Employing Flight Simulation in the Classroom to Improve the Understanding of the Fundamentals of Instruction among Flight Instructor Applicants

Kenneth P. Byrnes Ph.D.
Embry-Riddle Aeronautical University, byrnesk@erau.edu

Introduction

Certificated Flight Instructors (CFIs) are critical to the success of the aviation industry. Their ability to attract, retain, and teach pilots is critical to the future of aviation. However, working as a flight instructor is a job that is predominantly used by low-time pilots to build flight experience so that they can move on to full-time flying positions with an airline (Blair, 2011). Since many pilots use the teaching profession as a stepping stone, the flight training industry suffers from inadequate experience as well as high flight instructor turnover (Erickson, 2009). In addition to the high turnover, many CFIs are not actively employed as instructors, and they do not provide flight instruction on a regular basis.

An active flight instructor can be defined as one who provides an endorsement for a student applicant to take a Federal Aviation Administration (FAA) practical exam (Blair, 2011). On average 15%, or approximately 15,000, of the 98,842 FAA certificated instructors are considered active (Blair, 2011). Additionally, the majority of the active full time instructor population is comprised of low time pilots building experience to meet the requirements to work at an airline (Thurber & Epstein, 2016).

Wiggins and Henley (1997) maintained that there is a consistent cohort of inexperienced flight instructors that lack the required expertise to facilitate effective learning among pilot trainees. To combat the high turnover and low experience of instructors, flight training organizations must focus on the quality of flight instruction in order to ensure good customer service to student pilots. However, becoming an effective flight instructor requires both piloting and teaching skills. Henley (1991) discovered that the emphasis of CFI training was focused strictly on content expertise and piloting skills rather than the development of teaching methods and learning theory. This focus on content expertise and piloting skills, rather than teaching

methods, may produce less effective instructors. While these instructors have great content knowledge and flying skill, they may not have the teaching skills required to effectively transfer their knowledge and skill to a student. According to Andreasen and Haciomeroglu (2009), the content knowledge of the teacher becomes irrelevant if they cannot appropriately manage student behavior and learning.

According to the Federal Aviation Administration [FAA] (2014), instructors who have an in-depth understanding of how learning occurs, and understand how to apply teaching methods, foster better learning for students. The FAA reasons that "by understanding the teaching and learning processes, instructors will be better qualified to produce pilots who are able to operate safely within the National Airspace System" (FAA, 2014, p. 2). To ensure that instructors have the proper training, the FAA requires them to pass a 50-question knowledge exam on teaching methods known as the Fundamentals of Instruction (FOI). The FOI knowledge exam is the first requirement that a flight instructor applicant must meet. The FOI test, as well as a second knowledge exam that focuses on teaching content, is required prior to beginning the FAA flight instructor practical exam. The purpose of the FOI exam is to test the knowledge that flight instructor applicants have in areas such as human behavior, learner characteristics, and instructional design.

Erickson (2009) maintains that preparation to take this exam requires approximately one hour of study time. As a result, instructor applicants generally memorize the information to pass the FOI test. Since memorization is the lowest level of learning, the information is not retained and, more importantly, not applied when they begin actively teaching student pilots (FAA, 2014). Due to the lack of focus on teaching methods, new instructors have often not developed responses to novel teaching situations or the unstable, ill-structured environment that they

encounter (Wofford, Ellinger, & Watkins, 2013). Instructors initiate informal learning to improve their teaching in response to their students' short comings (Wofford et al., 2013). Wofford et al. (2013) found that novice instructors go through multiple iterations (approximately three) of the informal learning process before they have the ability to develop appropriate responses. As a result, instructors develop teaching expertise through trial and error (Wofford et al., 2013). This gain in expertise comes at the expense of the student since the student pays the hourly cost of the instructor and aircraft.

Henley (1991) found that 81% of CFIs felt that their CFI training was inadequate. In addition, 97% of CFIs agree that instructor training should provide better competency in teaching methods to provide applicants with a superior understanding of learning and evaluation theory (Henley, 1991). According to Conner and Sliwka (2014), pedagogical approaches used in initial teacher education "provide a powerful backdrop for which beginning teachers consciously and subconsciously draw ideas and concepts that shape their own practice of teaching" (p. 173). Hence, improvement in initial flight instructor education may improve the teaching skills of novice CFIs.

