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Collaborative Audio Transcription and Repair as a Method for Novice Pilots to Learn Approach Briefing Crew Resource Management (CRM) Skills

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COLLABORATIVE AUDIO TRANSCRIPTION AND REPAIR AS A METHOD FOR NOVICE PILOTS TO LEARN APPROACH BRIEFING CREW RESOURCE MANAGEMENT (CRM) SKILLS

by

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This Dissertation was prepared under the direction of the candidate's Committee Chair, Dr. David Esser, Professor, Daytona Beach Campus; and Dissertation Committee Members Dr. Mary Jo Smith, Assistant Professor, Daytona Beach Campus; Dr. Ian McAndrew, Associate Professor, Lakenheath Campus; and Dr. Gillian Driscoll, External Committee Member; and has been approved by the Dissertation Committee. It was submitted to the College of Aviation in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Aviation.

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ABSTRACT

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Title: COLLABORATIVE AUDIO TRANSCRIPTION AND REPAIR AS A METHOD FOR NOVICE PILOTS TO LEARN APPROACH BRIEFING CREW RESOURCE MANAGEMENT (CRM) SKILLS

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The growth of aviation in scope, scale, and complexity increases the demands for student learning, including crew resource management (CRM) skills. Instructor facilitated methods have proven effective for CRM skill learning. This study investigated a method of collaborative audio transcription and repair based learning (CTRBL) offering the potential for reduced demand upon instructor resources for CRM learning. The theory-based CTRBL method was used in this study as a way for novice pilots to learn the CRM skill of conducting a crew approach briefing with a focus on risk mitigation. Learning methods used to develop the CTRBL method were drawn from facilitated scenario-based training in aviation, instructional methods in language learning, and discourse analysis in aviation. The CTRBL method effectiveness was evaluated by a quasi-experimental method using 42 participants formed into 21 dyadic groups. The results suggest that CTRBL is a manageable, independent student activity that is perceived by learners to be nearly as enjoyable as comparable ground-based CRM learning methods. Participants self-rated their post-treatment crew briefings higher than their pre-treatment briefings, and subject matter experts rated post-treatment crew briefings higher than pre-treatment briefings, suggesting the CTRBL method resulted in learning. Recommendations are made for future applications and research of CTRBL.

DEDICATION

To my Lord Jesus Christ in all things: I hope the time devoted to this dissertation pursuit was consistent with your plan for my life.

To my mom and dad, for the many things you tried to teach me—I wish I could have shared this time with you. Dad, on July 18, 1942, you were 25 years old and offered this advice to your brother Jerry Tuccio when he was in North Africa serving under the U.S. 213th Antiaircraft Battalion at the outset of World War II:

> I suggest you keep a notebook, wherein to write things that often you may think worth remembering, or better yet never to be forgotten. You will derive a rich and strange pleasure when someday you shall turn to these notebooks and live again some of the moments which, however hateful when real, will now you have survived them, make you feel good and deep about life, and kindly toward especially the humbler portion of humanity.

ACKNOWLEDGEMENTS

Thanks to my wife Barbara for your love and support in everything I do; through a move and your stroke, you never blinked in your support. One entity throughout this effort that always performed consistently was the Embry-Riddle Library—thank you "Library." Thanks to my Embry-Riddle internal committee. A special thanks to my external committee member, Dr. Gillian Driscoll, for warmly responding to my outreach. A great many people also gave selflessly of their time and talent. Dr. Paul Craig of Middle Tennessee State University (MTSU) was a subject matter expert (SME) who also offered to help me find participants for the experiment. Thanks to Captain Tom Miller for spreading the word at MTSU in my quest for participants. My good friends Todd Huvard and Dr. Michael Hodish served as SMEs and actors. Tracy Brannon of SIMCOM graciously helped me find necessary SMEs. Thanks to all the SMEs from all sources, including Arlynn McMahon, John H. Schmitt, Bill Gant, Brent J. Tuchler, Spence Watson, Jenna Albrecht, Dr. Loren Groff, Erin Gormley, Dr. Joe Gregor, and Jim Ritter. Scenario actors included Julia Hodish, Elizabeth Chatsworth, Mitch Warren, Dennish Thibeau, Tina Orvin, Mary Gianelloni, Emmett George, and Captain Sean Minear. Thanks to Dr. Kat Wilson and Captain David Lawrence for their advice. I was greatly assisted in finding participants through the support of Carolina Anderson, Paul Wirkowski and David Freiwald. Susie Bencsik perfectly orchestrated the facilities needed to conduct the experiment. Thanks to my colleagues Dr. Buck Joslin, BJ Goodheart, Dr. Floyd Bland, and Kelly Whealan-George for their assistance. Dr. Tony Lynch and Dr. Guy Smith also shared their knowledge and experience. Thanks to Dr. Alan Stolzer for the student assistantship opportunities and for coordinating Embry-

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CHAPTER I

INTRODUCTION

The dynamic complexity of modern work environments has created a significant need for workforce learning (Salas & Fiore, 2007) and aviation is no exception. The increasing capability and complexity of aviation systems has expanded the need for pilot learning (Federal Aviation Administration, 2011; Kearns, 2010). In the commercial aviation segment, learning demand is further increased by fleet growth and pilot retirements, creating an influx of relatively inexperienced pilots in need of learning (Boeing, 2011). In the general aviation segment, the capability and complexity of the aviation system has increased initial, recurrent, and transition learning needs of all pilot experience levels (French, Blickensderfer, Ayers, & Connolly, 2005). In both commercial and general aviation, the need for crew resource management (CRM) skills has further increased learning demands (Kearns, 2010).

Skills necessary for effective CRM include communication, coordination, stress identification, team building, and crew briefings among other factors. When these skills have been correctly applied, crews have achieved the effective use of all available human, hardware, and information resources to mitigate risk and promote safe operations (Federal Aviation Administration, 2004a; Gregorich, Helmreich, & Wilhelm, 1990).

One key technique emphasized by the Federal Aviation Administration (FAA) for CRM learning has been the use of instructor facilitation, which has been used across all pilot experience levels (Dismukes, McDonnell, Jobe, & Smith, 2000; McMahon, 2009; Summers, 2007). Techniques that have used instructor facilitation include scenario-based training (SBT), FAA Industry Training Standards (FITS), and Line Oriented Flight

Training (LOFT). One CRM skill trained and used across experience levels to mitigate risk has been the use of briefings in such operational phases as pre-flight planning, crew introductions, takeoff briefings, approach briefings, and post-flight debriefs (Federal Aviation Administration, 2004a; Federal Aviation Administration, 2009; National Transportation Safety Board, 2009).

Instructor facilitated CRM learning has typically required at least one instructor for every one to three students (Federal Aviation Administration, 2004b). A principal way to reduce training resources is through learning methods that reduce the need for an instructor-facilitator. If such learning methods are possible, learning can be delivered to many students with minimal increases in costs and resources (Kearns, 2010).

In order to create efficient learning methods, Salas and Fiore (2007) encouraged multidisciplinary research. Multidisciplinary areas of aviation facilitated learning, language learning methods, and discourse analysis (DA) combine to offer a theoretical foundation for a CRM learning method with potentially reduced demand for instructor resources. Language learning methods examined in this study engaged learners in collaborative exercises utilizing dictation, transcription, and correction (repair) of language production (Lynch, 2001; Wajnryb, 1990). The transcription element used by language learners shared similarities with DA used for aviation research. Aviation attitudes, behaviors, and communications have been studied by using DA in order to improve CRM skills (Driscoll, 2002; Fischer & Orasanu, 1999; Nevile, 2004a). Language learning methods and DA are related by the discipline of applied linguistics.

The theory-based method introduced and evaluated in this study was developed from aviation facilitated learning and applied linguistics and is referred to as collaborative transcription and repair based learning (CTRBL). The CTRBL method begins with planned learning objectives guiding the design of a scenario. A scenario is recorded as audio of sufficient fidelity to represent the planned scenario as well as salient features of the sociotechnical discourse. A two-step collaborative, student-centered learning process may then occur, as shown in Figure 1. In the first step, aviation-pilot trainees are instructed to collaboratively, verbatim transcribe the audio scenario. In the second step, the transcript produced in the first step is collaboratively analyzed and *marked-up*, with the objective of repairing the transcript to create an ideal scenario.

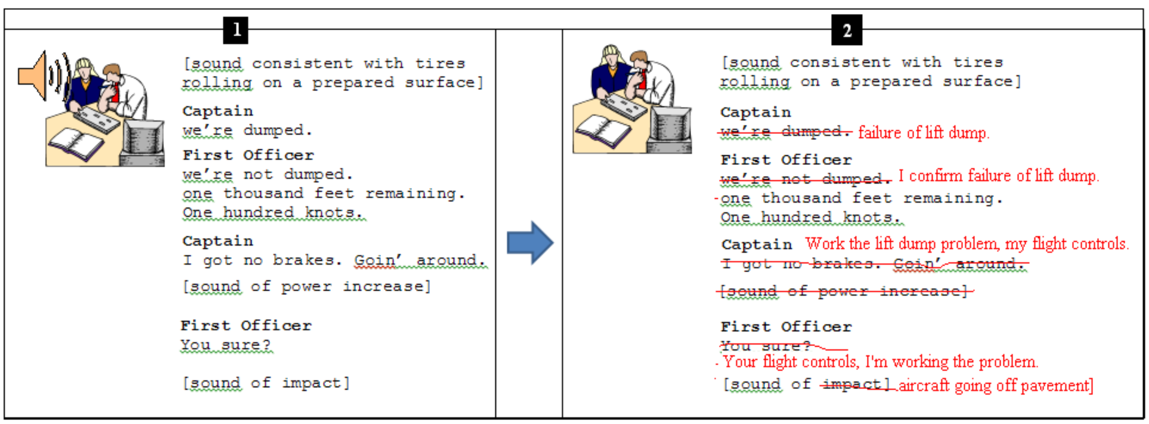


Figure 1. Process diagram of the CTRBL method. Adapted from "Crash During Attempted Go-Around After Landing East Coast Jets Flight 81 Hawker Beechcraft Corporation 125-800A, N818MV Owatonna, Minnesota July 31, 2008," by National Transportation Safety Board (NTSB), 2011.

Statement of the Problem

Instructor facilitated learning has been demonstrated in theory and application to improve CRM skills, leading to improved operational behaviors (Dismukes, McDonnell, et al., 2000; Federal Aviation Administration, 2004b). However, instructor resources are necessary for facilitated CRM learning methods to be effective. Applied linguistics offers a theory-based design of a learning method with reduced demand for instructor resources. The CTRBL method has the potential to be an effective means for novice pilots to learn approach briefing CRM skills. For the purpose of this study novice pilots were defined as those having at least a private pilot certificate with less than 500 hours of flight time.

Purpose Statement

The purpose of this study was to examine whether the CTRBL method is an effective way for novice pilots to learn approach briefing CRM skills. This study gauged effectiveness in three dimensions: the ability of novice pilots to perform the CTRBL method, the reactions of novice pilots to the CTRBL method, and evidence of approach briefing CRM skills learning by novice pilots related to the CTRBL method.

Significance of the Study

First, this study introduced the new CTRBL method to aviation and evaluated whether it was an effective way for novice pilots to learn the CRM skill of an approach briefing. Secondly, this study united the disciplines of aviation and applied linguistics in a unique manner to create a theory-based learning method. Finally, this study promoted learning system design as the basis for technological implementation, as opposed to technology guiding learning system design (Adams & Morgan, 2007; Kanki & Smith, 2001; Salas & Fiore, 2007).

Delimitations

Only dyadic subject groups were considered in this study, as collaborative dynamics of different size groups was expected to introduce confounding effects (Dismukes, Jobe, & McDonnell, 2000; Driscoll, 2002). As only English speaking audio was used, subjects were restricted to those for whom English was their first language, to reduce confounding influences. Further, this study focused on U.S. civilian flight training and did not consider multi-cultural issues (Hofstede, n.d.) or military applications.

Study participants were a homogeneous group of undergraduate, novice pilots with limited flight and CRM experience who were actively engaged in flight training. Different participant demographics may affect study outcomes.

Participants were asked not to disclose experiment details with other potential participants, and participants were asked if they had knowledge of experiment details. Participant knowledge of experiment details may have affected results (Lichtenstein, 1970).

Instructional design is required for SBT to plan and create scenarios (Federal Aviation Administration, 2008b; Kanki & Smith, 2001). While instructional design is expected to be critical to the use of CTRBL in practice, it was not included in this research.

Similar to facilitated instruction, CTRBL may have a broad range of applicability. However, this study focused only on one particular aviation scenario. The process used to create the scenario is described in Chapter III. The scenario used scripted audio spoken by actors rather than naturally occurring discourse. Naturally occurring discourse may change the learning dynamic and was not explored in this study (Heritage & Clayman, 2010).

Only audio content was considered for use in the CTRBL sessions. Although video content may have been effective for the CTRBL method, video transcription by students may have introduced confounding factors and was not considered in the CTRBL method.

Transcription and repair activities used one particular technological approach determined by beta-testing. Many alternative technologies for listening to audio, transcribing, and marking up text existed; only limited alternatives were considered. Participants had time limits imposed on the transcription and repair activities for experimental setting practicalities, which may have influenced outcomes.

Audio may be transcribed in a variety of styles (Duranti, 2006). Only one transcript style emphasizing simplicity of creation and readability was evaluated in this study.

The CTRBL method contained within-treatment moderators of affect, including scenario design, transcription, repair, collaboration, and changes in participant communication skills. Within-treatment moderators of affect were not explored in this study, as doing so would have increased the sample size requirements beyond the scope of this study (Byrne, 2009).

Only immediate effectiveness of the CTRBL method was the focus of this study. No longitudinal measures of long-term effects were examined in order to mitigate the threat of attrition-related validity (Shadish, Cook, & Campbell, 2001; Vogt, Gardner, &

Haeffele, 2012). Behavioral transformation in the workplace and organizational safety results were not examined (Kirkpatrick, 1976; Salas, Wilson, Burke, & Wightman, 2006).

Research Questions

The following research questions were used to evaluate the purpose statement that the CTRBL method may be an effective way for novice pilots to learn the CRM skill of an approach briefing. Research questions focused on three areas to evaluate effectiveness: (1) the ability of learners to perform the CTRBL method, what Lynch (2007) labeled *manageability* (p. 318); (2) the satisfaction of learners with CTRBL, what Kirkpatrick (1976) labeled *reactions* (p. 295); and (3) the skills that were learned, what Kirkpatrick (1976) labeled *learning* (p. 302). Research questions were addressed at two different units of measure: the dyadic subject group and the individual participant.

Manageability research questions. Manageability research questions focused on the ability of participants to perform the CTRBL method. If students cannot perform the method then higher-order measures of reactions and learning are less relevant. Manageability is a necessary, though not sufficient, condition to evaluate student reactions and learning. The manageability descriptive research questions were:

Q-M1. To what extent is the CTRBL method a manageable, student-centered activity as measured by the transcript produced by the dyadic subjects?

Q-M2. To what extent is the CTRBL method a manageable, student-centered activity, as measured by the time and variability the CTRBL exercise takes to perform by dyadic subjects?

Q-M3. To what extent is the CTRBL method a manageable, student-centered activity as measured by a rubric-weighted count of repairs made by the dyadic subjects?

Reaction research questions. Reaction research questions focused on student satisfaction with CTRBL. Favorable reactions do not assure learning, but are indicators of students' interest and enthusiasm as precursors to learning (Kirkpatrick, 1976). The reaction research questions were:

Q-R1. To what extent do individuals rank CTRBL differently compared to an alternative SBT approach to which they were exposed?

Q-R2. To what extent do individuals recommend CTRBL to their peers compared to an alternative SBT approach to which they were exposed?

Learning outcomes research questions. Learning outcomes research questions focused on the learning outcomes of the CTRBL method. These learning outcomes included convergent measures for reliability and a nonequivalent dependent variable to support validity of learning measures (Coryn & Hobson, 2011; Vogt, 2005). The learning outcomes research questions were:

Q-L1. To what extent does individual performance of an approach briefing change after CTRBL, as measured by subject matter expert (SME) scoring?

Q-L2. To what extent does individual performance of an approach briefing change after CTRBL, as measured by individual briefer self-rating?

Q-L3. To what extent does individual performance of an approach briefing change after CTRBL, as measured by the individual rating of the recipient of the briefing?

Q-L4. To what extent does the individual briefer change the self-rating of the pre-CTRBL approach briefing after performing CTRBL?

Q-L5. To what extent does the individual recipient of the briefing change the rating of the pre-CTRBL approach briefing after performing CTRBL?

Q-L6. To what extent does individual performance of the nonequivalent dependent variable, air traffic control (ATC) readback skill, remain unchanged after CTRBL, as measured by SME scoring?

Research Hypotheses

Reaction and learning research questions are restated as testable hypotheses. Manageability research questions were used for descriptive results rather than testable hypotheses and as such are not covered in this section. The numbering scheme used for research questions is maintained by replacing the “Q” prefix from research questions with an “H” for hypotheses.

Reaction hypotheses. The reaction research hypotheses were:

H-R1. The rank individual CTRBL participants give to CTRBL is significantly different than the rank participants give to other SBT aviation learning methods to which they were exposed.

H-R2. The level of peer recommendation individual CTRBL participants give to CTRBL is significantly different than the recommendation participants give to other SBT aviation learning methods to which they were exposed.

Learning outcomes hypotheses. The learning outcomes hypotheses were:

H-L1. Individual performance of the approach briefing delivered after CTRBL is significantly different compared to the approach briefing delivered before CTRBL, as measured by SMEs using a scoring rubric.

H-L2. Briefer individual self-rating of the approach briefing delivered after CTRBL is significantly different compared to the briefer individual self-rating of the approach briefing delivered before CTRBL, as measured by a repeated-measures survey instrument.

H-L3. Non-briefer individual rating of briefer performance of the approach briefing delivered after CTRBL is significantly different compared to the non-briefer individual rating of the approach briefing delivered before CTRBL, as measured by a repeated-measures survey instrument.

H-L4. Briefer individual self-rating of the approach briefing performance delivered before CTRBL, rated before CTRBL, is significantly different from the briefer self-rating of the same approach briefing performance rated after CTRBL, as measured by a repeated-measures survey instrument.

H-L5. Non-briefer individual rating of the approach briefing performance delivered before CTRBL, rated before CTRBL, is significantly different from the non-briefer rating of the same approach briefing performance rated after CTRBL, as measured by a repeated-measures survey instrument.

H-L6. There is no significant difference between individual ATC readback performance after CTRBL compared to individual ATC readback performance before CTRBL, as measured by SMEs using a scoring procedure.

Limitations and Assumptions

The fatigue and fitness level of the participants when they arrived for the experiment was not controlled or assessed. Since the activity was a collaborative exercise, if one member of the dyad had a fatigue or fitness issue, the dyad dynamics may have been affected. For example, in one instance it was observed a participant had the remnants of a cold causing some concern for the partner.

Sound insulation of the rooms may have allowed bleed through of individual audio exercises to be heard by other experimental subjects, influencing independence of measures. Dyad collaborative discussions may have similarly bled through and been heard by other dyads working simultaneously in nearby rooms.

Participants all indicated English was their native language based upon their own interpretation of the question; however, no test was administered to verify the claim. Researcher interaction with all participants supported participant claims that English was their native language.

Participants may have biased their answers to survey and rating questions based on their perceptions of desired experimental outcomes. This bias may have contributed to a Hawthorne Effect in the results.

Air traffic control readback and briefing exercises were performed out of context of a real cockpit, requiring participants to imagine themselves in an actual environment. The varied capacity of participants to place themselves in situ may have added variability to the results.

Most of the instructions given to participants were pre-written; however, the researcher interacted with the participants. Examples of researcher interactions included: stepping through the audio listening software tutorial, explaining Microsoft® Word's® track changes feature, and supplying notepaper to participants. Despite the researcher's efforts to be uniform in the interactions, the interactions may have added variability to the results.

Participants had different experience levels with computers, typing, and use of Microsoft® Word's® track changes feature. More experienced typists may have completed exercises faster than less experienced typists. Participants familiar with Microsoft® Word's® track changes feature may have had more comfort making changes than those participants with less familiarity. These varied experience levels may have contributed to variability of the transcript and repair outputs.

Evaluation methods used by SMEs for transcripts, repairs, ATC readbacks, and briefings were intended to be discriminate within the context of the study. Each SME evaluation was not linked to an absolute measure of learning or aviation safety. The SME scoring values should be interpreted relative to other scores within the study and not interpreted as an absolute measure of learning or safety.

Disclaimer

The views herein were the result of independent research of the author and contributions of SMEs. Views herein do not necessarily represent the views of the National Transportation Safety Board (NTSB), the United States, or the organizations with which individual contributors were associated.

Definitions of Terms

Crew Resource Management. The effective use of all available human, hardware, and information resources. Effective CRM depends upon skills including leadership, communication, coordination, stress identification, team building, team maintenance, information transfer, crew briefings, problem solving, decision making, maintaining situation awareness, and dealing with automated systems (Federal Aviation Administration, 2004a; Gregorich et al., 1990).

Dictogloss. A task-based procedure for grammar learning whereby students are asked to collaboratively reconstruct dictated text; also known as *Grammar Dictation* (Wajnryb, 1990).

Discourse Analysis. "A method of examining human communications and discovering patterns and modes of interaction as well as the possible motivations and goals of participants" (Driscoll, 2002, p. 108).

Manageability. When evaluating a learning method, the ability of students to perform the steps of the learning method (Lynch, 2007).

Novice Pilots. For the purpose of this study, novice pilots are defined as those pilots who have at least a private pilot certificate with less than 500 hours of flight time.

Problem-Based Learning. "The type of learning environment in which lessons are structured in such a way as to confront students with problems encountered in real life that force them to reach real world solutions" (Federal Aviation Administration, 2008b, p. 4-16).

Scenario-Based Training. "A training system that uses a highly structured script of real-world experiences to address flight training objectives in an operational environment" (Summers, 2007, p. 11).

List of Acronyms

APA	American Psychological Association

ATC	Air Traffic Control
ATSB	Australian Transportation Safety Board
CA	Conversation Analysis
CFIT	Controlled Flight into Terrain
CMAQ	Cockpit Management Attitudes Questionnaire
CRM	Crew Resource Management
CTRBL	Collaborative Transcription and Repair Based Learning
CVR	Cockpit Voice Recorder
DA	Discourse Analysis
FAA	Federal Aviation Administration
FITS	FAA Industry Training Standards
FOQA	Flight Operational Quality Assurance
IQR	Interquartile Range
IRB	Institutional Review Board
L2	Second Language
LOFT	Line Oriented Flight Training
LOS	Line Operational Simulation
MEL	Multiengine Land
NASA	National Aeronautics and Space Administration
NTSB	National Transportation Safety Board
PIC	Pilot-In-Command
RCT	Random Control Trial
SBT	Scenario-Based Training

SEL	Single Engine Land
SIC	Second-In-Command
SME	Subject Matter Expert
UTOS	Units, Treatments, Observations, and Settings

CHAPTER II

REVIEW OF THE RELEVANT LITERATURE

Literature is reviewed to support the theory-based CTRBL method. The evolutionary need for CRM learning in aviation is discussed. Problem-based learning methods that have proven effective for CRM learning, such as LOFT and SBT, are introduced. The need for an instructor facilitator in most forms of CRM learning is then shown to be effective for learning, but resource intensive. Studies that have examined ways to reduce instructor resources in aviation CRM learning are explored.

Facilitation and prior CRM learning studies are then integrated with applied linguistics to provide the theory for CTRBL. Applied linguistics in the areas of language learning and aviation research are combined to define the theory-based CTRBL method. The importance of crew approach briefings as a CRM skill is discussed as an application of CTRBL. Finally, measurement techniques used in various studies are outlined to support the quasi-experimental methodology used in the present study.

Aviation Training and CRM

Training demands of commercial aviation have continued to be challenged by an aging and retiring pilot workforce, increased demand for air transportation, and increases in the complexity, density, and capability of aviation systems (Boeing, 2011; Kearns, 2010). Boeing (2011) estimated the worldwide airline fleet will grow to about 39,500 aircraft by 2030 requiring nearly 460,000 new pilots. Training programs will need to adapt to the learning styles of this new generation of pilots in order to gain optimal advantage of the capabilities of the latest generation of aircraft operating in a complex aviation system (Boeing, 2011).

The capability and complexity of the aviation system has affected general aviation training. Novice pilot training demands critical thinking and flight management skills in addition to traditional maneuver-based training. Higher-order skills are necessary to mitigate risks and increase pilot resource management skills including decision making, situational awareness, automation management, and controlled flight into terrain (CFIT) awareness (Summers, Ayers, Connolly, & Robertson, 2007).

Pilot training prior to the 1970s followed an apprenticeship model of instruction, aimed at imparting maneuver-based skills to achieve a predetermined level of technical performance (Kearns, 2010). As aviation grew in complexity, accident trends made clear that training technical skills alone were insufficient for safe operations, resulting in a new component of training focused on CRM (Kearns, 2010; Salas, Burke, Bowers, & Wilson, 2001). Skills comprising CRM include communication, command and authority, conflict management, crew briefings, decision making, team building, team maintenance, workload management, resource management, error identification and repair, and stress identification (Arminen, Auvinen, & Palukka, 2010; Federal Aviation Administration, 2004a; Gregorich et al., 1990; Kanki & Smith, 2001). The FAA (2002) has recommended that CRM skills should be learned as an integral part of all pilot training, from beginner to expert.

LOFT and SBT to Improve CRM Skills in Aviation

One consistently successful CRM learning method has been LOFT (Federal Aviation Administration, 2004b; Salas et al., 2006). Noting the evolution of LOFT in response to the need for CRM learning, the FAA (2004b) described LOFT as an SBT technique whereby crews flew simulators in complete or limited portions of actual flight scenarios. The FAA prescribed that LOFT sessions should have four distinct elements consisting of a pre-briefing, preflight planning, the simulator session, and a debriefing. Debriefings have imparted improved CRM skills through the mechanisms of improved behavioral understanding and positive attitudinal change (Dismukes, Jobe, et al., 2000). The FAA (2004b) emphasized the importance of facilitation in the crew-led debrief. Debrief facilitators have served as a resource to foster crew-initiated review, critique, and discussion.

Facilitation

Facilitation is the process whereby one member of a group helps other members of the group analyze issues and learn from experience. An aviation instructor traditionally conveyed information and evaluated performance. When acting as a facilitator, the instructor instead assists trainees in a learning process driven by the trainees' own inquiry (Dismukes, Jobe, et al., 2000).

The dynamics of instructor facilitation of LOFT debriefings has been studied to determine the nature and effectiveness of the practice. In their study of 36 U.S. airline crews, Dismukes, Jobe, et al. (2000) found that facilitated debriefs were an effective means of CRM learning provided the instructor-facilitator was properly trained in facilitation. In follow-on studies, Prince, Salas, Brannick, and Orasanu (2005) confirmed the need for proper training of debrief facilitators, noting items were often forgotten in debriefs, performance was varied, and valuable resources were often overlooked when facilitators lacked proper training. Dismukes, Jobe, et al. (2000) and Prince et al. (2005) suggested further research into methods to foster greater crew participation in debriefs.

Research areas included debrief tools and more in-depth debriefing of CRM in line operations.

Student-Centered Learning and SBT

While facilitation has been studied extensively in LOFT debriefings, more generally, facilitation is a technique used to manage student-centered, problem-based learning (Federal Aviation Administration, 2008b). Student-centered learning has been shown to elicit active rather than passive student participation, self-initiated learning that is more lasting and pervasive than passive listening, and greater student exploration of his or her own attitudes and values (Dismukes, McDonnell, et al., 2000). Two methods of student-centered learning have been the use of problems to trigger learning through learner-centric activities and collaborative learning achieved through student dialogue (Woodward-Kron & Remedios, 2007).

Student-centered learning has been used successfully for soft-skills learning in domains other than aviation. Adams and Morgan (2007) explored student-centered learning in the design of e-learning systems for corporate leadership training. The authors explained how student-centered learning needed to bring the context of situations to the learner. Effective student-centered learning used provocative, open-ended scenarios to promote student ownership of their learning activities.

Authentic, thought-provoking, context-specific scenarios—SBT—form the basis of student-centered, higher-order skills learning in aviation. Whereas LOFT scenarios are actually flown in simulators, SBT is the general term used to describe learning by way of scenarios, which may or may not include a simulated or actual flight component. Examples of SBT applications include LOFT-like techniques of fly and debrief, single learner case studies, instructor-student discussions, FITS, and collaborative discussions. Instructor facilitation is a key element of SBT in many collaborative training settings (Federal Aviation Administration, 2008b).

In a study of 27 instrument rated pilots, SBT was evaluated as a training technique for single-pilot resource management in technically advanced aircraft. The study found an integrated training approach of SBT with instructor debrief was more effective for learning elements of judgment, decision making, automation management, and situational awareness than traditional, maneuver-based approaches (French et al., 2005).

Dismukes, McDonnell, et al. (2000) summarized the interplay of student-centered learning and instructor facilitation in aviation crew training. The rationale for student-centered learning in LOFT debriefings and SBT was that deeper learning occurred when students were personally involved and collaboratively participated in analysis, rather than listening passively to an instructor. However, the depth of crew-led debriefs varied substantially without an instructor-facilitator; it was the properly trained instructor-facilitator who created consistency in student-centered learning outcomes.

Reduced Instructor Facilitation

By definition, facilitation relies upon one or more learners and one or more facilitators to facilitate learning (Dismukes, McDonnell, et al., 2000). Research and practical experience have recognized the potential productivity benefits of eliminating the need for a human facilitator by way of lesson structure and learning tools (Duivenvoorde, Briggs, Kolfschoten, & de Vreede, 2009; McClernon & Swanson, 1995; Overby, 2002; Smith, 1994).

Self-analysis CRM study. Smith (1994) studied undergraduate, novice aviators to compare instructor-led debrief to instructorless, self-analysis of LOFT debriefings as a means for students to learn CRM skills. Smith provided five dyadic crews with videotapes of their five different LOFT scenarios, written transcripts of their LOFT session communications prepared by a third-party transcriptionist, and a communication analysis of their LOFT sessions as tools to facilitate their instructorless debrief.

Smith (1994) measured effectiveness by using multiple, convergent, repeated measures. Each crew was given two opportunities to perform either a self-analysis or an instructor facilitated debrief. Repeated measures were taken after each of the five LOFT sessions with the intent of gauging CRM skill changes resulting from the debrief method. The 25-question Cockpit Management Attitudes Questionnaire (CMAQ) was completed after each LOFT session. A LINE/Line Operational Simulation (LOS) checklist instrument was completed by trained observers during each LOFT session. A coded communication analysis of each LOFT session was performed by the researcher. A CRM survey was completed by each crew, soliciting student's perceptions of the value of the LOFT session and the debrief that followed. In addition, crews were asked to reflect on the training and write lessons learned.

Smith (1994) concluded that under certain conditions, self-analysis was more effective as a supplemental learning technique when compared to instructor-led facilitation; however, the time involved to create the LOFT session transcripts used as a tool to facilitate self-analysis was expensive and time-consuming to produce, rendering it impractical. Further, compiling the transcript needed for the debrief created a two-day delay between the LOFT session and the debrief activity. The two-day delay decreased the emotional intensity of the learning experience. Smith suggested further research to determine the conditions under which self-analysis might prove effective.

Worksheet guided SBT study. A study by Nokes-Malach, Meade, and Morrow (2012) replaced the facilitator role with a worksheet based approach to guide an aviation SBT session using a combination of expert and novice pilots. In their study, Nokes-Malach et al. (2012) used worksheets to guide subjects through a process of identifying and correcting problems found in a textual description of a contrived scenario. The study compared 16 individual problem solvers to seven dyadic group problem solvers, seeking to find the mediators of collaborative success in a SBT session.

Task performance was measured by Nokes-Malach et al. (2012) based on the accuracy of problem identification and the accuracy of the solution arrived at across four scenarios. Problem identification and solution accuracy were binary measures (e.g., right or wrong) for each of the four scenarios. The study also compared the performance of the experimental subject dyads to theoretical dyads.

Nokes-Malach et al. (2012) concluded that learning was the consequence of a *zone of proximal facilitation* (p. 41), whereby the proper mix of collaborative structure, student prior knowledge expressed as expertise, and content design enabled instructorless, collaborative learning that was aided only by use of worksheet tools. The authors suggested future work should investigate resources that foster collaborative learning of problem-solving skills. Their recommendation was based on observations that the worksheet tools facilitated student tracking of scenario information and may have helped to overcome collaborative inhibition.

Guided mental practice SBT study. A study by Kearns (2007) compared conventional simulator-based SBT training to non-simulator based, instructorless SBT for learning CRM-like affective skills through a process of guided mental practice. In the study of 36 novice pilots, the guided mental practice group watched videos of flight simulations and were asked to imagine themselves in that situation, with the stated emphasis on learning affective skills rather than memorizing the procedures. The study found the student-independent, computer-guided mental practice method produced results that were as effective as a simulator-based training method to train CRM-like affective skills. For Kearns' (2007) study both treatment groups operated with minimal instructor facilitation; however, the simulator-based training technique required significantly greater technical and human resources than that of the guided mental practice group.

Considering Kearns' (2007) findings in light of the other studies in this literature review, two conclusions may be drawn by this study. First, instructorless techniques hold promise for CRM learning using SBT. Secondly, investigating methods that reduce instructor resources and do not require a simulator offer an opportunity for effective delivery of CRM training.

Narratives and stories in learning systems. Guided mental practice learning bears similarities to the use of narratives and stories in complex training environments. Fiore, Johnston, and McDaniel (2007) defined a learning strategy for distributed learning systems incorporating the use of narratives and stories to reduce resources needed to train complex U.S. Navy operations. Narratives provided the opportunity for increased memory recall and retention with reduced instructor resources. Narrative-based learning offered benefits because it immersed the learner in a scenario-based context, while challenging the learner to "engage in imaginative gap-filling by drawing on personal experience" (Fiore et al., 2007, p. 124).

Applied Linguistics

The search for a viable means to learn CRM skills with reduced instructor resources found similarities between aviation and language learning characteristics. Aviation learning used techniques including: facilitation, collaboration, active rather than passive student participation, self-initiated learning, guided mental practice, and narratives. Benefits of aviation learning techniques were longer lasting and more pervasive learning, greater student exploration of their own attitudes and values, learning transfer to operations, and improved CRM skills (Dismukes, McDonnell, et al., 2000; Fiore et al., 2007; Kearns, 2007; Smith, 1994).

Aviation student-centric learning characteristics are similarly expressed in the work of Swain (2004) when she spoke of second language (L2) acquisition and the benefit of *collaborative dialogue* as a *knowledge-building dialogue* (p. 97). The active engagement of students in collaborative dialogue encouraged negotiation of meaning through the students' interactive search for language comprehensibility. Swain defined language learning through the negotiation of meaning as the Comprehensibility Input Hypothesis: L2 learning was caused by the learner understanding input. Swain extended the Comprehensibility Input Hypothesis further and defined the Comprehensible Output Hypothesis: L2 learning occurred when output was produced by the learner.

Dictogloss. Swain's (2004) Comprehensible Input and Output Hypotheses were manifested in the 1990s as a grammar learning method known as Dictogloss, incorporating the use of teacher dictation and student reconstruction (Nabei, 1996). The method was introduced in response to a gap between learners who limited their scope of language to the mechanics of grammar and teachers who recognized language problems as rooted in communicative practice. This gap manifested between students who expected strict grammar lessons and teachers who provided communicative instruction. Dictogloss sought to resolve the gap between learner and teacher (Wajnryb, 1990).

Dictogloss centered around four major steps: (1) preparation; (2) dictation; (3) reconstruction; and (4) analysis and correction (Wajnryb, 1990). A typical Dictogloss lesson involved the teacher preparing students by describing the Dictogloss procedure and the story-scenario. The story-scenario was a section of text from literature, newspapers, or any variety of sources appropriate to the learning objectives. After this preparation, the teacher twice dictated the section of text, the first time instructing students to listen, the next time instructing students to take as many notes as possible, while cautioning students against attempting to transcribe the text verbatim. Verbatim transcription was not possible due to the pace at which the teacher read the text. With the dictation notes in hand, the students were then asked to form into small groups and reconstruct the text they had just heard, as accurately as possible. After the reconstruction, the class collaboratively analyzed and corrected the work produced by each small group (Cardoso, 2009; Harwood, 2008; Wajnryb, 1990).

Dictogloss was documented to have a number of learning benefits. The procedure was, by its nature, a process of active involvement at a variety of levels. Students formed tentative hypotheses about language and communication and then tested these hypotheses throughout the exercise, both consciously and subconsciously. Teachers benefited because the activity was a combined learning and evaluative activity. Students' memory and creativity were challenged by an information gap due to the dictation process. When the students began the reconstruction effort they were faced with imperfect and incomplete information from the dictation step that competed with a writing task to produce a grammatically sound reproduction of what was just heard. This balance between memory and creativity complemented the other benefits of Dictogloss (Jacobs, 2003; Wajnryb, 1990).

Learner collaborative involvement and interaction was a central element of Dictogloss. Wajnryb (1990) suggested nine benefits of the collaborative aspect:

- Task-based collaboration served to trigger and activate knowledge that otherwise may not be accessed. Task-based collaboration fostered hypotheses testing (Wajnryb, 1990).
- The collaborative work spawned greater use of "language involvement" (Wajnryb, 1990, p. 17). Absent a teacher-centric style of learning, more language was used in Dictogloss per unit time than in a teacher-centric style. The quality of the experience was also increased due to interactive "feedback, learner-initiated repair, and monitoring" (Wajnryb, 1990, p. 17).
- Students used language to learn language, creating an authentic reason for interacting, rather than a teacher-constructed reason. Wajnryb (1990) observed the interaction fostered by Dictogloss may have been more important than the text produced as a result of the student interaction.
- Small group collaboration was a more natural setting for language than a whole-class environment. Small group collaboration was less stressful on the

learners than whole-class interaction. Learners were not limited to grammar learning, but were able to "engage in cohesive and coherent sequences of utterances" (Wajnryb, 1990, p. 17).

