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Effectiveness of Flight Training Devices Used for Instrument Training

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EXECUTIVE SUMMARY

The effectiveness of ground-based flight training devices in teaching flying skills is measured by transfer of training, quantifiable by a transfer effective ratio (TER). The incremental transfer effectiveness ratio (ITER) determines the transfer effectiveness of successive increments of training in the ground trainer. Previous research on a personal computer based aviation training device (PCATD) has shown that this device is effective for teaching instrument tasks (Taylor et al., 1996; 1999). In a later study as predicted by the incremental transfer of training theory of Roscoe (1971)., the greatest transfer of training effect was found for the group that received five hours compared to 10 and 15 hours of prior PCATD training in an airplane (Taylor et al., 2002b). In some cases the results indicate a complex pattern supporting the notion that more training in a PCATD is not necessarily better. The research reported here sought to replicate the previous findings by Taylor et al. (1996, 1999, 2002b) using both PCATDs and flight training devices (FTDs).

Participants in this experiment were assigned to four flight training device (FTD) groups, one PCATD group, and a control (airplane) group. Training in the FTD was conducted in Frasca 141, level-1 FTDs. The PCATD training was conducted using FAA approved PCATDs from Aviation Teachware Technologies (ELITE) v. 6.0.2, with flight controls by Precision Flight Controls. Airplane training was carried out in the Piper Archer III aircraft.

Using a transfer of training design, the six groups of subjects were tested in the airplane for proficiency on various instrument flying tasks in both basic (AVI 130) and advanced instrument (AVI 140) courses. One group received 5 hours of prior training on instrument tasks in a PCATD, four groups received 5, 10, 15 and 20 hours of prior training in a FTD, and the control group received all training in the airplane. The FTD 15 and 20 groups received an additional 5 and 10 hours respectively of cross- country training in the FTD. With the exception of the cross-country time, the treatment of the FTD 10, 15 and 20 groups was identical.

Mean trials to reach criterion in the airplane for selected instrument tasks and mean time to complete the flight lesson were computed for all groups for both courses. Separate ANOVAs were performed to analyze the difference between the four groups on the three dependent measures for both AVI 130 and 140 to determine the significance of the trial and flight lesson to completion time variables as a function of experimental treatment, and to explore variability in the time to a successful evaluation flight as a function of the experimental treatment.

The results indicate that the FTD is effective for teaching basic instrument tasks to private pilots. The current study systematically replicated the finding from a study by Taylor et al. (2002b), which had established similar results for the PCATD. For AVI 130 the current study found that compared to the control group prior training in the FTD resulted in a smaller number of trials in the airplane for 10 of 12 flying tasks tested, as well as a significant treatment effect (assignment to group). For mean trials to criterion in the airplane in AVI 140, the control group required more trials than the FTD 5 and the FTD 10 for all instrument tasks for all lessons. Significant treatment effects were found for four instrument tasks. The mean times to complete each of the four flight lessons in AVI 130 and 140 were less than the time for the control (airplane) group for the PCATD 5 and the FTD 5 and 10 experimental groups.

One objective of the current study was to investigate the effectiveness of the FTD for cross-country training. In addition to the ten hours of prior FTD training on instrument tasks, the FTD

15 and 20 groups received an additional 5 and 10 hours, respectively, of cross-country training in the FTD. The FTD 15 group received 2 hours of cross country time in AVI 130 and 3 hours in 140; the FTD 20 group received 4 hours of cross country time in AVI 130 and 6 hours in 140. With the exception of the cross-country time, the treatment of the FTD 10, 15 and 20 groups was identical. Although the results failed to show an hour for hour replacement of aircraft cross-country training with FTD cross-country training, savings of approximately 50% were realized by the FTD 15 and FTD 20 groups.