The use of technology, in the form of a virtual teaching environment, may improve the effectiveness of initial CFI training. Andreasen and Haciomeroglu (2009) maintained that a virtual teaching environment can provide a focus on the development of behavioral management strategies rather than a simple focus on content knowledge. Dieker, Hynes, Hughes, and Smith (2008) suggested that educating teachers in virtual environments protected students from harm by reducing informal, on-the-job training while increasing the teaching experience among novice teachers. Other studies have concluded that realistic, virtual environments can be used to

enhance a prospective teacher's instructional ability by successfully training them on how to manage classroom behavior (Andreasen & Haciomeroglu, 2009).

Problem

The traditional training required to become a CFI focuses on content expertise and piloting skills and does not properly prepare individuals to teach (Henley, 1991). Due to these circumstances, each instructor must employ an informal, on-the-job, learning process to improve their teaching skills (Wofford et al., 2013). This informal learning process may harm students by extending their training time as well as their cost of completion. This study will employ a realistic virtual learning environment to measure the FOI knowledge among flight instructor applicants during training.

The purpose of this quantitative study is to measure the effect that a virtual learning environment, using flight simulation in the classroom, has on the understanding of FOI concepts/lessons among CFI applicants in a university aviation program. Specifically, this research addressed the following questions:

1: Does training in a virtual learning environment improve CFI applicants' understanding of FOI theory?

2: What elements of FOI are improved by training in a virtual learning environment?

Hypotheses

H$_0$: Using flight simulation to create a virtual learning environment in the classroom will not increase the understanding of FOI theory among CFI applicants in a university aviation program.

H₁: Using flight simulation to create a virtual learning environment in the classroom will increase the understanding of FOI theory among CFI applicants in a university aviation program.

Method

This quantitative, experimental study focused solely on the classroom portion of the CFI training curriculum. The classroom training is where the initial FOI theory is introduced and where the teaching necessary to pass the FAA FOI knowledge exam is provided. For the purpose of this study, two groups of CFI applicants were used to measure student understanding of FOI knowledge after completion of the required ground training. Both groups were regularly scheduled flight instructor academic courses on the university's spring 2014 calendar.

Students selected courses without prior knowledge of this experiment. In fact, student registration was completed prior to the development of this experiment. A flip of the coin determined that one course section was assigned as the control group, and the other section assigned as the experimental group. The control group included 18 CFI applicants as did the experimental group. The control group received traditional CFI ground training. This training consisted of 8 hours of training on FOI followed by a FOI classroom test; this test was used as a pre-test for this study.

After completing the classroom test, students took the FAA FOI knowledge exam. Following the FOI exam, the instructors prepared the CFI applicants to take the Flight Instructor Airplane and Flight Instructor Instrument knowledge exams. Both of these exams consist of 100 multiple-choice questions and are focused on content and piloting skills rather than teaching methods. During the ground school portion of their training, each CFI applicant was required to prepare a lesson plan and deliver a lecture. Students were randomly assigned different tasks

from the FAA Private Pilot Practical Test Standards (PTS) as topics for their lesson plans. As the CFI applicant lectured about a specific task, fellow students critiqued him or her. The experimental group followed the same class schedule. However, the CFI applicants prepared a lesson plan covering a PTS task and delivered the task lesson in a virtual learning environment rather than a simple traditional lecture classroom setting.

The virtual learning environment was set up in a 30-seat classroom and consisted of three segments: (1) a mock, one-on-one training environment using a whiteboard and a desk where the CFI applicant would provide the knowledge of a lesson to a fellow classmate who was playing the role of a student, (2) a Cessna 172 level 6 Flight Training Device (FTD) where the CFI applicant would teach the student how to apply the knowledge that was delivered in Segment 1, and (3) a mock one-on-one debriefing environment using a whiteboard and a desk where the CFI applicant provided a thorough debriefing to the student on their performance during Segment 2.

In Segment 2, the audio communication was broadcast to the entire class through speakers in the classroom. Cameras in the FTD broadcasted a live feed through a classroom projector to enhance the ability for the class to observe. The visual scene and the instrumentation of the FTD were repeated to the class through the projector. This setup allowed the participants in the experimental group to observe and evaluate the role-playing group in real time.