- Small groups developed their own unique pace, accommodating to the capabilities of the group rather than the whole class. The small group, task-based approach fostered "greater autonomy and independence. The benefits of such reduced teacher-dependence should produce spin-off outside the classroom" (Wajnryb, 1990, p. 17).
- The group environment simultaneously provided some comfort of anonymity of contribution, while also providing "pride of ownership" (Wajnryb, 1990, p. 18) for the output produced. The dynamic of anonymity and responsibility produced individual responsibility for the final product, increasing learner commitment to the exercise (Wajnryb, 1990).
- Small group collaboration increased contributions by individuals and fostered cooperation. The cooperation allowed learners to "complement each others' strengths and weaknesses" (Wajnryb, 1990, p. 18).
- Interaction was removed from the whole classroom, reducing learner stress. The reduced stress encouraged "exploratory talk" (Wajnryb, 1990, p. 18), allowing focus on meaning-building rather than content production. Learners were encouraged to "explore aloud" (p. 18), using language like a non-learner (Wajnryb, 1990).
- Students working in Dictogloss were working with an "information-gap" (Wajnryb, 1990, p. 18) between the language they knew and what they needed

to know to complete the exercise. This information-gap was shown to result in a level of accuracy of student production in Dictogloss as high as in teacher-monitored work (Wajnryb, 1990).

Since 1990, the *ELT Journal* (formerly *English Language Teaching*), has published 16 articles supporting the value of Dictogloss (journal search, December 1, 2011). In a small scale experiment using L2 Asian adult learners, Dictogloss was evaluated and students surveyed for their reaction to the procedure. The teacher reported Dictogloss was a useful learning tool, and the students found the technique useful and enjoyable (Harwood, 2008). The experiment reported mostly qualitative results and did not statistically test the results, limiting its generalizability. While Dictogloss shares characteristics of collaborative SBT, such as collaborative discussion, student-centered learning, and active involvement, there was no evidence that Dictogloss had been directly studied in aviation.

Second language transcription and repair. Modifying Dictogloss, Lynch (2001, 2007) used transcription, rather than dictation, as part of an L2 student-centered learning method. Using transcription rather than dictation allowed for reduced instructor resources during student learning and greater student attention to details due to the repetitive listening required by student transcription. The transcription and repair technique was used on a class of adult, English L2 learners who had varying degrees of English proficiency and who came from multiple culture backgrounds.

The transcription and repair learning technique was described as follows. Students formed into small groups to create and act out a scenario in front of the class as the teacher taped their performance. Students then worked as a group with a shared cassette recorder and transcribed their taped performance (Transcript 1). Thereafter, the students collaboratively revised Transcript 1 to repair any linguistic problems (Transcript 2). Transcript 2 was then critiqued by the teacher resulting in an edited copy (Transcript 3). Students then compared and discussed the three transcripts in a classroom setting (Lynch, 2001, 2007).

In two separate studies using transcription and repair as a learning tool, Lynch (2001, 2007) investigated a number of areas including students' interest in the transcription process; collaboration; types of revisions; and if students could perform the procedure, what Lynch (2007) called *manageability* (p. 311). Lynch (2001) also examined the learning exercise as it related to the Comprehensible Input and Output Hypotheses of Swain (2004). Lynch (2007) postulated that the benefits of collaborative transcription included cooperative learner interaction, attention to fine details in the construction of output, and the opportunity to renegotiate learning.

Lynch's (2001) classroom experiments were measured qualitatively and quantitatively. Lynch (2001) analyzed and transcribed videotapes he made of the students performing the transcription and repair exercise. The analysis showed that students worked cooperatively during the collaborative exercise and students were self-motivated to produce an accurate product. Lynch (2001) noted in all of the four videotaped recordings, the students were so engaged in identification of minute details, he ran out of videotape in all four instances. He also observed how students renegotiated meaning during the transcription exercises. Lynch (2001) summarized his observations by observing the precision demands of the transcription process naturally directed learners towards acquisition of language.

The quantitative measures of Lynch's 2001 study have shown that after transcribing only two minutes of performance, the L2 learner-transcribers subsequently made about 30 repairs to Transcript 1 in order to produce the corrected Transcript 2; the vast majority of the repairs improved the output. In his 2007 study of 14 students, Lynch created a control group of eight students who did not engage in transcription, instead using a teacher produced transcript of their performance. Following the interventions, the students completed reaction surveys. Lynch (2007) found all six members (100%) of the transcribing group found the class, and particularly the transcribing sessions, "useful," with five out of six students (83%) finding the transcription exercise in particular "very useful." The control group had less favorable responses and, in particular, whereas all six students in the transcription group (100%) found the video viewing of their own performance "useful," four out of eight (50%) students in the control group found it "not useful." Lynch (2007) further evaluated learner retention of both groups after six weeks by recording a student oral class presentation. Lynch (2007) then transcribed and scored the presentation relative to language concepts identified in the original performances. The scoring found that there was greater retention in the transcription group (64%) compared to the control group (47%).

Lynch's (2001, 2007) experiments were in large part repeated qualitatively by Mennim (2012) with similar results. Mennim (2012) concluded that collaborative transcription and repair was an effective L2 learning technique. Mennim suggested the reason why the learners responded positively to the transcription and repair process was because it allowed them to address language issues that were appropriate to their own level of performance, develop teamwork skills, and develop problem solving skills in a gratifying learning environment.

The L2 transcription and repair learning studies share characteristics with the aviation facilitated SBT methods discussed earlier. These common characteristics include active participation, self-initiated learning, and deeper processing of information brought about by a collaborative, retrospective based learning environment.

Transcription. The use of transcription as a learning technique found further support in its procedural technique and epistemological foundations. Transcription was defined as a process to transform analog or digital recordings of sound or video into an agreed upon text format for later analysis (Duranti, 2006). Embodied in the discussion surrounding this contextual definition were significant epistemological debates within disciplines using transcription, most of which are of tangential concern to the present study. However, a relevant part of the debate was the trade-off between the readability of a transcript and its phonetic accuracy; this debate influencing the formatting style of a transcript (Duranti, 2006). Figure 2 shows a transformation of audio to text using a transcript format favoring simplicity and readability rather than features such as phonetic accuracy or timing precision.

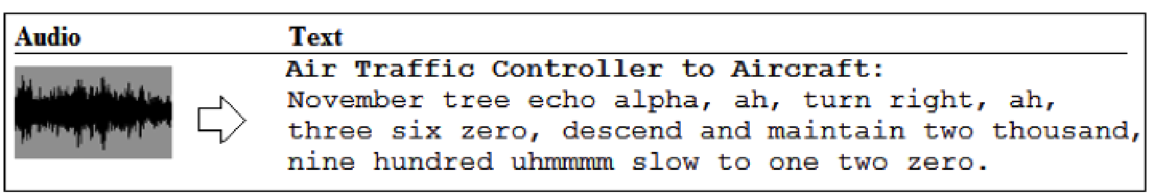


Figure 2. Transcription example converting recorded audio to text. Notional text and waveform created by author for illustrative purposes only.

A transcription format known as *Jeffersonian* is shown on the right in Figure 3 compared to an aviation forensic format on the left; the aviation format emphasizing absolute timing and readability. The Jeffersonian format sacrificed readability, instead emphasizing a notational format that made clear discourse features such as expressing turns in talk, periods of silence, rise and fall of pitch, relative time, and changes in speed. Jeffersonian formatting also required special transcriber training and took more time to produce than other formats (Nevile & Walker, 2005).

Australian Transportation Safety Board Format				**Jeffersonian Format**	
TIME	**FROM**	**TO**	**TEXT**	**FROM**	**TEXT**
1934.05	PIC	SIC	we'll go down to forty-three hundred to there and if you can wind in thirty-four fifty and when we when we get over there wind in twenty-seven eighty that'll be the minimum we'll see how it looks for a giggle and you can put the steps in now too if you wouldn't mind but you only need to put the steps in below the lowest safe (non-pertinent transmissions)	PIC	(18.0) we'll go down to fortythree hundred to there, (0.5) and if you c'n wind in thirtyfour fifty, (0.6)
				PIC	and when we- (0.9) when we get over there wind in twentyseven eighty. (0.3)
				PIC	°that'll be the minimum°. (1.8)
				PIC	see how it looks. (2.5)
				PIC	just for a ↑giggle, (6.4)
				PIC	ah::: you c'n put the steps in there too if you wouldn't mind. (1.5)
				PIC	>but you only need< to put the steps in <below the lowest safe>.

Figure 3. Forensic transcript format compared to Jeffersonian transcript format. Adapted from "A Context for Error: Using Conversation Analysis to Represent and Analyse Recorded Voice Data," by M. Nevile and M. B. Walker, 2005, *Australian Transportation Safety Board (ATSB),* pp. 6-7. Reprinted courtesy of the ATSB.

Transcriber perspectives. In discussing the epistemological implications of transcripts and formats, Duranti (2006) said,

> The temporal unfolding of repeated listening and viewing of the same strip of interaction, as Erving Goffman [sociologist] used to say, makes our transcription process a classic hermeneutical circle, or actually a spiral, in which each loop gives us a new listening, a new viewing, exposing us to the possibility of a new interpretation, which happens at a different time. (pp. 307-308)

The repetition and interpretation aspects can be found in the work of the transcriber and the reflexive impact the transcription process has on the transcriber.

In a transformative social sciences study related to feminism, the researcher asked the transcriptionist to keep personal notes on the transcription process to study the transcriptionist (Tilley, 2003a). The transcriptionist noted how repetitive listening contributed to the construction of meaning. In the study, the transcriber *Ken* (pseudonym) explained, “the only way you can figure out what they’re saying is to go over it and over and over it again…so what at first sounds like a big knot of meaningless noise ends up being several different strings that were tied together” (Tilley, 2003a, p. 759). This repetitive necessity was noted by Lynch (2001, 2007) as one of the benefits observed in the transcription component of L2 learning using transcription and repair.

Ken pointed out the judgments made in transcription, “Deciding where to put in a period, a comma, or an ellipsis. When somebody stops speaking is a complete judgment for each person for each speech that they make” (Tilley, 2003a, p. 758). This comment further supports the assertion that the transcription activity requires precision as well as it being a process of reconstructing meaning (Lynch, 2001).

In another study of the transcriber perspective, the transcriber *Debbie* (pseudonym), expressed how her experiences as the transcriptionist in a study of marginalized female prisoners was quite different from her prior technical transcription, "Because it (the tape) is dealing with personal experience of different people, I'm more interested…I'm not just mechanically typing. I'm listening and sorting it out as I'm typing" (Tilley, 2003b, p. 841). By the end of the study, *Debbie* had formed a friendship with one of the female prisoners who she transcribed, and summed up her transcription experience by saying, "It was like reading a good book. I would never on my own have picked up a book and learned what I have learned from all of this. It kind of, not forced me, but it was a good initiative for me to get involved" (Tilley, 2003b, p. 848). These observations further support the negotiation of meaning and student engagement observed by Lynch (2001) as well as the use of provocation suggested by Adams and Morgan (2007) and Tuccio (2011).

The literature on transcription leads to the following two conclusions for this study. First, a format and style of the transcript must be adopted. Secondly, the perspectives of transcriptionist cultural insiders regarding repetition, meaning construction, engagement, and reflexive experiences are consistent with those suggested as learner benefits of Dictogloss and L2 transcription.

Aviation discourse. Dictogloss, and its evolution as L2 transcription and repair, have evidenced effectiveness for language learning. The adaption of language learning techniques to the aviation domain builds upon aviation research that has used DA and conversation analysis (CA). The similar applied linguistics techniques of DA and CA—one being a macro view of talk the other a micro view of talk (G. Driscoll, personal communication, June 20, 2012), respectively—have furthered the understanding of CRM in aviation (Driscoll, 2002; Fischer & Orasanu, 1999; Nevile & Walker, 2005). Nevile and Walker (2005) pointed out how CA has played an increasingly important role in the study of sociotechnical work environments such as in aviation, medicine, counseling, education, law, policing, business, human-computer interaction, and control centers. The study of CA has led to organizational intervention strategies, whereby organizational practitioners have reviewed recorded data resulting in revelatory and reflexive change (Heritage & Clayman, 2010).

The literature revealed a number of studies and discovered themes from DA and CA from aviation accidents using data from cockpit voice recordings. In her dissertation, *Cockpit Conversation: A Communication Analysis of Three Aviation Accidents*, Driscoll (2002) examined the relationship between communication and safety in aviation. Using existing transcripts and other information from three well-documented accident investigations, DA was used to discover communication and CRM themes.

Loose ends of talk. The tragic CFIT accident of American Airlines flight 965 in Cali Columbia killing 159 people in 1995 was analyzed by Driscoll (2002). She noted the differences between scripted talk often heard through commercial media and real talk, noting real talk contains numerous occasions of "…*loose ends*…of grammar blunders, hedges, and indirect speech. Real people do not always speak in sentences and paragraphs" (Driscoll, 2002, p. 264). Examples of loose ends from flight 965 included "We goin' out…" (p. 264) and "what the, what happened here?" (p. 264) and "where we goin'…we got #[expletive] up here didn't we" (p. 264). These examples were not unique to flight 965; loose ends exist in all parts of spontaneous speech.

Situational awareness and shared mental models. Social and task oriented demands of aviation communication affecting situational awareness have been examined using DA. Driscoll (2002) illuminated the difference between social and task related talk in this way, "…in the more socially-oriented phase of these [accident] flights, the crews all demonstrated effective discussion skills, in the task-related, and also in these instances novel, phase of flight they did not apply them" (Driscoll, 2002, p. 297). In the case of American Airlines flight 965, Driscoll highlighted a lengthy discourse between the captain and the first officer used to resolve a problem with a flight attendant duty time concern. However, when confusion related to loss of situational awareness began, the cockpit communication deteriorated, in kind.

Situational awareness in the cockpit was further elaborated by the CA of Nevile (2004a). After audiotaping, videotaping, and transcribing over 18 routine flights in Australia and Europe, Nevile (2004a) observed that situational awareness is jointly constructed. The pilot's situational awareness "is constructed, demonstrated, and interpreted, moment-to-moment, in the immediate and evolving contexts of the pilots' talk and non-talk activities" (Nevile, 2004a, p. 209). Orasanu (1993) labeled the joint construction of knowledge a *shared mental model* (p. 159). Shared mental models in aviation were subsequently studied, defined, and refined (Smith-Jentsch, Cannon-Bowers, Tannenbaum, & Salas, 2008).

Briefings. The NTSB cited the shared mental model concept of Orasanu (1993) when issuing a safety recommendation encouraging crew briefings in response to the CFIT accident in Guam of Korean Air Flight 801, killing 228 people. The inadequate approach briefing of the captain was cited by the NTSB as a missed opportunity to prepare the crew for the approach. The NTSB recommended improved briefing of visual approaches to improve safety (National Transportation Safety Board, 2000). The NTSB further addressed the importance of briefings in response to the loss of control accident of Colgan Air Flight 3407 in Clarence Center, New York killing 49 people. The NTSB recommended the FAA provide guidance to operators to improve the effectiveness of crew briefings in all phases of operations (National Transportation Safety Board, 2010).

Briefing operational guidelines were consistent with NTSB recommendations. The *FAA Risk Management Handbook* (2009) encouraged the use of briefings in single pilot and crew pilot environments to mitigate CFIT and other risks. The *FAA Practical Test Standards* (2008a) emphasized the importance of briefings as a CRM skill. Briefings were listed as a threat and countermeasures technique in the FAA Advisory Circular *Line Operations Safety Audits* (2006). Airline newsletter communications to crews emphasized the importance of crew briefings as a form of risk mitigation (Lemos, 2007).

Approach Briefing. Nevile (2004b) used CA to examine the micro-interactional features of pilot approach briefings in routine operations based on videotapes of 18 routine flights. One example in the analysis demonstrated that a briefing began with a 13.4 second pause, followed by, "okay we need to plan so the plan shall be, go downhill at fortyeight…" (Nevile, 2004b, p. 457). Missing from the monologue was an introduction of context, such as "It's time to conduct the approach briefing" (Nevile, 2004b, p. 457). Instead, the discourse marker, "okay" (Nevile, 2004b, p. 457), combined with the leading silence, was used to separate the approach briefing from the prior topic. Other salient points of the approach briefing were long pauses not typical in normal discourse. For example, the analysis showed the copilot paused for 3.4 seconds during the brief, and the captain waited and did not interject. Nevile (2004b) noted that this type of silence in task-oriented system operation was normal yet distinct from social discourse.

Nevile (2004b) outlined key features of an approach briefing. The briefing was a social and technical phenomenon involving both talk and interaction, affording opportunities for risk management through crew dialogue. The briefing also embodied a crewmember knowing how to talk, act, and interact like an airline pilot. Nevile (2004b) summarized that the briefing was one way a crew developed and demonstrated a shared mental model.

Context. The approach briefing generally involves intra-cockpit communications. Nevile (2004a) pointed out the general situated aspect of cockpit interaction. Cockpit discourse often involved a remotely situated third party, ATC. Nevile (2004a) observed there were different discourse scenarios: communications where one pilot talked to ATC with no follow-up conversation in the cockpit, and other occasions where the communication with ATC generated a pilot-to-pilot exchange. Both of these interactions took place in a sociotechnical arrangement where both pilots may have heard the ATC communication, or only one pilot may have heard the ATC communication. These unique interactions created permutations of how a shared understanding was created and maintained in the cockpit (Nevile, 2004a).

The breakdown of ATC and pilot communications was noted in the fatal accident of two private pilots flying an experience building flight in Julian, California in 2004. The accident aircraft was one of five, similar call sign aircraft flying the same training route, each separated by five to ten minutes. An ATC clearance for N434PA was incorrectly readback and accepted by N304PA. The aircraft subsequently crashed into terrain in night, instrument conditions. The NTSB determined the probable cause was the use of an abbreviated call sign by ATC in issuing the clearance, and the failure of the pilots to question the clearance, which included a descent below the minimum safe altitude (National Transportation Safety Board, 2004).

Training implications. The aforementioned studies investigated and described aviation situated discourse. Kanki and Smith (2001) outlined three areas of communication objectives in aviation: technical, procedural, and CRM. Examples of technical objectives included flight control, navigation, and systems management. Examples of procedural objectives included checklists, briefings, and air traffic control. Objectives of CRM included leadership, monitoring, workload management, and decision-making. Of these items, the studies of Nevile (2004b) and Orasanu (2010) suggested briefings may lie in the CRM domain of shared understanding, leadership, monitoring, and workload management.

Kanki and Smith (2001) provided guidelines for communication learning including interactive exercises to engage the student, media suggestions, and evaluative principles. The authors noted how communication learning does not need to be expensive to implement, noting in a well-developed curriculum “more learning could occur in a 1-hour session using two chairs and broomstick than in a 4-hour period in a level D simulator” (Kanki & Smith, 2001, p. 119). Notably, none of the aviation discourse literature reviewed considered the application of Dictogloss or L2 transcription-like methods as the basis for an aviation learning method.

Gap in Research and Training Needs in Aviation

The review of applied linguistics, including language studies and DA, completes the review of literature needed to define a theory-based CRM learning technique. This literature review suggested the need for aviation CRM skills learning has been addressed through robust instructor facilitated LOFT and SBT collaborative training methods. However, if effective student-centered methods of CRM learning can be formulated, these methods may provide gains in productivity and a more efficient allocation of instructional resources than instructor facilitated methods. Instructor facilitated methods used for CRM learning in aviation share characteristics of methods used in Dictogloss and L2 language learning; aviation DA research shares elements of L2 language learning. Salas and Fiore (2007) and Kozlowski and Bell (2007) encourage the synthesis of multidisciplinary knowledge and techniques to create and evaluate theoretically based approaches to learning. Following their advice, language learning methods are viewed through the lens of aviation facilitated instruction and aviation DA research so a potential student-centered CRM learning method may be defined and evaluated.

Theory-Based CTRBL Method

As summarized in Chapter I, the theory-based CTRBL method has at its core two main steps as shown in Figure 4. The method begins with instructional design guiding the creation of a scenario. As with other SBT and LOFT techniques, the scenarios are derived and adapted from operational experience, operational problems, mishaps, or accidents (Federal Aviation Administration, 2008b; Stolzer, Halford, & Goglia, 2008). For example, a scenario could be derived from the Julian, California CFIT accident discussed earlier (National Transportation Safety Board, 2004), adapting elements based upon instructional design learning objectives. Whatever scenario is ultimately designed, it is then recorded as audio with sufficient fidelity to represent the planned scenario as well as salient features of sociotechnical discourse.

A two-step collaborative, student-centered process then occurs, as shown in Figure 4. In the first step, dyadic aviation-pilot trainees are instructed to collaboratively, verbatim transcribe the audio scenario according to a provided template style. The template style may be expressed by providing a few lines of exemplary transcription pre-inserted. In the second step, the transcript produced in the first step is collaboratively analyzed and *marked-up*, with the objective of repairing the transcript to create an ideal scenario. In both steps, the structure of the CTRBL method allows the collaborators to work independently engaging in a DA-like activity.

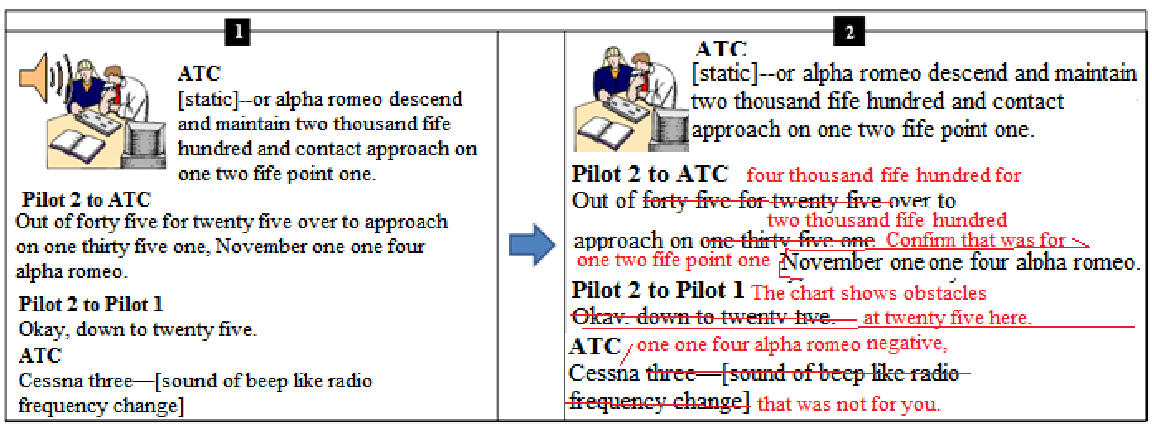


Figure 4. Two central steps of the CTRBL method. Adapted from accident reports and instructional design objectives.

The two central steps of the CTRBL method notionally exist within a larger set of organizational and instructional design features, as shown in Figure 5. Like most aviation SBT methods and the training methods of Dictogloss, instructional design will

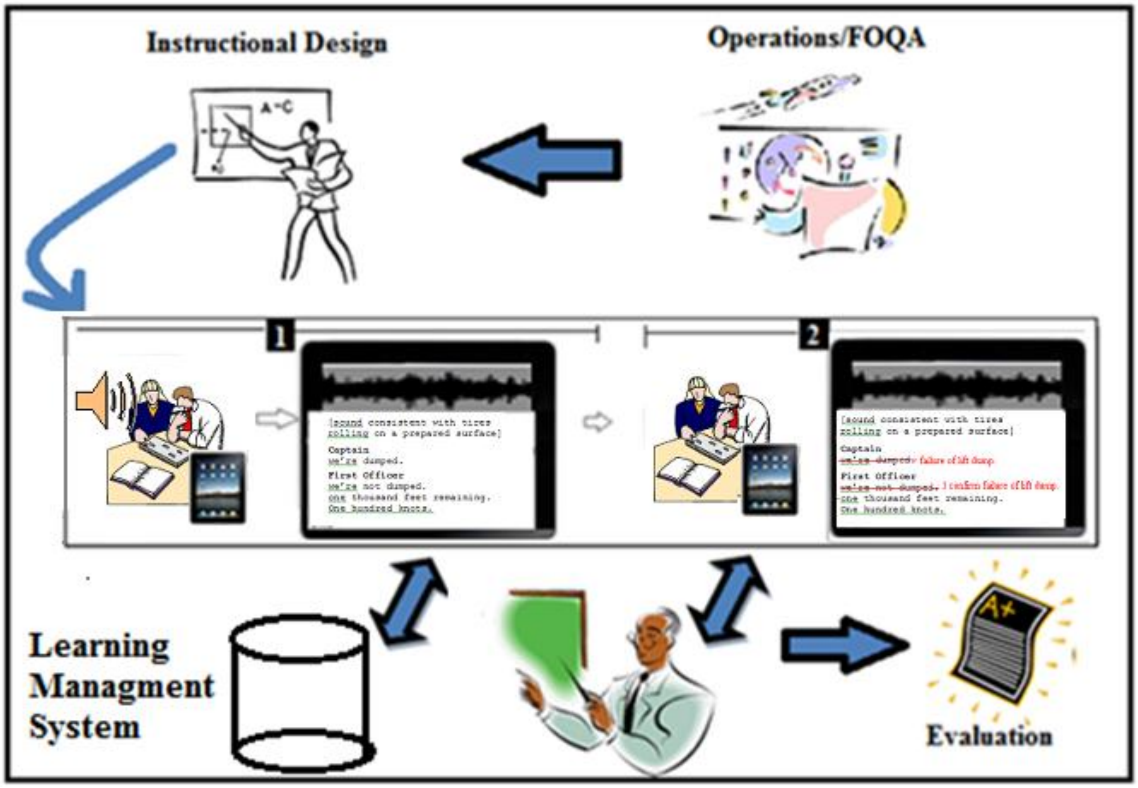


Figure 5. Central steps of the CTRBL method in larger context. Operations lead to instructional design of scenarios, which can be delivered directly to learners and managed by a learning management system.

be necessary to create scenarios (Federal Aviation Administration, 2008b; Wajnryb, 1990). Instructional design sources may come from organizational observations of hazards from sources such as flight operational quality assurance (FOQA) programs, anonymous reporting systems, or industry data sharing (Stolzer et al., 2008). Further, the delivery mechanism of the CTRBL content might be part of a larger learning management system, with content delivered to electronic flight bag dedicated applications, with asyncronous evaluation of outcomes. While this larger context of the CTRBL method provides perspective, only the two central steps of the CTRBL method, as shown in Figure 4, were examined in this study.

Evaluating Effectiveness

Salas et al. (2006) reviewed 28 published accounts of CRM training programs, updating a prior study of 58 CRM training programs (Salas et al., 2001). In both studies, the authors adopted the four-level Kirkpatrickian (1976) framework to review CRM training. Kirkpatrick's (1976) framework suggested evaluating training at four levels: reaction, learning, behavior, and results. Reaction evaluated how well students liked the training. Learning evaluated what was learned and what attitudes were changed during the training. Behavior evaluated on-the-job behavioral change. Results evaluated tangible organizational improvements in areas such as safety, quality, costs, or production capacity.

Kirkpatrick (1976) and other studies (Hamtini, 2008; Kearns, 2010; Swanson, 1996) noted that behavior and result level measurements were more appropriate for programs of research and in particular with longitudinal studies. Lynch (2007) added a level of measure to his studies that he called *manageability* (p. 318) defined as the ability of students to perform the training procedure. Based on the Kirkpatrickian framework and the work of Lynch (2007), the present study emphasized measures of manageability, reaction, and learning.

Measurement of teamwork skills was used to evaluate the effectiveness of a student self-analysis, CRM LOFT training program (Smith, 1994). The study focused on the improvement of skills observed in LOFT simulator sessions, crew attitudes, student reactions, and lessons learned from student-led facilitation compared to lessons learned from instructor-led facilitation. Smith's (1994) assessment measures included the use of the CMAQ survey instrument, a CRM survey instrument, and students' self-reports of lessons learned. Additionally, Smith used two repeated measures of LOFT simulator performance, the LINE/LOS Checklist and a communication analysis of LOFT sessions, as well as collecting participant demographic information.

Smith (1994) addressed reliability by collecting data from five different sources and confirming the difference sources converged as a measure of treatment effectiveness. Smith noted validity issues with the CMAQ instrument, as it had been validated in prior studies to be effective for airline crews, but validity with undergraduate college students had not been validated. The LINE/LOS Checklist was reported as the most valid measure of training effectiveness in the study, as it was able to distinguish between CRM skill variance and technical performance variance. Reliability of the LINE/LOS Checklist was increased by using multiple independent raters.

In measuring the effectiveness of instructor-led facilitations of LOFT debriefings, Dismukes, Jobe, et al. (2000) focused on variations of instructor-facilitator methods, crew participation in the debrief, and the viability of crew participation in self-analysis. Dismukes, Jobe, et al.'s (2000) assessment measures included the Debriefing Assessment Battery, the coding of crew discourse during the debrief, the time taken in the debrief, and three measures of LOFT simulator performance. The Debriefing Assessment Battery instrument was used to rate debrief participation of instructors and crews. Notably, the study did not mention the LOFT simulator performance measures in the conclusions and recommendations of the study.

Dismukes, Jobe, et al. (2000) addressed reliability of the Debriefing Assessment Battery by using multiple independent raters and measuring interrater reliability using Pearson correlation coefficients. The interrater reliability scores were between 0.56 and

0.99. After an 18-month period, one rater repeated the rating process as a measure of retest reliability, achieving scores between 0.64 and 0.99. The Debriefing Assessment Battery was validated by its consistency with crew performance in LOFT sessions.

In Lynch's 2001 and 2007 studies using collaborative transcription and repair as an L2 learning method, and then in Mennim's 2012 qualitative study of a similar technique, their assessment measures included process manageability, student reactions, and learning outcomes. Process manageability areas assessed the ability of students to perform the transcription and repair activity in addition to the quality of student collaboration during the exercise. Reactions measured the students' interest level and satisfaction with the transcription and repair activity. Learning outcomes assessed to what extent students identified errors, students corrected those errors, and students' English speaking skills were impacted by the exercise. The studies' measures included qualitative observations of students' collaborative interactions. Quantitative measures included counts of error identification, counts of repairs, directional correctness of repairs, numerical evaluation of repair counts, duration of the activity, and surveys of student reactions to the training (Lynch, 2001, 2007; Mennim 2012).

Reliability and validity were not specifically discussed by Lynch (2001, 2007) or Mennim (2012). In both of Lynch's (2001, 2007) studies, reliability was supported because the measures were multiple and convergent; face validity was supported because the measures used were similar to grading techniques traditionally used in language learning assessment. In Mennim's study, the data collected was qualitative and ethnographic, achieving credibility through prolonged engagement and triangulation (Teddlie & Tashakkori, 2009).

Fischer and Orasanu (1999) conducted two observational studies of communication strategies with crewed pilots. In the first study, pilots were provided written scenarios and asked to write out verbatim what they would say to another crewmember to respond to the scenario. Written responses were classified into eight classes of communication using an established coding scheme. The study measures were able to distinguish between captain and first officer communication strategies, as well as different strategies when risk increased. In their second study, Fischer and Orasanu used a collection of statements from the first study and asked pilots to rank the effectiveness of the communication strategy. Fischer and Orasanu were able to distinguish different perceptions of effectiveness between captains and first officers in addition to differences related to the directness of the communication style.

Fischer and Orasanu (1999) did not specifically discuss reliability and validity in their studies. However, the use of two studies measuring similar concepts supports reliability through a test-retest approach (Babbie, 2010). The construct validity of the first study by Fischer and Orasanu was supported by the use of a communication coding scheme used in prior studies. The reliability of the coding scheme was supported by using multiple coders. The measures used in the second study by Fischer and Orasanu were original to the study; the construct validity of the measures was supported by extension of coding schemes used in prior communication studies. The reliability of the study was supported by splitting participants into different groups to measure similar concepts, similar to a split-half reliability approach (Babbie, 2010).

Coryn and Hobson (2011) described the use of nonequivalent dependent variables to reduce internal validity threats in quasi-experimental designs. In their nonequivalent design, the dependent variable under study and expected to change was measured along with a nonequivalent variable that was not expected to change. Coryn and Hobson provided the example of charging customers for local directory assistance and not charging customers for long distance directory assistance. In the example, the dependent variable of local directory assistance call volume decreased while long distance directory assistance call volume remained unchanged.

A nonequivalent design may be viewed through the three-tiered communication objectives of Kanki and Smith (2001): technical, procedural, and CRM. In a nonequivalent design for the present study, instructional design targeted at learning of the approach briefing CRM skill (the dependent variable) should show greater effect than technical or procedural skills not targeted for learning (the nonequivalent dependent variable).

Combined, the literature of measurement reviewed provided multiple process and outcome measures as converging sources of measurement for this study. First, were measures of the ability of students to perform the CTRBL method, what Lynch (2007) labeled manageability. Secondly, were measures of student reactions to the CTRBL method (Kirkpatrick, 1976). Finally, were measures of learning outcomes consistent with designed CRM learning objectives. Increased confidence in the measurement validity of learning objectives may be increased by the selection of a suitable nonequivalent dependent variable (Coryn & Hobson, 2011).

Literature Review Summary

The aviation system continues to expand in scope and complexity, increasing learning needs across aviation (Boeing, 2011; Kearns, 2010). An essential area of learning identified across all experience levels was in the area of CRM (Federal Aviation Administration, 2008b; Federal Aviation Administration, 2009; Salas et al., 2006). Skills comprising CRM include communication, command and authority, conflict management, crew briefings, approach briefings, team building, error identification and repair, and stress identification (Arminen et al., 2010; Federal Aviation Administration, 2004a; Gregorich et al., 1990). The approach briefing CRM skill has been the subject of ethnographic studies, NTSB recommendations, and operational guidelines as a risk mitigation technique (Federal Aviation Administration, 2009; National Transportation Safety Board, 2000; Nevile, 2004b).

One successful method to deliver CRM learning was through instructor facilitated methods, including LOFT and SBT. Instructor facilitated methods, while successful, generally required a ratio of one instructor to two students, creating an opportunity for process improvement by a student-centric approach (Dismukes, McDonnell, et al., 2000; Kearns, 2010).

Applied linguistics provided a way to design a learning method response to CRM training needs. From the language learning method of dictation-based Dictogloss, evolved the L2 learning method using collaborative transcription and repair (Lynch, 2007; Wajnryb, 1990). These language learning methods were considered in light of the reflexive effect of the transcription activity on the transcriber and aviation DA research (Driscoll, 2002; Duranti, 2006; Nevile, 2004a).

Consideration of these multidisciplinary areas resulted in the proposition of a theory-based CTRBL method for learning the CRM skill of an approach briefing (Kozlowski & Bell, 2007; Salas & Fiore, 2007). Prior studies and theory suggested three levels of CTRBL evaluation in terms of manageability, reactions, and learning (Kirkpatrick, 1976; Lynch, 2007; Salas et al., 2006). Chapter III describes the methodology that was used to evaluate the efficacy of CTRBL as a means for novice pilots to learn the CRM skill of an approach briefing to mitigate risk.

CHAPTER III

METHODOLOGY

The literature review suggested the need for training of CRM skills in aviation was extensively addressed through instructor-facilitation of SBT, including LOFT debriefings. As training demands increase, one alternative to increase training volume would be through the use of student-centric learning methods. Applied linguistics literature in language and aviation were used to create the theory-based CTRBL method as a potential way for students to learn CRM skills. The purpose of this study was to examine whether the CTRBL method is an effective way for novice pilots to learn approach briefing CRM skills. This study gauged effectiveness in three dimensions: the ability of novice pilots to perform the CTRBL method, the reactions of novice pilots to the CTRBL method, and evidence of approach briefing CRM skills learning by novice pilots related to the CTRBL method.

Research Methods

A quasi-experimental, quantitative design was used to evaluate the research questions and related hypotheses. The CTRBL method evaluated had no existing empirical data, thus posing the need for data collection. The data collection intended to examine a causal relationship between CTRBL and learning outcomes; compare participant reactions between CTRBL and other training methods participants have used; and quantitatively describe the manageability of the CTRBL method. Experimental and quasi-experimental designs each require that cause preceded effect, cause was related to effect, and alternative explanations for the causal relationship are implausible (Shadish et al., 2001). Exposing participants to the CTRBL method in a controlled setting and measuring pre-treatment and post-treatment learning outcomes met the three necessary causal conditions for experiments and quasi-experiments.

An experimental design is premised upon random assignment of participants to a control or treatment group. Such a design can be compared to a repeated-measure, within-participant, quasi-experimental design (Shadish et al., 2001). An experimental design requires a suitable control group, control treatment, and adequate sample size. Alternatively, a repeated-measures design without a control group reduces sample size by half, helps increase statistical power, and reduces error variance (Grimm & Yarnold, 1995; Stevens, 2009).

A quasi-experimental design does not equate with a quantitative design; quasi-experiments can be quantitative, qualitative, or mixed. Creswell and Plano Clark (2011) caution the mixing of quantitative and qualitative methods should occur only when there are compelling reasons to do so. The problem statement and research questions in this study were framed in a quantitative manner. As such, a quantitative stance was taken for the quasi-experimental research design.

Quasi-experimental design. A repeated-measure, nonequivalent dependent variable, within-subject, one-group, quasi-experimental design was used in this study. The quasi-experimental design was defined as,

$$O_{1D} \ \{O_{1A}, O_{1B}\} \quad X \quad O_P \quad \{O_{2A},\ O_{3A}, O_{2B}\} \ O_{2R}$$

where: *O* were observations, *X* was treatment, *A* was the dependent variable, *B* was the nonequivalent dependent variable, *D* was a pre-treatment demographic survey, *R* was a post-treatment reaction survey, and *P* were process measures during *X*. The quasi-experimental design is shown in Figure 6.

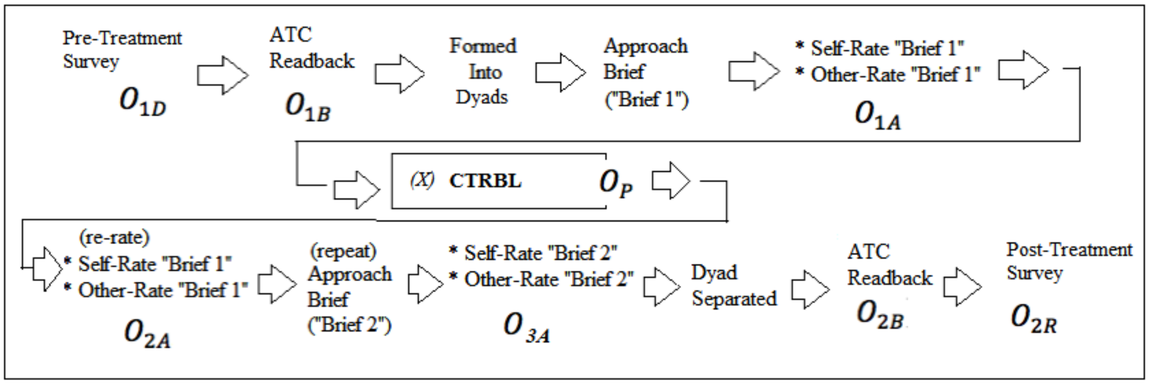


Figure 6. Quasi-experimental design. The quasi-experimental design was a repeated-measure, nonequivalent dependent variable, within-subject design.

