or methods) for yourself and fellow pilots.**

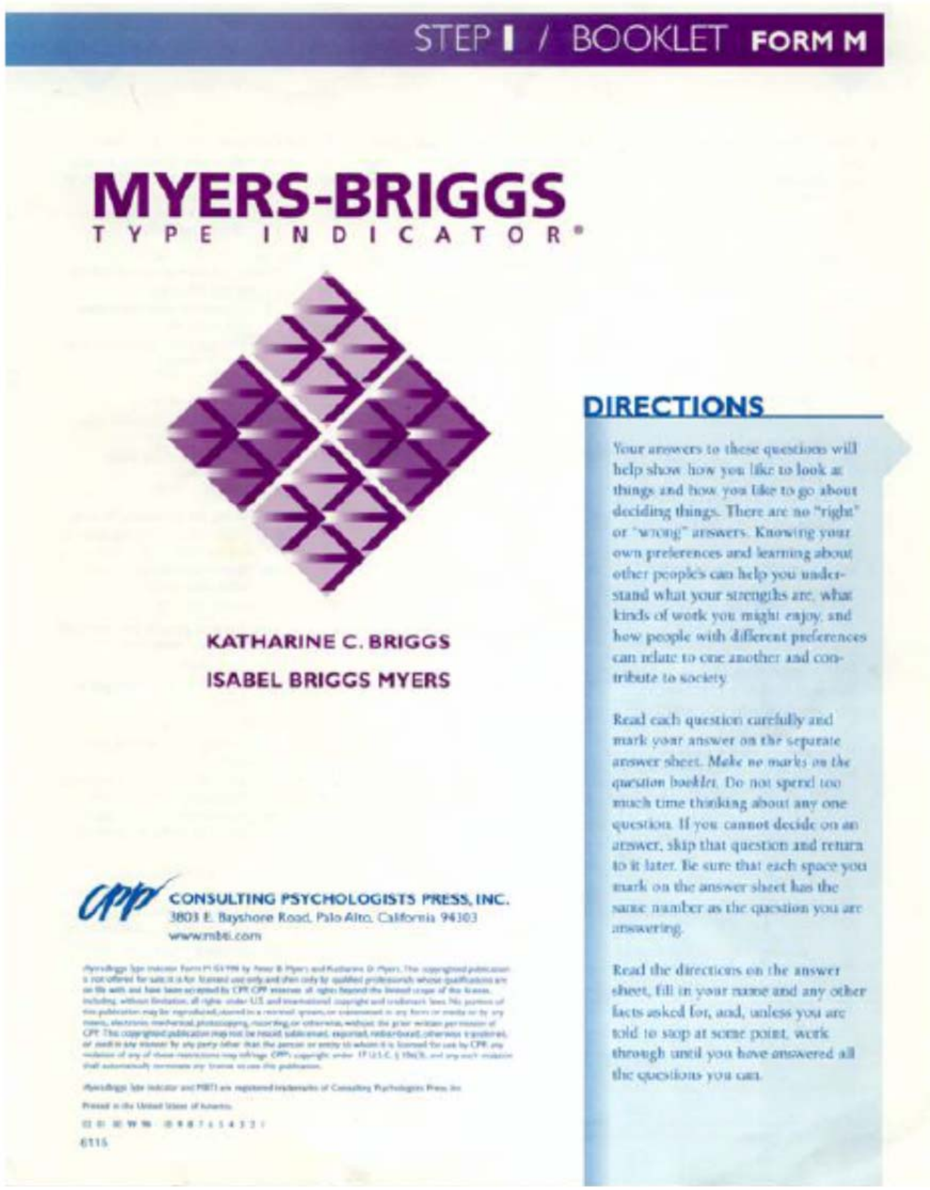
   Use your best judgment to score their answer.
   To rate a 3 – provide 3 or more legitimate and correctly-written "rules"
   To rate a 2 – provide 2 legitimate and correctly-written "rules"
   To rate a 1 – provide 1 legitimate and correctly-written "rules