The virtual learning environment was used 18 times so that each CFI applicant in the experimental group had the opportunity to (1) teach a lesson, (2) play the role of the student, and (3) observe the teaching/learning activity. CFI applicants were randomly selected and given 24 hours of notice of the lesson that they were required to prepare and teach. Various roles were developed for the CFI applicants who were acting as the student. Each role was different and

was developed using the student attributes, learning styles, defense mechanisms, and error types that are discussed in the Aviation Instructors Handbook that is published by the FAA. Each role required a student to play a role that portrayed a specific (1) personality type, (2) level on Maslow's hierarchy of needs, (3) level of learning, (4) defense mechanism, (5) learning style, (6) motivation level, (7) type of anxiety, (8) type of error, and (9) type of memory error. These nine areas are further defined in Table 1. At the beginning of each class, a CFI applicant was randomly selected to play the role of the student. The CFI applicant was briefed on the role and given a key that explained each of the nine components of the role that they were required to play, including examples on how to play the role. The briefing was completed outside of the course room, by the course instructor, and lasted between 3 to 5 minutes. The CFI applicant who developed the lesson plan delivered the lesson to the individual who was playing the role of the student as the rest of the class observed in real time.

Students who were observing the lesson were required to complete a worksheet. The worksheet required them to identify the specific (1) personality type, (2) level on Maslow's hierarchy of needs, (3) level of learning, (4) defense mechanism, (5) learning style, (6) motivation level, (7) type of anxiety, (8) type of error, and (9) type of memory error of the student. The worksheet also required the class to evaluate the instructor's performance in regard to their lesson preparation, organization, communication, teaching methodology, evaluation/assessment techniques, pre/post briefing, as well as their identification and response to the learner's anxiety, personality, level of learning, learning style, and defense mechanisms. The worksheet also included a free-form section where observers were asked to share how they would improve the lesson.

The typical duration to complete all three segments was approximately 45 minutes. The remaining 15 minutes of class were used by the classroom instructor to facilitate a guided discussion about the exercise and to compare the observer's worksheet results to the role that the student was playing. Significant time was also spent discussing the CFI applicant's response to the student role and overall performance. The worksheets were used to ensure that observers were actively participating in the exercise. These daily worksheets were not analyzed as part of this study since the research design was to measure the overall understanding of FOI rather than daily learning process. However, the instructor reported high agreement on the observer's analysis of the roles and performance of the participants.

Table 1

Student Roles Played by CFI Applicants

Role Category	Roles for Each Category							
Personality - Attitude	Introvert	Extrovert						
Personality - Perceiving	Sensation	Intuition						
Personality - Judging	Thinking	Feeling						
Personality - Lifestyle	Judging	Perceiving						
Student Errors	Slip	Mistake						
Motivation	Low	Moderate	High					
Memory	Retrieval failure	Fading	Interference	Repression				
Level of Learning	Rote	Understanding	Application	Correlation				
Human Needs	Physiological	Security	Belonging	Esteem	Self-Actualization			
Anxiety	Hesitancy to act	Impulsivity	Freeze	Over cooperation	Inappropriate laughter	Rapid changes in mood/emotions	Anger	
Defense Mechanisms	Repression	Denial	Compensation	Projection	Rationalization	Reaction Formation	Fantasy	Displace-ment
Learning Style	Active	Reflective	Sensing	Intuitive	Visual	Verbal	Sequential	Global

This study focused on answering two research questions: (1) does training in a virtual learning environment improve CFI applicants' understanding of FOI theory and (2) what elements of FOI are improved the most by training in a virtual learning environment? To answer these questions, a pre-test was given to both the control group and the experimental group to ensure that the groups had similar FOI knowledge prior to treating the experimental group. Both groups were also given a multiple choice knowledge test to measure their understanding of the FOI at the end of the semester. The overall scores, as well as scores for specific elements of FOI, between the groups were analyzed using an independent sample t test.

Results

A pretest was given to both the control and experimental group and an independent t test was used to determine if the groups were statistically different prior to treating the experimental group with the new training method. Based on 34 degrees of freedom, the critical t value where the groups were considered statistically different would be identified by a t value that is greater than -1.6909. The analysis identified a t statistic of -.775with a p value of .444 between the pretest scores of each group. These results suggest that there was no statistical difference between the experimental and control groups' FOI knowledge prior to treatment. An independent t test was also completed on the FOI knowledge posttest to identify if the treatment to the experimental group improved FOI knowledge. Based on 34 degrees of freedom, the null hypothesis would be rejected if the t value is less than -1.6909. The t statistic result of -2.917 (shown in Table 2) meets that requirement; thus, the null hypothesis is rejected. The result indicates that the mean test grades of the control group are significantly less than the mean test grades of the experimental group and that the difference in student performance is not simply by chance.