The quasi-experimental design began with individual observations consisting of the Pre-Treatment Survey (Appendix A), and an ATC readback exercise (Appendix B), that created observations O_{1D} and O_{1B}, respectively. Thereafter, participants formed into dyads. The learning outcome measure related to an approach briefing first occurred after the dyad formation. One member of the dyad was selected at random to be the briefer, the other member the non-briefer. After the dyads read the Briefing Scenario (Appendix C), the briefer then briefed the non-briefer (Brief 1). Each member of the dyad then rated Brief 1 using the Participant Briefing Rating Instrument (Appendix D), creating observations O_{1A}. The dyad then performed the CTRBL treatment, *X*, using the audio of the CTRBL Scenario (Appendix E), creating process observations O_P. After performing CTRBL, each member of the dyad was asked to re-rate Brief 1, creating observations O_{2A}. The same briefer who performed Brief 1 then repeated the oral approach briefing (Brief 2). Each member of the dyad was then asked to rate Brief 2, creating observation O_{3A}. The dyad was then separated. Thereafter, each participant again performed the ATC readback exercise, creating observations O_{2B}. The quasi-experiment concluded with the Post-Treatment Survey (Appendix F) completed by each participant, creating observations O_{2R}. The Treatments and Procedures section provides details on how the quasi-experimental process was administered.

All measures were taken at the individual level, except the artifacts of CTRBL, O_P. All individual measures violated parametric statistical assumptions of independence (Gooty & Yammarino, 2011).

Research Approach

Beta-testing was used to refine the quasi-experimental design. The beta-testing improved the readability and usability of the instruments; however, the overall content, presentation, and constructs to be measured were not altered.

Treatments and procedures. In order to control the flow of participants through the experiment, participant and dyad checklists were used, as shown in Appendix G and Appendix H, respectively. Each step of the quasi-experimental design is next discussed. The detailed treatments and procedures are described.

Introduction. At the start of the procedure, participants were provided an overview of the experimental procedure, as shown in Appendix I. The overview allowed participants to anticipate the experimental steps and served to inform ethical consent.

Pre-Treatment Survey. The Pre-Treatment Survey (Appendix A) was administered to individuals. The Pre-Treatment Survey (Appendix A) collected participant demographics and was potentially used to reject participants who did not meet the homogeneous profile of the experiment. Each Pre-Treatment Survey (Appendix A) was labeled with a unique, anonymous participant identification code (Participant ID).

Readback exercise (pre-treatment). After participants performed the Pre-Treatment Survey (Appendix A), each participant then performed the readback exercise. The readback exercise consisted of participant readbacks of short ATC instructions, played as audio for the participant. Transcripts of the ATC audio are presented in Appendix B. In the beta-test, the ATC audio used actual radio transmissions from LiveATC.net, and re-use in this study was consistent with LiveATC.net's terms of use (LiveATC.net, 2010). In the beta-test, the actual ATC transmissions contained different locations, aircraft calls signs, controller voices, and audio quality that caused confusion for the participants. As a result of the beta-test, the researcher recorded ATC instructions using a consistent location and aircraft call sign and added the participant directions shown in Appendix B. Each ATC instruction was played two times for the participant, and the participants were not permitted to take any written notes. Immediately after the second audio playback, the participant was audio recorded reading back the ATC instruction. The process was repeated for each ATC instruction in Appendix B. Each recording was labeled with the Participant ID, the readback sequence number, and the identifier "Readback Pre-Treatment."

The participants then worked with their assigned dyad. Each dyad was assigned a unique, sequential, dyad identification code (Dyad ID). The individual Participant ID and associated Dyad ID were also recorded.

Brief 1 (pre-treatment). A coin toss was used to determine which member of the dyad was the briefer and the non-briefer, and the Participant ID record was annotated accordingly. After both participants reviewed the Briefing Scenario and directions (Appendix C), an audio recorder was turned on and the briefer briefed the non-briefer, creating Brief 1. The audio recording was labeled with the Participant ID, Dyad ID, and the identifier "Brief 1." Each member of the dyad completed the pre-treatment Participant Briefing Rating Instrument (Appendix D) for Brief 1 without any audio review. Each rating was labeled with the Participant ID, Dyad ID, and the identifier "Pre-Treatment Brief 1."

Main CTRBL treatment. Following Brief 1 and associated ratings, the dyads started the CTRBL phase. The dyads listened to audio using the software described in Equipment, Hardware, and Software. In order to practice with the software, the dyads first listened to a sample, generic ATC audio recording and were asked to (1) view the built in tutorial, and (2) find three specific pieces of content and write down about 2 seconds of content. When the practice session was done, the dyads were allowed to resolve questions about software operation with the researcher.

The dyad then performed the CTRBL treatment. The CTRBL process used the scenario developed for the treatment, as described in Scenario Development. The dyadic participants were given instructions on how to perform the transcription portion of CTRBL, as shown in Appendix J. The dyadic participants' primary information was the scenario audio (transcript in Appendix E), supplemented with additional materials, as were determined by beta-testing. All dyadic participant instructions were given in a pre-structured written format. Human involvement with the dyads during CTRBL was limited to necessary administrative elements to reduce confounding influences.

During beta-testing, the dyads were given only a few lines of sample transcription text and asked to transcribe nearly seven minutes of content. The beta-test transcription task took about two hours to perform, and seemed to fatigue the participants. Using the transcription rates from the beta-test, a partial transcript approach was used in the actual study with four segments of the audio, totaling 100 seconds, designated for transcription. Appendix E shows the areas designated for transcription. Dyads were given a maximum of 45 minutes to complete the transcription phase of CTRBL.

Once the dyads completed the transcription phase of CTRBL, the experiment administrator saved the transcript file. Dyads then read the CTRBL repair instructions, as shown in Appendix K. A professionally completed transcript, fully covering the audio, was then opened with Microsoft® Word's® track changes feature activated. The dyad was then given a maximum of 20 minutes to complete the repair phase of CTRBL. The artifacts produced by the dyadic participants resulting from CTRBL were the original transcript and the repaired transcript. The artifacts were labeled with the Dyad ID.

Brief 1 (post-treatment). Following CTRBL, each participant re-rated Brief 1 using the Participant Briefing Rating Instrument (Appendix D), creating the post-treatment measures of Brief 1. The participants performed the re-rating based upon their recollection of the briefing and did not re-listen to the recording of the briefing. They were only instructed (via text at the top of the Participant Briefing Rating Instrument), "Considering the scenario you just reviewed, re-rate the briefing that was previously performed." The ratings were labeled with the Participant ID, Dyad ID, and the identifier "Post-Treatment Brief 1."

Brief 2. The same briefer from Brief 1 then briefed the non-briefer after both participants read the second briefing instructions, while having access to the briefing scenario, as shown in Appendix C. The audio recorder was turned on and the briefer briefed the non-briefer, creating Brief 2. The audio recording was labeled with the Participant ID, Dyad ID, and the identifier "Brief 2." Each member of the dyad completed the Participant Briefing Rating Instrument (Appendix D) of Brief 2. The ratings were labeled with the Participant ID, Dyad ID, and the identifier "Brief 2." After Brief 2, the dyads were separated.

Readback exercise (post-treatment). Each participant then repeated the pre-treatment readback exercise as described in Readback Exercise (Pre-Treatment). Each audio recording was identified with the Participant ID, the readback sequence number, and the identifier "Readback Post-Treatment."

Post-Treatment Survey. Each participant then completed the Post-Treatment Survey (Appendix F). As a result of the beta-test, a leading statement was added to the Post-Treatment Survey instructing the participants to only rate CTRBL, and not the evaluative activities (e.g., the ATC readback and briefings). Each survey was labeled with the Participant ID.

Exit activities. The experiment concluded with a participant debrief. Participants were told the importance of keeping the experiment details confidential so as not to taint the experience of future participants, and were asked not to share any details for two weeks (Lichtenstein, 1970). Participants were also informed the experimental procedure of not taking notes during the receipt of ATC instructions was not meant to imply an operational practice; the note-taking limit was only for the purpose of the experiment. The debrief also offered an opportunity for each participant to resolve any questions or concerns. Participants were paid after the debriefing.

Scenario development. The scenario *S* that was used was developed through an iterative process of refinement. A May 10, 2004, fatal, crewed, novice pilot accident in Julian, California provided the context for the scenario (National Transportation Safety Board, 2004). Actual accident details were adapted considering the objective of improving approach briefing skills in three primary domains of CRM consideration: (a) communication and coordination; (b) command responsibility; and (c) recognition of stressor factors (Gregorich et al., 1990). The three CRM domains created an assortment of threats to jointly constructed situated understanding that may be mitigated through an effective approach briefing. These sources were used to produce an initial draft of scenario *S*. At no time was any actual cockpit voice recorder audio or other non-public accident investigation content used to create this scenario.

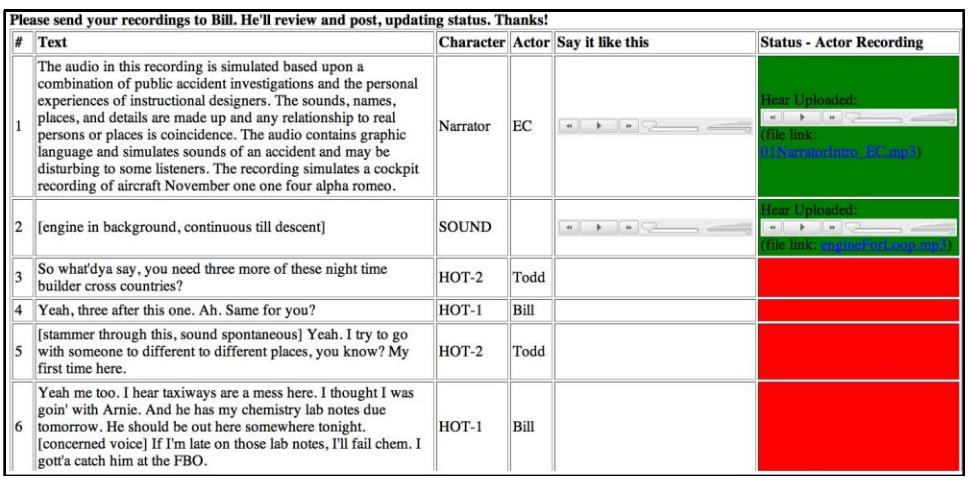
Scenario *S* was refined by drawing on four SMEs, whose qualifications are described in Appendix L. The SMEs were used to increase the credibility of the scenario consistent with peer debriefing techniques (Teddlie & Tashakkori, 2009). Each SME provided his or her feedback without knowing the identity or comments of the other SMEs; this feedback was used to refine the scenario.

The refinement process baseline plan contained three textual evolutions (Evolutions #1-#3), followed by three audio evolutions (#4-#6), as described in Table 1. As the evolutions proceeded, it was decided to eliminate text Evolution #3. As shown in Table 1, the main development occurred with SMEs #1 and #2 to produce a viable audio scenario. Credibility of the scenario was enhanced by restricting SMEs #3 and #4 scenario review only to the Evolution #5 and #6 audio developed in prior evolutions by SMEs #1 and #2. Late stage involvement of SMEs #3 and #4 helped provide an etic perspective relative to the scenario evolution process.

Table 1. *Evolutions of Scenario Development.*

Evolution	Type	Description	SMEs
1	Text	Broad overview of major elements of scenario, with little to no specific scripted utterances.	1-2
2	Text	Revised broad overview, with many specific utterances.	1-2
3	Text	Substantially finalized scripted scenario (not used).	1-2
4	Audio	Initial audio expression, with low fidelity sounds, and mostly scripted, non-spontaneous talk.	1-2
5	Audio	Revised audio expression, with higher fidelity sounds, and more spontaneous talk.	3-4
6	Audio	Final audio expression.	1-4

The final audio was recorded using a number of volunteer voices, with emphasis on uniquely different voices to simplify the transcription process during CTRBL. The actors were provided a text script of their lines and an audio sample of how to speak their lines, using a custom website as shown in Figure 7. The combination of text and audio samples helped to guide audio features such as cadence, loose ends of talk, and tokens of speech to increase the fidelity of the final audio to an acceptable level, as determined by SME review. Actors emailed or used social media to transmit their audio fragments to the researcher, who combined the fragments into a cohesive whole using commercial audio editing software. Actors completed releases to permit their voices to be used in this study.



Please send your recordings to Bill. He'll review and post, updating status. Thanks!

#	Text	Character	Actor	Say it like this	Status - Actor Recording
1	The audio in this recording is simulated based upon a combination of public accident investigations and the personal experiences of instructional designers. The sounds, names, places, and details are made up and any relationship to real persons or places is coincidence. The audio contains graphic language and simulates sounds of an accident and may be disturbing to some listeners. The recording simulates a cockpit recording of aircraft November one one four alpha romeo.	Narrator	EC		Hear Uploaded: (file link: 01NarratorIntro_EC.mp3)
2	[engine in background, continuous till descent]	SOUND			Hear Uploaded: (file link: engineForLoop.mp3)
3	So what'dya say, you need three more of these night time builder cross countries?	HOT-2	Todd		
4	Yeah, three after this one. Ah. Same for you?	HOT-1	Bill		
5	[stammer through this, sound spontaneous] Yeah. I try to go with someone to different to different places, you know? My first time here.	HOT-2	Todd		
6	Yeah me too. I hear taxiways are a mess here. I thought I was goin' with Arnie. And he has my chemistry lab notes due tomorrow. He should be out here somewhere tonight. [concerned voice] If I'm late on those lab notes, I'll fail chem. I gott'a catch him at the FBO.	HOT-1	Bill		

Figure 7. Website used to collect audio fragments for scenario development. Actors were able to read their script and hear an example of how the content should sound.

Once the final, single track audio scenario was created, it was transcribed by a professional transcriber. A transcript of the final audio is provided in Appendix E. The transcript style favors readability and simplicity in the presentation format.

Equipment, hardware, and software. Dyads required a mechanism to play back the audio. Practical transcription experience and the transcription software marketplace indicated software audio playback is superior to analog playback, allowing for rapid playback of small segments of audio. Further, the efficiency of repetitive listening required for transcription was increased by display of the waveform (Sony Creative Software, 2012). The SME developed audio was incorporated in a researcher developed, web browser compatible software, as shown in Figure 8. The software contained features for pause/play, visual position identification, and segment play. Usability testing revealed user adoption of all features within five minutes of first use. Usability was further verified during beta-testing.

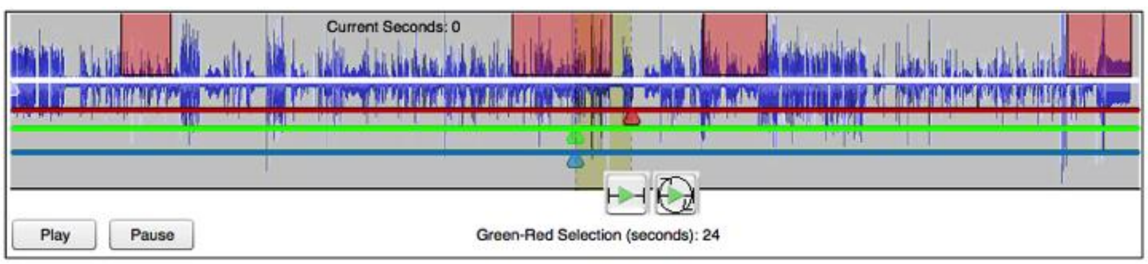


Figure 8. Custom audio playback software. Researcher developed software with minimal feature set for playback. The four highlighted areas helped the dyads identify areas to be transcribed.

Dyadic participants required a method to construct the textual transcript and then annotate repairs consistent with the CTRBL method design. While integrated transcription software existed it may have increased task complexity in the context of the experiment. As such, the audio playback software was kept distinct from the method to construct the transcript and perform the repair activity. Each transcript was typed using

Microsoft® Word® by the dyadic participants; repairs were annotated using Microsoft® Word's® track changes feature.

All software was run on identically configured, Hewlett-Packard nc6400 laptop computers with 13 inch displays. Each computer had built in speakers and an external mouse in addition to a track pad. When a dyad began each experimental activity, the necessary software was started by the researcher and placed in the same screen location for all dyads.

Population and Sample

The population for this study was novice pilots in a university setting. The convenience sample from the population was novice pilots from a university who were engaging in on-going training, had attained a private pilot certificate, had some exposure to crew training, but had not yet accrued 500 hours of total flight time.

University pilots used in this study had been exposed to a variety of aviation training methods, including SBT, FITS, and resource management principles. Furthermore, the scenario and instructional design objectives were tailored to the target population, as discussed in Scenario Development. As this study used audio spoken in English, this study was further limited to participants for whom English was their first language, to reduce confounding influences.

The use of a homogeneous sample population was consistent with other studies trying to determine the effect of training interventions (Connolly, Blackwell, & Lester, 1989; French et al., 2005; Karpicke & Blunt, 2011; Snyder, 2000). A purposive sample of a homogeneous demographic was used rather than a representative sample of the pilot population to increase the internal validity of the quasi-experimental study (Shadish et al., 2001; Vogt et al., 2012).

Sample size. The minimum number of participants needed for the quasi-experiment was determined by an a priori statistical power analysis using *G*Power* software (Faul, Erdfelder, Lang, & Buchner, 2009) as recommended by Mayr, Buchner, Erdfelder, and Faul (2007). A power analysis was consistent with American Psychological Association (APA) guidelines on the importance of presenting effect sizes and power in research findings (Marszalek, Barber, Kohlhart, & Holmes, 2011).

The measurement scales used in this study may not have resulted in normally distributed data; as such, nonparametric tests were planned for the analysis (Leech, Barrett, & Morgan, 2008). A power analysis using *G*Power* software was performed using an α-level of 0.05, a power of 0.95, and the nonparametric Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test. The *G*Power* output is shown in Figure 9. Considering the largest unit of measure to be groups of two individuals, as well as non-independence considerations, the number of participants needed for this study was two times the sample size as determined by the power analysis. A larger sample size leads to smaller detectable effects and minimizes the risks of Type II errors (Stevens, 2009). Balancing the nature of the power curve in Figure 9 and resource constraints, a trade-off effect size of 0.85 was selected. According to the *G*Power* analysis in Figure 9, this corresponds to a sample size of 21. Multiplying by 2 for dyadic group size, the minimum total participants needed for the quasi-experiment was 42.

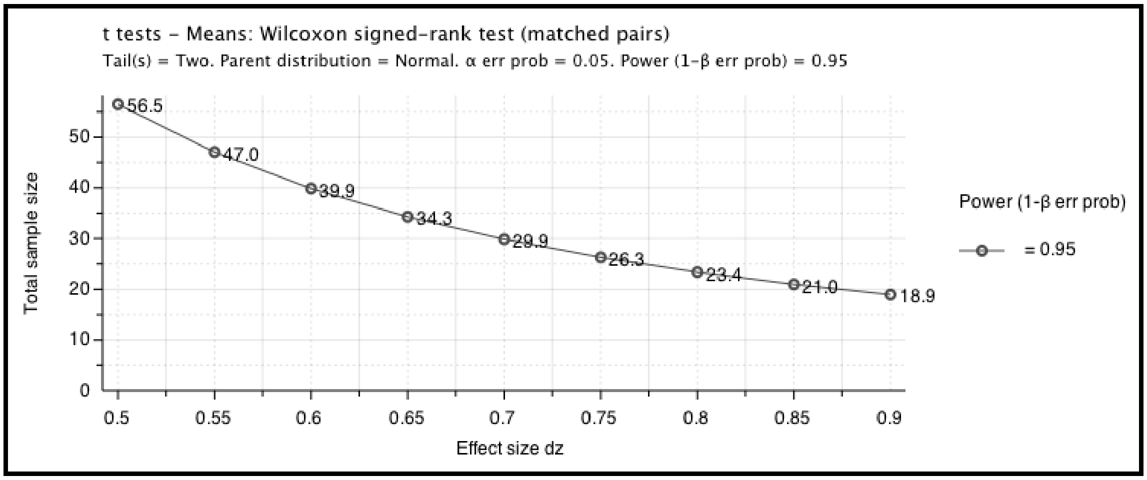


Figure 9. G*Power analysis for α-level of 0.05. Sample size for effect sizes from 0.5 to 0.9, for a Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test.

Generalizability. Study findings were expected to be generalizable to other novice pilots in a university setting, with limited generalizability to novice pilots beyond a university setting. The CTRBL method as an aviation learning technique was expected to have limited generalizability across all pilot experience levels.

Ethical Considerations

The quasi-experimental design involved human participants and commensurate ethical considerations. Ethical review considered three principal areas: consent, harm, and privacy (Vogt et al., 2012). The ethical considerations were reviewed and approved by the Embry-Riddle Institutional Review Board (IRB), as shown in Appendix M. All involvement with the research was voluntary, and the participants were provided information about the research purpose and design without any deception so they were able to make a participation decision with informed consent.

The identity of the participants was recorded only for administrative documentation purposes and kept confidential. By the nature of the experimental design, the participants worked in dyadic pairs, so each participant knew the identity of his or her partner. Given these design constraints, participation was classified as confidential rather than anonymous.

Sources of the Data

The quasi-experiment produced data from the survey instruments, the audio recordings, and the artifacts of the CTRBL treatment, as described in Treatments and Procedures. The quasi-experimental data was further evaluated to create additional sources of data as next described.

Readback. Each participant audio recorded readback was transcribed by the researcher, a professional forensic transcriber. The readback transcript was scored by two SMEs using the Readback Evaluation Scoring Procedure (Appendix N). The SMEs had experience with ATC clearances and instructions; their biographies are presented in Appendix O. The SME readback information did not contain the Participant ID or identify if the readback was pre-treatment or post-treatment.

Briefing SME evaluation. Audio recordings of Briefings 1 and 2 were transcribed by the researcher, a professional forensic transcriber. The Briefing Evaluation Rubric (Appendix P) was used by the SMEs to evaluate the Brief 1 and Brief 2 transcripts. Two SMEs independently rated each briefing. The SMEs had experience in flight instruction, SBT, or aviation human factors; their biographies are presented in Appendix Q. The SME briefing information did not contain the Participant ID, Dyad ID, or identify if the briefing was Brief 1 or Brief 2.

Transcript evaluation. The transcripts made during CTRBL by dyads were independently scored by two SMEs using the Transcript Evaluation Rubric (Appendix R). The SMEs had experience in transcription; their biographies are presented in Appendix S.

Repair counts. The repairs made during CTRBL by dyads were counted by two SMEs using the Repair Counts Rubric and Procedures (Appendix T). The SMEs had aviation knowledge as well as experience editing documents to prescribed standards; their biographies are presented in Appendix U.

Data Collection Devices

Vogt (2005) defined reliability as the consistency of a measure across multiple usages. When a measure is repeated and achieves similar results the measurement instrument is considered reliable. Vogt defined validity as a measurement that accurately measures what it is intended to measure. Shadish et al. (2001) defined validity relative to the inferential value of measures, cautioning, "assessing validity always entails fallible human judgments" (p. 34). For an instrument to be valid its measures must first be reliable. One means of supporting reliability and validity is to use established measurement instruments (Babbie, 2010). This study used original instruments and adapted established instruments; as such, the study design and analysis provided mechanisms to support reliability and validity.

Instrument reliability. Demographic data were collected in this study. Data were also collected to enable the evaluation of manageability, reactions, and learning.

Instrument reliability is discussed for demographic data and in each of the three evaluative areas.

Demographic data. The Pre-Treatment Survey (Appendix A) was completed on paper to avoid computer entry errors by participants. Beta tests were used to verify the usability, wording, and placement of items on the survey form to minimize user error. Entry of the Pre-Treatment Survey (Appendix A) into an electronic database was cross-checked for data entry errors.

Manageability. During the CTRBL activity, time was a directly observable measure. Reliability of the time measure was achieved through procedural specificity and clarity of collection techniques that were verified and documented during beta-testing (Babbie, 2010).

The two artifacts produced by dyads during CTRBL were the transcript and the repair of the transcript. The transcript was typed electronically in Microsoft® Word® to avoid legibility interpretation inconsistencies. The transcript repairs were performed using the Microsoft® Word's® track changes feature to avoid legibility interpretation inconsistencies.

The transcript scoring used the Transcript Evaluation Rubric (Appendix R) developed by the researcher. The rubric was used by two independent, expert raters. Raters were trained in beta-testing and the rubric adjusted as necessary (Joslin, Goodheart, & Tuccio, 2011). Interrater reliability of SME transcript scoring was performed as described in Treatment of Data.

Transcript repair counting was performed by SMEs using the Repair Counts Rubric and Procedures (Appendix T) developed by the author. The repair count is a weighted count, intended to give more value to content repairs rather than spelling errors in the transcript, or misidentification of sources. The threat to reliability was a shared understanding of what constitutes a repair for counting purposes, and how to apply the rubric weighting. Threats to reliability in the present study were similar to threats experienced in prior communication analysis studies; the threats were mitigated using procedural coding instructions and rater practice (Dismukes, Jobe, & McDonnell, 1997; Joslin et al., 2011). The two independent SME raters in the present study used procedural coding instructions similar to techniques used in other studies. The procedures were beta-tested and modified to achieve agreement between raters. Interrater reliability of SME counts were performed as described in Treatment of Data.

Reaction. The Post-Treatment Survey (Appendix F) was the instrument used to collect reaction measures of individual participants. The survey form was completed on paper to avoid computer entry errors by participants. The form was beta-tested to verify usability, wording, and placement of items to minimize user error. Entry of the Post-Treatment Survey (Appendix F) into an electronic database was cross-checked for data entry errors.

The Post-Treatment Survey (Appendix F) instrument asked similar questions in different ways as a means of alternate-form reliability (Litwin, 2003). The individual reaction measures were separated between dyadic partners and separately analyzed. The separate analyses were compared between data sets as a means of split-half reliability (Babbie, 2010). Treatment of Data details how reliability measures were performed.

Learning. The audio recordings of Brief 1, Brief 2, and the Participant Briefing Rating Instrument (Appendix D) were used to collect evaluative learning data. The audio recordings of the briefings were transcribed by the researcher, and the transcripts scored by two independent SME raters using the Briefing Evaluation Rubric (Appendix P). The independent SME briefing scores were compared for interrater reliability. The Participant Briefing Rating Instrument (Appendix D) asked similar questions of the participants in different ways as a means of alternate-form reliability (Litwin, 2003). The participant responses were split between briefer and non-briefer and then compared as a means of split-half reliability (Babbie, 2010). Treatment of Data details how reliability measures were performed. Further, the SME briefing rating and the participant ratings provided a convergent means to achieve reliability. The recording process, the use of the Participant Briefing Rating Instrument (Appendix D), and the SME Briefing Evaluation Rubric (Appendix P) were beta-tested and adapted to increase procedural reliability (Joslin et al., 2011).

The ATC readbacks of each individual participant were audio recorded and then transcribed by the researcher. Readback transcripts were scored by two independent SMEs using the Readback Evaluation Scoring Procedure (Appendix N) and scores compared for interrater reliability. Analysis of SME readback scores split each member of the dyad into separate groups to maintain independence of measures and the two sets of readback scores were compared in the analysis as a measure of split-half reliability (Babbie, 2010). Each statistical operation performed is described in Treatment of Data. Beta testing was used to adapt the recording process and the use of the SME Readback

Evaluation Scoring Procedure (Appendix N) to increase procedural reliability (Joslin et al., 2011).

Instrument validity. This study collected demographic data and evaluated the areas of manageability, reactions, and learning. Instrument validity is discussed for demographic data and in each of the three evaluative areas.

Demographic data. The Pre-Treatment Survey (Appendix A) instrument asked basic demographic information as a means to verify the population sample as it related to external validity of the results. The instrument was adapted from a prior study (Smith, 1994), further supporting content validity.

Manageability. The manageability measures were descriptive measures used to support transcription and repair task competency. The CTRBL time measure was intended to measure average rate of task execution as well as variation of task execution between groups. Validity was supported by consistency between rate being the intended and actual measurement (Babbie, 2010).

The transcript scoring was theoretically similar to academic grading of a transcript, providing construct validity (Babbie, 2010). Further, validity means the concept being considered aligns with the measure being used (Babbie, 2010). For transcript scoring, the concept being considered was the ability of dyads to produce a transcript that aligns with the measure of academic-like scoring of the transcript that was used.

Similar to transcript scoring, repair count scoring was intended to measure the concept of repair production during CTRBL compared between dyadic groups. The inferential value of repair count scoring was intended to compare between-group performance, further supporting alignment between the concept being considered and the measure that was used (Babbie, 2010; Shadish et al., 2001).

Reaction. Participant reaction data is commonly collected as a measure of training and is considered the simplest data to collect (Salas et al., 2001). Reaction measures by participants closely aligned with the satisfaction construct intended to be measured, supporting content validity (Babbie, 2010). The Post-Treatment Survey (Appendix F) instrument used was adapted from a prior study (Smith, 1994), further supporting content validity.

Learning. Causal inferences of effect of CTRBL were drawn from the learning measures. In the present study, the causal inference supported by the briefing measures was that CTRBL influences change of briefing skills. As such, there was alignment between the measure of pre-treatment and post-treatment briefing scoring and the causal inference of learning, supporting content validity (Babbie, 2010).

In order to support discriminant validity of the approach briefing skill learning measurement, the nonequivalent dependent variable measurement of readback performance was used. Change in participant performance of a readback was expected to be different from the change in briefing performance. A different variation of outcomes between readback performance and approach briefing performance would further support the content validity of the briefing performance measure under study (Coryn & Hobson, 2011; Shadish et al., 2001).

Treatment of Data

Raw data was collected as described in Research Approach and then coded and converted as further described in Sources of Data. Raw and coded data was entered into a Microsoft® Access® database and then processed in SPSS® Version 18.0. Figure 10 shows the mapping of the quasi-experimental design, research hypotheses, descriptive research questions, and comparisons as discussed in this Treatment of Data section.

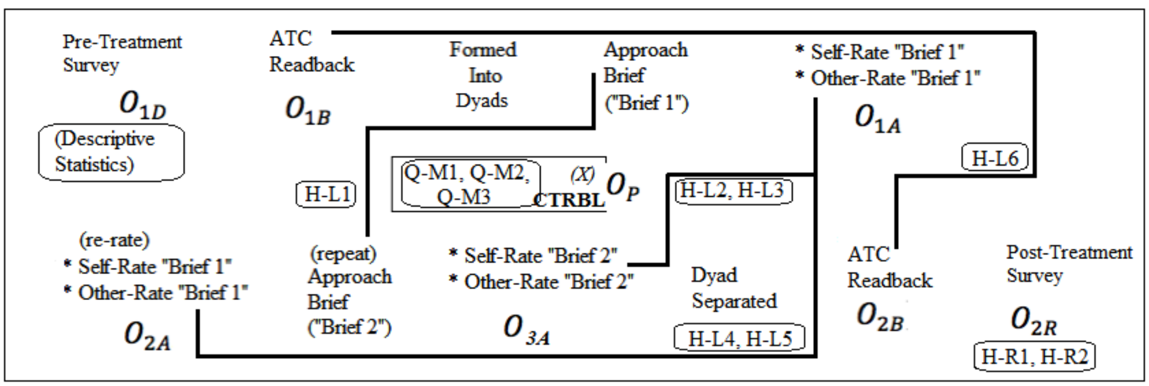


Figure 10. Treatment of data mapping. The quasi-experimental design, research hypotheses, descriptive research questions, and comparisons used in treatment of data.

Descriptive statistics. The demographic data collected in the Pre-Treatment Survey (Appendix A) was summarized as descriptive statistics. Pilot certificate (Question 1), FAA rating (Question 2), educational level (Question 5c), and familiarity with the experiment (Question 7) reported frequency counts, expressed as numeric counts and percentage of total participants. All logbook times (Question 4) reported mean and standard deviation for each type of time collected. Participant months since first solo, private pilot certificate, and last FAA certificate (Question 3) reported mean, median, mode, and standard deviation for each type of month data. Age in years (Question 5a) reported mean, median, mode, and standard deviation. Gender distribution (Question 5b) was also reported. The number of people rejected from the experiment was reported along with the reason for rejection. Any outlier values in the descriptive statistics were subject to further analysis.

Post-Treatment Survey (Appendix F) descriptive measures were summarized. Frequency counts for each of the questions about scenario awareness (Questions 1, 2, and 3) were reported. Median and interquartile range (IQR) of scenario realism (Question 4) were reported. The open-ended question about the comparative training technique (Question 5) were coded for consistency, and then frequency counts reported. Familiarity of the dyad with their partner prior to the exercise (Question 12) was reported as median and IQR. Any outlier data was investigated, with emphasis on disparities in partner familiarity (Question 12), and prior knowledge of the training method and scenario (Questions 1, 2, and 3).

Manageability research questions. Manageability research questions were used to create descriptive statistics about manageability research questions.

Research Question Q-M1. The transcript scoring by both SMEs was averaged for each dyad transcript. The average SME transcript scores were then used to report descriptive statistics of sample size, mean, median, mode, standard deviation, minimum, maximum, skewness, kurtosis, and a graph of SME averaged transcript score distributions.

Research Question Q-M2. Descriptive statistics of CTRBL transcription performance rate and CTRBL repair count rate per unit time were reported. The descriptive statistics for rate included sample size, mean, median, mode, standard deviation, minimum, maximum, skewness, kurtosis, and a graph of CTRBL rates for transcription and repairs.

Research Question Q-M3. The weighted repair counts created by all SMEs were averaged for each dyad transcript. The average SME counts were then used to report descriptive statistics of sample size, mean, median, mode, standard deviation, minimum, maximum, skewness, kurtosis, and a graph of SME averaged weighted count distributions.

Manageability measures reliability analysis. Interrater reliability of the SME transcript scorings was assessed by comparing individual SME scores for each transcript using Cronbach's alpha (Leech et al., 2008). Interrater reliability of the SME repair counting was assessed by comparing individual SME weighted repair counts for each transcript using Cronbach's alpha (Field, 2009; Leech et al., 2008).

Reaction hypotheses testing. Reaction hypotheses were evaluated using within-subject analyses of different responses to the Post-Treatment Survey (Appendix F) questions. Since dyadic pairs violated independence of measures, the survey responses were split using stratified random sampling. Each odd numbered Dyad ID had the briefer responses placed in Group A, with the non-briefer responses placed in Group B. Each even numbered Dyad ID had the briefer responses placed in Group B, with the non-briefer responses placed in Group A. The analysis on each group was then considered independent (Turel, 2010).

Hypothesis H-R1. Group A Post-Treatment Survey (Appendix F) responses to overall rating of training value for non-CTRBL and CTRBL (Questions 6 and 7) was compared using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The analysis was repeated for Group B. The median, test statistic, significance level, and effect size was reported (Field, 2009).

Group A Post-Treatment Survey (Appendix F) responses to non-CTRBL and CTRBL learning opinions (Questions 10 and 11) was compared using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The analysis was repeated for Group B. The median, test statistic, significance level, and effect size was reported (Field, 2009).

Group A Post-Treatment Survey (Appendix F) responses to non-CTRBL and CTRBL enjoyment (Questions 13 and 14) was compared using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The analysis was repeated for Group B. The median, test statistic, significance level, and effect size was reported (Field, 2009).

The distributions of binary responses regarding which training was enjoyed more, non-CTRBL or CTRBL (Question 15), was reported as a descriptive count for Group A. The descriptive counts and percents were presented. The analysis was repeated for Group B.

Hypothesis H-R2. Group A Post-Treatment Survey (Appendix F) responses regarding recommendations to other pilots of non-CTRBL and CTRBL methods (Questions 8 and 9) was compared using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The analysis was repeated for Group B. The median, test statistic, significance level, and effect size was reported (Field, 2009).

Post-Treatment Survey reliability analysis. In order to assess alternate-form reliability, responses to alternate-form Post-Treatment Survey (Appendix F) questions were compared. For the reliability analysis, the binary question regarding which training was enjoyed more, non-CTRBL or CTRBL (Question 15), was recoded into two questions, 15A and 15B. If the response to Question 15 favored the non-CTRBL procedure rather than CTRBL, 15A received a value of 7, or else 15A was 0. Likewise, if the response to Question 15 favored the CTRBL procedure rather than non-CTRBL, 15B received a value of 7, or else 15B was 0. Using the recoded values, responses to Questions 6, 8, 10, 13, and 15A (overall training value, recommend to other pilots, how much was learned, training enjoyment of non-CTRBL training, and recoded non-CTRBL preference) was compared for Group A using Cronbach's alpha. The analysis was repeated for Group B. The Group A and B analyses were repeated for Questions 7, 9, 11, 14, and 15B (overall training value, recommend to other pilots, how much was learned, training enjoyment of CTRBL training, and recoded CTRBL preference). Cronbach's alpha and correlation matrices were reported for the four analyses (Field, 2009; Leech et al., 2008; Schmitt, 1996).

Participant intraclass correlations. Intraclass correlations were examined for each of the alternate-form preference questions (Questions 6, 7, 8, 9, 10, 11, 13, 14, 15A, and 15B) between Group A and B using Cronbach's alpha. Cronbach's alpha value was reported for each question (Field, 2009; Leech et al., 2008).

Learning outcomes hypotheses testing. Learning hypotheses were evaluated using within-subject analyses of different responses from the participant ratings of briefings, SME ratings of briefings, and SME ratings of readbacks. Since dyadic pairs violated independence of measures, the individual participant responses were split. Participant responses from the briefing member of each dyad pair were placed in Group C, the non-briefing member in Group D. The analysis of each group were considered independent (Turel, 2010).

The Participant Briefing Rating Instrument (Appendix D) asked four questions of each individual; five questions after Brief 2. Question 4 was reverse phrased and was reverse coded for the reliability analysis (Field, 2009). The average of Questions 1 through 3 were referred to as the Participant Briefing Average Score in the analysis.