The current study found the greatest transfer for the FTD 5 group compared to the FTD 10 group for trials in AVI 130 (6 of 8 comparisons), trials in AVI 140 (14 of 14 comparisons), time to complete the flight lesson in AVI 130 (3 of 4 comparisons), and time to complete the flight lesson in AVI 140 (4 of 4 comparisons). Increased trials/time in the FTD saved trials/time in the airplane for trials in AVI 130 (5 of 6 comparisons) but not for trials in AVI 140 (1 of 11 comparisons), nor for time to complete the flight lesson in AVI 130, (1 of 4 comparisons), nor for time to complete the flight lesson in AVI 140 (2 of 4 comparisons). The TERs for all instrument tasks for flight lesson 34/35, 36, and 37, and VOR flight lessons 38 showed the predicted negatively decelerated function for increased number of trials. Examination of the ITERs for FTD 5 and FTD 10 indicates that additional training for trials for the FTD 10 group provided little benefit over the FTD 5 group. Taylor et al. (2002b) reported that two of the five ITERs for number of trials showed the predicted pattern of a negatively decelerated function (Roscoe, 1971; Flexman et al., 1972).

Both the current research and the study by Taylor et al. (2002b) show that more training in the FTD or the PCATD is not necessarily better in terms of savings. The results in the current study indicted that reduced transfer for the FTD occurred for trials and for time to complete the flight lessons in AVI 140 as compared to AVI 130. The results systematically replicated the findings of Taylor et al. (2002b) for the PCATD for AVI 140 when compared to AVI 130. The negatively decelerated function of the ITER predicts reduced transfer for instrument tasks introduced during later stages in the instructional sequence (Roscoe, 1971). Taylor et al. (1999) also found less transfer during AVI 140 than AVI 130. They noted that “the evident reason for this is that what is learned while mastering one task in a training device generalizes (i.e., transfers to some extent) to other tasks introduced later, thus reducing the remaining potential for transfer” (Taylor et al., 1999).

In the current study, the time to a successful evaluation flight was less for the PCATD 5, the FTD 5, and the FTD 10 groups compared to the control group for both AVI 130 and 140. The total savings for both AVI 130 and 140 was 2.75, 5.06, and 4.26 for the PCATD 5, the FTD 5, and the FTD 10 groups respectively. Taylor et al. (2002b) also found that time to a successful evaluation flight was less for three PCATD groups when compared to the control group for both AVI 130 and 140. The total savings for both AVI 130 and 140 was 4.08, 5.49, and 3.19 for the PCATD 5, 10, and 15 groups respectively. For the current study the total time savings for both AVI 130 and 140 was 2.75 for the PCATD 5 group compared to 4.08 hours for this group in the Taylor et al. (2002b) study. These differences are likely due to the comparatively low power of the current study. These findings systematically replicated the findings of Taylor et al. (1999) who found overall savings of 3.90 hours.

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FOREWORD

This work is supported under Federal Aviation Administration (FAA) Cooperative Agreement Number 02-G-033 and sponsored by the FAA Headquarters, Flight Standard Service, General Aviation & Commercial Division. Dennis Beringer served as the COTR. Views expressed herein do not necessarily represent official FAA positions. We express our appreciation to Ms. Sybil Phillips for invaluable assistance with flight operations and with student management. Mr. William Jones, Mr. David Boyd, and Mr. Donald Talleur served as check pilots. We also thank the Institute of Aviation the flight instructors and students for their participation in the study.

INTRODUCTION

Training of flying skills in ground-based devices offers many attractive benefits, of which the two most important are safety and cost. However, it is critical to ascertain that use of flight training devices (FTDs) and personal computer aviation training devices (PCATDs) indeed work in this capacity, that is, their use saves training time in an airplane. Such effectiveness is measured by transfer of training. To evaluate transfer of training effectiveness of a ground-based trainer, the performance of participants trained on instrument tasks in the trainer, and later trained to criterion in an airplane, must be compared to the performance of participants trained to criterion only in the airplane. Percent transfer is commonly used to determine the savings (trials/time) in an airplane as a result of prior training in a ground trainer. The percent transfer measure, however, does not account for the trials/time in the ground trainer to achieve those savings. Roscoe (1971) demonstrated that the transfer effective ratio (TER) accounts for the amount of prior training in ground trainers by specifying the trials/time saved in the airplane as a function of the prior trials/time in the ground trainer. The incremental transfer effectiveness ratio (ITER) determines the transfer effectiveness of successive increments of training in the ground trainer (Flexman, Roscoe, Williams & Williges, 1972).