Table 2

Independent t-Test Results of Total FOI Test Averages between Groups

t H$_0$ Region of Non-rejection	t Statistic	t Significance	Mean Difference
>-1.6909	-2.917	.006	-.08768

The mean difference of -.0877 indicates that the experimental group scored more than 8.7% higher on the FOI test than the control group. The *p* value of .006 confirms that there is a significant difference between the FOI test grades of the control and experimental groups. These results suggest that the virtual learning environment did improve CFI applicants' understanding of FOI theory. An analysis was also completed on test questions that were specific to topic areas of the FOI. As noted in Table 3, students in the experimental group scored approximately 23% higher on the questions that tested their knowledge of anxiety. The *t* value of -3.23 is less than the minimum *t* statistic of -1.6909 and the statistical significance of 0.003 suggest that this difference is not by chance. The difference of the mean scores between groups shows that the experimental group did perform better than the control group on the remaining FOI topic areas of teaching (11.29%), learning (3.68%), human needs (3.64%), and defense mechanism (3.16%). However, the *t* statistics for each of these FOI topic areas did not fall below the required *t* value (-1.6909) and were not statistically significant. While the results suggest that the experimental group performed better in these areas, the statistics do not confirm that the difference in performance was due to the use of creating a virtual learning environment using simulation in the classroom. However, qualitative feedback from the students and instructor suggested that

students gained a greater understanding of all FOI topic areas because of the hands-on experience that they acquired as well as the numerous demonstrations that they observed.

Table 3

Independent t-Test Results for FOI Topic Areas

FOI Topic Area	*t* Statistic	*t* Significance	Mean Difference
Reaction to Anxiety	-3.23	0.003	-22.969%
Teaching	-1.428	0.163	-11.285%
Learning	-0.903	0.377	-3.678%
Human Needs	-0.415	0.681	-3.638%
Defense Mechanism	-0.516	0.609	-3.158%

Conclusion

Research suggests that the current FAA training requirements fail to adequately prepare CFI applicants to become instructors (Wofford, Ellinger, & Watkins, 2013). While the FAA requires a knowledge exam on FOI, most CFI applicants do not retain the FOI knowledge that is necessary to provide good instruction (Erickson, 2009). An applicant's understanding of this FOI knowledge is critical to the development of CFIs because beginning instructors consciously and subconsciously base their own practice of teaching on the initial training that they receive (Conner & Sliwka, 2014). Instructors who have a better understanding of FOI know that their choice of teaching and learning methods is not arbitrary or based on personal preference but is adapted and modified according to the needs of the learner (Conner & Sliwka, 2014).

Flight instruction requires CFIs to be focused on the learner since it occurs in a one-on-one training environment. Learner-centered training is more effective when instructors understand and apply FOI concepts that are appropriate for each individual student. Novice CFIs

who have a better understanding of FOI have increased teaching expertise and can provide more effective learner centered training to their students. Furthermore, understanding the FOI concepts reduces the informal, on-the-job, learning that a CFI has to go through to develop appropriate responses to student behavior. This minimizes the negative effect that on-the-job training has on student learning.

This study focused on a new method of FOI instruction using simulation and role play in the classroom environment. The results do not support the hypothesis that a virtual learning environment, using simulation in the classroom, improves the understanding of FOI knowledge among CFI applicants. However, the results do suggest that a virtual learning environment, using simulation in the classroom, improves the understanding of the specific FOI topic of reaction to anxiety among CFI applicants. At the same time, descriptive statistics and qualitative feedback suggests that the virtual environment improved CFI applicants' understanding of FOI knowledge areas. These findings have significant implications for the improvement of flight education in the aviation industry. Improving a novice CFI's understanding and retention of FOI concepts may increase their teaching effectiveness. This improvement may result in a reduction of student training time and cost as well as improved customer service. These advances may also lower the student pilot attrition rates, which is currently between 70% and 80% (Aircraft Owners and Pilots Association [AOPA], 2011).

The study also confirmed that the largest improvement of FOI knowledge was in the CFI applicant's identification of anxiety in trainees. This is important since the FAA (2008) suggests that anxiety is the most significant psychological factor that affects student training. Furthermore, Lindseth (1994) states that CFIs who appropriately modify their teaching strategy, when higher anxiety levels are present in flight, students create deeper learning. The results of

this study suggest that use of the virtual learning environment may improve a novice instructor's ability to identify and respond properly to student anxiety and thus provide better instruction to students.

While the study suggests that the use of simulation in the classroom environment improves a CFI applicant's understanding of FOI knowledge, more research is required to measure the effect that this training has on the actual flight instruction that the CFI applicant provides once the CFI applicant is certificated by the FAA. In this study, the various characteristics of student behaviors were limited by the abilities of the CFI applicant who was playing the role of the student. Future research should focus on improving the portrayal of the various student characteristics in the virtual learning environment. This will ensure that the specific student behaviors are displayed appropriately.

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