Hypothesis H-L1. Briefing scores by SMEs were averaged. The SME average scores of Brief 1 were compared to Brief 2 using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The median, test statistic, significance level, and effect size were reported (Field, 2009).

Brief SME scoring reliability analysis. In order to assess interrater reliability, SME scores of Brief 1 were compared using Cronbach's alpha. Cronbach's alpha was reported. The analysis was repeated for Brief 2 (Leech et al., 2008).

Hypothesis H-L2. Group C Participant Briefing Average Score of Brief 1 (rated post-treatment) was compared to Brief 2 Participant Briefing Average Score using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The median, test statistic, significance level, and effect size was reported (Field, 2009). Similarly, the response to Question 5 for Brief 1 (overall ranking of Brief 1) was compared to Question 5 for Brief 2 (overall ranking of Brief 2) using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The median, test statistic, significance level, and effect size was reported (Field, 2009).

Hypothesis H-L3. Group D Participant Briefing Average Score of Brief 1 (rated post-treatment) was compared to Brief 2 Participant Briefing Average Score using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The median, test statistic, significance level, and effect size was reported (Field, 2009). Similarly, the response to Question 5 for Brief 1 (overall ranking of Brief 1) was compared to Question 5 for Brief 2 (overall ranking of Brief 2) using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The median, test statistic, significance level, and effect size was reported (Field, 2009).

Hypothesis H-L4. Group C Participant Briefing Average Score of Brief 1 (rated pre-treatment) was compared to Participant Briefing Average Score of Brief 1 (rated post-treatment) using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The median, test statistic, significance level, and effect size was reported (Field, 2009).

Hypothesis H-L5. Group D Participant Briefing Average Score of Brief 1 (rated pre-treatment) was compared to Participant Briefing Average Score of Brief 1 (rated post-treatment) using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The median, test statistic, significance level, and effect size was reported (Field, 2009).

Participant Briefing Rating Instrument reliability analysis. Scale reliability was assessed using the three sets of responses to the Participant Briefing Rating Instrument (Appendix D) by Group C and D related to Brief 1 (pre-treatment), Brief 1 (post-treatment), and Brief 2. The responses for Brief 1 (pre-treatment) to Questions 1 through 3 and reverse coded Question 4 were compared using Cronbach's alpha.

The post-treatment response analyses included Question 5 (overall score). Accordingly, the responses for Brief 1 (post-treatment) to Questions 1 through 3, reverse coded Question 4, and Question 5 (overall score, Brief 1) were compared using Cronbach's alpha. Similarly, the responses for Brief 2 to Questions 1 through 3, reverse coded Question 4, and Question 5 (overall score, Brief 2) were compared using Cronbach's alpha.

Cronbach's alpha and correlation matrices were reported for each of the four reliability comparisons. The reliability analyses were separately performed for Group C and Group D (Leech et al., 2008).

Hypothesis H-L6. The SME scores for each readback were averaged. Group A SME readback average score pre-treatment and post-treatment were compared using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The median, test statistic, significance level, and effect size were reported (Field, 2009). The analysis was repeated for Group B.

Readback SME scoring reliability analysis. In order to assess interrater reliability, the SME scores of readbacks (both pre-treatment and post-treatment) of Group A were compared using Cronbach's alpha. Cronbach's alpha was reported (Leech et al., 2008). The analysis was repeated for Group B.

Participant intraclass correlations. Group C Participant Briefing Average Score of Brief 1 (pre-treatment) was compared to the Group D (dyad's partner) Participant Briefing Average Score (pre-treatment) using Cronbach's alpha. Cronbach's alpha was reported (Leech et al., 2008). The analysis was repeated for Participant Briefing Average Score of Brief 1 (post-treatment), as well as Brief 2.

Group C's response to Question 5 (overall score) for Brief 1 was compared to Group D's response to Question 5 (overall score) for Brief 1 using Cronbach's alpha. Cronbach's alpha was reported (Leech et al., 2008). The analysis was repeated for responses to Brief 2.

Qualitative data. Open-ended responses from the Post-Treatment Survey (Appendix F) questions about reasons for the preferred training method (Question 16) and additional comments (Question 17) were listed and thematically organized. The repairs identified by dyads during CTRBL were collected and thematically organized (Creswell & Plano Clark, 2011).

Examples of evaluation and treatment artifacts were presented in the results. These artifacts include briefing transcripts, readback transcripts, CTRBL dyad produced transcripts, and CTRBL dyad repaired transcripts.

CHAPTER IV

RESULTS

Data were collected from Embry-Riddle Aeronautical University students over a seven-day period. Students were solicited through flyers posted on campus, classroom handouts, a website, and one-on-one solicitation by the researcher at flight operations and around campus. When students expressed interest, their contact information was entered into a spreadsheet along with scheduling preferences. Based on scheduling preferences, students were paired with other students and then sent an email confirming their scheduled time. Students were provided at least three scheduling reminders of the experiment by email and text messaging to encourage appointment commitments.

The solicitation process resulted in 48 participants formed into 24 dyads, all of whom participated in the 2-hour experimental procedure. Of the 24 dyad results, three dyads were rejected because of procedural errors. In two of the rejected cases, the dyads wrote the transcript on paper by hand rather than typing the results. In one of the rejected cases, the dyad spent a significant amount of time trying to colorize the repairs in Microsoft® Word®, rather than using Word's® track changes feature. Due to the three dyad rejections, 42 participants, formed into 21 dyads, were analyzed.

Descriptive Statistics

The Pre-Treatment Survey was used to verify participants had met the study requirements and to collect participant demographic data. Every participant who completed the demographic survey met the study requirements and subsequently completed the entire experiment. The experiment had no attrition. The Post-Treatment

Survey was used to collect reaction information, experiment familiarity, and partner familiarity.

Pre-Treatment Survey. All the participants reported English was their native language. None of the participants reported any familiarity with the experimental details. All the participants had at least an FAA private pilot certificate and a single-engine land class rating. Of the 42 participants, 21 (50%) participants earned their private pilot certificate at Embry-Riddle, and 21 (50%) earned their private pilot certificate prior to attending Embry-Riddle. Of the 42 participants, 27 (64.3%) participants held an instrument rating, 12 (28.6%) held a multi-engine land class rating, 11 (26.2%) held a commercial pilot certificate, and 3 (7.1%) held a flight instructor certificate. The participants were all active students at Embry-Riddle; their educational levels are shown in Table 2. One participant reported an educational level of “other,” reflecting a special transfer status into the university with military service credit.

Table 2. *Educational Level of Participants (N = 42).*

Educational Level	*n*	%
Freshman	9	21.4
Sophomore	11	26.2
Junior	8	19.0
Senior	11	26.2
Graduate	2	4.8
Other	1	2.4

The mean age of the participants was 21.2 (*SD* = 2.2) years old, with 6 (14.3%) females and 36 males (85.7%). The mean time since the participants first soloed was 30.2 (*SD* = 17.8) months, 22.4 (*SD* = 16.5) months since earning their private pilot certificate, and 9.7 (*SD* = 12.6) months since earning their most recent pilot certificate or rating milestone. The mean total flight time was 161.0 (*SD* = 65) hours. Table 3 details the participant flight times, participant elapsed time since milestone certification events, and participant age with expanded descriptive statistics.

Table 3. *Flight Times, Certification Milestones, and Age (N = 42).*

Characteristic	Min	Max	*Mdn*	Mode	Mean	*SD*
Total Time	59.0	391.0	151.0	140.0	161.0	65.2
Single-Engine Land	59.0	385.0	144.8	190.0	147.1	58.9
Multi-Engine Land	0.0	100.0	0.0	0.0	13.3	23.4
Pilot-in-Command	6.0	271.0	67.1	60.0	78.5	55.0
Second-in-Command	0.0	15.0	0.0	0.0	0.6	2.7
Simulated IFR	3.0	77.0	39.5	40.0	37.4	21.8
Actual IFR	0.0	16.0	3.0	0.0	4.1	4.2
Dual Received	33.0	250.0	120.2	185.0	120.1	47.0
Dual Given	0.0	18.0	0.0	0.0	0.4	2.8
Night	3.0	62.0	27.1	30.0	24.0	14.8
Months Since First Solo	9.0	79.0	25.0	30.0	30.2	17.8
Months Since Private	2.0	68.0	18.0	8.0	22.4	16.5
Months Since Last Cert	0.0	68.0	7.0	2.0	9.7	12.6
Age, years	18.6	28.3	20.6	19.5	21.2	2.2

Note: All flight times in hours.

Post-Treatment Survey. Of the 42 participants, 40 (95.2%) indicated no prior awareness with any aspect of the scenario, and 2 (4.8%) reported slight familiarity with the scenario, contrary to their pre-treatment opinion. Of the two participants indicating slight familiarity, one gained familiarity "based on prior experiences and training," and the other participant heard about the study from a peer. In both cases, the participants felt the familiarity had no effect on the training value.

Partner familiarity was ranked on a 7-point scale, where 1 represented "never met him/her" and 7 represented "knew him/her very well." The partner familiarity median was 1.0 (*IQR* = 1 to 3.75) and the mode was 1.0. Eight (19.0%) participants reported the maximum value of 7.

The distribution of participant opinion of scenario realism is shown in Figure 11. The median was 6.0 (*IQR* = 5 to 7), and the mode was 6.0.

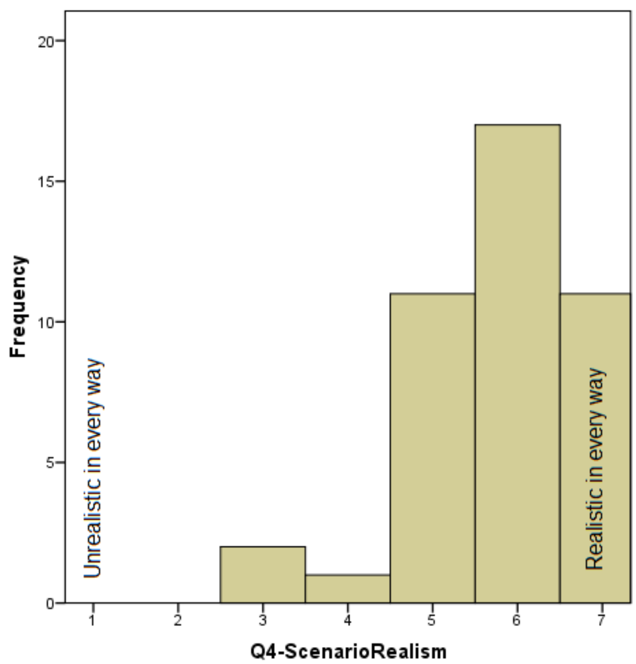


Figure 11. Distribution of scenario realism (*N* = 42). The responses were skewed towards greater realism, consistent with the median and mode of 6.0.

Participants were asked to compare the CTRBL technique to a ground-based, non-simulator, CRM, or single-pilot resource management training technique they liked the most. The 42 participants wrote-in 25 distinctly different responses. The write-in responses were thematically coded and are reported in Table 4. Scenario-based training, either general or ground, accounted for 27 responses (64.3%). Four of the responses

Table 4. *Comparative Training Techniques, Thematically Coded (N = 42).*

Technique	*n*	Percent	Cumulative Percent
Scenario Based Training, Ground	17	40.5	40.5
Scenario Based Training, General	10	23.8	64.3
Discussion	7	16.7	81.0
Simulator-Scenario	4	9.5	90.5
Video	4	9.5	100.0

(9.5%) used a simulator-based technique for comparison. The write-in responses and thematic coding are presented in Appendix V.

Reliability Testing

Reliability measures were incorporated into all three evaluation areas of manageability, reaction, and learning. Each evaluation area is next discussed.

Manageability data reliability. Two SMEs independently scored each of the 21 transcripts. The Cronbach's alpha was .90 between the two SMEs, indicating excellent interrater reliability.

Two SMEs independently counted the repairs in each of the 21 repaired transcripts. Each SME generated an integer count of repaired items, as well as a weighted count of repaired items; the definition of an item and the weighting scheme are defined in Appendix T. The Cronbach's alpha was .98 for the integer count of repairs, and the Cronbach's alpha was .96 for the weighted count of repairs. The Cronbach's alphas indicated excellent interrater reliability.

Reaction data reliability. In order to maintain independence of measures, the Post-Treatment Survey data was divided into two groups, A and B, using stratified random sampling, as discussed in Treatment of Data in Chapter III. Each group consisted of 21 participants. The two groups had a reliability analysis performed for answers favoring CTRBL and answers favoring the alternative technique the participant self-identified (non-CTRBL). In all four analyses, the central tendency of the preference question (Questions 15A and 15B) response were substantially different than the other question responses, as such the Cronbach's alpha based on standardized items was reported (Field, 2009; Leech et al., 2008).

Standardized Cronbach's alpha for answers favoring CTRBL was .89 for Group A and .75 for Group B. Standardized Cronbach's alpha for answers favoring non-CTRBL was .65 for Group A and .84 for Group B. These values suggest the responses have acceptable internal consistency reliability; non-CTRBL Group A values were the least consistent, but still acceptable to be used for this study given the sample size and number of questions. The non-parametric Spearman rho bivariate correlations were calculated for the subordinate scales, as suggested by Schmitt (1996).

Table 5 shows the Spearman rho correlation matrix of four CTRBL preference questions and the recoded CTRBL question for Groups A and B. All the correlations were positive. All Group A correlations had a strong effect and were significant to $p < .01$. Group B correlations were weaker, and none of the Group B correlations to the CTRBL preference question was significant.

Table 6 shows the Spearman rho correlation matrix of four non-CTRBL preference questions and the recoded non-CTRBL question for Groups A and B. For

Table 5. *CTRBL Correlations Groups A and B (N = 21).*

	Value	Rec	Learn	Enjoy	CTRBL
Value	—	.85**	.61**	.60**	.64**
Recommend	.70**	—	.68**	.68**	.60**
Learn	.62**	.49*	—	.63**	.52**
Enjoy	.41	.43	.50*	—	.53**
CTRBL	.06	.07	.09	.05	—

Note: The correlations above the diagonal are Group A, correlations below the diagonal are Group B.
* $p < .05$, two-tailed. ** $p < .01$, two-tailed.

Table 6. *Non-CTRBL Correlations Groups A and B (N = 21).*

	Value	Rec	Learn	Enjoy	Non-CTRBL
Value	—	.69**	.59**	.29	.09
Recommend	.69**	—	.40	.36	-.05
Learn	.64**	.56**	—	-.09	-.02
Enjoy	.72**	.57**	.57**	—	.31
Non-CTRBL	.38	.40	.09	.40	—

Note: The correlations above the diagonal are Group A, correlations below the diagonal are Group B.
** $p < .01$, two-tailed.

both Group A and B, the non-CTRBL correlations were not significant. Enjoyment correlations were statistically significant for 3 of the 4 pairs for Group B, but not significant for the same Group A pairs.

The intraclass correlations between members of each dyad were assessed using Cronbach's alpha. Table 7 shows all Cronbach alpha values were below .40 for all reaction questions, with four negative average covariance values. In contrast, the partner familiarity question had a Cronbach's alpha of .98, supporting the expected strong reliability of how well partners knew each other. The low Cronbach alpha's suggest members of the dyad were answering exit questions with some amount of independence.

Table 7. *Intraclass Correlations Between Dyad Members (N = 21).*

Question	Cronbach's Alpha
Partner Familiarity (Q12))	0.98
Recommend Non-CTRBL (Q8)	-0.38
Learning Non-CTRBL (Q10)	0.32
Prefer Non-CTRBL (Q15A)	-0.32
Prefer CTRBL (Q15)	-0.32
Value CTRBL (Q7)	0.29
Enjoy Non-CTRBL (Q13)	0.29
Recommend CTRBL (Q9)	0.15
Enjoy CTRBL (Q14)	-0.13
Learning CTRBL (Q11)	-0.08
Value Non-CTRBL (Q6)	0.02

Learning data reliability. The two Briefing SMEs independently scored each of the 42 briefings, without knowing the dyad identification or if the briefing was pre-treatment or post-treatment. The Cronbach's alpha for the 21 pre-treatment briefings was .88, and the Cronbach's alpha for the 21 post-treatment briefings was .95. The Cronbach's alpha across all 42 briefings was .93, indicating excellent interrater reliability.

The participant briefing evaluations were divided by briefer (Group C) and non-briefer (Group D), each group having 21 participants. The three different participant briefing evaluations were: (a) evaluation of the pre-treatment briefing, completed pre-treatment (Brief1-Pre); (b) evaluation of the pre-treatment briefing, completed post-treatment (Brief1-Post); and (c) evaluation of the post-treatment briefing (Brief2). The effectiveness question was reverse-phrased and reverse-coded. Reliability analysis was conducted for each group and each set of evaluations, reporting an overall Cronbach's alpha and correlation matrices.

The Brief1-Pre evaluations reported Cronbach's alpha of .75 for Group C and .69 for Group D, a questionable to acceptable reliability. Table 8 shows the Spearman rho correlation matrix of the individual components. All correlations were positive. Non-significant correlations varied across the two groups.

Table 8. *Brief 1-Pre Reliability Correlations (N = 21).*

Measure	Coverage	Understood	Risks	Effectiveness
Coverage	—	.23	.59**	.53**
Understood	.24	—	.27	.52*
Risks	.60**	.30**	—	.60**
Effectiveness	.44*	.17	.40	—

Note: The correlations above the diagonal are Group C, correlations below the diagonal are Group D. Effectiveness was reverse-phrased and reverse-coded.
* $p < .05$, two-tailed. ** $p < .01$, two-tailed.

The Brief1-Post evaluations reported Cronbach's alpha of .88 for Group C and .86 for Group D, a good reliability. Table 9 shows the Spearman rho correlation matrix of the individual components. All correlations were positive. Group C and Group D showed a difference in correlations related to understanding; the correlations were significant for 3 out of 4 pairs for Group C but not significant for the same pairs for Group D.

The Brief2 evaluations reported Cronbach's alpha of .89 for Group C and .74 for Group D, a good to acceptable reliability. Table 10 shows the Spearman rho correlation matrix of the individual components. All correlations were positive between 0.24 and 0.88. Group C and Group D showed a difference in correlations related to effectiveness; the correlations were significant for 2 out of 5 pairs for Group C but not significant for the same pairs in Group D.

Table 9. *Brief 1-Post Reliability Correlations (N = 21).*

Measure	Coverage	Understood	Risks	Effectiveness	Brief1 Rank
Coverage	—	.50*	.61*	.60*	.60**
Understood	.29	—	.45*	.60*	.67**
Risks	.88**	.32	—	.74**	.78**
Effectiveness	.75**	.38	.85**	—	.75**
Brief1 Rank	.64**	.24	.71**	.50*	—

Note: The correlations above the diagonal are Group C, correlations below the diagonal are Group D. Effectiveness was reverse-phrased and reverse-coded.
* $p < .05$, two-tailed. ** $p < .01$, two-tailed.

Table 10. *Brief 2 Reliability Correlations (N = 21).*

Measure	Coverage	Understood	Risks	Effectiveness	Brief2 Rank
Coverage	—	.76**	.68**	.60**	.70**
Understood	.47*	—	.49*	.44*	.36
Risks	.68**	.36	—	.77**	.86**
Effectiveness	.47*	.25	.33	—	.71**
Brief2 Rank	.93**	.58**	.72**	.42	—

Note: The correlations above the diagonal are Group C, correlations below the diagonal are Group D. Effectiveness was reverse-phrased and reverse-coded.
* $p < .05$, two-tailed. ** $p < .01$, two-tailed.

Table 11 shows Cronbach's alpha comparing the briefing measures for each dyadic pair. The Cronbach's alpha for Brief 1, pre-treatment Participant Average Score is unacceptable and show little consistency between the dyadic members. The Cronbach's alpha for Brief 2, Participant Average Score was acceptable. The Cronbach's alpha for the remaining measures are questionable and show little consistency between dyadic members.

For the two ATC Readback exercises, the SMEs independently scored each of the three sets of 96 ATC briefings, using the data from the 21 acceptable dyads and the 3 rejected dyads. The SMEs were provided between 9 and 15 exemplar scoring rows, some

Table 11. *Briefing Participant Rating Internal Consistency (N = 42).*

Measure	Cronbach's Alpha
Brief 1, Pre-Treatment Participant Average Score	.45
Brief 1, Post-Treatment Participant Average Score	.60
Brief 2, Participant Average Score	.73
Brief 1, Overall Rank Score (post-treatment)	.68
Brief 2, Overall Rank Score	.68

from the three rejected dyad groups and some from actual data. Table 12 shows the Cronbach's alpha computed for the three sets of readbacks by Group A and B, with exemplar rows omitted. Interrater reliabilities were excellent, with the lowest Cronbach's alpha being .918 on readback 2, the more complex ATC instruction.

Table 12. *ATC Readback SME Scoring Cronbach's Alpha.*

	Group A		Group B	
Readback	Cronbach's Alpha	*n*	Cronbach's Alpha	*n*
1	.955	38	.932	33
2	.918	39	.941	36
3	.996	36	.992	37

Hypotheses Testing

Reaction and learning areas had testable hypotheses. The manageability area was assessed with descriptive statistics. Each assessed area is discussed in turn.

Manageability research questions. Each of the 21 dyads was given 45 minutes to complete the transcription portion of CTRBL and 20 minutes to complete the repair portion of CTRBL. A total of 14 (66.7%) of the 21 dyads ran out of time performing the transcription portion. A total of 13 (61.9%) of the 21 dyads ran out of time performing the repair portion. Due to an administrative error, one of the dyads exceeded the transcription 45 minute time limit by 5 minutes, yet this dyad still ran out of time.

Research question Q-M1. The research question was: to what extent is the CTRBL method a manageable, student-centered activity as measured by the transcript produced by the dyadic subjects? Two SMEs independently scored the transcripts using the rubric in Appendix R. The SME scoring resulted in a mean score of 7.6 (*SD* = 1.44) out of a possible 10. The SME scoring did not incorporate how much content was transcribed, and the SME scoring instead evaluated the quality of the transcription completed. The descriptive statistics of the SME scoring is shown in Table 13.

Table 13. *SME Averaged Transcript Scores (N = 21).*

Statistic	Value
Mean	7.59
Median	7.86
Mode	7.14
Std. Deviation	1.44
Skewness	-1.17
Kurtosis	.78
Minimum	3.96
Maximum	9.14

Figure 12 shows the distribution of the SME averaged transcript scores. The negative skewness towards the higher transcript scores is evidenced in the histogram. The transcript scores support the manageability of the CTRBL method.

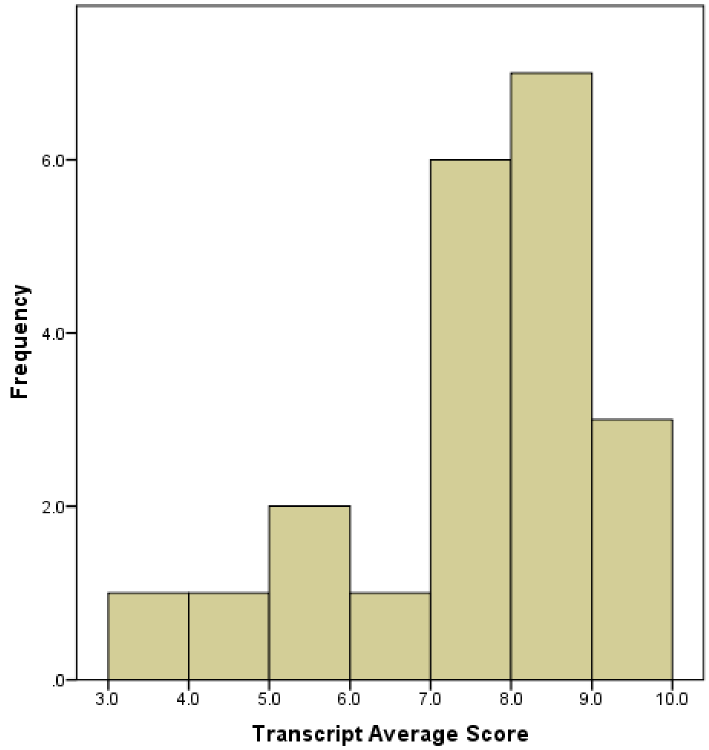


Figure 12. Transcript average score distribution (*N* = 21). Each score was averaged between two independent SME raters.

Research question Q-M2. The research question was: to what extent is the CTRBL method a manageable, student-centered activity, as measured by the time and variability the CTRBL exercise takes to perform by dyadic subjects? Timing of the CTRBL activity was performed to determine rates of performance. For the transcription portion, the mean rate of transcription was 1.92 seconds of content transcribed per minute engaged in the activity (*SD* = 0.53), which is equivalent to about 1 minute of content transcribed in 30 minutes of engaged activity. Figure 13 shows the time the dyads engaged in the transcription activity versus the amount of content transcribed in seconds. The top-most series of data points show those dyads who fully transcribed the 100 seconds (1 minute and 40 seconds) of audio content. On the right of the graph, above 45 minutes of total activity time, the vertical array of data points represent those dyads who

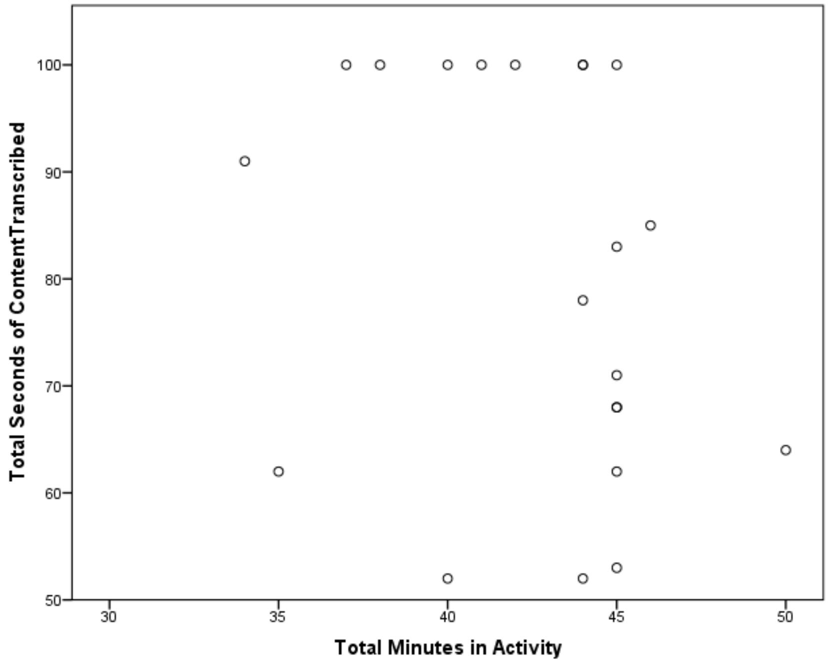


Figure 13. Transcription time and output ($N = 21$). The amount of content transcribed on the y-axis, in seconds versus the amount of time the participants engaged in the activity on the x-axis, in minutes.

ran out of time. The data points at 46 minutes and 50 minutes represent two dyads that exceeded the 45 transcription minute time limit due to administrative errors stopping the transcription activity, yet the dyads still ran out of time and did not complete the 100 seconds of transcription.

The rate of transcription was weighted for quality by multiplying the transcript score, divided by 10 (the maximum score possible), by the transcription rate. The mean weighted transcription rate was 1.42 (*SD* = .37) seconds of transcription per minute of activity. Figure 14 shows the weighted transcription versus the total minutes in the activity. Compared to Figure 13*,* the values cluster more towards the middle of the graph, rather than dominating the upper limit of the y-axis.

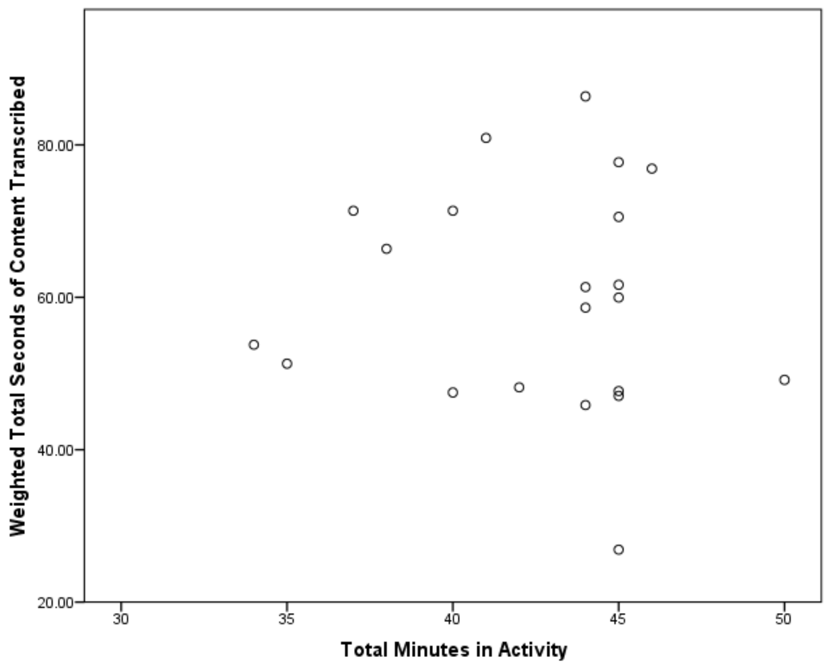


Figure 14. Weighted transcription time and output ($N = 21$). The amount of content transcribed, in seconds was multiplied by the transcription score for the y-axis value versus the amount of time the participants engaged in the activity, in minutes on the x-axis.

Figure 15 compares the transcript average scores for the 21 dyads to the total minutes engaged in the transcription activity and the total seconds of content transcribed. The linear regression trends are shown; however, the low R^2 values were not statistically significant ($p > .05$). Given the transcript scores were independent of the amount of the content transcribed and were quality focused, the trends shown in Figure 15 are as expected: (a) the more time engaged in the activity, the higher the quality, and (b) the more content transcribed, the lower the quality.

For the repair portion, the mean number of integer repairs per minute was 1.5 (*SD* = .61), and the mean weighted rate of repairs per minute was 1.3 (*SD* = .57). Figure 16 shows the frequency distribution of rate of repairs. The rates of transcription and repair support the manageability of the CTRBL method.

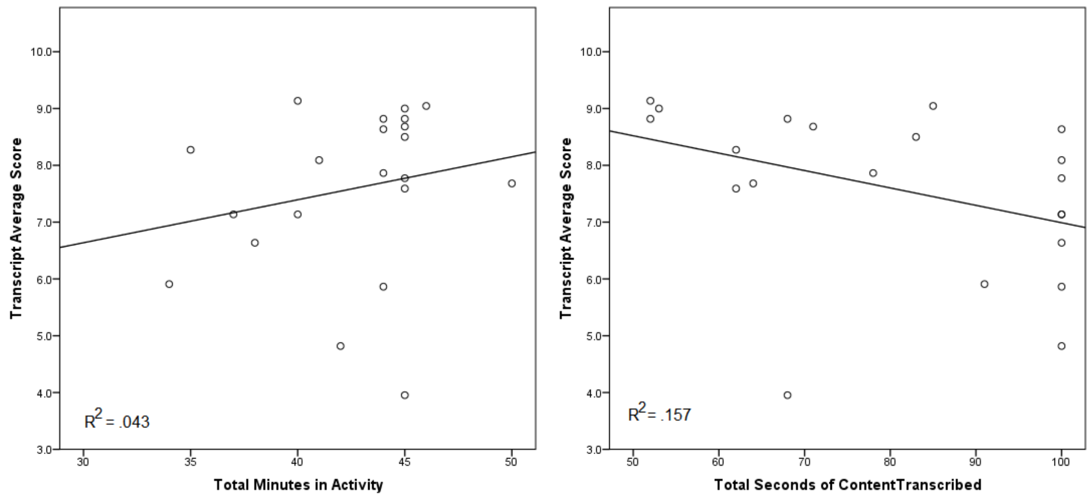


Figure 15. Transcript scoring versus activity and content transcribed ($N = 21$). Transcript scores trended up with activity time and down with amount of content transcribed.

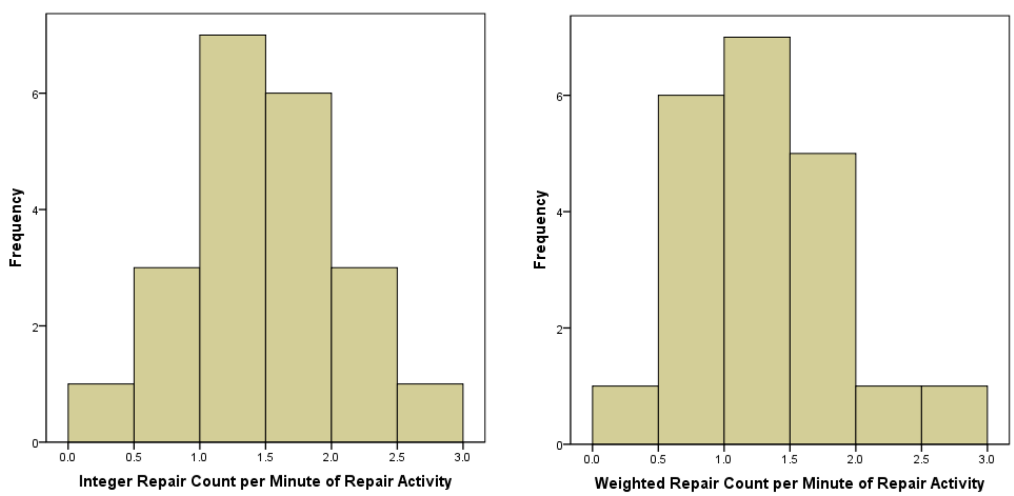


Figure 16. Rate of repair frequency distribution ($N = 21$). On the left is the repair rate based on integer counts of repairs; on the right is the repair rate based on weighted counting of repairs.

Research question Q-M3. The research question was: to what extent is the CTRBL method a manageable, student-centered activity as measured by a rubric-weighted count of repairs made by the dyadic subjects? Two SMEs independently counted repairs using the rubric in Appendix T. The two SME counts were averaged.

The average SME integer count of repairs resulted in a mean count of 25.7 (*SD* = 9.7), a weighted mean count of 23.2 (*SD* = 8.7), and a mean ratio of weighted count to integer count of .91 (*SD* = .06). The descriptive statistics of the SME repair counting are shown in Table 14. The score distributions were non-normal.

Table 14. *Average Repair Counts (N = 21).*

Statistic	Count	Weighted	Ratio
Mean	25.74	23.24	.91
Median	26.00	23.25	.92
Mode	20.00	13.25	.74
Std. Deviation	9.71	8.73	.06
Skewness	.10	.13	-1.04
Kurtosis	-.80	-.98	1.22
Minimum	10.00	9.50	.74
Maximum	44.00	38.00	1.00

Figure 17 shows the distribution of the average weighted repair counts. The slightly non-normal distribution is evident. The repair counts support the manageability of the CTRBL method.

Reaction hypotheses testing. Participant reactions to CTRBL were evaluated through four questions, comparing the participants' most favored non-CTRBL technique to CTRBL. An overall question (Question 15) asked participants to directly state the technique that the individual preferred. For Group A, 10 (47.6%) of the 21 participants preferred a non-CTRBL technique and 11 (52.4%) participants preferred the CTRBL technique. For Group B, 12 (57.1%) of the 21 participants preferred a non-CTRBL technique and 9 (42.9%) participants preferred the CTRBL technique. The remainder of

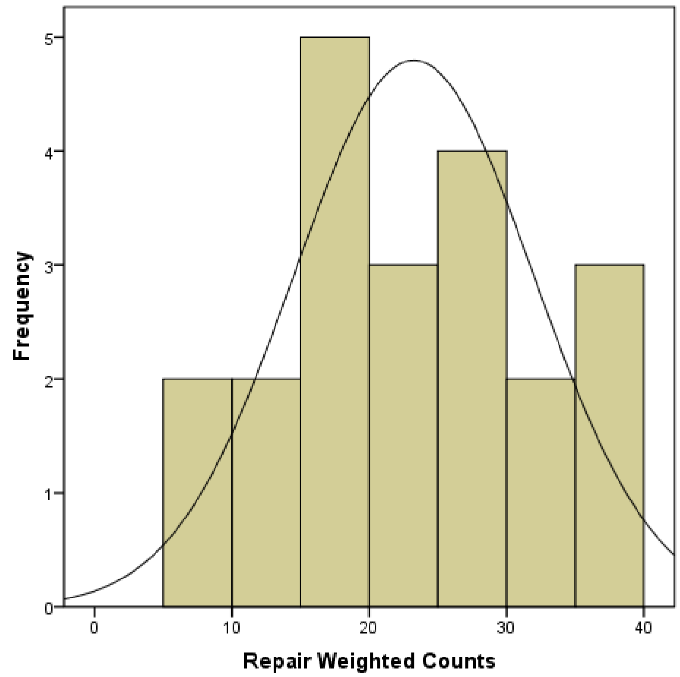


Figure 17. Average weighted repair counts ($N = 21$). A normal distribution is overlayed for comparison to the data.

the comparative question pairs were used in testing the null hypotheses using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05.

Hypothesis H-R1. The null hypothesis was: there is no significant difference between the level of value participants give to CTRBL compared to other SBT aviation learning methods to which they were exposed. For Group A, the value level of a non-CTRBL technique was significantly higher ($Mdn = 6.00$, $M = 6.14$, $N = 21$) than the CTRBL technique ($Mdn = 5.00$, $M = 5.43$, $N = 21$), $T = 22$, $p < .05$, $r = -.35$, a medium effect. Therefore, the null hypothesis was rejected. For Group B, the value level of a non-CTRBL technique was not significantly different ($Mdn = 6.00$, $M = 5.95$, $N = 21$)

than the CTRBL technique (*Mdn* = 6.00, *M* = 5.95, *N* = 21), $T = 22$, $p > .05$. Therefore, the null hypothesis failed to be rejected.