Prior Research

A study to determine the extent to which a PCATD can be used to develop specific instrument skills that are taught in instrument flight training and to determine transfer of these skills to the aircraft was reported by Taylor et al. (1996, 1999). Students in instrument training at the Institute of Aviation, University of Illinois at Urbana-Champaign (UIUC) were taught instrument tasks using a commercially available PCATD. The performance of one group of students trained to criterion on a number of instrument tasks in a PCATD and later trained to criterion in an aircraft (PCATD group) was compared with a group of students who received no PCATD training but were trained to criterion on the same instrument tasks in the airplane (control group). In order to evaluate transfer of training effectiveness of the PCATD to complete each flight lesson in the airplane and make comparisons of trials to criterion in the airplane, course completion times for the two groups were recorded. The findings of the study indicated that the PCATD was an effective training device for teaching instrument tasks. When new tasks were introduced, transfer savings were generally positive and statistically significant. No significant transfer was found when tasks already learned in previous lessons were reviewed. The comparison of course completion times indicated an overall savings of about four hours in the airplane for the PCATD group compared to the control group; the savings were statistically significant. The overall transfer effectiveness ratio was 0.15 or a savings of 1.5 flight hours for each ten hours of PCATD time.

In a later study, Taylor et al. (2002a, b) measured the effectiveness of a PCATD and determined the point at which additional training in a PCATD was no longer effective. Three groups of students at the UIUC received 5, 10, or 15 hours of prior training on selected instrument tasks required for the instrument rating. After training on each instrument task the participants were evaluated in the airplane using completion standards for each task and these results were compared to a control group trained only in the airplane. The dependent measures were number of trials to specific completion standards, time to complete a flight lesson, and time to a successful evaluation flight in both basic and advanced instrument courses (AVI 130 and AVI 140, respectively). The data from the study indicated that the PCATD was effective in

teaching basic and advanced instrument tasks to private pilots. For all three PCATD groups in AVI 130, prior training in the PCATD reduced the mean trials to completion standards in the airplane for 21 of the 24 instrument tasks tested when compared to the mean trials for the control group. A significant difference was found for the treatment effect for mean trials in AVI 130 for the four groups. Post-hoc tests indicated that the treatment effect was due to differences between the control group and both the PCATD 5 and the PCATD 15 groups. For AVI 140, the data indicate that, with six exceptions out of 33 instrument task measures, the mean trials in the airplane were less for all three PCATD groups for all instrument tasks when compared with the mean trials in the airplane by the control group. Statistical analyses indicated no significant differences due to experimental treatment for the four groups

In AVI 130 the mean times to complete the flight lesson in the airplane for the four flight lessons in which there was prior training in the PCATD were lower for all three PCATD groups than for the control group. A significant treatment effect was found for the four groups. Three of the flight lessons showed the predicted decreased mean time with increased prior training in the PCATD when the PCATD 5 and 10 groups were compared, and one flight lesson showed this pattern when the PCATD 10 and 15 groups were compared. For AVI 140, the mean times for all three PCATD groups to complete each of the four flight lessons were less than the time for the Control group. An analysis of mean times for the four groups to complete the flight lesson indicated a significant treatment effect. Post-hoc tests, however, indicated no significant differences between the control group and any of the experimental groups. Analyses of individual flight lessons comparing the time to complete the flight lesson among the four groups found a significant treatment effect for one flight lesson, but not for the other three scored flight lessons in AVI 140. The pattern of the TERs for the mean time to complete the flight lesson variable for the PCATD groups showed the predicted negatively decelerated function for three of the four flight lesson for increased amounts of training time in the PCATD. Increased training time in AVI 140 beyond PCATD 5 did little to reduce the training time in the airplane.

In AVI 130, the mean time to a successful evaluation flight was less for all three PCATD groups compared to the control group. A significant treatment effect was found for the four groups for the time to a successful evaluation flight during the basic instrument course. Post-hoc comparisons indicated a significant difference between the PCATD 10 group and the Control group. For AVI 140, the mean time to a successful evaluation flight was less for all three PCATD groups than for the control group. A significant treatment effect was found in AVI 140 for the four groups for the time to a successful evaluation flight during the advanced instrument course. Post-hoc comparisons, however, indicated no significant differences between the control group and any of the PCATD groups (Taylor et al., 2002b).