Appendix K - Metacognitive Awareness Inventory (MAI)

	True	False
1. I ask myself periodically if I am meeting my goals.		
2. I consider several alternatives to a problem before I answer.		
3. I try to use strategies that have worked in the past.		
4. I pace myself while learning in order to have enough time.		
5. I understand my intellectual strengths and weaknesses.		
6. I think about what I really need to learn before I begin a task		
7. I know how well I did once I finish a test.		
8. I set specific goals before I begin a task.		
9. I slow down when I encounter important information.		
10. I know what kind of information is most important to learn.		
11. I ask myself if I have considered all options when solving a problem.		
12. I am good at organizing information.		
13. I consciously focus my attention on important information.		
14. I have a specific purpose for each strategy I use.		
15. I learn best when I know something about the topic.		
16. I know what the teacher expects me to learn.		
17. I am good at remembering information.		
18. I use different learning strategies depending on the situation.		
19. I ask myself if there was an easier way to do things after I finish a task.		
20. I have control over how well I learn.		
21. I periodically review to help me understand important relationships.		
22. I ask myself questions about the material before I begin.		
23. I think of several ways to solve a problem and choose the best one.		
24. I summarize what I've learned after I finish.		
25. I ask others for help when I don't understand something.		

26. I can motivate myself to learn when I need to		
27. I am aware of what strategies I use when I study.		
28. I find myself analyzing the usefulness of strategies while I study.		
29. I use my intellectual strengths to compensate for my weaknesses.		
30. I focus on the meaning and significance of new information.		
31. I create my own examples to make information more meaningful.		
32. I am a good judge of how well I understand something.		
33. I find myself using helpful learning strategies automatically.		
34. I find myself pausing regularly to check my comprehension.		
35. I know when each strategy I use will be most effective.		
36. I ask myself how well I accomplish my goals once I'm finished.		
37. I draw pictures or diagrams to help me understand while learning.		
38. I ask myself if I have considered all options after I solve a problem.		
39. I try to translate new information into my own words.		
40. I change strategies when I fail to understand.		
41. I use the organizational structure of the text to help me learn.		
42. I read instructions carefully before I begin a task.		
43. I ask myself if what I'm reading is related to what I already know.		
44. I reevaluate my assumptions when I get confused.		
45. I organize my time to best accomplish my goals.		
46. I learn more when I am interested in the topic.		
47. I try to break studying down into smaller steps.		
48. I focus on overall meaning rather than specifics.		
49. I ask myself questions about how well I am doing while I am learning something new.		
50. I ask myself if I learned as much as I could have once I finish a task.		
51. I stop and go back over new information that is not clear.		
52. I stop and reread when I get confused.		

Appendix L – Myers Briggs Type Indicator (MBTI) Form M



STEP I / BOOKLET **FORM M**

MYERS-BRIGGS TYPE INDICATOR®

KATHARINE C. BRIGGS

ISABEL BRIGGS MYERS

DIRECTIONS

Your answers to these questions will help show how you like to look at things and how you like to go about deciding things. There are no "right" or "wrong" answers. Knowing your own preferences and learning about other people's can help you understand what your strengths are, what kinds of work you might enjoy, and how people with different preferences can relate to one another and contribute to society.

Read each question carefully and mark your answer on the separate answer sheet. *Make no marks on the question booklet.* Do not spend too much time thinking about any one question. If you cannot decide on an answer, skip that question and return to it later. Be sure that each space you mark on the answer sheet has the same number as the question you are answering.

Read the directions on the answer sheet, fill in your name and any other facts asked for, and, unless you are told to stop at some point, work through until you have answered all the questions you can.

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Appendix M – Beliefs Questionnaire

1. About This Survey

The purpose of this survey is to investigate the relationship between students' beliefs about CRM Human Factors and their success with the module on MBTI and NTSB Case Study Reports used in CRM flight training. Your answers will not affect your grade. Your instructor will not see your individual answers, only the compiled results in report form.