The null hypothesis was: there is no significant difference between the level of learning participants give to CTRBL compared to other SBT aviation learning methods to which they were exposed. For Group A, the level of learning for a non-CTRBL technique was significantly higher (*Mdn* = 6.00, *M* = 6.00, *N* = 21) than for the CTRBL technique (*Mdn* = 5.00, *M* = 5.00, *N* = 21), $T = 14$, $p < .05$, $r = -.41$, a medium to large effect. Therefore, the null hypothesis was rejected. For Group B, the level of learning for a non-CTRBL technique was not significantly different (*Mdn* = 6.00, *M* = 5.81, *N* = 21) than the CTRBL technique (*Mdn* = 6.00, *M* = 5.90, *N* = 21), $T = 33.5$, $p > .05$. Therefore, the null hypothesis failed to be rejected.

The null hypothesis was: there is no significant difference between the level of enjoyment participants give to CTRBL compared to other SBT aviation learning methods to which they were exposed. For Group A, the enjoyment level of a non-CTRBL technique was not significantly different (*Mdn* = 6.00, *M* = 5.48, *N* = 21) than the CTRBL technique (*Mdn* = 5.00, *M* = 4.76, *N* = 21), $T = 30$, $p > .05$. Therefore, the null hypothesis failed to be rejected. For Group B, the enjoyment of a non-CTRBL technique was not significantly different (*Mdn* = 6.00, *M* = 5.48, *N* = 21) than the CTRBL technique (*Mdn* = 6.00, *M* = 5.33, *N* = 21), $T = 21$, $p > .05$. Therefore, the null hypothesis failed to be rejected.

Hypothesis H-R2. The null hypothesis was: there is no significant difference between the level of peer recommendation participants give to CTRBL compared to other SBT aviation learning methods to which they were exposed. For Group A, participant recommendation level to peers of a non-CTRBL technique was not significantly different (*Mdn* = 6.00, *M* = 6.19, *N* = 21) than the CTRBL technique (*Mdn* = 6.00, *M* = 5.57, *N* = 21), *T* = 9.5, *p* > .05. Therefore, the null hypothesis failed to be rejected. For Group B, participant recommendation level to peers of a non-CTRBL technique was not significantly different (*Mdn* = 6.00, *M* = 6.05, *N* = 21) than the CTRBL technique (*Mdn* = 6.00, *M* = 6.24, *N* = 21), *T* = 6.0, *p* > .05. Therefore, the null hypothesis failed to be rejected.

H-R1 and H-R2 Summary. Table 15 summarizes the reaction statistical hypotheses testing. The only statistically significant differences between CTRBL and non-CTRBL reactions were observed by Group A in the areas of value and learning. In the areas of enjoyment and peer recommendation, Group A and Group B both shared no statistical difference in their reactions comparing CTRBL and non-CTRBL.

Table 15. *Summary of Reaction Hypotheses Testing.*

Reaction Area	Group A	Group B
Value	Sig., *r* = -.35*	—
Learning	Sig., *r* = -.41*	—
Enjoyment	—	—
Peer Recommendation	—	—

Note: All statistically significant results favored non-CTRBL.
**p* < .05.

Learning hypotheses testing. Learning outcomes were assessed by repeated measures. Pre-treatment and post-treatment measures were evaluated by SMEs and through participant evaluative surveys. In this section, Group C refers to participants whose role was the briefer, and Group D refers to participants whose role was non-briefer.

The total time the dyads spent briefing was tabulated and then compared using the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test using an α-level of 0.05. The null hypothesis was: there is no significant difference between the pre-treatment briefing time and the post-treatment briefing time. There was no significant difference in the pre-treatment briefing time, measured in seconds, (Mdn = 94.0, M = 90.6, N = 21) compared to the post-treatment briefing time, measured in seconds (Mdn = 82.0, M = 81.5, N = 21), T = 71.5, $p > .05$. Therefore, the null hypothesis failed to be rejected. The descriptive statistics for the 42 briefings (pre-treatment and post-treatment combined) times was a mean of 86.1 (SD = 31.1) and a median of 90.0 seconds.

Hypothesis H-L1. The two independent, blind SME scores of each of the 42 briefings (21 pre-treatment and 21 post-treatment) were averaged. The null hypothesis was: there is no significant difference between SME averaged pre-treatment briefing scores and SME averaged post-treatment briefing scores. The post-treatment SME averaged briefing score was significantly higher (Mdn = 4.01, M = 3.86, N = 21) than the pre-treatment SME averaged briefing score (Mdn = 3.19, M = 3.03, N = 21), T = 27.5, $p < .05$, r = -.47, a medium to large effect. Therefore, the null hypothesis was rejected.

Hypothesis H-L2. The null hypothesis was: there is no significant difference between Group C’s evaluation of their post-treatment briefings compared to their pre-treatment briefings (evaluated post-treatment). Group C evaluated their post-treatment briefing significantly higher (Mdn = 4.33, M = 4.37, N = 21) than their pre-treatment briefing (evaluated post-treatment) (*Mdn* = 3.67, *M* = 3.76, *N* = 21), *T* = 29.5*, p* < .05, *r* = -.41, a medium to large effect. Therefore, the null hypothesis was rejected.

The null hypothesis was: there is no significant difference between Group C's ranking of their post-treatment briefings compared to their pre-treatment briefings. Group C ranked their post-treatment briefing significantly higher (*Mdn* = 4.00, *M* = 4.19, *N* = 21) compared to their pre-treatment briefing (*Mdn* = 3.00, *M* = 3.33, *N* = 21), *T* = 16*, p* < .05, *r* = -.50, a large effect. Therefore, the null hypothesis was rejected.

Hypothesis H-L3. The null hypothesis was: there is no significant difference between Group D's evaluation of their partner's post-treatment briefings compared to their partner's pre-treatment briefings (evaluated post-treatment). Group D evaluated their partner's post-treatment briefing significantly higher (*Mdn* = 4.33, *M* = 4.35, *N* = 21) than their partner's pre-treatment briefing (evaluated post-treatment) (*Mdn* = 4.00, *M* = 3.86, *N* = 21), *T* = 31.5*, p* < .05, *r* = -.40, a medium to large effect. Therefore, the null hypothesis was rejected.

The null hypothesis was: there is no significant difference between Group D's ranking of their partner's post-treatment briefings compared to their partner's pre-treatment briefings. Group D ranked their partner's post-treatment briefing significantly higher (*Mdn* = 4.00, *M* = 4.33, *N* = 21) compared to their partner's pre-treatment briefing (*Mdn* = 3.00, *M* = 3.33, *N* = 21), *T* = 0*, p* < .05, *r* = -.59, a large effect. Therefore, the null hypothesis was rejected.

Hypothesis H-L4. The null hypothesis was: there is no significant difference between Group C's pre-treatment evaluation of their pre-treatment briefing compared to how the same pre-treatment briefing was reevaluated post-treatment. For Group C, there was no significant difference in how the pre-treatment briefing was evaluated pre-treatment (Mdn = 4.00, M = 4.00, N = 21) compared to the how pre-treatment briefing was reevaluated post-treatment (Mdn = 3.67, M = 3.76, N = 21), T = 30, $p > .05$. Therefore, the null hypothesis failed to be rejected.

Hypothesis H-L5. The null hypothesis was: there is no significant difference between Group D's pre-treatment evaluation of their partner's pre-treatment briefing compared to how the same pre-treatment partner's briefing was reevaluated post-treatment. For Group D, there was no significant difference in how their partner's pre-treatment briefing was evaluated pre-treatment (Mdn = 4.00, M = 4.11, N = 21) compared to the how their partner's pre-treatment briefing was reevaluated post-treatment (Mdn = 4.00, M = 3.86, N = 21), T = 42, $p > .05$. Therefore, the null hypothesis failed to be rejected.

Hypothesis H-L6. Three different ATC instructions (Appendix B) were given to each of the 42 participants for readback pre-treatment and post-treatment. Thus, for each ATC instruction, there were a total of 84 readbacks.

The null hypothesis related to the ATC readbacks was: there is no significant difference between pre-treatment ATC readbacks and post-treatment ATC readbacks as scored by SMEs. Two SMEs independently scored each of the 252 ATC readbacks using the scoring procedure in Appendix O, resulting in a score between 0 and 100 for each readback. The SME average score was used to evaluate the null hypothesis. The ATC readback SME averaged scores showed significant improvement ($p < .05$) in Group A and Group B post-treatment compared to pre-treatment ATC readback SME averaged scores, except for Group B's readback 1 SME averaged scores ($p = .06$). Therefore, in all but one case, the null hypothesis was rejected. Table 16 shows the results of the Wilcoxon Matched-Pairs Signed-Ranks, 2-tailed test. The change in post-treatment SME averaged scores compared to pre-treatment SME averaged scores had a medium to large effect size for all the statistically significant tests.

Table 16. *ATC Wilcoxon Matched-Pairs Signed-Ranks Test (N = 42).*

	Pre-Treatment		Post-Treatment			
	M	*Mdn*	*M*	*Mdn*	*T*	*r*
Group A						
R1	85.2	95.0	96.4	100.0	28.0	-.32*
R2	69.6	72.5	84.9	90.0	5.0	-.56*
R3	72.7	85.0	87.1	90.0	24.0	-.32*
Group B						
R1	93.5	95.0	94.7	95.0	43.0	-.29†
R2	72.1	72.5	86.5	90.0	9.5	-.51*
R3	80.7	90.0	85.4	90.0	5.0	-.41*

Note: Each mean and median represents the SME averaged score.
† $p < .10$; * $p < .05$.

Qualitative Data

This study produced qualitative data from a number of sources. The Post-Treatment Survey had free form text answers. The evaluations and treatments produced transcripts of readback and briefing recordings, transcripts produced by dyads, and repairs produced by dyads. Summaries and examples of this qualitative data are next presented.

Post-Treatment Survey. The full answers to the post-treatment questions regarding why the non-CTRBL or CTRBL technique was preferred (Question 16) and additional comments (Question 17) are presented in Appendix W. Table 17 shows the thematic coding of reasons for preference of CTRBL or a non-CTRBL technique. The most frequent reason for CTRBL preference was interactivity, followed by the ability to analyze talk-in-action. The most frequent reason for non-CTRBL preference was greater depth of analysis, followed by a preference for simulator instruction, despite the directions asking participants for a non-simulator based comparison to CTRBL.

Table 17. *Thematic Coding of Technique Reason Preference (Question 16).*

Preferred CTRBL	*n*	Preferred Non-CTRBL	*n*
Interactive	7	Greater Depth	4
Talk-In-Action Analysis	4	Preferred Simulators	3
Collaborative	2	CTRBL Tedious	2
Could relate to Scenario	2	Learning Style Preference	1
Multisensory	2	Preferred Groups More Than 2	2
No Depth Answer	2	ADM	1
Awareness	1	Applied Learning	1
Compare-Contrast	1	CTRBL Ambiguous	1
Eye-Opener	1	CTRBL Bad User Interface	1
Increased Confidence	1	CTRBL No Debrief	1
Increased Knowledge	1	CTRBL Unrelated to Flying	1
		Instructorless	1
		Interactive	1
		NonCTRBL More Enjoyable	1

Note: One participant response could result in more than one theme.

Table 18 shows the thematic coding of additional comments separated by CTRBL and non-CTRBL preference. Three participants commented on the thorough planning and execution of the experimental procedure. Two participants commented that transcription was difficult. Positive comments included a desire to see more CTRBL,

Table 18. *Thematic Coding of Additional Comments (Question 17).*

Preferred CTRBL	*n*	Preferred Non-CTRBL	*n*
Good Experimental Process	3	Combine CTRBL with Other Training	3
Transcription Difficult	2	CTRBL is Interesting	3
Useful, See More CTRBL	2	Avoid Computer Based Technique	1
Engaged	1	CTRBL Good for ATC Radio Skills	1
Reflective Experience	1	CTRBL Good for Situational Awareness	1
		CTRBL is Nothing New	1
		CTRBL Needs Better User Interface	1
		Did not Realize CTRBL was Training	1

combine CTRBL with other training, and a general comment that CTRBL was interesting.

Exemplar artifacts. The qualitative data used for the quantitative analysis came from the individual participant ATC readback exercise, the dyad briefings, the dyad transcripts, and the dyad repairs. Examples of each of these items are presented next.

ATC readbacks. Each participant responded to three different ATC instructions twice, pre-treatment and post-treatment. The first ATC instruction was, *Cessna two romeo juliet, contact New York approach one two zero point four*. The most common response, used 11 out of 84 times was, *Contact New York approach one two zero point four Cessna two romeo juliet*. An example of an erroneous readback was, *Over to approach one two two point four two romeo juliet*. For this first ATC instruction there were 54 unique readback phrases spoken out of the 84 readbacks, considering all readbacks pre-treatment and post-treatment.

The second ATC instruction was, *Cessna two romeo juliet, turn left heading one zero zero, intercept the Kennedy two five five radial inbound*. The most common response, used 3 out of 84 times, was *Turn left one zero zero intercept the Kennedy two five five radial Cessna two romeo juliet*. An example of an erroneous readback was, *Turn left two zer-- one two zero and ah intercept Kennedy radial two five zero two romeo juliet*. For this second ATC instruction, there were 79 unique readback phrases spoken out of 84 readbacks, considering all readbacks pre-treatment and post-treatment.

The third ATC instruction was, *Cessna two romeo juliet, New York altimeter two niner eight eight*. The most common response, used 9 out of 84 times, was *New York altimeter two niner eight eight Cessna two romeo juliet*. An example of an erroneous readback was, *Cessna two romeo juliet altimeter two nine nine eight*. For this third ATC instruction, there were 47 unique readback phrases spoken out of 84 readbacks, considering all readbacks pre-treatment and post-treatment.

Dyad briefings. One member of the dyad was designated the briefer, the other was designated the non-briefer. The directions encouraged the non-briefer to participate. One briefer began the pre-CTRBL briefing by saying,

> Alright so. We're ah. Flying to Zangster International airport winds are calm. So we will be landing runway two seven. Seven thousand two hundred feet available. Uhm we're arriving from the East expecting a straight in approach. Field elevation is five hundred. Ah but there are some hills and mountains around the airport so let's keep an eye out for those. Uhm also keep an eye out for traffic. Uhm altimeter's set and that concludes my briefing. Did I miss anything? Do you have anything to add?

The non-briefer responded, leading to an interactive exchange,

Non-Briefer	How much runway do we need to land this airplane?
Briefer	Uh we need fifteen hundred feet.
Non-Briefer	Okay...uhm and ah what are the winds like?
Briefer	Winds are calm.
Non-Briefer	Okay. Oh and what is our runway exit strategy?
Briefer	Landing runway two seven we will exit on the ah ... Second taxiway off on the left.
Non-Briefer	Okay. Sounds good.

An example of briefing improvement was evidenced post-CTRBL when the briefer added a caution about electronic distractions, "I know we're dying, mines in the back, but we got the diagrams that we need to land and so we should be okay." The pronominalized reference "we're dying," was interpreted to be a reference to battery power on an electronic device diminishing, as was the case in the audio scenario when the iPad low battery power distracted the pilots. The briefer went on to caution about similar aircraft call signs, "…ah I've been told especially since this is a flight school and everything there is going to be a lot of similar uhm call signs out." The briefer finally added a caution for a disciplined, sterile cockpit, "…when we begin our approach, ah please have a sterile cockpit so we do not confuse any transmissions whatsoever." These three indicators were not present in the pre-CTRBL briefing by the same dyad. These direct risk areas, synthesized from the audio scenario into the post-CTRBL briefing, raised the briefing scores and were evidence of learning.

The scenario briefing materials given to the dyads (Appendix C) included a researcher developed FAA publication for the fictitious airport, Zangster International. The fictitious publication was adapted from a real publication and included airport remarks about hazards due to wildlife and weather balloon launches. Of the 21 dyads, 4 (19%) addressed the hazards in their briefings. Word stem trees summarizing the usage are shown in Figure 18. The wildlife and balloon hazards were unintended details included by the researcher in the briefing materials. The SMEs rated the wildlife and balloon hazards under the Briefing Evaluation Rubric (Appendix P) area of "technical."

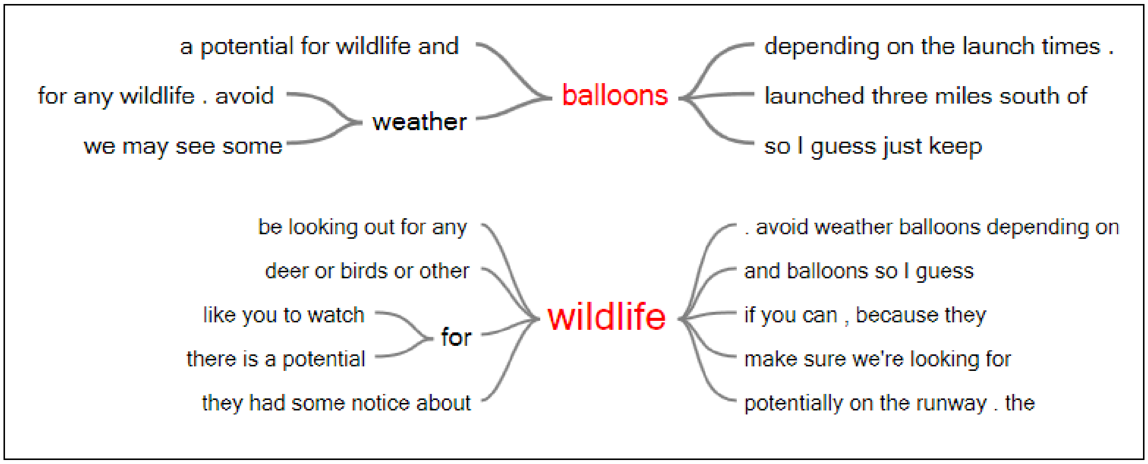


Figure 18. Word stem trees related to airport hazards. The word stem trees were aggregated from four dyads who mentioned these hazards.

Transcription. Each dyad was assigned 100 seconds of audio to transcribe. Figure 19 shows an example of dyad transcription of the first block of audio transcribed. In this case, the dyad parenthetically noted they were not sure about a part of the audio, noting "(pretty sure)" in the transcript. The audio the dyad had trouble transcribing purposely had fragmented speech inserted during scenario development.

A qualitative review of transcripts produced showed that approximately 80% of the dyads followed the style of the example transcribed content, using a heading of source and destination identification, followed by transcribed content. Approximately

Dyad Transcription	Professional Transcription
Intercom Pilot 2 to Pilot 1 Yep me too. I hear taxi ways are a mess here. I thought I was going with (pretty sure) Carnie. And uh, you know he's got like chemistry lab notes they're due tomorrow. He uh he should be outta here tonight. And uh, boy if I'm late on those lab notes, I'll fail chem. I've gotta catch him in the FBO.	**Intercom Pilot 2 to Pilot 1** Yeah me too. I hear taxiways are a mess here. I thought I was going with Arnie. And ah you know he's got my chemistry lab notes they're due tomorrow. He ah he should be out here tonight. And uh boy if I if I'm late on those lab notes. I'll fail chem. I gotta catch him at the FBO.

Figure 19. Example of dyad transcription. Dyad transcription on the left is compared to professional transcription on the right.

20% of the dyads deviated from the style, and incorporated the source and destination identification directly into the transcribed content. In one instance (4.7%), a dyad did not perform any source and destination identification. Figure 20 compares two different extremes of source and destination identification produced by two different dyads.

Higher Scoring	Lower Scoring
Intercom Pilot 2 to Pilot 1 Ahh shoot, my Ipad (luck) battery's low. I'd, I'd like to have the taxi diagram. Yep, yup here's how. **Intercom Pilot 1 to Pilot 2** No, my Ipad's in the back. Should I get it? **ATC to Cessna 334AR** Cessna tree tree four alpha romeo, decend and maintain two thousand five hundred, contact approach one two five point one.	Ah shoot, my ipad * battery is low, I'd like to have a taxi diagram, yep******* no my ipad is in the back... Cessna Tree tree four alpha romeo decend and maintain two thousand five hundred, contact approach one two five point one.

Figure 20. Example of source/destination identification. The left side shows a higher scoring source/destination identification, the right side a lack of source/destination identification.

The transcription instructions and example transcribed content asked dyads to express numbers as words rather than numerals. Out of 21 dyad transcripts, 16 (76%) followed the instructions and the example and wrote out all numbers, while the remaining 5 (24%) expressed numbers as numerals to some degree. Figure 21 shows two different extremes of number transcription produced by two different dyads.

Higher Scoring	Lower Scoring
[interrupting] 2nd Approach Controller to Cessna 114AR Cessna tree tree four alpha romeo, descend and maintain two thousand fife hundred. Contact approach one two fife point one. **N124AR to 2nd Approach Controller** Was that for us? November one two four alpha romeo?	**Second Approach to cessna 224er** Cessna 224 ER, descend and maintain 2500 contact approach 125.1 **N114AR to ATC 2** Was that for us? N124AR?

Figure 21. Example of number expression. The left side shows a higher scoring expression of numbers, the right side the use of numerals.

Repair. After the transcription portion of the experiment, each dyad was given the professional, fully prepared transcript. The dyad was asked to correct the scenario in order to produce an ideal scenario outcome. Figure 22 shows an excerpt of repairs made by a dyad. The dyad both deleted and replaced text in this example.

A thematic summary of all repairs is shown in Appendix X. All repairs to each block of the transcript were thematically grouped. The thematic summary shows each block of the original transcript, followed by a count of how many dyads made a change to the block, followed by a description of the nature of the repairs dyads made to the block.

Intercom Pilot 2 to Pilot 1
Yeah me too. I hear taxiways are a mess here. I thought I was going with Arnie. ~~And ah you know he's got my chemistry lab notes they're due tomorrow. He ah he should be out here tonight. And uh boy if I if I'm late on those lab notes. I'll fail chem. I gotta catch him at the FBO.~~

Aircraft Cessna 104AR to ATC
One ~~twenty five~~two fife point one out of four thousand ~~five~~ fife hundred for two ~~and a half~~thousand fife hundred. ~~Ten~~ one zero four alpha Romeo. Good night.

Intercom Pilot 2 to Pilot 1
That must be Arnie and Steve. I think there's like five of us up here tonight. You know. That's cool. I should I should be able to be able to catch up to him on the ground Arnie and ground and get my Chem lab notes ah. ~~He better. I better cat-- he better * ah...my instructor showed me this high speed approach profile you want to try it? Your instructor show you that one?~~

Figure 22. Excerpt of repairs made by a dyad. Deletions and replacements are shown.

CHAPTER V

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Pilot training prior to the 1970s was focused on learning technical skills. As aviation grew in complexity, accidents trends made clear that technical skills alone were insufficient for safe operations in the increasingly complex aviation system, resulting in a new component of training focused on CRM (Kearns, 2010; Salas et al., 2001). Skills comprising CRM include communication, command and authority, conflict management, crew briefings, decision making, team building, team maintenance, workload management, resource management, error identification and repair, and stress identification (Arminen et al., 2010; Federal Aviation Administration, 2004a; Gregorich et al., 1990; Kanki & Smith, 2001).

In response to the need for CRM training aviation has adopted successful methods for CRM learning. These learning methods include instructor facilitation of scenarios using LOFT and SBT to instill change in CRM attitudes and develop CRM skills (Dismukes & Smith, 2000). Instructor facilitation presents a resource challenge of having one instructor interact with one or two students. When the demand for instructor resources can be reduced learning resources can be better allocated to maximize safety advantages (Kearns, 2010).

This study examined multi-disciplinary fields within applied linguistics to construct the theory-based CTRBL method of learning. The CTRBL method has students collaboratively analyze a flawed aviation scenario recorded as audio using a two-step process. First, the students collaboratively transcribe a select portion of the audio scenario. Secondly, the students collaboratively repair the transcript with the objective of creating an ideal scenario. The repairs are expressed by *marking-up* the transcript to correct errors that students believe contributed to the flawed scenario.

In order to test the efficacy of the CTRBL method a quantitative, repeated-measure, nonequivalent dependent variable, within-subject, quasi-experimental design was used. During the quasi-experiment, participants operated as dyads (groups of two) and performed CTRBL and other evaluative exercises. This study used a modified Kirkpatrickian (1976) framework to measure efficacy by focusing on the ability of participants to perform CTRBL (manageability), satisfaction of learners with CTRBL (reactions), and what skills were learned after CTRBL (learning). In this study, the CTRBL method was designed for novice pilots to learn the CRM skill of planning for a landing, referred to as an approach briefing. During the approach briefing, crews typically discuss technical aspects of the landing sequence, alternative plans, crew responsibilities, and risk mitigation.

After the quasi-experimental methodology was beta-tested, 42 novice pilot, university students engaged in the actual CTRBL quasi-experiment, operating in dyadic pairs resulting in 21 groups performing CTRBL. After data collection, SMEs converted qualitative data to quantitative data as part of the manageability and learning measures.

The study supported the efficacy of CTRBL as a means for novice pilots to learn the CRM skill of a crew approach briefing. Within the scope of the present study, the outcomes support the possibility of CTRBL as a new CRM learning alternative that can be used to optimize learning, thereby contributing to improvements in aviation safety. In aviation, where most accidents are the result of a sequence of relatively small errors, CTRBL offers an additional option for pilots to learn effective CRM skills leading to accident prevention (Dismukes, Berman, & Loukopoulos, 2007; Gladwell, 2008).

Discussion

The results presented in Chapter IV are discussed fully in this section. The discussion first focuses on results of the present study followed by generalizability considerations. The discussion of results is presented using the modified Kirkpatrickian (1976) framework of manageability, reactions, and learning that were used to evaluate the CTRBL method.

Manageability. The transcripts produced by dyads during the transcription portion of the CTRBL treatment were scored by SMEs. The transcript scores indicate variability of performance skewed towards higher scores, with an average score of 7.6 out of 10. The average rate of dyad transcription is about 1.9 seconds of content transcribed per minute, without considering the quality of output. When quality is considered, the average rate of dyad transcription lowers to about 1.4 seconds of content transcribed per minute. Of the 21 dyads, 14 (66.7%) ran out time performing the assigned transcription. The transcription rates observed, which equate to about one minute of content transcribed in 30 minutes of engaged activity, represent an intensive activity consistent with Lynch's qualitative observations of L2 learners, "the time and trouble they take over details is striking: in all four recordings I ran out of videotape" (2001, p. 128). The rates are practically useful for planning the time allocations for the transcription phase of CTRBL.

Qualitative review of the transcripts generally evidenced a concerted effort by dyads to produce a transcript in-line with the exemplar transcribed content. The transcripts demonstrated an effort by dyads to fully cover the audio content, to be accurate in transcription, to identify sources and destinations of output, and to write out numbers rather than use numerals. In fact, many dyads used a parenthetical notation to indicate areas where they could not be sure of what was heard, which was an indicator the dyads followed the instructions to express unresolved disagreements.

The transcript repairs produced by dyads during the repair portion of the CTRBL treatment indicate an average weighted repair rate of 1.3 repairs per minute. The repair counts evidenced wide variation of output by the dyads, from 10 to 44 repairs, or 9.5 to 38.0 weighted repairs. This variability in repair output could possibly be attributed to at least five factors. First, the repair activity time limit affected 13 of the 21 dyads (61.9%) and the dyad's time management skills may have affected repair output. Secondly, the dyads may have interpreted the repair instructions differently. Thirdly, the motivation of the dyads may have varied. Fourthly, the collaborative dynamic of each dyad may have varied. Finally, how the dyads conceptualized what constituted a repair may have been different. It is the fifth item—how the dyads conceptualized a repair—that is most related to CRM skills and the intended focus of the activity; the other four items confounded this observation. For this study, the scope did not permit a thorough investigation of the dyad repair conceptualization, but the confounding factors may be of interest to future studies and to the usage of CTRBL in practice.

Qualitative review of repairs showed most dyads made deletions and replacements to the transcript, with very few dyads creating completely new blocks of content. For example, no dyads created new transcript lines of the accident pilots verifying altitudes on a chart before descent, and no dyads created new transcript lines of an automated warning of terrain that may be produced by GPS based terrain avoidance systems. Overwhelmingly, transcript deletions and replacements focused on improved cockpit discipline, expressed by deletion of references of the need of one scenario pilot to get to the airport quickly to meet another colleague, and the associated desire to conduct a novel flight profile. Dyads also deleted transcript text related to operational iPad distractions.

Transcript, repair, and timing results support the manageability of CTRBL. Significantly, pilots untrained in transcription and repair activities—traditionally viewed as the domain of professional researchers and conversation analysts—successfully collaborated to produce a partial transcript and repair of a transcript. Transcript artifacts produced by dyads permit a discriminate view of dyad output with some insight into task commitment. Repair artifacts produced by dyads provide insight into what the dyads believe constitutes a well-functioning team in an aviation context. Both the transcript and repair artifacts will prove useful for follow-on, instructor feedback. Removal of time constraints might provide greater clarity of dyad task commitment, dyad CRM concepts, and dyad aviation concepts.

Reactions. Participant reactions to CTRBL in the areas of value, learning, enjoyment, and peer recommendation were on par with reactions to non-CTRBL methods. Only in the area of value and learning did half of the split groups favor value and learning of a non-CTRBL method; in the reaction areas of enjoyment and peer recommendation both of the split groups showed no statistical difference in their preference for CTRBL or a non-CTRBL method. The mean and median CTRBL ratings are on the higher end of the 7-point scale and are similar to that of the non-CTRBL favored method.

The qualitative comments of participants provide some explanation of the quantitative preferences. Reasons favoring CTRBL included its interactivity, the ability to analyze talk-in-action, the multisensory component, and the collaborative elements of CTRBL. Reasons favoring non-CTRBL included that CTRBL lacked depth or that it was tedious; some participants preferred simulators, though the instructions stated that simulators should not be used for comparison. Across participants favoring CTRBL or non-CTRBL, participants found CTRBL interesting and engaging, and the participants suggested integrating CTRBL with other training.

The reaction results suggest that CTRBL is on par with other non-CTRBL, ground-based CRM learning methods the participants had used. With clear participant expectations of the CTRBL activity, the qualitative remarks suggest integration of CTRBL into a larger context of learning may increase the favorability of student reactions.

Learning. Before the CTRBL treatment, one of the two participants in each dyad led an oral, impromptu crew approach briefing directed at the other member of the dyad. After the CTRBL treatment, the dyad repeated the crew approach briefing. Each briefing was audio recorded and later transcribed by the researcher for SME scoring. Participants consistently evaluated their post-treatment briefings higher than their pre-treatment briefings, with a medium-to-large effect. The time spent on post-treatment briefings was not statistically different from the pre-treatment briefings. Two SMEs independently and blindly scored the post-treatment briefings higher than the pre-treatment briefings, with medium-to-large effect. These emic and etic briefing improvement perspectives are supportive of learning. Significantly, pilots demonstrated measurable changes in CRM crew approach briefings after successfully engaging in a learning activity they perceived to be on par with their most favored ground-based CRM learning method. Furthermore, the pilots performed CTRBL without any instructor facilitation.

The post-treatment, participant re-rating of the pre-treatment briefings showed no statistical difference. Interpretation of this outcome suggests at least two possibilities. From a learning disconfirmatory perspective, the lack of statistical difference suggests participants did not take away any hindsight from the CTRBL activity, hindsight that may have caused participants to downgrade their original pre-treatment rating. From a statistical reliability perspective, the lack of statistical difference suggests the briefing rating instrument was a reliable instrument, as it showed consistent results pre-treatment and post-treatment.

A qualitative review of the post-treatment briefings evidenced specific differences between pre-treatment and post-treatment briefings, consistent with the SME quantitative scoring. The post-treatment briefings incorporated acknowledged aviation CRM emphasis areas such as cockpit discipline, after landing planning, radio communications, and distractions that were not addressed in the pre-treatment briefings. An unintended feature of the briefing scenario was that the fictitious FAA publication, created by the researcher, referenced wildlife and weather balloon hazards (Appendix C), which 4 (19%) of the 21 dyads noticed and incorporated in their briefings. The experiment would have been better served if the wildlife and weather balloon hazards had been omitted from the fictitious FAA publication by the researcher, as these hazards were unrelated to the learning outcomes designed into the scenario used in CTRBL.

Each individual participant read back ATC instructions before and after the CTRBL treatment. The ATC readbacks were audio recorded, transcribed by the researcher, and then blindly scored by SMEs. The ATC readbacks post-treatment compared to pre-treatment showed significant improvement, contrary to the null hypothesis that the readbacks would remain unchanged. The improvement in readback performance suggests at least two possibilities. First, it is possible that CTRBL contributes to readback performance. Secondly, it is possible that ATC readback performance improves simply due to repetition. The true explanation may lie somewhere in between each of these extremes. If the ATC readback improvement explanation is due more to repetition, then this may suggest the improvement in crew briefings is due to task repetition rather than CTRBL causal impact. The most likely outcome lies somewhere between these extremes: the crew briefing improvement is due in part to repetition and in part to CTRBL causal impact. The limitations of the quasi-experimental design and its lack of a control group, combined with the nonequivalent, dependent variable (ATC readbacks) not performing as hypothesized, limits the ability to reach a strong, causal CTRBL learning inference without knowing the full impact of repetition on the improved briefing performance.

Generalizability. Within the context of the study, the results support conclusions about manageability, reactions, and learning as discussed. These conclusions have internal validity for the particular study operations actually performed. Shadish et al.

(2001) labels these study operations as units (participants), treatments, observations, and settings (UTOS) (p. 513). The generalizability discussion (i.e., external validity) that follows considers UTOS variation.

Units. Participants (units) used in the study were pilots from a particular university with a highly structured aviation curriculum. The participants were novice pilots, all spoke English as their native language, and their average age was approximately 21 years old. Extrapolating the results to other university students with different curriculums and safety cultures may impact the results. Extending the results to participants who are not in a university setting, of different ages, of different group sizes, of different educational backgrounds, of different cultures, of different experience and professional maturity, and of different English language proficiency levels may also change the results. Further, changing all UTOS operations beyond aviation, using participants where the work environment involves collaborative, sociotechnical discourse will certainly impact the results beyond the scope of the present study and is worthy of further consideration (Heritage & Clayman, 2010; Nevile & Walker, 2005).

Treatment. The main CTRBL treatment used in the study had necessary particulars of a combination of pre-transcribed content, audio that remained to be transcribed, and time constraints for transcription and repair. The CTRBL task operated on a particular scenario. Each of these CTRBL elements offers variability to future application of the CTRBL treatment, be it in learning applications or future studies. As was observed in the beta-test, excessive transcription in one sitting seemed to fatigue the participants and detract from learning. The scenario used was tailored to the university student population and the learning outcome of an improved crew briefing; any number of different scenarios could be used, affecting the results. The CTRBL technique was limited to audio and did not include video. Future scenarios may have different degrees of realism, different uses of scripted and natural talk, different media combinations, and different attention to the particulars of discourse and talk-in-action.

Observations. Manageability, reactions, and learning outcomes were the observations of the study. Manageability was observed through transcript and repair artifact production, as well as rate of performance of these activities. Reactions were observed through traditional exit surveys. Manageability and reaction observational techniques should extrapolate to other units, treatments, and settings. The trend of manageability observations in this study should generalize to other units, treatments, and settings. The substance of reaction observations is difficult to generalize beyond the particular combination of units, treatments, and settings simply based on a lack of surface similarity that may exist when different populations (units) use CTRBL, when the scenario is changed (treatment), and when environment changes occur, such as hardware and software upgrades (settings).

The learning outcomes of the present study were designed to measure the particular learning outcome of improved crew briefings with a focus on risk mitigation. The learning outcomes of the present study should extend to other novice pilots, given the same combination of treatment and setting.

The learning outcome of improved crew briefings is one of many possible learning outcomes CTRBL could explore. Other notional learning outcomes include: (a) L2 pilot communication skills; (b) radio communication skills; (c) professionalism;

(d) CRM skills and attitudes; (e) instrument approach briefing skills; (f) conflict resolution; (g) training performance of memory items; (h) deciding upon the declaration of an emergency or aircraft evacuation; (i) briefing relief pilots on long-haul flights; (j) reactions to sudden, unusual, or unexpected events; (k) unstabilized approaches; (l) pilot monitoring skills; (m) cognitive biases; (n) runway incursions; and (o) fostering safety cultures (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile, 2012; Dismukes et al., 2007; Joslin et al., 2011; Kanki & Smith, 2001; National Transportation Safety Board, 2009, 2012; Orasanu, 2010; Stolzer et al., 2008). This aviation outcome list may be expanded by venturing beyond aviation to other sociotechnical, collaborative environments.

Professionalism is an example of a learning outcome that exists in many sociotechnical environments. In a study of rules compliance in the transit industry, an array of employee training techniques were inventoried to promote rules compliance (Gertler, DiFiore, Hadlow, Lindsey, & Meenes, 2011). Gertler et al. (2011) outlined best practice training methods used in the transit industry to foster professionalism, including the use of action-based learning and low-fidelity simulations. The CTRBL method bears similarity to the action-based methods identified by Gertler et al. This study cannot offer efficacy predictions for a professionalism outcome or learning outcomes in non-aviation environments, as they require large variation in units, treatments, and settings beyond the scope of the present study. The Recommendations section of this chapter offers a pathway for the exploration of varied learning outcomes in aviation and in other sociotechnical environments.

The observations used in the study directly measured crew briefings and quantitatively measured manageability and reactions. The study did not observe the interaction of the dyads performing the CTRBL activity. Significant information may have been gleaned from qualitatively observing the interactions of dyads while they performed the transcription and repair components of CTRBL, as was suggested by anecdotal, qualitative observations from Dictogloss and L2 transcription and repair reported in the literature review. Wajnryb (1990) suggested the collaboration about language spawned during Dictogloss may be the *raison d'être* of Dictogloss (p. 17); likewise, the collaboration about CRM spawned during CTRBL may be the *raison d'être* of CTRBL. Longitudinal observations of learning, behavioral modification, and safety results may provide an expanded view of the efficacy of CTRBL (Kirkpatrick, 1976; Salas et al., 2006).

Settings. The setting of the study contained particulars that affected the result. The hardware used was laptop computers with one screen. The transcription software ran two programs separately: the audio listening software and Microsoft® Word®. Using multiple screens and integrated audio listening/transcription software would likely increase the rate of transcription and improve participant reactions to CTRBL. The introduction and instructions given to CTRBL participants may affect the results. Having the participants conduct the activity in a classroom with time constraints may be quite different then having them perform the activity as a take-home assignment over a longer period of time.

Lessons learned. The quasi-experimental design resulted in a number of lessons learned useful to future researchers. The method used to prepare the audio scenario was quite effective and is recommended as a template for future scenario development. Recording the scenario with distinctly different voices aided speaker identification during transcription; however, if the distinctly different voices are overdone, they may detract from realism. Having a CA professional review the scenario audio discourse may improve scenario realism and value.