The Taylor et al. (2002b) study replicated the findings of Taylor et al. (1996) in that PCATDs are useful to teach instrument tasks to private pilots. As a result of prior training in a PCATD, trials, time to complete the flight lesson, and time to a successful evaluation flight were all less when compared to an airplane control group. Overall, the greatest effect was found for the PCATD 5 group, which was predicted by the incremental transfer of training theory of Roscoe (1971). In some cases the results indicated a complex pattern supporting the notion that more training is not necessarily better. That is, additional training in the PCATD did not always lead to more trials/ time saved in the airplane compared to the control group. The results also indicated reduced trials/time saved for AVI 140 compared to AVI 130. The negatively decelerated function of the ITER predicts reduced transfer for instrument tasks introduced during later stages

in the instructional sequence (Roscoe, 1971). Taylor et al. (1999) also found less transfer during AVI 140 than AVI 130. They concluded that what is learned while mastering one task in a training device generalizes to other tasks introduced later, which reduces the remaining potential for transfer. Generally, in the Taylor et al. (2002b) study, little additional time/trials were saved by the PCATD 10 group when compared to the PCATD 5 group and practically no incremental transfer was found for the additional hours of training by the PCATD 15 group compared to the PCATD 10 group. One purpose for conducting an incremental transfer of training study is to determine at what point additional training in the PCATD in no longer effective. Taylor et al. (2002b) concluded that no appreciable benefit was found for more than 5 hours of PCATD training on instrument tasks. These results provide support for the current FAA policy of permitting PCATD time to be used in lieu of time in an approved training device or airplane, but found that only 5 of the 10 hours permitted could be used in a cost-effective manner. The results also provide no support for increasing the amount of time using PCATDs from 10 to 15 hours as a substitute for time in the aircraft to train instrument tasks.

Purpose of the Research

The question remains, however, how can flight schools most effectively use the 10 hours of instrument training time in a PCATD currently permitted by AC No: 61-126 (FAA, 1997). Taylor et al. (1999) suggested the approach used in this research of allocating the above time to the training of the following instruments tasks: steep turns, intersection holds, ILS, VOR and LOC BC Approaches, VOR, ILS and DME ARC approaches, review approaches, NDB holds and approaches, NDB holds and approaches review, and holds and approaches using partial panel. The results of Taylor et al. (2002b) clearly indicated that the use of 5 hours of PCATD time in accordance with the suggestions of Taylor et al. (1999) was cost-effective based on the allocation of PCATD time for the PCATD 5 group, but the doubling and tripling of the trials/time in these flight lessons, which was done as part of the experimental design in the Taylor et al. (2002b) study, was not an effective use of the additional time for the 10 nor the 15 hour groups. Flight schools should examine their training course outlines (TCOs) to determine where the additional 5 hours could be effectively used. Taylor et al. (2002b) suggested that PCATDs would be effective in cross-country training.

The purpose of the research reported here was to replicate the Taylor et al. (2002b) study that provided prior training on selective instrument tasks. We directly replicated the PCATD 5 group using a PCATD and systematically replicated the PCATD 5 and 10 groups using FTDs. In addition, two new FTD groups were added to the experimental design, the FTD 15 and 20 groups. These two groups directly replicated the FTD 10 group in the current study for instrument flight tasks but added 5 and 10 hours of cross country time respectively. The final group in the study is a control group that received training only in the airplane.

METHOD

Participants

Participants were assigned to four flight training device (FTD) groups, one PCATD group, and a control (airplane) group. In the initial proposal a total of 180 pilots (30 in each of the 6 groups) were scheduled to participate in the study. Due to funding reductions in the second and third years of the research, the number of pilots in the study was first reduced to a total of 120 (20 subjects in each group) and, due to the elimination of FY 2005 funding, the eventual number

of participants for each group who successfully completed the instrument program ranged between 15 and 20 for the six groups. The participants were private pilot students at the UIUC who were enrolled in the Institute of Aviation's instrument flight program. This program consists of two semester courses: AVI 130, Basic Instruments and AVI140, Advanced Instruments. All students in the instrument program were involved in the study. A total of 102 students completed the study. Each semester the students were assigned equally to the six groups while maintaining a balanced number of participants across all groups to account for students who did not complete the course.