Instructions: You are asked to rate each statement that best expresses your beliefs and perceptions. This information will be very helpful for designing more effective CRM courses.

2. Questions regarding overall content and pacing of the module

1. Please enter your name

2. The following are statements regarding the Case Study Instrument (CSI)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Using the CSI to learn about higher order thinking was beneficial.	○	○	○	○	○
I found it easy to create new rules of thumb.	○	○	○	○	○
I will think more about accident judgments and errors.	○	○	○	○	○
Aviation courses that use the CSI are better than those that do not.	○	○	○	○	○
I enjoyed figuring out answers to all CSI questions.	○	○	○	○	○
I was more interested in reading the accident than answering the CSI.	○	○	○	○	○
Using the CSI helped me identify where I got stuck.	○	○	○	○	○
The 6 CSI levels helped me know how to ask for help.	○	○	○	○	○
I will use the CSI to help me in other courses.	○	○	○	○	○
Judgment, decision making, and communication skills are important for CRM.	○	○	○	○	○
My interest in accident reports has increased.	○	○	○	○	○

Comments:

3. Which questions were most difficult(check all that apply):

- [ ] Bloom's Level 1 - Remember: Present the facts/circumstances of the accident.
- [ ] Bloom's Level 2 - Understand: Paraphrase what happened in your own words.
- [ ] Bloom's Level 3 - Apply: Given prior knowledge and the evidence provided, state the probable cause(s) that the NTSB determined of this accident.
- [ ] Bloom's Level 4 - Analyze: Identify specific human factors related to the causes(s) of this accident.
- [ ] Bloom's Level 5 - Evaluate: Evaluate/critique this pilot's actions in terms of the degree to which error(s) could have been avoided.
- [ ] Bloom's Level 6 - Create: Given the combination of human factors presented in this case, create new rules (i.e., rules of thumb, new procedures or methods) for yourself and fellow pilots.

Comments:

4. Questions regarding MBTI personality preferences:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I learned a lot about myself.					
I learned how to interact with others more effectively.					
I expect some of my behaviors to change.					
I learned more about my classmates' personality preferences.					
I understand more about how my preferences can affect others in CRM.					
I am more aware of how personality affects crew communication.					
I am more aware of how I think because of this module.					
I better understand myself in relation to others on my team.					
Understanding my type helped me use the CSI.					
When answering the CSI, I thought about my MBTI type.					
Team based exercises should be part of every aviation course.					
I will change some of my behaviors.					
I would take an MBTI refresher course if offered.					
I wish important people in my life understood the value of personality preferences.					

Comments:

5. Questions regarding content and pacing of the NTSB Case Study training and the personality type module:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I learned a lot from this module.	○	○	○	○	○
Not enough time was dedicated to this module.	○	○	○	○	○
More time should have been devoted to this module.	○	○	○	○	○
I thought the pace of the instructor guidance was just right.	○	○	○	○	○
The textbook helped me learn more about these topics.	○	○	○	○	○
I learned the value of NTSB reports.	○	○	○	○	○
I will pay more attention to NTSB reports in order to learn.	○	○	○	○	○

Comments:

6. How would you rate yourself in terms of your ability to establish rapport and maintain healthy CRM relationships with others?

○ Superior
○ Above Average
○ Average
○ Below Average
○ Poor

7. What is your level of interest in aviation:

○ Very High
○ High
○ Moderate
○ Low
○ Very Low

Comments:

8. Do you future plans include (check all that apply):

- [ ] Military career
- [ ] Graduate school
- [ ] Aviation related grad school
- [ ] Career in commercial aviation
- [ ] Teaching aviation

Other (please specify)

3. Thank you!

Thank you for taking the time to fill out this questionnaire. Your participation is valuable because knowing more about students' beliefs about flight training and CRM helps improve our course teaching practices.

Appendix N – Semi-Structured Interview Questions

Overall Module Experience

1. Tell me which aspects of the course produced the greatest learning for you, personally? Please explain?
2. Tell me which aspects of the course produced the least learning for you, personally? Please explain?