Using web-browser compatible listening software was convenient for portability of the CTRBL method. The use of smartphones for digital recording of briefings provided a high fidelity recording capability that was easily secured by password encryption of the smartphone. Microsoft® Word®'s track changes feature was an effective way to record participant changes to the transcript; however, researchers must allow time to make sure students understand how to use the feature.

Directions for the performance of CTRBL will need to be clear to avoid unexpected results. Consequently, participants need to be clearly told to collaboratively, electronically type their results, rather than use a workflow of note taking on paper followed by entering their notes into the electronic transcript.

The scenario briefing instructions need to avoid extraneous information that may confuse the participants. For example, in the present study the fictitious airport information mistakenly included hazards of wildlife and weather balloons that distracted some participants from the intended learning objectives.

Within the present study, the nonequivalent dependent variable of ATC readbacks was used in lieu of a control group. The ATC readbacks showed improvement, contrary to the expectation that ATC readback performance would not change. While the ATC readback improvement may be a valid learning outcome of CTRBL, in the scope of the present study, the change did not benefit the research design. Further, ATC readbacks were time consuming to collect, process, and score. In future studies, ATC readbacks should not be used as a nonequivalent dependent variable.

In the present study, participants were scheduled in pairs requiring that both participants had to show up on time, which presented logistic challenges. In future studies, researchers must define ways to encourage participants to meet schedule commitments, such as repetitive phone calls, email, and text messages. Once participants arrived at the experiment, the use of a checklist to guide them through the steps of the experiment helped to avoid confusion and missed steps.

During the repair activity all participants made deletions and changes, rather than large scale insertions of new content. Enhancing the directions to dyads to encourage deletions, changes, and insertions may improve the repair outcome.

Most dyads ran out of time in both transcription and repair. Allocating ample time for each activity will enhance the results of future studies.

Conclusions

During the 1970s, the aviation industry recognized the need to focus on CRM attitudes and skills training to improve aviation safety. Since the 1970s, numerous studies have gauged the impact of CRM on aviation safety and evaluated the efficacy of various CRM learning methods (Salas et al., 2006). The skills of CRM are one of the defenses used to break the chain of errors that may lead to an accident. Given the scope and scale of aviation operations, even small improvements in CRM skills may provide the needed defense to prevent an accident and save human lives.

An example of a chain of events leading to a near-accident were experienced by the crew and 179 passengers aboard a Boeing 757 landing at Jackson Hole, Wyoming in 2010 when the aircraft overran the end of the runway by 730 feet. The accident report explained how the simultaneous anomalies of two highly reliable aircraft mechanical systems interacted with the crew CRM dynamics leading to the runway overrun. In his concurring statement on the event, NTSB Vice Chairman Christopher Hart noted how the sequence of events leading to the dual mechanical systems failure was on the order of microseconds. Vice Chairman Hart said, “I submit that we [NTSB], along with the entire aviation community, need to focus more attention on the human factors challenges that are brought about by increasing reliability, including but not limited to expectation bias” (National Transportation Safety Board, 2012, p. 28). For the 179 passengers onboard the Boeing 757 that overran the runway into a snow-covered field in Wyoming, investing in new CRM learning methods to enable crew defenses against automation failures is well worth the investment.

Kanki and Smith (2001) suggested “more learning could occur in a 1-hour session using two chairs and broomstick than in a 4-hour period in a level D simulator” (p. 119). In the present study, two students sat in chairs and in the course of an hour their broomstick was a computer enabling them to listen and interact with a scenario using CTRBL. The study supported the efficacy of CTRBL as a structured way for novice pilots to learn the CRM skill of a crew approach briefing. The technology to enable the broomstick of CTRBL has evolved over the last five to ten years, through the propagation of hardware and software to manipulate digital audio and enable the social portability of audio.

In the present study of CTRBL, novice pilots demonstrated learning through improvement of the CRM skill of a crew approach briefing. Novice pilots used CTRBL—without any instructor facilitation—to identify key CRM risk features of cockpit discipline, after landing planning, radio communications, and distractions and incorporated those features into an impromptu crew briefing. It can be argued that crew briefings were significantly improved following CTRBL. The demonstration of CTRBL for the CRM skill of a crew approach briefing offers promise for the application of CTRBL for the learning of other CRM skills, as was elaborated in the UTOS discussion. The Recommendations section of this chapter expands upon other CRM learning outcomes possible with CTRBL.

The study intended to use ATC readbacks as a nonequivalent dependent variable; however, ATC readbacks significantly improved after CTRBL. While ATC readbacks are not a suitable nonequivalent dependent variable, the improvement in ATC readbacks may be another area of exploration as a learning outcome of CTRBL, as was mentioned in the UTOS discussion.

The two central activities of CTRBL—transcription and repair—were successfully performed by participants who favorably reacted to CTRBL on par with other CRM learning methods they have been exposed to. Considering transcription is traditionally the domain of specialized researchers, the fact that novice pilots could perform the transcription activity—and enjoy it—bodes well for future applications of CTRBL.

The success of CTRBL with novice, university pilots makes the university environment the most likely choice for CTRBL implementation. Using an existing CRM curriculum, CTRBL may be used as a collaborative homework assignment by student peers. The nature of CTRBL means that students can produce a transcript and a repaired transcript for instructor evaluation. The broader general aviation pilot community may benefit from online downloads of CTRBL scenarios with instructions and templates for the performance of CTRBL. Aviation instructors may be able to incorporate CTRBL scenarios into curriculums.

Maintaining aviation safety demands continual identification of deficiencies and remedies of those deficiencies. For CRM, the FAA recommends initial and recurrent training combined with continual reinforcement (Federal Aviation Administration, 2004a). For the aviation organization as a whole, FOQA programs are used to identify deficiencies leading to organizational improvement. Traditionally, FOQA programs have used numerical data from flight operations to identify deficiencies. However, attitudes towards FOQA data are changing.

The 2009 loss of control accident of Colgan Continental Connection flight 3407, killing 50 people in Clarence Center, New York, resulted in 25 safety recommendations by the NTSB to the FAA (National Transportation Safety Board, 2009), as well as far-reaching statutory changes to pilot experience requirements (Public Law 111-216). Recommendation A-10-29 by the NTSB to the FAA recommended *all* flight data be used in FOQA programs. In his concurring statement to the accident report containing the recommendation, Member Sumwalt made clear *all* data included cockpit voice recorder (CVR) data, saying,

> I realize that our recommendation that air carriers should routinely download *all* available sources of safety information may include the download and analysis of CVRs…Can we achieve safety benefits by including CVRs in FOQA programs? Without question we can. And considering that some are calling for using CVRs in a punitive fashion, I would prefer to see them instead used in a safety context. (National Transportation Safety Board, 2009, Board Member Statements)

The CTRBL method demonstrated in this study, and the notional organizational context outline in Figure 5, may offer one avenue for the use of CVR data to improve safety. The CTRBL method may be the structured learning technique opening the door to the de-identified use of CVR data in an organizational FOQA environment. The Recommendations section of this chapter expands on this conclusion.

Learning methods such as CTRBL that encourage learning from the past—be it FOQA or other safety assurance processes—are critical to aviation safety (Stolzer et al., 2008). The case of Colgan flight 3407 in 2009 bore a tragically striking resemblance to the circumstances of Atlantic Southeast flight 6291 in 1994. Both flights involved a relatively inexperienced crew, rapidly decelerating an airplane while on an autopilot approach, receiving a stick shaker, improperly responding to the stick shaker, stalling the aircraft, and crashing into the ground resulting in fatalities. In both instances, the investigations included considerations of enhanced CRM training to prevent future recurrences (National Transportation Safety Board, 1994; National Transportation Safety Board, 2009). The CTRBL method integrated into an organizational training environment offers a new CRM learning method to contribute to aviation safety and deliver lessons of the past to enable current practitioners to avoid those same mistakes in the future.

Recommendations

The implementation of CTRBL will benefit from further studies to expand the depth and extend the scope of present study. The recommendations that follow provide a comprehensive program of evaluation leading to a possible organizational implementation in a closed-loop FOQA environment.

Qualitative study. The present study pursued a quantitative stance, collecting quantitative data and converting qualitative data to quantitative data through rubrics. Examining CTRBL from a qualitative stance may better explain the participant CRM learning process of the CTRBL method (Creswell & Plano Clark, 2011).

A qualitative study may examine a variety of phenomenon. Participant interviews combined with discussion of the participant produced transcript and repair artifacts may deepen the understanding of how participants interact during CTRBL and explain the dyad's choice of repairs. In the tradition of qualitative research, the researcher can inject himself or herself into the research study to discuss the CTRBL transcription process and repair decisions in an immersive interview (Creswell & Plano Clark, 2011). For example, the researcher with aviation and CRM knowledge may be able to probe instances of repairs to find out how the dyads decided upon a certain repair to gain a better understanding of how dyads conceptualized a repair. Interviews may also delve into how dyads resolved disagreements about what was heard by each participant during transcription.

Videotaping the interactions of dyads during the transcription and repair activities of CTRBL may be used by CA to gain an understanding of how dyads reconstruct the meaning of the scenario. The dyad interactions during CTRBL present numerous opportunities to explore the fundamental question of CA, "Why that now?" (Heritage & Clayman, 2010, p. 17; Nevile & Walker, 2005, p. 3). The transcript and repair artifacts produced during the course of the dyad interaction may be integrated with the CA of the videotaped sessions to produce a unique analytical opportunity. For example, during the transcription activity, CA may focus on how the dyad resolved disagreements about what they heard and compare the CA to the produced transcript. The comparison of CA and the produced transcript may provide insight into the use of politeness and mitigated speech in institutional discourse (Heritage & Clayman, 2010; Linde, 1988).

Qualitative studies provide the opportunity to develop an in depth picture of CTRBL. Qualitative methods allow for explorations, understandings, and discoveries that are not possible in a quantitative study (Creswell & Plano Clark, 2011).

Randomized experiment. The recommended qualitative study provides the opportunity for an in depth understanding of CTRBL. However, the qualitative study cannot support causal learning inferences due to CTRBL. The present study used a quantitative, quasi-experimental, repeated-measure design with the nonequivalent dependent variable of ATC readbacks to support causal learning inferences due to CTRBL. The nonequivalent dependent variable did not perform as expected in the present study, limiting support for the causal learning inference of CTRBL based on the observed change in dyad briefing performance.

A quantitative, random control trial (RCT) using a control group and random assignment of participants to the control group will reduce alternative explanations of the observed improvement of briefing skills (Shadish et al., 2001). A variety of RCT designs are possible; an RCT design of two treatments and a control is recommended for a future study of CTRBL,

R	X_{CTRBL}	O
R	X_B	O
R		O

where: R is the random assignment of dyads to treatments and control, X_{CTRBL} is the CTRBL treatment, X_B is the non-CTRBL treatment, and O are observations. For the RCT design, O will be the ratings of briefing performance as in the present study.

The X_{CTRBL} treatment may be similar to the present study. An RCT design allows for elimination of the observations (O) of the pre-treatment briefings and the ATC readbacks from the participant activities, allowing more time for the CTRBL activity. Additional time should be used to increase the amount of content transcribed, allowing more time for transcription, and more time for repair. Instructions given to dyads for the repair activity should verify the dyads know how to use Microsoft® Word's® track changes feature and encourage dyads to perform insertions as well as deletions and changes. Listening and transcription software may be improved to create one integrated software application, rather than separate audio and transcription applications. Dyads should also be instructed to perform all activities on the computer, rather than creating hand-written notes that are subsequently entered into the computer.

The X_B treatment may be designed in number of alternative ways. The recommended X_B treatment is to provide the dyad with resources describing the same scenario used in X_{CTRBL}. The resources should include the written transcript of the audio scenario, the audio scenario, diagrams of the scenario, and synoptic information about the scenario. The dyads should be asked to discuss the scenario and listen to the audio with the intent of identifying deficient areas and providing corrections to the scenario accident. Providing the dyads with a fill-in form to list deficient areas in the scenario and a fill-in form to list corrections will help provide structure to the dyad X_B activity. Alternatively, the X_B activity may also ask the dyads to repair a provided transcript without specific guidance to listen to the scenario. The specific choice of the X_B activity design will depend on the research questions of the particular future study.

The control group should receive no treatment. All three groups will perform the briefing, *O*, based upon the Briefing Scenario (Appendix C) materials. Briefing scenario materials should be modified, at minimum, to eliminate the confounding factors of specific airport hazards of wildlife and weather balloons that were included in the present study and discussed in this chapter. The present study collected observations of demographics and post-treatment reactions, which should be repeated in the RCT design.

The three-group RCT design recommended for a future study will allow for a comparison of treatments and no treatment. All participants will have fewer repeated-measure influences through the elimination of observational activities of pre-treatment briefings, pre-treatment evaluations of briefings, post-treatment evaluation of pre-treatment briefings, and ATC readbacks.

A challenge of the RCT design will be the increased number of participants needed for the study. The increased number of participants will increase costs and increase complexity of recruitment and scheduling.

Field experiment. An alternative or supplement to the RCT design is to perform a field experiment of CTRBL (Vogt, 2005). Since the demographics of the present study were university students, it is recommended CTRBL be field tested in a university setting by incorporating CTRBL into a CRM lesson or series of lessons.

Experimental manipulation may occur in the field test by providing CTRBL to some student groups and denying CTRBL to other student groups. Should a sufficient population of CRM course sections exist, one course section may incorporate CTRBL and the other course section may not incorporate CTRBL.

The scenario used for the CTRBL method will need to be aligned with the learning objectives of a course syllabus. If the identical scenario used in the present study were used in the proposed field study, then the learning objectives of a course syllabus need to be carefully considered to assure alignment between the scenario and learning objectives. The methods used by existing classrooms to measure learning outcomes may be used to compare the CTRBL and non-CTRBL groups. Student reactions to the CTRBL method should be collected, using a tailored version of the Post-Treatment Survey (Appendix F) used in the present study. A method to rate the collected transcripts and repairs for the CTRBL group, similar to the methods used in the present study, should be implemented.

The manner in which CTRBL is performed should also be considered. The field setting of a CRM course permits students to perform the CTRBL activity as a homework assignment over a longer duration compared to the RCT setting or the quasi-experimental setting of the present study. The ethical considerations of the field setting must be carefully considered, especially since some groups will be denied CTRBL.

A field experiment offers the advantage of ecological validity by using CTRBL in the context of a curriculum of learning (Vogt et al., 2012). Field experimentation offers challenges in terms of reaching causal conclusions about CTRBL due to confounding factors in the curriculum. The combination of qualitative study, RCT, and field experiment methodologies offer the possibility for a thorough examination of short-term learning related to CTRBL.

Longitudinal measures. The present study delimitations did not permit longitudinal measures that may provide insight into behavioral change and operational results from CTRBL. Longitudinal measures of behavioral change can assess if learning demonstrated immediately after CTRBL is also demonstrated in the operational environment. Longitudinal measures of results can assess if targeted operational metrics are reduced, such as altitude deviations, runway excursions, excessive equipment wear, incident rates, or accident rates (Kirkpatrick, 1976; Salas et al., 2001).

In the context of the current outcome measure of a crew approach briefing, behavioral results could be assessed through a repeat of a crew approach briefing after a time delay (i.e., three months) without repeating CTRBL. Behavioral results could also be measured in flight by trained evaluators during line operational evaluations (Holt, Boehm-Davis, & Beaubien, 2001). The evaluation results could be compared to groups who used CTRBL and those who did not.

As Salas et al. (2001) discussed, evaluating operational results is often difficult due to confounding influences. However, if an operational metric in need of change can be defined and other operational factors are relatively absent of change, operational results attributable to CTRBL use may be possible. An example would be if a trend of altitude deviations were observed related to specific CRM deficiencies then a CTRBL training module could be created to address the specific CRM deficiencies. After a sufficient time period, the trend of altitude deviations could be evaluated for change. In order to enable the longitudinal measures needed to assess operational results, CTRBL likely needs to be implemented at an organizational level rather than as an RCT or field experiment.

Longitudinal measures will extend the manageability, reaction, and learning outcomes observed in the present study to the higher-order outcomes of behavior and organizational results. These longitudinal measures will fully evaluate the efficacy of CTRBL, as suggested by Kirkpatrick (1976) and Salas et al. (2001).

UTOS variation. The recommendations for the qualitative study, RCT, field experiment, and longitudinal measures of CTRBL are made predominantly in the context of the UTOS operations used in the present study. The UTOS conditions may be varied as discussed in the Discussion section of this chapter.

Units (participants) may be varied to other novice pilots beyond a university setting. Pilots of single pilot operations may find benefit from CTRBL by teaming up with other single pilots to engage in collaborative learning. Professional aviation crews in institutional environments may find CTRBL an effective means of distributed learning. Different cultures may react differently to CTRBL. Given English is the international language of aviation, pilots of different English language proficiency may find CTRBL effective as an aviation language learning technique. Outside of aviation, institutional environments where sociotechnical discourse is necessary for work performance may find CTRBL a practical application of CA. The dyadic group size used by CTRBL may also change; perhaps a non-collaborative “TRBL” approach or collaborative groups larger than two.

The treatment used in CTRBL may be varied, particularly the scenario used in this study. Scenario topics and content offer a nearly limitless range of opportunities dependent upon desired learning outcomes. The time planned for the transcription activity and the repair activity will vary depending on the length of the scenario and other UTOS variations. The supplementary materials included with CTRBL may also change.

Improved crew approach briefing skills were the designed outcome of the present study. The Discussion section of this chapter presents a large number of learning outcomes within aviation that may be possible with CTRBL.

The setting of CTRBL may be altered from the present study. Integrated transcription and listening software will ease the task load of the participants and increase transcription rates. Distributed learning environments may be envisioned where collaborators work at remote locations, listening to the same audio, simultaneously creating a common transcript and then a repaired transcript, while interacting with remote communication software. Distributed learning systems may also create mobile applications for use on tablet devices, expanding the return on investment of mobile tablet devices to function as part of a learning management and distribution system.

Integration with FOQA. Should the qualitative study, RCT, field experiment, longitudinal measures, and UTOS variations suggested in the prior sections further support the efficacy of CTRBL, integration with FOQA programs may be possible as suggested in Figure 5 and discussed in the Conclusions section of this chapter. The FOQA, closed-loop model of organizational process improvement may utilize CTRBL as an additional learning method available to optimize the alignment between learning objectives and learning method.

Should aviation organizations seek to use CVR data as suggested by the NTSB in recommendation A-10-29 (National Transportation Safety Board, 2009), CTRBL may offer a viable method for content delivery and structured learning. The scenario development method used in this study drew upon the context of an actual accident to produce a fictitious scenario. The use of a fictitious scenario offers at least two benefits as it relates to CVR content. First, by using a fictitious scenario the identity of the real pilots is protected. Second, the fictitious scenario allows for modification of a real scenario to compress time by eliminating content that is not necessary for the desired learning outcomes. While naturalistic discourse is quite important to CA (Heritage & Clayman, 2010), well designed scenarios created with input from CA professionals may be sufficient to produce quality, fictitious learning scenarios for the purpose of CTRBL and improved aviation safety.

In the 1961 classic aviation book, *Fate is the Hunter*, Ernest K. Gann observed one aspect of pre-CRM era pilot learning dynamics,

> Our zeal for air transport is always soured when we so easily reflect on failures involving certain late comrades, who proved in the final analysis to be, like ourselves, only the tip of the arrow. We are obliged to recognize our possible epitaph—His end was abrupt.
>
> These thoughts of actual disaster are, paradoxically, the prime favorite conversational meat in any cockpit. Each, as it occurs, is analyzed, argued, disputed, and distorted with such lugubrious fascination that it is some wonder

> any of us continue to venture aloft. We become businessmen discussing the bankruptcy of a recognized firm, and the only factor which rescues these conversations from outrageous morbidity is the purely clinical nature of the dialogue. (1961, p. 5)

Perhaps CTRBL, in the context of a closed-loop FOQA environment, is the 21st century structured CRM learning evolution of Gann's pre-CRM era observations.

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APPENDIX A

Pre-Treatment Survey

PRE-TREATMENT QUESTIONNAIRE

PLEASE FILL IN: Participant ID: _____ Date:________

>>>MAKE SURE YOUR PARTICIPANT ID AND DATE IS FILLED IN ABOVE<<<

1. Do you now hold, or have your ever held the following FAA Pilot Certificates:

__ Private

__ Commercial

__ Flight Instructor

__ Airline Transport Pilot

2. Do you now hold, or have you ever held the following FAA Ratings:

__ Single-Engine Land (SEL)

__ Instrument

__ Multi-Engine Land (MEL)

3. From your logbook, please enter (month /year):

Date of First Solo: ___/_____

Date of Private Pilot Certificate: ____/_____

Date of Last FAA Certificate: ____/_____

CONTINUE ON NEXT PAGE

4. From your logbook, please enter the following logged hours:

Total Time:....................................____________

Airplane (SEL):.................................____________

Airplane (MEL): ....____________

Pilot-in-Command: ....____________

Second-in-Command: ....____________

Simulated Instrument: ....____________

Actual Instrument: ....____________

Dual Received:..................................____________

Dual Given as Flight Instructor: ....____________

Total Night:.......................................____________

5. Personal Information

a. Month/Year of Birth :................. ___/___ (mm/yyyy)

b. Gender (circle one): .... M F

c. Educational Level (check one):

__ Freshman in college __ Sophomore in college

__ Junior in college __ Senior in college

__Graduate student

__Other If other, please explain: ____________________________

CONTINUE ON NEXT PAGE

6. Is English your native language? (check one):

__Yes __No

7. What familiarity do you have with the experiment you are about to participate in (check one)?

___ Only what I have read in solicitations and been told thus far.

___ A heard about the experiment beyond the solicitation, but have no details.

___ A have heard some details about the experimental procedure, but not the scenario.

___ A have heard some details about the scenario, but not the experimental procedure.

___ I have heard some details about both the experimental procedure and scenario.

___ I have detailed information about particulars and what to expect.

8. How did you earn your private pilot certificate?

___ Through Embry-Riddle's flight training school.

___ Before coming to Embry-Riddle.

___ Other. Please Explain ___________________________.

<u>END OF QUESTIONNAIRE – THANK YOU!</u>

APPENDIX B

Readback Exercise ATC Transcripts and Directions

BETA

1. *Centurion eight niner alpha contact So Cal approach one two zero point four.*
2. *Bonanza zero eight sierra turn left heading one zero zero. Intercept the Van Nuys two five five radial inbound.*
3. *One golf alpha. Roger. Burbank altimeter's two niner eight eight.*

FINAL

1. *Cessna two romeo juliet contact New York approach one two zero point four.*
2. *Cessna two romeo juliet turn left heading one zero zero. Intercept the Kennedy two five five radial inbound.*
3. *Cessna two romeo juliet. New York altimeter two niner eight eight.*

ATC Readback Directions

PURPOSE:

Directions to perform ATC Readback.

DIRECTIONS:

- Imagine you are in N2RJ.
- The ATC instructions will be played for you TWICE while your "N" number is held in front of you.
- After the second time, read back the ATC instruction as "correctly" as possible (you can define "correctly" to yourself, based on your pilot training and experience).
- Please **do not** take any written notes.
- Your participant ID will be recorded by the administrator before all the readbacks begin to avoid interruptions.

GUIDELINES:

  - For the purpose of the exercise, please **do not** respond by *only* saying "say again" or *only* saying "wilco."

CALL SIGN:

CESSNA

N2RJ

APPENDIX C

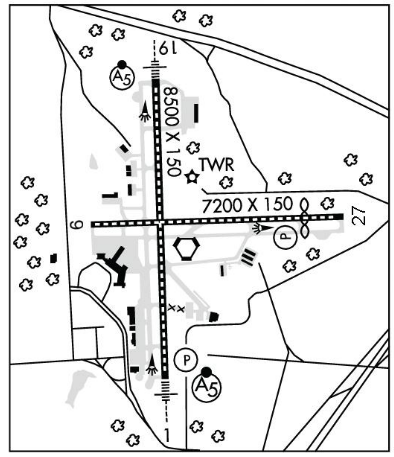
Briefing Scenario and Instructions

BRIEFING SCENARIO

You and your partner are flying on a night cross country. You are both equally rated and experienced, sharing the flight responsibilities. The weather is clear, visibility unlimited, with no moon. The destination airport is surrounded by hilly but not mountainous terrain, and it is surrounded by Class C airspace. Based on light wind conditions, you will be landing on runway 27, which is 7,200 feet long. You are arriving from the East and expecting a straight-in approach. The field elevation is 500 feet MSL. You are in a Cessna 172. The airport name is fictitious, Zangster International. Please brief the other pilot on a non-instrument, VFR approach into the airport, emphasizing risk mitigation.

(attached is the Airport Facility Directory for the Zangster)

Zangster Intl (ZIL) 6 NW UTC−5(−4DT) N42°44.95′ W73°48.12′
500 B S4 **FUEL** 100LL, JET A AOE OX 3 Class I, ARFF Index C **H–10I, 11C, 12K, L–32G, 33B, 34I**
NOTAM FILE ZIL **IAP, AD**



RWY 01–19: H8500X150 (ASPH–GRVD) S–140, D–200, 2D–400
PCN 70 F/C/X/T HIRL CL
RWY 01: MALSR. TDZL. PAPI(P4R)—GA 3.0° TCH 56′.
RWY 19: MALSR. Tree.
RWY 09-27: H7200X150 (ASPH–GRVD) S–140, D–200, 2D–400
PCN 67 F/C/X/T MIRL CL
RWY 09: REIL.
RWY 27: REIL. PAPI(P4L)—GA 3.35° TCH 47′. Thld dsplcd 1202′.

LAND AND HOLD-SHORT OPERATIONS

LDG RWY	HOLD-SHORT POINT	AVBL LDG DIST
RWY 01	09-27	4150
RWY 27	01–19	3750

RUNWAY DECLARED DISTANCE INFORMATION

RWY 01:	TORA–8500	TODA–8500	ASDA–8500	LDA–8500
RWY 09	TORA–7200	TODA–7200	ASDA–6780	LDA–6780
RWY 19:	TORA–8500	TODA–8500	ASDA–8500	LDA–8500
RWY 27:	TORA–7200	TODA–7200	ASDA–7200	LDA–5998

AIRPORT REMARKS: Attended continuously. Birds, deer and other wildlife on and invof arpt. PAEW (mowing) within safety areas of all rwys and twys May through Nov. Weather balloon launches approximately 3 miles S of arpt at 1100Z‡ and 2300Z‡. Rwy 01 touchdown and rollout runway visual range avbl. Rwy 19 touchdown and rollout runway visual range avbl. Twy ‘C’ west of Twy ‘A’ non movement area. Twy D east of Rwy 01–19 restricted to acft 12,500 lbs and less. Customs/Immigration’s Flight Information Service located north end General Aviation apron. Acft clearing Customs utilize painted markings and proceed to minimize blast impact. Ldg fee. Flight Notification Service (ADCUS) available.

WEATHER DATA SOURCES: ASOS (518) 464–6423. LLWAS. WSP.

COMMUNICATIONS: D–ATIS 120.45 (1–800–342–0120) **UNICOM** 122.95
RCO 122.1R 115.3T **RCO** 122.45 122.2
Ⓡ **APP/DEP CON** 132.825 (011°–194°) 118.05 (194°–011°)
TOWER 119.5 **GND CON** 121.7 **CLNC DEL** 127.5

AIRSPACE: CLASS C svc continuous ctc **APP CON**

VOR TEST FACILITY (VOT) 108.2

RADIO AIDS TO NAVIGATION: NOTAM FILE ZIL
(L) VORTAC 115.3 ZIL Chan 100 N42°44.84′ W73°48.19′ at fld. 272/13W.

VOR unusable:

330°–019° blo 3000′	120°–135° byd 37 NM blo 14500′
330°–019° byd 10 NM blo 6000′	136°–175° byd 8 NM blo 6000′
330°–019° byd 19 NM blo 9000′	176°–193° byd 17 NM blo 8000′
330°–019° byd 28 NM blo 10000′	176°–193° byd 25 NM blo 12000′
020°–059° byd 13 NM blo 6000′	194°–221° blo 6000′
060°–080°	194°–221° byd 28 NM blo 8000′
100°–135° byd 8 NM blo 10000′	310°–320° byd 30 NM blo 5000′

DME unusable:

030°–055° byd 10 NM	255°–340° byd 28 NM
155°–195° byd 28 NM blo 5500′	

ILS/DME 109.5 I-ZIL Chan 32 Rwy 19. Class IB.
ILS/DME 109.5 I-ZLI Cham 32 Rwy 01. Class IE.

COMM/NAV/WEATHER REMARKS: CLASS C information available on ATIS frequency 20 NM.

Briefing Directions for First Briefing

PURPOSE:

Directions to perform the First Briefing Exercise.

CONTEXT:

- Imagine both of you—briefer and non-briefer—are in an airplane, about to descend from cruise and land at the destination airport.
- You are two pilots, flying together, sharing workload in a Cessna 172.
- You are reading the following checklist and are up to the item "CREW BRIEFING"; you are about to descend from cruise and land at the destination airport.

> FUEL … CHECKED
> ALTIMETERS…SET
> **CREW BRIEFING….COMPLETE**

DIRECTIONS:

- Perform the arrival crew briefing.
- Both the Briefer and Non-briefer should read the briefing scenario.
- The Briefer can take a moment to compose his or her thoughts.
- Emphasize risk mitigation in your briefing.
- Be sure that anything said during the briefing, by the Briefer or the Non-Briefer, is said loudly enough to be recorded.

GUIDELINES:

- If you feel a detail is necessary to make a good briefing, please feel free to make up realistic information.
- **NON-BRIEFER:** The non-briefer **is free to ask questions**, if the non-briefer feels such questions are necessary to understand what was said. Be sure you speak loud enough to be recorded!
- **Be concise but thorough. REMEMBER, you should IMAGINE you are in an airplane, approaching your destination!**

After the briefing, the briefer and the non-briefer will be asked to complete a survey to rate the briefing.

Briefing Directions for Second Briefing

PURPOSE:

Directions to perform the Second Briefing Exercise.

CONTEXT:

- Same context as first briefing.
- Imagine both of you—briefer and non-briefer—are in an airplane, about to descend from cruise and land at the destination airport.
- You are two pilots, flying together, sharing workload in a Cessna 172.
- You are reading the following checklist and are up to the item "CREW BRIEFING"; you are about to descend from cruise and land at the destination airport.

FUEL … CHECKED
ALTIMETERS…SET
CREW BRIEFING….COMPLETE

DIRECTIONS:

- Perform the arrival crew briefing, *applying **hindsight** from the scenario you just reviewed.*
- Be sure that anything said during the briefing, by the Briefer or the Non-Briefer, is said loudly enough to be recorded.

GUIDELINES:

- If you feel a detail is necessary to make a good briefing, please feel free to make up realistic information.
- **NON-BRIEFER:** The non-briefer **is free to ask questions**, if the non-briefer feels such questions are necessary to understand what was said. Be sure you speak loud enough to be recorded!
- **Be concise but thorough. REMEMBER, you should IMAGINE you are in an airplane, approaching your destination!**
- Remember, *try to use what you know about the scenario you just reviewed to perform the briefing.*

After the briefing, the briefer and the non-briefer will be asked to complete a survey to rate the briefing.

APPENDIX D

Participant Briefing Rating Instruments

BRIEFER SELF-RATING

>>>>FILL IN YOUR PARTICIPANT ID>>>>:

Participant ID: _____

BRIEF : Brief1 - Pre

No.	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I covered all relevant points.					
2	I believe I was understood by my partner.					
3	I addressed all conceivable risks.					
4	My briefing was **not** effective.					

<u>NON</u>-BRIEFER RATING

>>>>FILL IN YOUR PARTICIPANT ID>>>>:

Participant ID: _____

BRIEF : Brief1 - Pre

No.	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Briefer covered all relevant points.					
2	I understood what the briefer was saying.					
3	Briefer addressed all conceivable risks.					
4	The briefing was **not** effective.					

<u>BRIEFER</u> SELF-RATING

>>>>FILL IN YOUR PARTICIPANT ID>>>>:

Participant ID: _____

BRIEF : Brief1 - Post

Considering the scenario you just reviewed, re-rate the briefing that was previously performed.

No.	**Question**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	I covered all relevant points.					
2	I believe I was understood by my partner.					
3	I addressed all conceivable risks.					
4	My briefing was **<u>not</u>** effective.					

<u>NON</u>-BRIEFER RATING

>>>>FILL IN YOUR PARTICIPANT ID>>>>:

Participant ID: _____

BRIEF : Brief1 - Post

Considering the scenario you just reviewed, re-rate the briefing that was previously performed.

No.	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Briefer covered all relevant points.					
2	I understood what the briefer was saying.					
3	Briefer addressed all conceivable risks.					
4	The briefing was **<u>not</u>** effective.					

<u>BRIEFER</u> SELF-RATING

>>>>FILL IN YOUR PARTICIPANT ID>>>>:

Participant ID: _____

After Brief2

PLEASE RATE BRIEFING #2 (THE ONE JUST GIVEN):

No.	**Question**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	I covered all relevant points.					
2	I believe I was understood by my partner.					
3	I addressed all conceivable risks.					
4	My briefing was **<u>not</u>** effective.					

5. Please rank Briefing #1 and Briefing #2 as follows.

Briefing	**Very Poor**	**Poor**	**Neutral**	**Good**	**Very Good**
Briefing #1					
Briefing #2					

NON-BRIEFER RATING

>>>>FILL IN YOUR PARTICIPANT ID>>>>:

Participant ID: _____

After Brief2

PLEASE RATE BRIEFING #2 (THE ONE JUST GIVEN):

No.	**Question**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	Briefer covered all relevant points.					
2	I understood what the briefer was saying.					
3	Briefer addressed all conceivable risks.					
4	The briefing was **not** effective.					

5. Please rank Briefing #1 and Briefing #2 as follows.

Briefing	**Very Poor**	**Poor**	**Neutral**	**Good**	**Very Good**
Briefing #1					
Briefing #2					

APPENDIX E

CTRBL Audio Scenario Transcript

This appendix presents the audio used in this study as professionally transcribed. Note the underlined, yellow highlighted text represents the areas dyads were asked to transcribe (the text was not provided to the dyads during the exercise and was replaced with red, asterisked text, ****TRANSCRIBE HERE****).

Narrator
The audio in this recording is simulated. The sounds names places and details are made up and any relationship to real persons or places is coincidence. The audio contains graphic language and may be disturbing to some listeners. The recording simulates a cockpit recording of aircraft November one one four alpha Romeo.

Sound
[sound of engine, continues at same level for about 5 minutes]

Intercom Pilot 1 to Pilot 2
So what'dya say you need three more night cross countries?

Intercom Pilot 2 to Pilot 1
Yeah I need three after this one. Ah yeah same for you right?

Intercom Pilot 1 to Pilot 2
Yeah I try to go with ah someone ah different to different places you know. Some-- my first time here.

Intercom Pilot 2 to Pilot 1
Yeah me too. I hear taxiways are a mess here. I thought I was going with Arnie. And ah you know he's got my chemistry lab notes they're due tomorrow. He ah he should be out here tonight. And uh boy if I if I'm late on those lab notes. I'll fail chem. I gotta catch him at the FBO.

Aircraft Piper 123 to ATC
America Approach Piper one two three requesting lower.

1st Approach Controller to Piper 123
Piper one two tree I'll need you to get another ah ten miles for terrain before I can start you down. Continue heading two six zero for now and I'll get you down as soon as I can.

Aircraft Piper 123 to ATC
Wilco. Continue on heading two six zero at four thousand five hundred one two three.

Intercom Pilot 2 to Pilot 1
Boy what a nice night. Not a cloud in the sky.

Intercom Pilot 1 to Pilot 2
Yeah. No moon. Can see all the stars. It's smooth too.

Intercom Pilot 2 to Pilot 1
No worries about the weather tonight [laughter].

Intercom Pilot 1
[laughter]

1st Approach Controller to Cessna 114AR
Cessna one one four alpha Romeo fly heading two six zero contact America Approach on one tree four point one.

Radio Pilot 2 to ATC
Two six zero approach on one three four point one. Ah for Cessna one one four alpha Romeo. Have a good night.

Intercom Pilot 2
[sound of clicks, like changing frequencies] [speaking to self] One three four...

Intercom Pilot 1 to Pilot 2
Headin' two six zero.

Sound
[high low tone, similar to new radio frequency]

2nd Approach Controller to Cessna 104AR
Cessna one zero four alpha Romeo descend and maintain two thousand fife hundred contact approach one two fife point one. Good day.

Aircraft Cessna 104AR to ATC
One twenty five point one out of four thousand five hundred for two and a half. Ten four alpha Romeo. Good night.

Intercom Pilot 2 to Pilot 1
That must be Arnie and Steve. I think there's like five of us up here tonight. You know. That’s cool. I should I should be able to be able to catch up to him on the ground Arnie and ground and get my Chem lab notes ah. He better. I better cat-- he better * ah...my instructor showed me this high speed approach profile you want to try it? Your instructor show you that one?

Intercom Pilot 1 to Pilot 2
[sigh] Well we did it once--

Intercom Pilot 2 to Pilot 1
Hold on I I gotta check in.

Radio Pilot 2 to ATC
America Approach ah Cessna one one four alpha Romeo. With you at four point five with Foxtrot at Zangster International.

2nd Approach Controller to Cessna 114AR
Cessna one one four alpha Romeo. America Approach. use caution for similar call signs on the same frequency. Expect straight in runway two seven. Altimeter two niner niner one.

Radio Pilot 2 to ATC
Okay ah we'll use caution. Expect runway two seven. Cessna one one four alpha Romeo.

Intercom Pilot 2 to Pilot 1
So you ah you never done it before? I-I can talk yah talk you through it's. It’s cake.

Intercom Pilot 1 to Pilot 2
Yeah ohh-kay. I've never done it at night.

Intercom Pilot 2 to Pilot 1
Ah shoot my iPad lah-- battery is low. * I'd like I'd like to have the taxi diagram. You have you have yours out?

Intercom Pilot 1 to Pilot 2
No my iPad's in the back. Should I get it?

2nd Approach Controller to Cessna 334AR
Cessna tree tree four alpha Romeo descend and maintain two thousand fife hundred. Contact approach one two fife point one.