Equipment

Training in the FTD was conducted in Frasca 141, level-1 FTDs with generic single-engine, fixed-gear, and fixed-pitch propeller performance models. The PCATD training was conducted using FAA approved PCATDs from Aviation Teachware Technologies (ELITE) v. 6.0.2, with flight controls by Precision Flight Controls (Figure 1). The PCATDs simulated the flight characteristics of the Piper Archer III aircraft. The system contained an instructor map display and a 20-inch monitor and hood. The 20-inch monitor permitted the display of eight flight instruments; avionics were contained in a separate unit positioned just to the side of the monitor. Airplane training was carried out in the Piper Archer III aircraft which is a single engine, fixed pitch propeller, fixed under-carriage aircraft.

Figure 1. PCATD from Aviation Teachware Technologies (ELITE) v 6.0.2, and flight controls by Precision Flight Controls.

Procedure

The instrument training program at the Institute of Aviation is divided into two courses: AVI 130, Basic Instruments and AVI 140, Advanced Instruments. AVI 130 emphasizes aircraft control and instrument departure, en route and approach procedures, while AVI 140 emphasizes NDB holds and approaches and partial panel procedures. This report presents the results from

both AVI 130, and AVI 140. The students received 45 hours of lectures during the semester for both courses as well as 15 flight lessons, each of which are programmed for one lesson per week. Experimental curricula for both courses were developed for PCATD group, the FTD groups and the control group.

Using a transfer of training design, six groups of subjects were tested in the airplane for proficiency on various instrument flying tasks in both courses. One group received 5 hours of prior instrument training in a PCATD, and four groups received 5, 10, 15 and 20 hours of prior training in a FTD. The prior training on instrument tasks was distributed equally between AVI 130 and AVI 140. A control group received all training in the airplane.

Training on selected instrument tasks using the FTD and PCATD was administered to the four FTD groups and the PCATD group during four flight lessons for each semester. The FTD 10, 15 and 20 groups received ten hours of prior FTD training on instrument tasks (see Table 1). In addition, FTD training was given during certain cross-country lessons in both AVI 130 and AVI 140 for the FTD 15 and FTD 20 groups to investigate the effectiveness of the FTD for cross-country training. The FTD 15 and 20 groups received an additional 5 and 10 hours respectively of cross-country training in the FTD. The FTD 15 group received 2 hours of cross-country time in AVI 130 and 3 hours in 140; the FTD 20 group received 4 hours of cross-country time in AVI 130 and 6 hours in 140. With the exception of the cross-country time, the treatment of the FTD 10, 15 and 20 groups was identical.

Table 1.
Time (hours) in PCATD and FTD by group and flight lesson in the AVI 130 and 140 courses.

	Experimental Group			
Flight Lesson	PCATD 5 and FTD 5	FTD 10	FTD 15	FTD 20
AVI 130				
34/35: Steep Turns	0.5	1.0	1.0	1.0
36: Holds	0.7	1.3	1.3	1.3
37: Approaches	0.7	1.3	1.3	1.3
38: Approaches	0.7	1.3	1.3	1.3
39: IFR X-country	NA	NA	2.0	2.0
42: IFR X-Country	NA	NA	NA	2.0
AVI 140				
48: Review Approaches	0.7	1.3	1.3	1.3
49: NDB Holds and App.	0.5	1.0	1.0	1.0
50: NDB Holds and App.	0.7	1.3	1.3	1.3
52: Holds/Approaches	0.7	1.3	1.3	1.3
53: IFR X-country	NA	NA	2.0	2.0
54: IFR X-country	NA	NA	1.0	2.0
55: IFR X-country	NA	NA	NA	2.0

Prior to the start of each semester, all flight instructors were standardized on the use of the FTD and PCATD, the training course outlines (TCOs), and experimental procedures. Flight instructors served as both instructors and data collectors, rating student performances on designated flight tasks in the aircraft. For performance assessment in the aircraft, each instructor recorded if the student met the completion standards during the execution of the designated flight

tasks. They also recorded the number of trials to criterion for specific tasks and flight time to complete a flight lesson (Phillips et al., 1995). An example of the check lists used (Flight Lessons 36 and 48) is presented in Appendix B. Three check pilots, blind to the allocation of students to training conditions, conducted the AVI 130 stage check and the AVI 140 instrument rating flight check.