Prior CRM Knowledge

3. What prior coursework did you complete in Aviation Human factors?
4. Tell me about the skills you possess that makes CRM easy for you to learn?
5. Were any of the CRM concepts challenging for you?
    a. (If yes) Help me understand one of the CRM concepts that were more challenging to you.
    b. (If yes) Can you explain to me what makes it more challenging?
6. Tell me what CRM practices you learned that can help reduce pilot errors.

NTSB case study and higher order thinking improvement

7. Tell me about your interest in aviation accident reports.
8. Tell me about the way you approached the case study instrument.
9. I'm curious about what was new about problem solving the case studies.
10. Were there any case study questions that you were stuck on? If yes, What helped you understand better (or become unstuck)?

Personality and behaviors

11. Tell me why you think personality type is a CRM topic.
12. I'm curious about what you learned about yourself.
13. On a scale of 1-10, how would you rate yourself in terms of your ability to establish rapport and maintain healthy relationships with others?
14. Tell me about working on the team project.
15. Anything else you'd like to tell me about you CRM experiences?

Appendix O – Crew Resource Management Course Syllabus

Wk	Day	Topic	In Class Assignment	Homework	Instruct
1	1	Intro to CRM Review 2010 version of book Class resources and D2L	MBTI Profile (20 min) MAI Assessment (10 min) Review all class resources	Socio-Demographic Web survey Chapter 1 – Why CRM? FAA CRM Advisory Circular Articles online	Ken and Rita
	2	Pretest CRM Human Factors – teamwork	Group A (Ken) and Group B (Rita) NTSB Pretest Case #1 (30 min) - Individual Introduce NTSB - Accident video	Chapter 16 – Accident Investigator Chapter 2 - Teamwork Articles online	Ken/Rita
2	3	Value of Non-Technical skills MBTI – Mental Functions	Return Case Study with Rubric Group exercises by type / CRM examples Assign 3 groups of 2 – prep for NTSB	Chapter 6 – Non Technical Skills pp 182-188 Chapter 3 – Crews as Groups Articles online	Rita
	4	Value of Non-Technical skills (con't) MBTI – Attitudes	Group work by type / CRM examples Self-assessment Return MBTI Profile Reports	Validate type by reading profiles Chapter 4 – Communication Table 4.4., p. 138 Articles online	Rita
3	5	Metacognition and CRM NTSB accident reports	Discuss the MAI results and MBTI Demonstrate aviation examples Practice higher order thinking (HOTS) with accident reports	Chapter 5 – Decision-making p. 194 Categories of skills pp. 403-407 Articles online	Rita
	6	Decision-Making	Small group work with Bloom's Metacognition, Bloom's and NTSB exercise Introduction to NTSB on AOPA	Chapter 4 – Communication Articles online	Rita

Appendix O – Crew Resource Management Course Syllabus (con't)

Wk	Day	Topic	In Class Assignment	Homework	Instruct
4	7	Aviation Decision-Making	Intro to decision-making using Bloom's Higher order thinking skills (HOTS) Reading NTSB reports – online Rubrics discussion; Q&A	Chapter 5 – Decision-making Articles online	Rita
	8	CRM Concepts Review Test Aviation Decision-Making (con't)	In class test of concepts (30 minutes) Prep for group presentations Feedback and crew debriefing techniques	3 groups prepare to present Chapter 3 – Crews as Groups Articles online	Rita
5	9	Group NTSB presentations Crew Briefing and Debriefing CRM Teamwork in action	NTSB Group presentations Videotape 3 groups – max 20 min each w/QA Use Videotape Rubric to evaluate Collect Peer Evaluations	Articles online	Rita
	10	Summary of CRM/NTSB/NO TECHS	NTSB Posttest Case #2 (30 min) – Individual Review of concepts Prep for CRM technical concepts	Chapter 6 – Non Technical Skills Chapter 4.1.4 – Communication concept 4.2.3. Predictable Behavior	Rita
6	11	Posttest	Return Group Rubric scores Return Individual Case Study #2 with Rubric Discussion all CRM concepts to date Debrief experiment Discuss returning to one group of 12 starting next class	Online web survey - Personal Learning Assessment	Rita
	12	Final class	Researcher provides the Treatment to the Control Group and provides their MBTI Profile reports; cooperative groups processing		Rita