Aircraft N124AR to ATC
Was that for us. November one two four alpha Romeo?

Intercom Pilot 2 to Pilot 1
Hold on. Uh. Let me just put it in sleep mode for a second. And I'll I'll get my charger.

2nd Approach Controller to Cessna N124AR
Negative. It was for Cessna November tree tree four alpha Romeo. Listen up people.

Aircraft Cessna 334AR to ATC
Approach on one thirty five one. Ah I mean one two five point one. November three three four alpha Romeo.

Sound
[sounds of rustling, bag snapping, like pilot looking for charger]

2nd Approach Controller to Shooter 3
Shooter tree contact America Center on UHF tree eight six point two.

Aircraft Cessna 134AR to ATC
Cessna four alpha Romeo ah is with you at four thousand five hundred with golf.

2nd Approach Controller to Cessna 134AR (and all aircraft)
Cessna one tree four alpha Romeo America Approach. Use caution similar call signs on the frequency. Break all aircraft ATIS information golf now active at Zangster. Altimeter two niner niner one.

Intercom Pilot 1 to Pilot 2
Okay. ATIS changes you want to get it.

Intercom Pilot 2 to Pilot 1
Yeah yeah okay. [sound of clicks similar to frequency change] so when you do this approach you keep the speed up around---

Sound
[static]

2nd Approach Controller to *4AR
Four alpha Romeo descend and maintain two thousand fife hundred. contact approach on one two fife point one.

Radio Pilot 2 to ATC
Out of forty five for twenty five over to approach on one thirty five one. November one one four alpha Romeo good night.

Aircraft Cessna 124AR
Was that for us four alpha Romeo?

Sound
[static]

2nd Approach Controller to 124AR / 114AR
Four alpha Romeo negat--

Sound
[sound of high low tone similar to new radio frequency]

ATIS
Temperature two zero dewpoint one zero altimeter two niner niner one. Runway two seven in use. Expect visual approach. Notices to airmen. Taxiway Zulu closed. All aircraft contact clearance delivery prior to taxi. Advise on initial contact you have information golf. Zangster Airport information golf time zero two fife zero Zulu wind two seven zero at fife. Sky clear visibility greater than six. Temperature two zero dewpoint one zero altimeter two niner niner one. [cough in cockpit] Runway two seven in use. Expect visual approach. Notices to airmen. Taxiway Zulu closed. All aircraft contact clearance delivery prior to taxi.

Intercom Pilot 2 to ???
No dude. That was for us. Huh. **.

Sound
[engine sound decreases and remains at lower level till near end of recording]

Intercom Pilot 1 to Pilot 2
Out of forty five down to twenty five.

Sound
[sound of clicks, similar to dialing frequency change]

Sound
[sound of high low tone similar to new radio frequency]

Intercom Pilot 2 to Pilot 1
ATIS ah. It sounds the same. Nice night still.

Intercom Pilot 1 to Pilot 2
Sure is.

Intercom Pilot 1 to Pilot 2
You call him?

Intercom Pilot 2 to Pilot 1
[laughter] Oh shit. Let me do that.

Radio Pilot 2 to ATC
[cough] America Approach ah Cessna one one four alpha Romeo out of three thousand niner hundred for two thousand five hundred with Golf.

Intercom Pilot 2 to Pilot 1
[cough] Okay ah I got my power charged iPad in. sorry ah. Taxiways are ah right there.

Intercom Pilot 1 to Pilot 2
Okay. So what's the high speed approach technique?

Intercom Pilot 2 to Pilot 1
So when you do this high speed approach. Ah like I was sayin'. He-he showed me. Ah you keep the speed up like one twenty till like fifteen hundred. And then you pull it back to like fifteen hundred RPM. And level out. So you can slow and then ah get the flaps down.

Intercom Pilot 1 to Pilot 2
Ahh okay. Thousand to go.

Radio Pilot 2 to ATC
America Approach Cessna one one four alpha Romeo how do you hear.

Intercom Pilot 1 to Pilot 2
What’s up with them?

Intercom Pilot 2 to Pilot 1
Ah let me go back to that other frequency. Ah eh ah shoot. What was it. Damn. I put in the ATIS and lost it. Damn.

Intercom Pilot 1 to Pilot 2
Oh you loser...check the airport diagram and use whatever.

Intercom Pilot 2 to Pilot 1
Oh yeah yeah. One thirty four point one. Oh yeah yeah that's it.

Sound
[sound of high low tone similar to new radio frequency]

2nd Approach Controller to N114AR
Four alpha Romeo acknowledge. Low altitude alert.

Radio Pilot 2 to ATC
America Approach I'm sorry ah Cessna one one four alpha Romeo ah what what was that frequency.

2nd Approach Controller Cessna 114AR
Cessna one one four alpha Romeo low altitude alert climb immed--

Sound
[sound of engine noise increases]

Intercom Pilot 1 to ???
Oh shit.

Sound
[sound of thunk]

Sound
[sound of static]

APPENDIX F

Post-Treatment Survey

EXIT SURVEY

DIRECTIONS:
Please complete this short survey to provide us your opinion about the usefulness of the training you just engaged in.

PLEASE FILL IN: >>> **Participant ID:** _____ <<<<

Please read this statement and place a checkbox to confirm your understanding:
This exit survey pertains ONLY to the *transcription and repair* activity I did with my partner. I am not evaluating or offering an opinion on the readback or briefing activities.

__ I understand

1. Were you aware of the scenario you were presented with prior to this training (check one)?

___ No information about any aspect of it.
___ Slight familiarity with the problem and scenario.
___ Considerable familiarity with the problem and scenario.
___ Detailed information on the problem and scenario.

2. If you indicated some awareness of the scenario, please indicate how you gained the awareness (check one).

___Not applicable, had no prior awareness.
___Solely based on prior experiences and training.
___Solely based on other students telling me about the study.
___A combination of other students telling me about the study and prior experiences.
___Other

3. If you indicated some awareness of the scenario, please check the statement below which is closest to your opinion (check one).

___Not applicable, had no prior awareness.
___This awareness greatly reduced the training value.
___This awareness slightly reduced the training value.
___This awareness had no effect on the training value.
___This awareness slightly increased the training value.
___This awareness greatly increased the training value.

CONTINUE ON NEXT PAGE

4. How realistic was the scenario (circle one)?

Unrealistic in every way						Realistic in every way
1	2	3	4	5	6	7

5. Consider **ground based, non-simulator training, CREW (or SINGLE PILOT) resource management training** you have taken (other than the training you just participated in). What was the training technique you liked the most (write-in response). Examples: videos, discussion, ground based scenario-based training, etc.

(WRITE IN) >>> ______________________________

6. Overall, how would you rate the value of the training you identified in Question #5 (circle one)?

Completely Useless						Completely Useful
1	2	3	4	5	6	7

7. Overall, how would you rate the value of the training you just participated in (circle one)?

Completely Useless						Completely Useful
1	2	3	4	5	6	7

CONTINUE ON NEXT PAGE

8. Would you recommend the training you identifed in Question #5 to other pilots (circle one)?

To No One						To Everyone
1	2	3	4	5	6	7

9. Would you recommend the training you just participated in to other pilots (circle one)?

To No One						To Everyone
1	2	3	4	5	6	7

10. Overall, considering the training you identified in Question #5, how much have you learned from that training you will actually use in your flying (circle one)?

Absolutely Nothing						Tremendous Amount
1	2	3	4	5	6	7

11. Overall, considering the training you just participated in, how much have you learned from this training that you will actually use in your flying (circle one)?

Absolutely Nothing						Tremendous Amount
1	2	3	4	5	6	7

12. How well did you know your group partner prior to the exercise (circle one)?

Never Met Him/Her						Knew Him/Her Very Well
1	2	3	4	5	6	7

CONTINUE ON NEXT PAGE

13. Considering the training you identified in Question #5, how much did you enjoy the training (circle one)?

Very Little						Tremendous Amount
1	2	3	4	5	6	7

14. Considering the training you just participated in, how much did you enjoy the training (circle one)?

Very Little						Tremendous Amount
1	2	3	4	5	6	7

15. Which training did you enjoy more (check only **1** response)?

__ The training identified in Question #5

__ The training I just participated in

16. Please explain the reason(s) you answered the prior question (Question #15) the way you did (write in response):

____

____

____

17. Additional Comments:

____

____

____

____

END OF SURVEY – THANK YOU!

APPENDIX G

Participant Checklist

Participant ID# _____

PARTICIPANT CHECKLIST

Purpose and Use: To make sure you perform the various steps in order. Do not proceed to a next step without first performing a prior step. Have all steps initialed by the administrator.

Step	Participant Checkmark	Administrator Initials
I was assigned a Participant ID Number. I wrote this number in the header of this page. I wrote this number in the header of the second page.		
I read the "Introduction and Overview."		
I completed the informed consent form.		
I filled out the Demographic Survey.		
I performed the initial ATC readback exercise.		
I was assigned a partner. I wrote our Dyad ID Number below. Dyad ID Number: #_____________		

Order may vary on these two steps

Participant ID# _____

Step	Participant Checkmark	Administrator Initials
(go to *DYAD CHECKLIST*)	--	--
I completed group, Dyad Activities and Dyad Checklist.		
I performed the after-dyad ATC readback exercise.		
I completed the exit survey.		
I was debriefed.		
I understand the importance of not sharing the details of this experiment with others for the next two weeks.		

Order may vary on these two steps

APPENDIX H

Dyad Checklist

Dyad ID# _____

DYAD CHECKLIST

Purpose and Use: To make sure you perform the various group steps in order. Do not proceed to a next step without first performing a prior step.

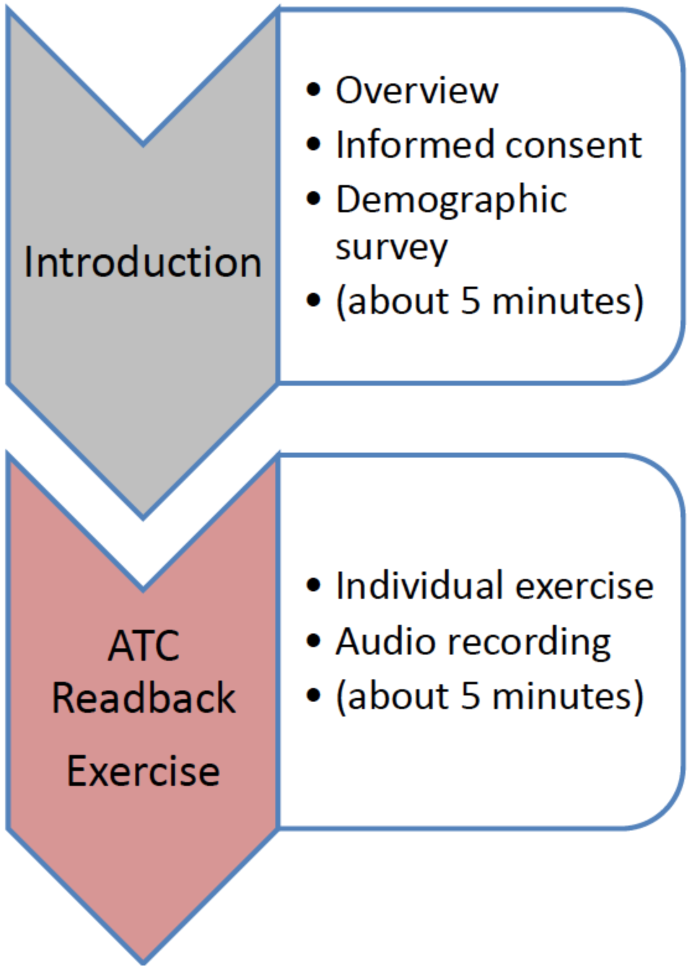
Step	**Dyad Check off**	**Administrator Initials**
Participant ID# of one member of Dyad is: Participant ID#__________		
Participant ID# of one member of Dyad is: Participant ID#__________		
Both members of the Dyad are up to the step on their *Participant Checklist* saying, "*go to DYAD CHECKLIST*".		
We were assigned a Dyad ID Number. We wrote this number in the header of this page. We wrote this number in the header of the second page.		
We flipped a coin and decided the BRIEFER would be: Participant ID# _____________________		
We read the first briefing instructions. We read the first briefing scenario. We performed the first briefing.		
We BOTH filled out a briefing evaluation of the briefing before transcription and repair.		
Administrator recorded transcription start time.		

Dyad ID# _____

Step	**Dyad Check off**	**Administrator Initials**
We performed the transcription.		
Administrator recorded transcription end time AND repair start time.		
We performed the repairs.		
Administrator recorded repair end time.		
We BOTH filled out a briefing re-evaluation of the first briefing.		
We read the second briefing instructions. We performed the second briefing.		
We BOTH filled out a briefing evaluation of the second briefing.		
END OF GROUP ACTIVITIES (Resume *PARTICIPANT CHECKLIST* items)		

APPENDIX I

Participant Introduction and Overview

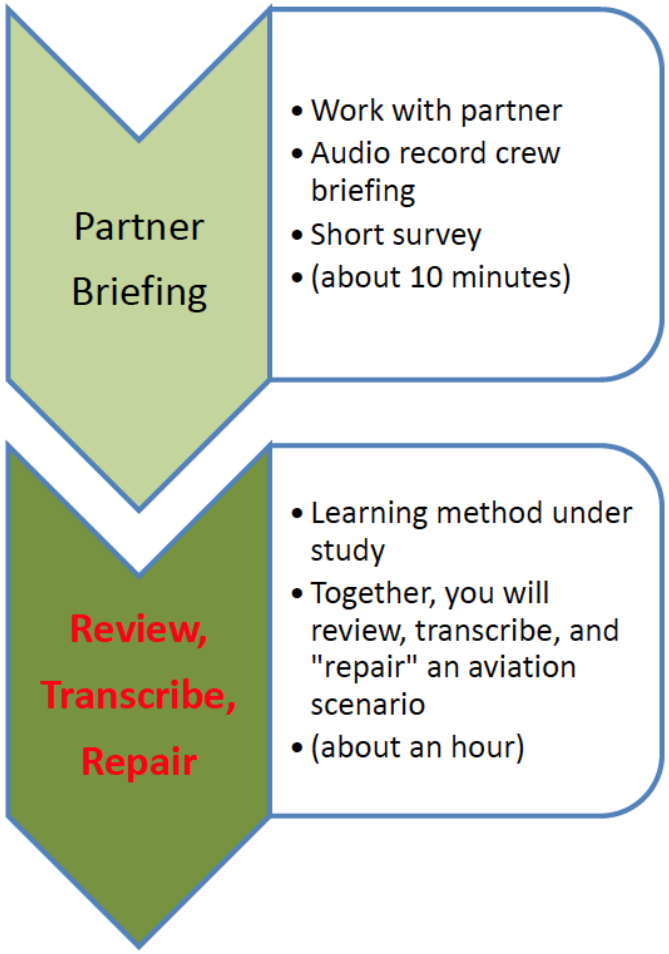


This document explains the experiment you will participate in for two reasons. First, so you can make an informed decision to participate. Second, so you understand the flow.

While your identity is known for administrative reasons, the data you produce will be de-identified. Only the researcher will process your voice recordings, converting them to text for post-processing.

After this informed consent is complete, you will fill out a demographic survey and perform an air traffic control ("ATC") readback exercise.

In the ATC readback exercise, three ATC instructions will be played for you. You will readback each instruction while being audio recorded.

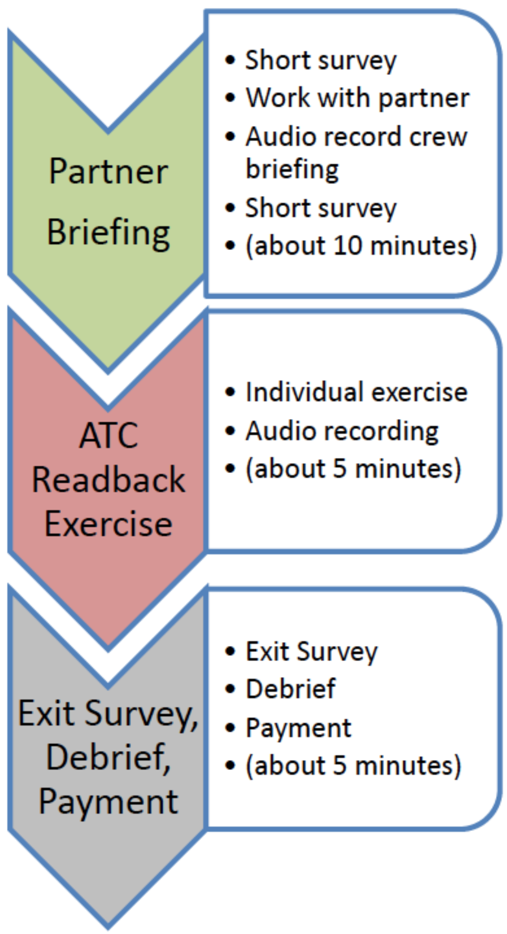


After the ATC readback, you will work with your assigned partner. The two of you (called a "Dyad") will first imagine you are in an airplane, approaching your destination. One of you will lead a crew briefing. Together, you will be audio recorded. Don't worry, you will get further instructions when you get to this part of the exercise.

After the briefing, you will each evaluate the briefing with a short survey.

You will then perform the central activity of this study. Together, you and your partner will evaluate an aviation scenario. You will do this by *listening to and partially transcribing* the audio of a simulated cockpit voice recording. After the listening and transcribing, together you will then "repair" the scenario. Don't worry, you will get further instructions when you get to this part of the exercise.

The simulated audio contains some profanity and sounds similar to an airplane crash. Please consider this in your decision to participate.



After the transcribe/repair session, you will re-evaluate the briefing performed previously.

Then, the same briefer will lead another crew briefing.

Then, you will both evaluate the second briefing.

After this second briefing, you and your partner will separate.

You will each repeat the ATC readback exercise and take a demographic survey.

You are being asked now, and will be reminded at the end, not to share the details of the experiment with your peers for two weeks. This is so your peers can have a fresh perspective on the scenario.

As you conclude, you will have an opportunity to debrief with the researcher, in case you have any concerns or questions.

Finally, you will be paid.

If you decide to leave early for any reason after informed consent is completed, you will still be paid, consistent with ethical research practices.

IN CONCLUSION, KEEP IN MIND:

- All the evaluative exercises are ***not*** meant to judge you personally – they are meant to evaluate the new learning method under study. **Just do your best!**
- There is no deception in this study. That is, everything is as stated.

****PLEASE SET YOUR CELL PHONES TO SILENT FOR THE DURATION OF THE EXPERIMENT.**

PLEASE TRY NOT TO BE INTERRUPTED FOR CALLS, TEXTS, OR EMAILS, EXCEPT ON A BREAK**

If you have any questions, please ask them now. If not, we'll get started by having you sign the informed consent.

APPENDIX J

CTRBL Transcription Instructions

Audio Transcribe Directions

PURPOSE: Directions for use during team transcription.

TEAM OBJECTIVE:

- Compare the transcript that has been provided to the audio (no tricks here, just verify/proof it).
- Transcribe those areas not yet completed (you will see RED markers saying ***TRANSCRIBE HERE***).
- As you work, reflect on the briefing you gave prior to the exercise.
- **Think about** what should have been done differently by everyone heard in the scenario. **Think about the** CRM areas of communication, coordination, command responsibility, stress factors, and operational errors.
- When you transcribe, transcribe every syllable, every cough, every sound EXACTLY.

PROCEDURE

1. Play the audio ONCE all the way through, **simultaneously** reading the transcript.
   a. Note down where you will have to come back and TRANSCRIBE as well as LISTEN again.
2. Then TRANSCRIBE those portions that say ***TRANSCRIBE HERE***

LISTENING TIP:

- When you transcribe, *expect to listen to the same thing multiple times.*

GENERAL TIPS:

- SAVE YOUR FILE OFTEN!!!
- Be efficient with your time.
- If you have a problem, call or text Bill at 850-582-7805. **When you are done, call or text Bill!**

STYLE GUIDE/TRANSCRIBE DIRECTIONS:

- **For each voice transcribed, the format is**

  WHO said what TO WHOM
  followed by text to transcribe here….

Symbol	Use For
Fifteen **NOT** 15	Spell out numbers as said, since they could be said differently!
(pretty sure)	Enclose text in (parentheses) if you can't be 100% sure

	what was said, but you are pretty sure.
*	Something was said, but it was unintelligible.
[sound of click]	To describe a sound, put it in [square brackets]
[interrupting] [elevated voice]	To elaborate on how something was said.

APPENDIX K

CTRBL Repair Instructions

Repair Directions

*****DO NOT BEGIN UNTIL ATTENDANT HAS PROCESSED YOUR TRANSCRIPT AND GIVEN YOU THE OKAY TO BEGIN THE REPAIR*****

PURPOSE: Directions for use during team repair.

MATERIALS: You will be given a fully prepared, full transcript. **Assume the transcript perfectly represents the audio**….No tricks here! This is just for consistent formatting and content.

OBJECTIVE: Make as many corrections (repairs) as possible to the scenario, to make it "text book" ideal. That is, *make corrections so the crash is avoided.*

TEAM OBJECTIVE AND DIRECTIONS:

- Correct all errors made in the scenario by anyone in the scenario.
- Make as many corrections as you possibly can to make an ideal, "textbook" scenario.
- The corrections should be SCRIPTED wording changes, not NOTIONAL ideas about what should be done.
- You should NOT provide reasons or rationale in writing, though you verbally will provide reasons to your peer. Just repair the transcript to make it read as you think it should (pretend you are a script writer.)
- Do NOT assume that any one correction will "fix" the problem and break the chain of events. FIX everything---assume every fix you make will not really occur in the scenario.
- WHEN YOU ARE DONE, TEXT BILL TUCCIO AT **850-582-7805**.

EXAMPLES	
DO's – RIGHT WAY	**DON'Ts – WRONG!!!**
Pilot to Copilot Okay, gear down, flaps fifteen. ~~Want to hear a joke?~~ **Copilot to Pilot** ~~Flaps thirty. Sure, what is it?~~ No jokes, later. Flaps fifteen.	**Pilot to Copilot** Okay, gear down, flaps fifteen. ~~Want to hear a joke?~~ (**he shouldn't be doing this right now, sterile cockpit**) **Copilot to Pilot** ~~Flaps thirty. Sure, what is it?~~ Flaps thirty. **tell the other guy no jokes***
Tower to Aircraft Cessna six alpha xray, You say you have the rotating beacon in sight? **Aircraft to Tower** Zangster Tower, negative ~~Right~~, we ~~have~~ are receiving the non-directional radio beacon. Still looking for the runway.	**Tower to Aircraft** You say you have the beacon? **ATC should use call sign and be clear what beacon!** **Aircraft to Tower** Right we have the beacon. Still looking for the runway. **prefix with tower…clarify what beacon, radio or rotating airport**

APPENDIX L

Scenario Development Subject Matter Experts

SCENARIO SME #1

SME #1 has assisted the FAA in publishing guidelines on SBT and has authored over 20 FITS SBT modules accepted by the FAA. SME #1 is a Gold Seal FAA Certified Flight Instructor, was the 2009 FAA National Flight Instructor of the Year, serves on the Board of Directors of the Society of Aviation and Flight Educators, and was the recipient of the National Air Transportation Association Excellence in Pilot Training Award. She is author of the book, *Train Like You Fly: A Flight Instructors Guide to Scenario Based Training* (McMahon, 2009), has contributed to SBT books, and written numerous articles in national aviation trade journals and FAA publications. She is a graduate of Embry-Riddle Aeronautical University and Amberton University.

SCENARIO SME #2

SME #2 is a researcher in the field of SBT in aviation. His work in the field began in the 1990s when he published *Pilot in Command* (Craig, 2000), a book based on his research with pilots placed in real-world scenarios. SME #2 became the principal investigator of four National Aeronautics and Space Administration (NASA) research projects that began with teaching pilots using scenarios in glass cockpit aircraft. Recently his work has brought the gains and discoveries made in the field of SBT to the entire aerospace curriculum. This project brings together students from all the aerospace concentrations (professional pilot, maintenance management, technology, flight dispatch, administration, and air traffic control) and allows them to learn in a scenario-based environment. SME #2 is an FAA Airline Transport Pilot and a Gold Seal Flight Instructor, having won the FAA's district Flight Instructor of the Year award twice. He won the 2004 Wheatley Award from the University Aviation Association and the *Turning Goals into Reality* award from NASA in 2005. SME #2 holds a Bachelor of Science in Aerospace Administration, a Master of Aerospace Education, and received his Doctor of Education from Tennessee State University.

SCENARIO SME #3

SME #3 is the Training Center Manager at the Scottsdale, Arizona office of SimCom Flight Training Centers, where he has obtained a 13-year background of simulator instruction, scenario usage, and scenario creation. He is a veteran flight instructor of nearly 40 years teaching in Piper, Cessna, and Beechcraft single and twin-engine airplanes including using SBT in SimCom's CRM program. He is a former designated pilot examiner who served in the Southern California area.

SCENARIO SME #4

SME #4 retired from United Airlines in 2003 as a B747-400 Captain, Line Check Airman, and the Air Line Pilots Association Flight Safety Awareness Program Manager. Prior to joining United, he flew in Vietnam as a U.S. Navy pilot. During a furlough at United, he was employed by the U.S. Park Police as their Chief Check Pilot and later by the FAA as an Aviation Safety Inspector. SME #4 has over 22,000 flight hours as a line pilot, check pilot, and flight instructor. He recently returned to SimCom's Scottsdale Training Center as a flight instructor after being the Chief Operating Officer of Gryphon Airlines in Kuwait. SME #4 currently instructs in various aircraft and in SimCom's CRM program.

APPENDIX M

Institutional Review Board

Human Subject Protocol Application Form

Project Title: COLLABORATIVE AUDIO TRANSCRIPTION AND REPAIR AS A METHOD FOR NOVICE PILOTS TO LEARN APPROACH BRIEFING CREW RESOURCE MANAGEMENT (CRM) SKILLS

Principal Investigator: William A. Tuccio
(If student, list advisor's name as investigator)

List all Other Investigators:

Committee Chair, Dr. Dave Esser
Committee Member, Dr. MaryJo Smith
Committee Member, Dr. Ian McAndrew
Committee Member, Dr. Gillian Driscoll

Beginning Date: March, 2013 **Expected End Date:** December, 2014

Type of Project: Dissertation Experiment

Type of Funding Support (if any): Possible Doctoral Scholarship Development

Please answer the following questions and provide a brief explanation of the answer for each. Include more lines where necessary.

1. Briefly describe the background and purpose of the research.

Aviation has crew resource management (CRM) training needs. While these needs are met by traditional instructor facilitated methods, if CRM learning methods exist that require less instructor resources they may increase the productivity of training. Applied linguistics and language learning disciplines formed the basis of a theory-based learning method based on the transcription and repair (i.e., correction) of simulated audio scenarios.

The purpose of this study is to evaluate whether the proposed Collaborative Transcription and Repair Based Learning (CTRBL) method is an effective way to for students to learn the CRM skill of an approach briefing. The study will gauge effectiveness in three dimensions: the ability of participants to perform the CTRBL method, the reactions of participants to the CTRBL method, and evidence of approach briefing CRM skill learning related to the CTRBL method.

2. Briefly describe each condition or manipulation to be included with the study.

An audio recording will be used, simulating approximately five minutes of intra-aircraft and radio communication from a flight. The audio includes brief periods of profanity as well as sounds simulating a crash. The transcript is included in [Appendix E].

The study participants will be pairs of pilots. Each pair will work together to collaboratively transcribe the audio. The pairs will then mark-up the transcript, trying to repair operational errors to create an ideal scenario.

Beta-testing with human subjects will precede the actual experimental data collection. The beta-testing will be used to improve the readability and usability of the instruments; however, the overall content, presentation, and constructs to be measured will not be altered.

3. What measures or observations will be taken in the study? If any questionnaires, tests, or other instruments are used, provide a brief description and include a copy for review (computer programs may require demonstration at the request of the IRB).

All collected data will de-identify the individual participants, except administrative records of identity, which will be kept confidential. All assets will be coded to enable matching of data across various instruments and artifacts. The following instruments will be used and artifacts collected:

- *Pre-Treatment Measures.* Prior to the experiment, participants will complete the pre-treatment demographic survey in [Appendix A]. The survey will serve two purposes, (a) it will allow rejection of participants who do not meet the target participant demographics required by the quasi-experimental design; and (b) the demographics will be used for data analysis to support external validity.

  After the survey, each participant will listen to air traffic control (ATC) instructions. The participants will read back the ATC instructions. The readbacks will be audio recorded. Transcripts of the ATC instructions are in [Appendix B].

  The participants will then form into pairs. The paired participants will read an aviation scenario and then one participant will deliver an oral approach briefing to the other participant. The oral briefing will be audio recorded. Each participant will then fill out a survey rating the briefing performance. The assets for the evaluations are contained in [Appendix C and Appendix D].

- *Treatment Artifacts.* The transcript and repaired transcript produced by the participants during CTRBL will be retained for later analysis.

- *Post-Treatment Measures*. After the transcription and repair activity, the participants will repeat the briefing, briefing evaluations, and ATC readbacks.

Additionally, the participants will complete the Post-Treatment Survey in [Appendix F].

4. Describe the possible risks and benefits (if any) to the participants and describe how the experimental design will limit risks.

The benefit to the participants is they will engage in a detailed analysis of a carefully constructed audio simulation of an aviation event involving human error.

The audio risk related to an accident flight will be mitigated by minimizing the amount of profanity and crash sounds. The participants will also be advised of the profanity and crash sounds in the informed consent.

The change in meta-communication skills is a slight and unlikely risk. Further, such change in attitudes could come about from watching television programs, engaging in case studies of aviation events, or attending the theatrical performance, *Charlie Victor Romeo* (http://charlievictorromeo.com). Furthermore, on a regular basis line flight crews of aircraft operators engage in collaborative transcription of real, often tragic events, as part of forensic accident investigation by the accident investigators worldwide as part of ICAO Annex 13.

5. Describe the methods to be used in securing the informed consent of the participants. If an informed consent form is to be used, attach to this form. See Informed Consent information sheet for more information on Informed Consent requirements.

Informed consent will consist of the following elements: (a) a solicitation; (b) a pre-experiment briefing; (c) a written informed consent form; and (d) a post experiment debriefing. Appendix IRB-1 contains each of the assets supporting these phases of consent. All participants will be at least 18 years of age.

6. Will participant information be anonymous, confidential, or public? Justify the classification and describe how privacy will be ensured/protected.

Participant information will be confidential and will be protected. When participants arrive for the experiment, their demographic qualifications will be verified by a visual scan of a pilot's certificate (no identification copies will be made). Full name and university affiliation will be recorded along with the numerical Participant ID on the Administrative Tracking Form (Appendix IRB-2) for administrative reasons, but will not be disclosed in the results.

The survey forms will only contain the Participant ID or Dyad ID and will only contain demographic information.

Since the Administrative Tracking Form and survey forms could be used to identify participants, the following security measures will be employed:

(1) The original paper surveys will be entered into an electronic database. Once entered into an electronic database, the original paper survey forms will have all potentially personally identifiable information (birth date, class standing, gender, certificate, solo date, etc. can potentially identify someone) redacted using a black marker to line out the items. The original, redacted surveys will be retained for seven years and then destroyed.
(2) The Administrative Tracking Form will be electronically scanned and the original paper destroyed. The scan will be saved as a secure, encrypted Adobe PDF, with password protection (currently Adobe calls this a "security envelope"). The password will be known only to the researcher. The electronic file will be retained for seven years and then destroyed.
(3) The electronic database of survey forms will be password protected while the database contains potentially personally identifiable information (birth date, class standing, gender, certificate, solo date, etc.). Once the dissertation is complete, the potentially personally identifiable information will be printed to an electronic PDF, and password protected (as described for the Administrative Tracking Form), and retained for seven years. The potentially personally identifiable information will be purged from the electronic database once it is exported to the secure PDF.

The researcher holds a Security+ certificate from CompTIA, further supporting his ability to manage the electronic information.

7. If video/audio recordings are part of the research, please describe how that data will be stored or destroyed.

Audio will be recorded as described in Section 3. The audio will be protected on a secure, encrypted electronic media. The electronic media will not contain any personally identifiable information. Only transcripts of ATC readbacks and briefings may be used in the study; the related audio will not be publically disclosed.

The audio recordings will retained until the dissertation is complete, and then destroyed.

8. Are students being required to participate in this research as part of a class project or as a class assignment? If so, please list the class(es) and faculty members involved and justify this situation in light of APA ethical guidelines 6.11 (d), pg. 392 of the APA Publication Manual.

Students are not required to participate as part of a class project.

9. Are participants going to be paid for their participation? If yes, describe your policy for dealing with participants who 1) Show up for research, but refuse informed consent; 2) Start but fail to complete research.

All participants who meet the qualifying demographics of the study will receive compensation in cash at the completion of the exercise. The amount will be $20 (beta study participants will receive $15).

If participants refuse informed consent they will not be paid.

If participants do not complete the experiment they will be paid the full $20 (beta study participants will receive $15).

10. Approximately how much time will be required of each participant?

Each participant will spend up to two hours in the experiment.

APPENDIX IRB-1

Informed Consent

Solicitation Phase

Participant solicitations may use distribution channels of email, on-campus postings, or classroom announcements. In all cases, the solicitations will present the following information:

Research Description
Cockpit Resource Management (CRM) research is being conducted. In this experiment, you will be asked to analyze an aviation scenario involving an unfortunate outcome.

Eligibility requirements
You must hold at least a private pilot certificate but not yet have received your Airline Transport Pilot rating to engage in this research, and English must be your first language. You must bring your pilot certificate and photo identification to the experiment as proof of eligibility. You must be at least 18 years of age to participate.

Possible Discomfort
The scenario will expose you to explicit and harsh language. You may also hear disturbing sounds simulating an aircraft accident.

Estimated time involvement
It is estimated the entire experience will take approximately two hours.

Compensation
Upon completion of the experiment, you will receive [$--] in cash.

Pre-Experiment Briefing Script

Note this script may in part be delivered by audio or video playback.
Hello, I would first like to verify your eligibility before we proceed. While this process involves disclosure of your identity, all results will have your identity removed. All audio recordings made will only be heard by one transcriber, so only the text of your sessions will be blindly evaluated by other parties. Before seeing your identification, I need to verify that English is your native language.

Is English your native language?
[If response is no, participant is not eligible and will be turned away without any compensation] [Else, continue]

May I please see your pilot certificate and photo identification?
[Pilot certificate and photo identification are presented. If not eligible, turn away without compensation. DO NOT RETAIN ANY COPIES OF DOCUMENTS]
[RECORD THE PERSON'S FIRST AND LAST NAME ON THE ADMIN SHEET]

[Else, continue]

I am now going to explain the experiment to you. If at any time you feel uncomfortable with the experiment, you may exit the experiment without questions or retribution.

[Give this Briefing in a closed room to each individual for privacy]
First, you will be asked to take a demographic survey. Then, you will listen to air traffic control (ATC) instructions and perform readbacks of each ATC instruction while being audio recorded.

You will then be assigned to a random partner pilot.

You will first be asked to read a scenario. You will use a coin toss and decide who will be the "Briefer." The Briefer will brief an approach as described on this handout (handout is in [Appendix C]) while being audio recorded. You will then each evaluate the briefing.

After the briefing, your team will be shown how to use the audio playback software and how to type your transcript together. Once you understand how to operate the software you will begin the experiment. The audio will contain swear words and sounds similar to a plane crash. You may find this disturbing.

First, your team will be asked to produce a transcript of the recording. You will type this into Microsoft® Word® using the template provided. The first few lines of the template have an example of the style you should use. You will note if you can't understand a sound, then just put an "" (asterisk). If you want to describe a sound, or something extraordinary, enter it in square brackets, like,*

> *[sound of switch, likely the landing light close square bracket]*
> *[interrupting] yeah yeah.*
> *[speaking rapidly, elevated voice] oh nooo.*

The transcript production may take most of the time. It is important to be as detailed as possible when you make the transcript. That is, there is a difference between "yeah" and "yep." Between "oh" and "oooohhhhh." Or "Sheeze" and "Jeeze." So be as specific and thorough as possible. Expect to replay a lot! You should transcribe everything you hear. Save your file often!

When your team is done transcribing, please let the attendant know. You will still have access to the audio, but for the experiment, the administrator needs to come in and make a note of when the transcription process is completed. The attendant will also save a copy of the transcript and then turn on Microsoft® Word's® track changes mode.

Your team will then be asked to "repair" the transcript. The purpose of the repair is to fix every mistake the crew made to make an ideal scenario. You should NOT try to increase the accuracy of the written transcript as compared to the audio during the *repair exercise! You should focus your repair activities on improving the outcome of the scenario, making it an ideal, textbook flight. You can strike-through things you want to eliminate, put in replacement text, or add new text. Don't stop at just one fix. Try to make as many repairs as you can. Type your updates in Microsoft® Word ®, leaving revision editing mode on the whole time. Save your file often!*

When your team is done, let the attendant know.

When you are done, you will each perform some additional rating, briefing, and readback activities. You will then complete an exit survey and have an opportunity for debriefing. Then you will be paid.

Remember, if you decide to leave the experiment at any point, that is unfortunate, but certainly okay consistent with ethical research policies.

Now that you have been briefed, if you would like to continue, I will have you complete the informed consent document.

Written Consent
I consent to participating in the research project entitled: **Aviation Case Study Transcription and Repair.**

The principal investigator of the study is: William A. Tuccio, an Embry-Riddle Ph.D. in Aviation candidate, being supervised by Dr. David Esser. William A. Tuccio may be reached at William.tuccio@my.erau.edu.

Research is being conducted into a training technique whereby pilots are given access to simulated, realistic audio of a two-person crew flying a flight with problems. You will be asked to analyze the flight, identify the errors, and repair the errors. You will work with a randomly assigned partner for most activities.

The audio is meant to simulate a real flight that goes bad. As such, you may hear explicit language. Further, you may hear voices under anxiety and sounds like an airplane crash. While none of the content you hear is from an actual aircraft, the intent of the simulated audio is to be as realistic as possible.

During the experiment you will perform approximately seven additional evaluative activities. Some of the evaluations will involve your voice being audio recorded.

To be eligible for this experiment, you must have at least a private pilot certificate and not yet received your ATP. English must be your native language. You must be at least 18 years of age.