Each flight instructor was instructed to schedule an evaluation flight after flight lesson 40 in AVI 130, and an instrument rating flight check after flight lesson 55 in AVI 140 when the student was judged to be able to meet the proficiency standards for the stage check and the instrument proficiency check, respectively. These evaluation flights permitted the assessment of the differential time to complete the flight course as a function of the amount of prior training in the FTD and the PCATD. Those students who failed the evaluation flight or failed to meet the proficiency standards by flight lesson 45 (stage check) and flight lesson 60 (instrument rating check flight) were provided additional flight time to reach proficiency. The dependent measures in this study were number of trials in the airplane to proficiency, time to complete the flight lessons in the airplane, and total course completion time in the airplane for both courses.

The amount of time in the PCATD and the FTD for the four flight lessons in AVI 130 and AVI 140 is shown in Table 1 for the PCATD group and the four FTD groups. The time in the PCATD 5 and the FTD 5 is the same for all flight lessons and the time for the FTD 10, 15 and 20 groups is the same for flight lessons during which there is training on instrument tasks. The FTD 15 and 20 groups have an additional 5 and 10 hours respectively in the FTD for cross country training. This training time was substituted on an hour for hour basis for aircraft cross country time. The number of trials in the PCATD and the FTD for the four flight lessons in AVI 130 and AVI 140 is shown in Table 2 for the PCATD group and the four FTD groups.

Table 2.
Trials in the PCATD and FTD for instrument tasks trained in AVI 130 and AVI 140.

	Trials in PCATD and FTD	
Task (AVI 130)	PCATD and FTD 5	FTD 10,15, 20
Steep Turns (FL 34/35)	1	2
Turn in Hold (FL 36)	6	12
ILS (FL 37)	1	2
VOR (FL 37)	1	2
LOC BC (FL 37)	1	2
ILS (FL 38)	1	2
VOR (FL 38)	1	2
DME ARC (FL 38)	2	4
Task (AVI 140)		
Turns in Hold (FL 48)	3	6
ILS (FL 48)	1	2
VOR (FL 48)	1	2
Turns in NDB Hold (FL 49)	3	6
NDB (FL 49)	1	2
Turns in NDB Hold (FL 50)	3	6
NDB (FL 50)	1	2
Turns in LOC Hold (FL 50)	3	6
NDB (FL 52)	1	2
GPS (FL 52)	1	2
Turns in Hold (FL 52)	3	6

Analyses

Mean trials to reach criterion on the airplane for selected instrument tasks and mean time to complete the flight lesson were computed for all groups for both courses. Separate ANOVAs were performed to analyze the difference between the four groups on the three dependent measures for both AVI 130 and 140 to determine the significance of the trial and lesson time variables as a function of experimental treatment, and to explore variability in the time to a successful evaluation flight as a function of the experimental treatment. To further identify the locus of any significant effects, Tukey's HSD post–hoc tests were employed to make pairwise comparisons. The effectiveness of the additional time in the FTD 15 and 20 groups for cross-country training was estimated by establishing a baseline by subtracting the control group time from the FTD 10 group time (FTD 10 group time saved in the airplane compared to control group time). The baseline was then used to evaluate the effectiveness of the FTD 15 and 20 groups cross country training in the FTD. To estimate the effectiveness of FTD cross country training the baseline time saved (FTD 10 group time) was subtracted from the time for the FTD 15 and 20 group time savings.