CRM Fall 2010 Briefing Team Assignments and NTSB Report Assignments

Link to the NTSB reports file: **http://www.ntsb.gov/Publictn/A_acc1.htm**

UNIVERSITY OF OKLAHOMA

Team STUDENT NTSB Report CASE STUDIES

You and your coworker(s) are new staff at the NTSB headquarters in Washington DC. Your boss calls you into their office and hands you this NTSB report file and tells you….. "You need to prepare and give a no more than 15 oral presentation to the Director of the NTSB who will have some FAA officials with him next week (this is typical in organizations and sometimes the brief may be the next day or two).

Your boss tells you which briefing room you will be in and she tells you that you will have about 14 people in the audience but the brief needs to be short, relevant, enough background to know what happened but to the point. **The key aspect of the brief is to focus on any human factors or aspects of CRM which may have been involved in the accident/incident.**

The following guidelines are to be used in preparing your presentations:

1. Plan on a "no longer **than 15 minute** oral presentation" but at least 10 minutes.
2. You should use some sort of media to present your brief (overhead slides; PowerPoint slides, dry erase board).
3. You must provide the Director (Ken and Rita) and all of your audience (your fellow classmates) a one or two page handout summary of your briefing (this is standard operating procedure at the NTSB for briefings).
4. Should you use slides (and most staffers do). You must provide print outs of the slides (notes pages).

5. You may use other handouts to enhance your presentation such as airport diagram or approach plate, copies of checklist, etc.
6. Your presentations will be given to the class on the dates indicated on D2L syllabus. EVERYONE must be prepared to present on the **first day** of scheduled presentations (Everyone will bring their presentations to class and hand in their handouts that day)

You ask a fellow new staffer who has been at the NTSB a few years about the presentation (this is a very good idea if you go to work in an organization – ask questions!!) and he tells you the following key information and that you should structure your presentation around the following outline:

- **Present the facts of the case**
- **Present a short summary** of the accident and the circumstances surrounding it
- **Ensure you state "What is/are the probable cause(s)** of this accident
- **Your boss asked you to discuss the HF and the CRM aspects therefore…..** What are **the human factors related to the causes(s)** of this accident? List and discuss them. (May be duplicates of facts above).
- **Critique/evaluate** the pilot(s) actions.
- The staffer tells you that the NTSB head is always impressed if you can identify future corrective actions, new procedures, rules of thumb,… what **would you recommend as ideas for you and your fellow pilots to ensure that this type accident would not occur again?**

Your grade in this phase will be determined by the thoroughness of your presentation in covering the areas noted above and the professionalism with which you present it. Your classmates will also peer review your presentation with the following rating sheet.

Appendix Q – Train the Trainer Narrative

The principal researcher who monitored and evaluated the treatment and control group has more than 5,000 hours of experience as a classroom instructor and over 300 flight hours as a certified private pilot. The CRM course instructor agreed to work with the researcher during the 2010-11 academic years and teach classes for both the experimental and control groups. The CRM instructor has thirty years of aviation experience and completed his undergraduate degree and Master's degrees. After air force pilot training he commanded peacetime, wartime and special operations missions in weather reconnaissance and global heavy airlift. During his armed forces career he served as aircraft commander, instructor and flight examiner in varied leadership positions to include commander and director of operations. He has over 4,400 multi-engine international flying hours and instructs in the fields of aviation operational risk management, crew resource management, aviation safety, organizational total quality management, and global and regional logistics / supply chain transportation management.