During this experiment you will be asked to listen to audio and repair the events using a printed transcript. The total time of the event should not exceed two hours. The experiment is not timed. You will be asked not to share the details of the experiment with anyone for two weeks, so other participants are not tainted by knowing the details.

The benefit of this study is the [$--] cash payment at the completion of the experiment. Further, you may benefit from engaging in a detailed examination of a realistic aviation case study.

The purpose of the study has been explained to me, the procedures to be followed, and the expected duration of my participation. Possible benefits of the study have been described.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction.

Furthermore, I understand that I am free to withdraw consent at any time and to discontinue participation in the study without prejudice to me. Finally, I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ___________

Participant Name: ________________

Participant Signature: _____________________

Post/Exit Briefing

Thank you for participating in this study. You understand you should not discuss the details of the experiment with anyone for two weeks, so as not to taint future participants?

[Wait for an acknowledgement and response; regardless of response continue].

Here is your payment of [$--].

[Wait for an acknowledgement and response; regardless of response continue].

Do you have any questions for me? I'll try to answer them.

[Do not record. If participant has concerns about study, have them contact [Dr. David Esser]]

APPENDIX IRB-2

Administrative Tracking Form

FOR INTERNAL USE ONLY		
Name	**University Affiliation**	**Participant ID**

Embry-Riddle Aeronautical University
Application for IRB Approval
Determination Form

13-176

Principle Investigator: William A. Tuccio
Other Investigators: Dave Esser, MaryJo Smith, Ian McAndrew, Gillian Driscoll

Project Title: ***Collaborative Audio Transcription and Repair as a Method for Novice Pilots to Learn Approach Briefing Crew Resource Management (CRM) Skills***

Submission Date: February 28, 2013

Determination Date: March 8, 2013

Review Board Use Only

Initial Reviewer: Teri Vigneau/Bert Boquet - EXPEDITED

Exempt: __ Yes X No EXPEDITED

Approved: X Yes ___ No

Comments: The purpose of this study is to evaluate whether the proposed Collaborative Transcription and Repair Based Learning (CTRBL) method is an effective way for student to learn crew resource management (CRM) skill of an approach briefing. This experiment uses a constructed audio simulation of an aviation event involving human error. Some risk is involved in that participants will be subjected to 'harsh' language. Therefore, this protocol may need **expedited** review. [Teri Vigneau 3-4-13]

I think this would be **expedited**. I'd recommend Mike Wiggins and Bob Oxley review. [Bert Boquet 3-8-13]

I read the entire proposal, and it seems relatively benign to me. The human subjects listen to a tape of a simulated (not real) general aviation flight and accident with a couple of bad words in the conversation. They transcribe the tape as best they can. Then they "repair" it. Seems like a good learning technique for pilots who are learning to work as a team in the cockpit. I'd say the proposal should be **expedited**. [Bob Oxley 3-8-13]

I don't see much, but I do have a couple of concerns:

1) In Item 6, it needs to be clear how the recorded name will be handled, secured, and stored or destroyed. The survey in Appendix B does contain enough data to potentially identify someone and link them to their name and participant number. Using a birth date, class standing, gender, certificate, solo date, etc. can potentially identify someone. The security, storage, etc., of the survey data needs to be addressed.

Response: Item 6 was modified to clearly identify how the direct and indirect personally identifiable information will be protected. Item 7 also had a line added to explain how audio recordings will be protected.

2) In Item 9, I'm concerned about the methods of determining who gets the $20 and who gets the $50. Is it fair and equitable? This is not clear. Also, what about someone who terminates early and does not complete by no fault of their own, such as taking too long and they have to leave for another commitment, power failures, etc. How is that compensation handled and how are they informed.

Response: Item 9 was modified to just keep the compensation at $20 for the study, and $15 for the beta study. Further, if participants terminate early they will be paid the full $20.

[Mike Wiggins 3-8-13]

Looks good to me, applicant may proceed. [Bert Boquet 3-11-13]

APPENDIX N

Readback Evaluation Scoring Procedure

READBACK EVALUATION SCORING PROCEDURE – SME USE

For All Readbacks:

- For perfect call sign, assign 20 points. Perfect call sign is "Cessna two romeo Juliet" or "November two romeo Juliet." If call sign is wrong, assign 0; if call sign is longer or shorter, assign 15.
- For slang usage or broken, repeated words deduct from 1 to 10 points.

For Readback 1:

- If facility mentioned and correct, add 10 points, else 0.
- If frequency mentioned and correct, add 70 points, else 0.

For Readback 2:

- If turn direction mentioned and correct, add 10 points, else 0.
- If heading value mentioned and correct, add 20 points, else 0.
- If word "intercept" used, add 10 points, else 0.
- If facility of radial mentioned and correct, add 10 points, else 0.
- If radial value mentioned and correct, add 20 points, else 0.
- If word "inbound" used, add 10 points, else 0.

For Readback 3:

- If facility mentioned and correct, add 10 points, else 0.
- If altimeter value mentioned and correct, add 70 points, else 0.

APPENDIX O

Readback Evaluation Subject Matter Experts

READBACK EVALUATION SUBJECT MATTER EXPERT BIOGRAPHIES

ATC READBACK SME #1

ATC Readback SME #1 is an aircraft broker with over 7,000 hours in 90 different types of aircraft. A commercially rated pilot, SME #1 was a former aviation magazine publisher who has composed and edited numerous aviation articles. In addition to flying regularly around the United States and South America as part of his aircraft brokerage business, SME #1 has served on various aviation foundations, including the Centennial of Flight celebratory committee.

ATC READBACK SME #2

ATC Readback SME #2 holds a commercial pilot certificate. He has been flying for 20 years in single engine aircraft. He is also a practicing dentist. In his practice, he has been an early adopter of many digital technologies that are employed in dentistry, and has travelled internationally training other doctors in procedures used for CAD/CAM dental restorations.

APPENDIX P

Briefing Evaluation Rubric

BRIEFING EVALUATION RUBRIC – SME USE

		Performance Levels		
Domains	**Pct**	**Excellent**	**Good**	**Poor**
Technical. The briefing covered technical areas, such as runway length, facilities.	9%	5 to 4 Between 66% and 100% of technical content was completely addressed.	3 to 2 More than 33% to 66% of technical content covered.	1 to 0 Less than 33% of technical content covered.
Interaction. How well briefer and non-briefer interacted.	13%	5 to 4 Between 66% and 100% of appropriate times the briefer interacted with the non-briefer.	3 to 2 More than 33% to 66% of appropriate times the briefer interacted with the non-briefer.	1 to 0 Less than 33% of appropriate times the briefer interacted with the non-briefer.
Ground Plan. How well the crew planned for taxi operations.	13%	5 to 4 Turnoff and taxiway planning was fully addressed.	3 to 2 Some mention of turnoff and turnoff planning.	1 to 0 No or cursory mention of taxiway planning.
CFIT. How well the briefing covered CFIT concerns.	13%	5 to 4 CFIT was fully addressed.	3 to 2 CFIT was addressed for cruise descent portion only.	1 to 0 CFIT was not addressed.
Sterile Cockpit. How well the briefing covered sterile cockpit concerns.	13%	5 to 4 Sterile cockpit was fully addressed.	3 to 2 Sterile cockpit was mentioned but less than fully addressed.	1 to 0 Sterile cockpit was not mentioned.
Distractions. How well potential distractions were addressed.	13%	5 to 4 Potential distractions were fully addressed.	3 to 2 Potential distractions were mentioned but less than fully addressed.	1 to 0 Potential distractions were not mentioned.
Communications. How well potential communication issues/confusions were addressed.	13%	5 to 4 Communication issues were fully addressed.	3 to 2 Communication issues were mentioned but less than fully addressed.	1 to 0 Communication issues were not addressed.
Roles. How well cockpit roles and workload issues were addressed.	13%	5 to 4 Roles and workload issues were fully addressed.	3 to 2 Roles and workload issues were mentioned but less than fully addressed.	1 to 0 Roles and workload issues were not addressed.

Directions:

1. Select a number for each domain as determined by performance level;

2. Multiply achievement level by “%” for achievement level (expressed as decimal number from 0 to 1);
3. Add up all weighted achievement levels, divide by 5, and multiply by 10.

Score will be between 0 and 10.

APPENDIX Q

Briefing Evaluation Subject Matter Experts

BRIEFING EVALUATION SUBJECT MATTER EXPERT BIOGRAPHIES

BRIEFING SME #1

Briefing SME#1 has been a pilot for over 20 years, a flight instructor for 14 years, and a Department of Defense air traffic controller for over ten years. He served as an Officer in the Navy, Air Force, and Air National Guard. He holds a Masters of Aeronautical Science from Embry-Riddle Aeronautical University.

BRIEFING SME #2

Briefing SME#2 has been flying for four years and has been a flight instructor for two years. He has achieved a 100% pass rate with his students. He had training in SBT and uses SBT regularly with his students in technologically advanced aircraft. He received his training from ATP Flight School.

APPENDIX R

Transcript Evaluation Rubric

TRANSCRIPT EVALUATION RUBRIC – SME USE

You will only consider those parts of the transcript that are highlighted in your copy. The transcript should only be evaluated based on what was completed. THAT IS, if the participants did not have time to finish, their score will only be based on what they had time to transcribe.

		Achievement Levels			
Domains	**Pct**	**Excellent**	**Good**	**Fair**	**Poor**
Coverage. The transcript text covers that part of audio that was assigned to be transcribed.	10%	11 to 9 100% to 75% of non-silence periods covered.	8 to 6 Less than 75% to 50% of applicable non-silence periods covered.	5 to 3 Less than 50% to 25% of applicable non-silence periods covered.	2 to 0 Less than 25% of non-silence periods covered.
Accuracy. The text in the transcript accurately reflects the audio content.	30%	11 to 9 100% to 75% of text accurately reflects audio.	8 to 6 Less than 75% to 50% of text accurately reflects audio.	5 to 3 Less than 50% to 25% of text accurately reflects audio.	2 to 0 Less than 25% of text accurately reflects audio.
Letters/Numbers. When a number is mentioned it is typed as text.	30%	11 to 9 100% to 75% of numbers are typed as text.	8 to 6 Less than 75% to 50% of numbers are typed as text.	5 to 3 Less than 50% to 25% of numbers are typed as text.	2 to 0 Less than 25% of numbers are typed as text.
Source & Destination Identification. The source of the audio (i.e., captain, copilot) and the destination (i.e., recipient) are accurately identified.	30%	11 to 9 More than 50% of sources AND destinations are accurately identified.	8 to 6 Less than 50% of sources AND destinations are accurately identified.	5 to 3 More than 50% of sources OR destinations are accurately identified (but not both).	2 to 0 Less than 50% of sources OR destination are accurately identified.

Directions:

1. Select a number for each domain as determined by achievement level;
2. Multiply achievement level by “%” for achievement level (expressed as decimal number from 0 to 1);
3. Add up all weighted achievement levels, divide by 11, and multiply by 10.

Score will be between 0 and 10.

APPENDIX S

Transcript Evaluation Subject Matter Experts

TRANSCRIPT EVALUATION SUBJECT MATTER EXPERT BIOGRAPHIES

TRANSCRIPT SME #1

Transcript SME#1 received a commission in the US Air Force in 1982 and completed undergraduate pilot training at Columbus Air Force Base in 1984. He has flight experience (pilot) in the J-3 Cub, Cessna 172, Piper PA-180, T-37, T-38, CT-39, C-21, and E-3 AWACS. Transcript SME#1 retired from the Air Force Reserves in 2012 with the rank of Colonel. He earned a PhD in electrical engineering from the University of Maryland in 1997. Transcript SME#1 has worked for over 12 years at the NTSB where he has served as chairperson on over 100 cockpit voice recorder forensic transcriptions.

TRANSCRIPT SME #2

Transcript SME #2 has worked in accident investigation for more than 20 years in all modes of transportation at the NTSB. His roles have included leading the vehicle performance division in conducting performance studies, reading out flight data recorders, and integrating cockpit audio recorder transcripts with aircraft simulations and animations. In his roles, SME #2 has worked with over 100 forms of audio recordings and transcripts from accidents, including quality review of transcripts produced by the NTSB. He holds a Bachelor of Science degree in Aerospace Engineering and is a commercially rated pilot with ratings in single and multi-engine airplanes. He is the first recipient of the NTSB's Dr. John K. Lauber award for technical excellence.

APPENDIX T

Repair Counts Rubric and Procedures

REPAIR COUNTS RUBRIC AND PROCEDURES – SME USE

Each repair item should be counted. The method to perform the counting is described in this Appendix.

SCORING METHOD DIRECTIONS TO RATER

The definition of an "item:" Any marked up text is a candidate to be an item. Any contiguous deletion without a replacement is one item. Any contiguous replacement or insertion is one item. A strike-through with replacement text should only be counted as one item.

With each item isolated, apply the rubric:

		Criteria	
Domains	**Pct**	**High**	**Low**
Depth. Rate the depth of the repair.	50%	Score: 1 If score is not "Low," then score assign the "High" score.	Score: 0 A spelling correction, correction to phonetic alphabet usage (such as "three" to "tree"). Or dropping a pause word like "uh.".
Directionality. Was repair in the correct direction?	50%	Score: 1 The repair potentially improved the outcome of the scenario.	Score: 0 The repair could potentially reduce the outcome of the scenario, i.e., eliminate a standard readback rather than correct the readback.

CALCULATION:

1. For each item:
    a. Sum all (criteria)*(percent);
    b. The sum from step (a) is a number between 0 and 1. This is the *Weighted Count.*
2. Sum all Weighted Counts for the repair transcript.

APPENDIX U

Repair Evaluation Subject Matter Experts

REPAIR EVALUATION SUBJECT MATTER EXPERT BIOGRAPHIES

REPAIR SME #1

Repair SME #1 is a National Resource Specialist for Safety Data Systems and Analysis in NTSB's Office of Research and Engineering, Safety Research Division. He assists accident investigations and conducts safety data analyses, and regularly represents the NTSB and United States in international aviation industry and government initiatives and working groups involving safety data sharing and analysis. He has managed or co-managed several NTSB safety studies since joining the NTSB in 2002, including weather-related general aviation accidents, the introduction of glass cockpit avionics into light aircraft, and most recently, the safety of experimental amateur-built aircraft. Prior to joining the NTSB, he held aviation positions as a flight instructor and as a pilot in Part 135 and Part 121 regional airline operations. SME #1 received his M.A. and Ph.D. from Wichita State University in Human Factors Psychology.

REPAIR SME #2

Repair SME #2 is an Aerospace Engineer working in the NTSB's Vehicle Recorder Division. She has worked on over 100 aviation accident investigations analyzing flight and cockpit recordings. SME #2 has served on international committees related to vehicle recorders and information processing, and mentors individuals pursuing careers in aviation. She is a private pilot, with a Master's of Aviation Science and Bachelor of Science in Aerospace Engineering from Embry-Riddle Aeronautical University.

APPENDIX V

Comparative Training Techniques

Theme Coded	Comparative Technique (Question 5)
Discussion	discussion to present then either scenario or video to drive in the point of what could go wrong
Discussion	discussion
Discussion	discussion
Discussion	discussion
Discussion	Discussion
Discussion	Discussion
Discussion	discussion and video
Scenario Based Training	scenario-based training
Scenario Based Training	scenario-based
Scenario Based Training	Scenario Based Training
Scenario Based Training	Scenario based training
Scenario Based Training	scenario based, stories
Scenario Based Training	scenario-based
Scenario Based Training	scenario-based training
Scenario Based Training	scenario-based
Scenario Based Training	scenario-based training
Scenario Based Training	Scenario based training
Scenario Based Training, Ground	videos, as well as ground based scenarios
Scenario Based Training, Ground	Ground Based Scenario
Scenario Based Training, Ground	"What if" scenarios
Scenario Based Training, Ground	ground based scenarios
Scenario Based Training, Ground	ground based scenario-based training
Scenario Based Training, Ground	Ground based scenario-based training
Scenario Based Training, Ground	Group Based Scenario Training or group based Training with no specific Scenario, But with specific learning goals.
Scenario Based Training, Ground	Ground based scenario training
Scenario Based Training, Ground	ground based scenario-based training
Scenario Based Training,	videos, ground based scenario based training

Theme Coded	Comparative Technique (Question 5)
Ground	
Scenario Based Training, Ground	ground based scenarios
Scenario Based Training, Ground	ground based scenario based
Scenario Based Training, Ground	videos, ground based scenario based training
Scenario Based Training, Ground	Group Training (scenario based)
Scenario Based Training, Ground	ground based scenario based training
Scenario Based Training, Ground	ground based scenario based training
Scenario Based Training, Ground	Ground based/scenario based
Simulator-Scenarios	in flight (simulators) practices
Simulator-Scenarios	line orientated flight training (scenario discussions & sms)
Simulator-Scenarios	scenario-based training in the simulator
Simulator-Scenarios	scenario based training (simulator)
Video	videos
Video	videos, real life recording of pilot-ATC error
Video	videos
Video	videos

APPENDIX W

Exit Survey Explanations and Comments

ROW	Q5-TechniqueCompare	Q16-ExplainWhyWhichMore	Q17-AdditionalComments
1	Group Based Scenario Training or group based Training with no specific Scenario, But with specific learning goals.	I found that working with groups of more than two benefitted me better.	
2	Group Training (scenario based)	I really liked visual & audio learning combined. When I write something it really sticks!	
3	Discussion	It was a little more interactive than listening to a traditional discussion.	Study was good because it kept us actively engaged in the assignment the entire time.
4	Ground based scenario training	This training was very interactive and lets participants learnin in multiple ways (through reading, writing, listening, recording) which is ideal for learning. Being able to compare/contrast before with after is also effective.	
9	videos, as well as ground based scenarios	Even though the videos did help, the hands on experience helps in great amounts.	Very well thought out, planned to the tee.
10	Ground based/scenario based	Because it was my first experience with ATC Training	
11	Scenario Based Training	They are very similar, however participating in reading back callbacks from ATC helps me to better understand potential pitfalls rather than listening to someone else's mistakes.	
12	videos	This training was more interactive and hands on and analyzing the accident step by step, instead of just watching a video or sitting in class then being asked your opinion.	

ROW	Q5-TechniqueCompare	Q16-ExplainWhyWhichMore	Q17-AdditionalComments
13	Scenario based training	I believe the audio and trying to identify what was being said increases your awareness with the scenario. The second part also had us very engaged in the task.	Very interesting study.
14	Scenario based training	This not only had a scenario but someone to analyze it with.	Very well put together & useful from a pilot standpoint.
17	discussion	While analyzing a scenario is extremely useful, it's very tedious. Much of the same can be learned from discussion which is more enjoyable.	
18	"What if" scenarios	"What if" scenarios involve you and only you and seemed more like avoiding hindsight. This CRM study involves you and another more better with good cockpit management.	
19	Ground Based Scenario	I thought that the training I just did was a great eye opener.	
20	discussion	More in depth and adds FAA aspect of CRM	Did not realize it was training. Should add a simulator flight with the two pilots being trained.
21	scenario-based training	This training was very pertinent and I could relate to some of what was happening.	
22	ground based scenario-based training	I was exposed to more situations that I might encounter in the real world so it seemed more helpful.	was very interesting! Glad that I participated!
23	videos, real life recording of pilot-ATC error	The training question #5 was much more extensive due to time & setting. Also #5 training was with classmates instead of a stranger.	Good partner study to recognize potential errors in radio transmissions.

ROW	Q5-TechniqueCompare	Q16-ExplainWhyWhichMore	Q17-AdditionalComments
24	scenario-based	It allowed for a more in-depth look at communication in and outside of the cockpit.	
25	scenario-based training	It gave me a reinforced knowledge and confidence the second time around.	
26	in flight (simulators) practices	Practicing scenarios in flight simulators (as well as the real thing) is hands on, and very informative. Nothing is better training than this.	
27	videos	This training was interesting, but video is my first pick. It's more enjoyable.	
28	scenario-based	I liked the scenario differences and how I was able to breakdown and disect other pilots mistakes and learn from them.	
29	line orientated flight training (scenario discussions & sms)	Because I was able to act as part of the scenario and the simulators add a whole new level of realism.	This sort of training combined with sims, so that participants are more in the moment wouild be fantastic and extraordinarliy beneficial.
30	discussion	While discussion is useful, getting something hands on like this will always be better.	I would like to see more of these. Even if there was no pay.
31	scenario-based training in the simulator	More realistic scenario that I could relat to and imagine myself in the same situation as a pilot.	
32	discussion to present then either scenario or video to drive in the point of what could go wrong	I chose it because that’s the way I originally started learning and I often stick to things I know when it comes to training.	Although I only rated this a 4 in how useful its because if you've had the right training before hand these points are already driven in.
33	scenario-based	It was similar training, this time I was paid though.	
34	ground based scenarios	Interesting scenario.	

ROW	Q5-TechniqueCompare	Q16-ExplainWhyWhichMore	Q17-AdditionalComments
35	ground based scenario based	It felt more time sensitive, which I think adds to the realism.	More instruction on the transcription portion.
36	Discussion	Provided insight to potential communication issues given off by pilots as well as ATC.	This training helped me reflect on potential issues/concerns that could arise in my flight career. Thank you very much for this experience.
37	scenario based training (simulator)	Add more realism and allowed me to actively fly and make decisions.	I believe both questions 5 & the training I participated in are equally important and should both be utilized in training.
38	videos	I could perform the training at my own discretion.	
39	ground based scenario based training	Ground based simulator/man sim training is more involved. The one I just participated in complements ground based training but not recommended for starting out pilots as the sole CRM experience.	
40	scenario-based training	Due to the fact that it was a very real scenario, it was easy to picture being there.	
41	ground based scenario based training	More discussion	
42	videos, ground based scenario based training	Training I just participated in was too long and repetitive.	
43	videos, ground based scenario based training	training methods and instrutions are too ambiguous, also the proper cause of action for the given scenario wasn't directly stated. Furthermore training is difficult to associate with actual flying.	
44	discussion and video	It is my learning style	Possible effective way of training.

ROW	Q5-TechniqueCompare	Q16-ExplainWhyWhichMore	Q17-AdditionalComments
45	scenario based, stories	I felt that themeans at which the scenario was analyzed was archaic. If a program was made other than simpliy using a word processor, the user might find more value.	Overall, the experiment did help me recognize some of the mistakes a pilot can make when situationally unaware. I would recommend a more intuitive user-friendly and more involved way to present the scenario. If possible avoid computer based training.
46	Ground based scenario-based training	Because it is very interactive and these are the types of training I enjoy the most.	fun and interesting activities.
47	ground based scenarios	Ground based scenarios offer training value without much risk, and allow for a debrief/lessons learned discussion.	Transcribing was tough, felt we should have managed our time and cooperated a bit better.
48	ground based scenario-based training	scenario-based training allows me to figure out the best ways of using crew resource management while applying them.	Great study. CRM is extremely important and can prevent many bad things from ever happening.

APPENDIX X

Thematic Summary of Repairs

Transcript	Count (% of 21)	Repaired (Thematic Exemplar)
Narrator		
The audio in this recording is simulated. The sounds names places and details are made up and any relationship to real persons or places is coincidence. The audio contains graphic language and may be disturbing to some listeners. The recording simulates a cockpit recording of aircraft November one one four alpha Romeo.	0	
Sound		
[sound of engine, continues at same level for about 5 minutes]	0	
Intercom Pilot 1 to Pilot 2		
So what'dya say you need three more night cross countries?	6 (28.6%)	All repairs of this item deleted the whole entry.
Intercom Pilot 2 to Pilot 1		
Yeah I need three after this one. Ah yeah same for you right?	7 (33.3%)	Most repairs of this item deleted the whole entry.
Intercom Pilot 1 to Pilot 2		
Yeah I try to go with ah someone ah different to different places you know. Some-- my first time here.	6 (28.6%)	All repairs of this item deleted the whole entry.

Transcript	Count (% of 21)	Repaired (Thematic Exemplar)
Intercom Pilot 2 to Pilot 1		
Yeah me too. I hear taxiways are a mess here. I thought I was going with Arnie. And ah you know he's got my chemistry lab notes they're due tomorrow. He ah he should be out here tonight. And uh boy if I if I'm late on those lab notes. I'll fail chem. I gotta catch him at the FBO.	16 (76.2%)	Some repairs deleted the whole entry; most altered the text to focus on the taxiway confusion while eliminating the time pressure, non-pertinent remarks.
Aircraft Piper 123 to ATC		
America Approach Piper one two three requesting lower.	4 (19.0%)	Repairs added specific altitudes, or added the word "altitude" to expand on the meaning of "lower."
1st Approach Controller to Piper 123		
Piper one two tree I'll need you to get another ah ten miles for terrain before I can start you down. Continue heading two six zero for now and I'll get you down as soon as I can.	5 (23.8%)	Repairs added more specific phraseology.
Aircraft Piper 123 to ATC		
Wilco. Continue on heading two six zero at four thousand five hundred one two three.	7 (33.3%)	Most repairs added specificity to the readback.
Intercom Pilot 2 to Pilot 1		
Boy what a nice night. Not a cloud in the sky.	4 (19.0%)	Most repairs deleted the whole entry.

Transcript	Count (% of 21)	Repaired (Thematic Exemplar)
Intercom Pilot 1 to Pilot 2		
Yeah. No moon. Can see all the stars. It's smooth too.	4 (19.0%)	Most repairs deleted the whole entry.
Intercom Pilot 2 to Pilot 1		
No worries about the weather tonight [laughter].	4 (19.0%)	All repairs deleted the whole entry.
Intercom Pilot 1		
[laughter]	3 (14.3%)	All repairs deleted the whole entry.
1st Approach Controller to Cessna 114AR		
Cessna one one four alpha Romeo fly heading two six zero contact America Approach on one tree four point one.	0	
Radio Pilot 2 to ATC		
Two six zero approach on one three four point one. Ah for Cessna one one four alpha Romeo. Have a good night.	8 (38.1%)	Some repairs deleted “ah,” some repairs corrected phonetic usage, some dropped courtesy “have a good night,” some added or removed specifying words (i.e., “for”)
Intercom Pilot 2		
[sound of clicks, like changing frequencies] [speaking to self] One three four...	0	

Transcript	Count (% of 21)	Repaired (Thematic Exemplar)
Intercom Pilot 1 to Pilot 2		
Headin' two six zero.	1 (4.8%)	Repair dropped contraction, making first word "heading."
Sound		
[high low tone, similar to new radio frequency]		
2nd Approach Controller to Cessna 104AR		
Cessna one zero four alpha Romeo descend and maintain two thousand fife hundred contact approach one two fife point one. Good day.	1 (4.8%)	Added word "on" before frequency.
Aircraft Cessna 104AR to ATC		
One twenty five point one out of four thousand five hundred for two and a half. Ten four alpha Romeo. Good night.	14 (66.7%)	Most corrected call sign to standard phraseology and corrected altitude readback to standard phraseology. Some dropped courtesy "good night."
Intercom Pilot 2 to Pilot 1		
That must be Arnie and Steve. I think there's like five of us up here tonight. You know. That's cool. I should I should be able to be able to catch up to him on the ground Arnie and ground and get my Chem lab notes ah. He better. I better cat-- he better * ah...my instructor showed me this high speed approach profile you want to try it? Your instructor show you that one?	18 (85.7%)	Some deleted the whole item; most retained the first two sentences, and dropped mention about catching up and the high speed approach. Some added mitigated speech at the end, such as "do the high speed approach if comfortable."

Transcript	**Count (% of 21)**	**Repaired (Thematic Exemplar)**
Intercom Pilot 1 to Pilot 2		
[sigh] Well we did it once--	16 (76.2%)	Most deleted the whole item. Some made the pilot more assertive, such as, "No we will do a normal approach."
Intercom Pilot 2 to Pilot 1		
Hold on I I gotta check in.	8 (38.1%)	Most deleted the whole item, some made the wording less slang and more formal.
Radio Pilot 2 to ATC		
America Approach ah Cessna one one four alpha Romeo. With you at four point five with Foxtrot at Zangster International.	15 (71.4%)	Most made the phraseology standard.
2nd Approach Controller to Cessna 114AR		
Cessna one one four alpha Romeo. America Approach. use caution for similar call signs on the same frequency. Expect straight in runway two seven. Altimeter two niner niner one.	1 (4.8%)	Deleted some extra words in statements.
Radio Pilot 2 to ATC		
Okay ah we'll use caution. Expect runway two seven. Cessna one one four alpha Romeo.	7 (33.3%)	Most added the altimeter to the readback. Some got rid of extra words.
Intercom Pilot 2 to Pilot 1		
So you ah you never done it before? I-I can talk yah talk you through it's. It's cake.	16 (76.2%)	Most deleted the whole item. Some shortened the statement to make it more pertinent. One added talk similar to, "since you have done it we should not do it."

Transcript	Count (% of 21)	Repaired (Thematic Exemplar)
Intercom Pilot 1 to Pilot 2		
Yeah ohh-kay. I've never done it at night.	17 (81.0%)	Most deleted the whole item. Some added more assertive statements against doing the high speed approach the first time at night.
Intercom Pilot 2 to Pilot 1		
Ah shoot my iPad lah-- battery is low. * I'd like I'd like to have the taxi diagram. You have you have yours out?	5 (23.8%)	Some deleted the whole item, some made reference to a paper taxi diagram.
Intercom Pilot 1 to Pilot 2		
No my iPad's in the back. Should I get it?	10 (47.6%)	Some deleted the reference to "should I get it." Others suggested a paper backup copy, or positive exchange of flight controls to look for the iPad.
2nd Approach Controller to Cessna 334AR		
Cessna tree tree four alpha Romeo descend and maintain two thousand fife hundred. Contact approach one two fife point one.	0	
Aircraft N124AR to ATC		
Was that for us. November one two four alpha Romeo?	3 (14.3%)	Some deleted the whole item; some changed it to "say again."
Intercom Pilot 2 to Pilot 1		
Hold on. Uh. Let me just put it in sleep mode for a second. And I'll I'll get my charger.	12 (57.1%)	Half deleted the whole item. Most others made reference to a paper copy. One dropped the repetitive word "I'll."

Transcript	Count (% of 21)	Repaired (Thematic Exemplar)
2nd Approach Controller to Cessna N334AR		
Negative. It was for Cessna November tree tree four alpha Romeo. Listen up people.	6 (28.6%)	All dropped the ending statement "Listen up People."
Aircraft Cessna 334AR to ATC		
Approach on one thirty five one. Ah I mean one two five point one. November three three four alpha Romeo.	10 (47.6%)	About half deleted the misspeak of "135.1." Some corrected the misspeak of 135.1 to make it phonetically correct.
Sound		
[sounds of rustling, bag snapping, like pilot looking for charger]	7 (33.3%)	Most deleted this whole item; one replaced it with "sound of sitting still."
2nd Approach Controller to Shooter 3		
Shooter tree contact America Center on UHF tree eight six point two.	0	
Aircraft Cessna 134AR to ATC		
Cessna four alpha Romeo ah is with you at four thousand five hundred with golf.	8 (38.1%)	About half added the full call sign; some made the phraseology more standard.
2nd Approach Controller to Cessna 134AR (and all aircraft)		
Cessna one tree four alpha Romeo America Approach. Use caution similar call signs on the frequency. Break all aircraft ATIS information golf now active at Zangster. Altimeter two niner niner one.	0	

Transcript	**Count (% of 21)**	**Repaired (Thematic Exemplar)**
Intercom Pilot 1 to Pilot 2		
Okay. ATIS changes you want to get it.	5 (23.8%)	Most made the sentence shorter and more direct. One replaced with a direction to skip updating the ATIS.
Intercom Pilot 2 to Pilot 1		
Yeah yeah okay. [sound of clicks similar to frequency change] so when you do this approach you keep the speed up around---	19 (90.5%)	Most deleted the high speed approach clause. Some replaced the statement to simply state they would get the ATIS.
Sound		
[static]	1 (4.8%)	Deleted the static.
2nd Approach Controller to *4AR		
Four alpha Romeo descend and maintain two thousand fife hundred. contact approach on one two fife point one.	6 (28.6%)	Most added the full call sign, using 114AR or 134AR.
Radio Pilot 2 to ATC		
Out of forty five for twenty five over to approach on one thirty five one. November one one four alpha Romeo good night.	12 (57.1%)	Many corrected the erroneous readback of “135.1” to “125.1.” Most corrected phraseology of frequencies and altitudes. Some corrected phraseology but left the erroneous “135.1.”
Aircraft Cessna 124AR		
Was that for us four alpha Romeo?	11 (52.4%)	Many deleted the whole item. Some added the full call sign. Some made the statement standard to “say again.”

Transcript	**Count (% of 21)**	**Repaired (Thematic Exemplar)**
Sound		
[static]	1 (4.8%)	Deleted the static.
2nd Approach Controller to 124AR / 114AR		
Four alpha Romeo negat--	6 (28.6%)	Some deleted the whole item. Some added the full call sign.
Sound		
[sound of high low tone similar to new radio frequency]	0	
ATIS		
Temperature two zero dewpoint one zero altimeter two niner niner one. Runway two seven in use. Expect visual approach. Notices to airmen. Taxiway Zulu closed. All aircraft contact clearance delivery prior to taxi. Advise on initial contact you have information golf. Zangster Airport information golf time zero two fife zero Zulu wind two seven zero at fife. Sky clear visibility greater than six. Temperature two zero dewpoint one zero altimeter two niner niner one. [cough in cockpit] Runway two seven in use. Expect visual approach. Notices to airmen. Taxiway Zulu closed. All aircraft contact clearance delivery prior to taxi.	0	

Transcript	Count (% of 21)	Repaired (Thematic Exemplar)
Intercom Pilot 2 to ???		
No dude. That was for us. Huh. **.	7 (33.3%)	Most deleted the whole item. Some dropped the slang. Some made this a radio call to ask ATC for clarification.
Sound		
[engine sound decreases and remains at lower level till near end of recording]	0	
Intercom Pilot 1 to Pilot 2		
Out of forty five down to twenty five.	5 (23.8%)	Most made the sentence more professional. One replaced the whole item with a need to confirm altitudes with ATC.
Sound		
[sound of clicks, similar to dialing frequency change]	0	
Sound		
[sound of high low tone similar to new radio frequency]	0	
Intercom Pilot 2 to Pilot 1		
ATIS ah. It sounds the same. Nice night still.	8 (38.1%)	Some deleted the whole item. Some noted a different altimeter.
Intercom Pilot 1 to Pilot 2		
Sure is.	4 (19.0%)	All deleted the whole item.

Transcript	Count (% of 21)	Repaired (Thematic Exemplar)
Intercom Pilot 1 to Pilot 2		
You call him?	4 (19.0%)	Most deleted the whole item.
Intercom Pilot 2 to Pilot 1		
[laughter] Oh shit. Let me do that.	6 (28.6%)	Most made the statement contain less slang and be more direct. Some deleted the whole item.
Radio Pilot 2 to ATC		
[cough] America Approach ah Cessna one one four alpha Romeo out of three thousand niner hundred for two thousand five hundred with Golf.	3 (14.3%)	All made the statement more direct and standard.
Intercom Pilot 2 to Pilot 1		
[cough] Okay ah I got my power charged iPad in. sorry ah. Taxiways are ah right there.	8 (38.1%)	Most deleted the first part and made the statement focus on taxiway diagrams. Some deleted the whole item.
Intercom Pilot 1 to Pilot 2		
Okay. So what's the high speed approach technique?	12 (57.1%)	Most deleted the whole item; most of the remainder dropped the high speed approach reference. One changed the statement to wonder if the controller should have responded already.

Transcript	**Count (% of 21)**	**Repaired (Thematic Exemplar)**
Intercom Pilot 2 to Pilot 1		
So when you do this high speed approach. Ah like I was sayin'. He-he showed me. Ah you keep the speed up like one twenty till like fifteen hundred. And then you pull it back to like fifteen hundred RPM. And level out. So you can slow and then ah get the flaps down.	13 (61.9%)	All deleted the whole item.
Intercom Pilot 1 to Pilot 2		
Ahh okay. Thousand to go.	7 (33.3%) (2 inserts) (9.5%)	One added a new statement saying they should be at 2,500 feet. Most deleted the "ahh okay."
Radio Pilot 2 to ATC		
America Approach Cessna one one four alpha Romeo how do you hear.	0	
Intercom Pilot 1 to Pilot 2		
What's up with them?	4 (19.0%)	Most made this a less ambiguous statement. One changed the words to make it a radio call to ATC.
Intercom Pilot 2 to Pilot 1		
Ah let me go back to that other frequency. Ah eh ah shoot. What was it. Damn. I put in the ATIS and lost it. Damn.	4 (19.0%)	Most shortened the words to make it more direct and shorter with a focus on the radio frequency. Some deleted the whole item.

Transcript	**Count (% of 21)**	**Repaired (Thematic Exemplar)**
Intercom Pilot 1 to Pilot 2		
Oh you loser...check the airport diagram and use whatever.	12 (57.1%)	Most dropped the "loser" part. Most made a more direct statement, dropping "whatever," with more direct information. Some deleted the whole item.
Intercom Pilot 2 to Pilot 1		
Oh yeah yeah. One thirty four point one. Oh yeah yeah that's it.	3 (14.3%)	Most deleted the whole item. Some made the phraseology standard for the frequency reference.
Sound		
[sound of high low tone similar to new radio frequency]	0	
2nd Approach Controller to N114AR		
Four alpha Romeo acknowledge. Low altitude alert.	3 (14.3%)	One deleted the whole item. One added the full call sign. One added to the end "Climb to…"
Radio Pilot 2 to ATC		
America Approach I'm sorry ah Cessna one one four alpha Romeo ah what what was that frequency.	6 (28.6%)	Most dropped "I'm sorry." Many changed the call to acknowledge the low altitude alert.
2nd Approach Controller Cessna 114AR		
Cessna one one four alpha Romeo low altitude alert climb immed--	2 (9.5%)	One deleted the whole item. One replaced the low altitude alert to "climb back to 2,500."
Sound		
[sound of engine noise increases]	0	

Transcript	**Count (% of 21)**	**Repaired (Thematic Exemplar)**
Intercom Pilot 1 to ???		
Oh shit.	2 (9.5%)	All changed to a more positive outcome or deleted the whole item.
Sound		
[sound of thunk]	3 (14.3%)	All changed to a more positive outcome or deleted the whole item.
Sound		
[sound of static]	1 (4.8%)	All changed to a more positive outcome or deleted the whole item.