During the fall of 2010 the researcher taught the experimental condition and during the spring of 2011 the CRM instructor taught the experimental condition. To reduce bias and error, the researcher worked with the CRM Instructor how to conduct the experimental condition. The researcher arranged a series of classes with the CRM Instructor for a total of fifteen hours to ensure that the principles of Bloom's, MAI, and the MBTI would be scaffolding in as identical a manner as possible. The instructor provided PowerPoint slides for each class and provided Instructor Notes.

The researcher is a nationally qualified practitioner of the MBTI and a validated ESFJ. The training associated with ensuring that the CRM instructor could assist students in validating their best-fit MBTI profile was important. The CRM instructor validated ENTP and as part of previous aviation instructor coursework, taught CRM personality styles and has used the theoretical construct. However, he had not taught in depth enough to conduct the course in a similar manner as the fall 2010 semester participants received. Therefore, for a period of three weeks, the CRM instructor and researcher met and reviewed the theoretical constructs of psychological type. Specific instruction was provided on how to conduct the three sessions of classes required to address scaffolding MBTI and Bloom's using the Case Study Instrument. A two-hour videotape of an MBTI Instructor presentation with a workbook was used by the CRM Instructor as a foundation for commencing the training provided by the researcher.

The other trainer was qualified to teach the CRM experimental conditions because of a commitment to human factors principles, domain knowledge, formal training in all aspects of crew resource management. The researcher provided training in how to scaffold Bloom's taxonomy and the MBTI during the CRM course. Formal training in applicable aspects of the non-technical variables to be addressed with the experimental group was provided. Periodic recalibration occurred as both instructors met and audio taped their conversations following each experimental class to ensure that the treatment provided was as similar as possible.

There were explicit goals for the use of the experimental treatment. The researcher explained the design of the intervention, as well as content and guidelines for its use. The researcher reviewed the main sources of rater biases (e.g., hindsight, halo, recency, primacy) with techniques to be used for minimization. The instructor understood the concept of inter-rater reliability and the methods to be used to maximize it. The MBTI training was provided with video examples, discussions, and hands-on exercises. The practical training included multiple examples with iterative feedback and appropriate debriefing skills as well as a formal assessment of instructor competence.

The instructor was provided a detailed outline of each class and the accompanying PowerPoint slides. The researcher and instructor met for one hour before class and one hour after class each day. In addition, for each class that was to be audio-taped or videotaped, instruction directions were included.

Appendix R – Beliefs Questionnaire Responses

Case Study Instrument Items #1-11

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Rating Average	Response Count
Using the six questions to learn about higher order thinking was was beneficial.	36.7% (11)	**46.7% (14)**	10.0% (3)	6.7% (2)	0.0% (0)	4.13	30
I found it difficult to create new rules of thumb from the case.	10.0% (3)	6.7% (2)	16.7% (5)	**53.3% (16)**	13.3% (4)	2.47	30
I will think more about the judgments and errors I make in my aviation career.	30.0% (9)	**70.0% (21)**	0.0% (0)	0.0% (0)	0.0% (0)	4.30	30
Aviation courses that use the case study questions are better than those that do not.	33.3% (10)	**53.3% (16)**	13.3% (4)	0.0% (0)	0.0% (0)	4.20	30
I enjoyed figuring out answers to all the NTSB case study questions.	26.7% (8)	**56.7% (17)**	13.3% (4)	3.3% (1)	0.0% (0)	4.07	30
I am more interested in just reading the NTSB cases than answering the questions about the accident.	13.3% (4)	20.0% (6)	23.3% (7)	**36.7% (11)**	6.7% (2)	2.97	30
When responding to an NTSB case study, using the questions helped me to figure out where I got stuck.	6.7% (2)	**46.7% (14)**	33.3% (10)	13.3% (4)	0.0% (0)	3.47	30
Using the questions helped me know how to ask for help.	3.3% (1)	36.7% (11)	**40.0% (12)**	16.7% (5)	3.3% (1)	3.20	30
I will use these questions to help me in other courses.	10.0% (3)	13.3% (4)	**53.3% (16)**	20.0% (6)	3.3% (1)	3.07	30
Judgment, decision making, and communication skills are important for CRM.	**83.3% (25)**	16.7% (5)	0.0% (0)	0.0% (0)	0.0% (0)	4.83	30
My interest in NTSB case studies as a tool for decreasing my errors has increased.	36.7% (11)	**56.7% (17)**	6.7% (2)	0.0% (0)	0.0% (0)	4.30	30

Beliefs Questionnaire
Personality and Self-Awareness Items #12-25

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Rating Average	Response Count
I learned a lot about myself.	26.7% (8)	**60.0% (18)**	10.0% (3)	3.3% (1)	0.0% (0)	4.10	30
I learned how to interact with others more effectively.	16.7% (5)	**50.0% (15)**	26.7% (8)	6.7% (2)	0.0% (0)	3.77	30
I expect some of my behaviors to change.	10.0% (3)	**50.0% (15)**	26.7% (8)	10.0% (3)	3.3% (1)	3.53	30
I learned more about my classmates' personalities.	23.3% (7)	**76.7% (23)**	0.0% (0)	0.0% (0)	0.0% (0)	4.23	30
I understand more about how my personality type can affect others in CRM.	33.3% (10)	**66.7% (20)**	0.0% (0)	0.0% (0)	0.0% (0)	4.33	30
I am more aware about how personality type can impact communication.	43.3% (13)	**56.7% (17)**	0.0% (0)	0.0% (0)	0.0% (0)	4.43	30
I am more aware of how I think because of this module.	26.7% (8)	**53.3% (16)**	16.7% (5)	3.3% (1)	0.0% (0)	4.03	30
I learned to better understand myself in relation to others on my team.	10.0% (3)	**66.7% (20)**	23.3% (7)	0.0% (0)	0.0% (0)	3.87	30
Understanding my type helped me when critically answering the six NTSB report questions.	6.7% (2)	23.3% (7)	**43.3% (13)**	26.7% (8)	0.0% (0)	3.10	30
When answering the case study questions, I thought about my type.	3.3% (1)	20.0% (6)	30.0% (9)	**40.0% (12)**	6.7% (2)	2.73	30
Team based projects should be part of every aviation course.	30.0% (9)	**36.7% (11)**	20.0% (6)	13.3% (4)	0.0% (0)	3.83	30
I will change some of my behaviors for improved CRM.	20.0% (6)	**70.0% (21)**	10.0% (3)	0.0% (0)	0.0% (0)	4.10	30
I would take an MBTI refresher course if offered.	20.0% (6)	**46.7% (14)**	26.7% (8)	6.7% (2)	0.0% (0)	3.80	30
I wish important people in my life	36.7%	**50.0%**	10.0% (3)	3.3% (1)	0.0% (0)	4.20	30

Beliefs Questionnaire
Overall Module Items #26-32

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Rating Average	Response Count
I learned a lot from this module.	23.3% (7)	**63.3% (19)**	10.0% (3)	3.3% (1)	0.0% (0)	4.07	30
Too much time was dedicated to this module.	3.3% (1)	10.0% (3)	13.3% (4)	**60.0% (18)**	13.3% (4)	2.30	30
More time should have been devoted to these topics.	3.3% (1)	26.7% (8)	**50.0% (15)**	20.0% (6)	0.0% (0)	3.13	30
I thought the pace of the instructor guidance was just right.	16.7% (5)	**63.3% (19)**	13.3% (4)	6.7% (2)	0.0% (0)	3.90	30
The textbook helped me learn more about these topics.	6.7% (2)	26.7% (8)	**33.3% (10)**	26.7% (8)	6.7% (2)	3.00	30
I learned how valuable the NTSB reports are.	44.8% (13)	**51.7% (15)**	3.4% (1)	0.0% (0)	0.0% (0)	4.41	29
I will pay more attention to critically reviewing NTSB accident reports in order to learn.	33.3% (10)	**63.3% (19)**	3.3% (1)	0.0% (0)	0.0% (0)	4.30	30