Percent transfer, transfer effectiveness ratios, and incremental transfer effective ratios were computed for each flight lesson using the following equations:

$$\frac{Y_c - Y_x}{Y_c} = Percent \quad Transfer \tag{1}$$

$$\frac{Y_c - Y_x}{X} = TER \tag{2}$$

$$\frac{(Yx - \Delta x) - Yx}{\Delta X} = ITER \tag{3}$$

where Y_c = Time/Trials in airplane by Control group, Y_x = Time/Trials in airplane by PCATD or the FTD group, X = Time/Trials in a PCATD or FTD, ΔX = Incremental unit in Time/Trials, for PCATD or FTD group, and $Yx-\Delta x$ = Time/Trials, required by a PCATD or FTD group to reach a performance criterion in an aircraft after $x - \Delta x$ trials in a PCATD or FTD

Percent transfer measures the difference, expressed as a percent, between the control and an experimental group (the PCATD 5, the FTD 5 and 10 hour groups) in terms of trials/time to reach criterion in the airplane. A positive percent transfer favors the experimental and a negative percent transfer favors the control group. Percent transfer does not consider the amount of prior training in the PCATD or FTD by the experimental groups. The TER is a ratio that compares the difference between the control and the experimental groups in terms of trials/time to reach criterion in the airplane as a function of the amount of prior training in the PCATD or FTD for the experimental group. The TER is a measure of the average transfer for each group as a function of prior training. The ITER measures the amount of transfer of successive increments of training in the PCATD or FTD (Roscoe, 1971; Flexman, Roscoe, Williams, & Williges, 1972).

RESULTS

Trials to Criterion

AVI 130. The mean trials to reach criterion in the airplane on the instruments tasks in AVI 130 by the control group, the PCATD group, and the FTD 5 and FTD 10 groups were computed and are shown in Table 3 and presented graphically in Figure 2. The data indicate that in almost all lessons, the control group required more trials in the airplane than any of the four experimental groups for Steep Turns (Lesson 34/35), Turns in the Hold (Lesson 36), ILS and VOR (Lesson 37), and VOR (Lesson 38). The exceptions are ILS (Lesson 37), for the PCATD 5 group, and ILS (Lesson 38), for both the PCATD 5 and FTD 5 groups. An ANOVA to compare the results in Table 3 of mean trials for all instrument tasks to criterion in the airplane of the Control, PCATD, FTD 5, and FTD 10 (treatment effect of assignment to groups indicated a significant treatment effect, $F(3, 79) = 3.06$, $p < .05$. Post-hoc tests show the FTD 10 group needed significantly less trials than the control; $p < .05$. Individual ANOVAs comparing trials to criterion in the airplane for these four groups were performed for each instrument task in Table 2. Both the steep turns task in lesson 34/35, and the holding task in lesson 36 showed a trend for a main effect for trials to reach completion standards, $F(3, 81) = 2.21$, $p = .09$ and $F(3, 81) = 2.42$, $p = .07$ respectively. In lesson 37, the ILS approach showed a significant main effect, $F(3, 81) = 2.78$, $p = .05$, but there were no significant differences between groups. The VOR approach indicated a significant main effect, $F(3, 81) = 5.12$, $p < .05$, and post-hoc tests showed significant differences between the control group and both the FTD 5 group and the FTD 10 group, $p<=.05$. One additional maneuver, localizer back course approach, was tested but no significant effects were observed. In lesson 38, significant main effects were found for the VOR approach trials and DME arc trials, $F(3, 81) = 2.84$, $p = .05$ and $F(3, 81) = 2.70$, $p = .05$ respectively. No significant differences were found between groups for either maneuver. The ILS approach was also tested in this lesson but no significant effect was found for this maneuver.

Table 3.
Mean trials in the airplane for the Control group, the PCATD group, and the four FTD groups for instrument tasks trained in AVI 130.

Lesson	A	P5	F5	F10	F15	F20
Mean Trials						
34/35 Steep turns	3.73	3.00	2.50	2.48	3.52	3.45
36 Turns in hold	7.50	5.05	6.36	5.20	6.75	5.23
37 ILS	1.55	1.70	1.27	1.29	1.83	1.50
37 VOR	2.59	1.85	1.55	1.33	2.13	1.77
38 ILS	1.33	1.47	1.45	1.33	1.48	1.23
38 VOR	2.23	1.80	1.55	1.48	1.65	1.73

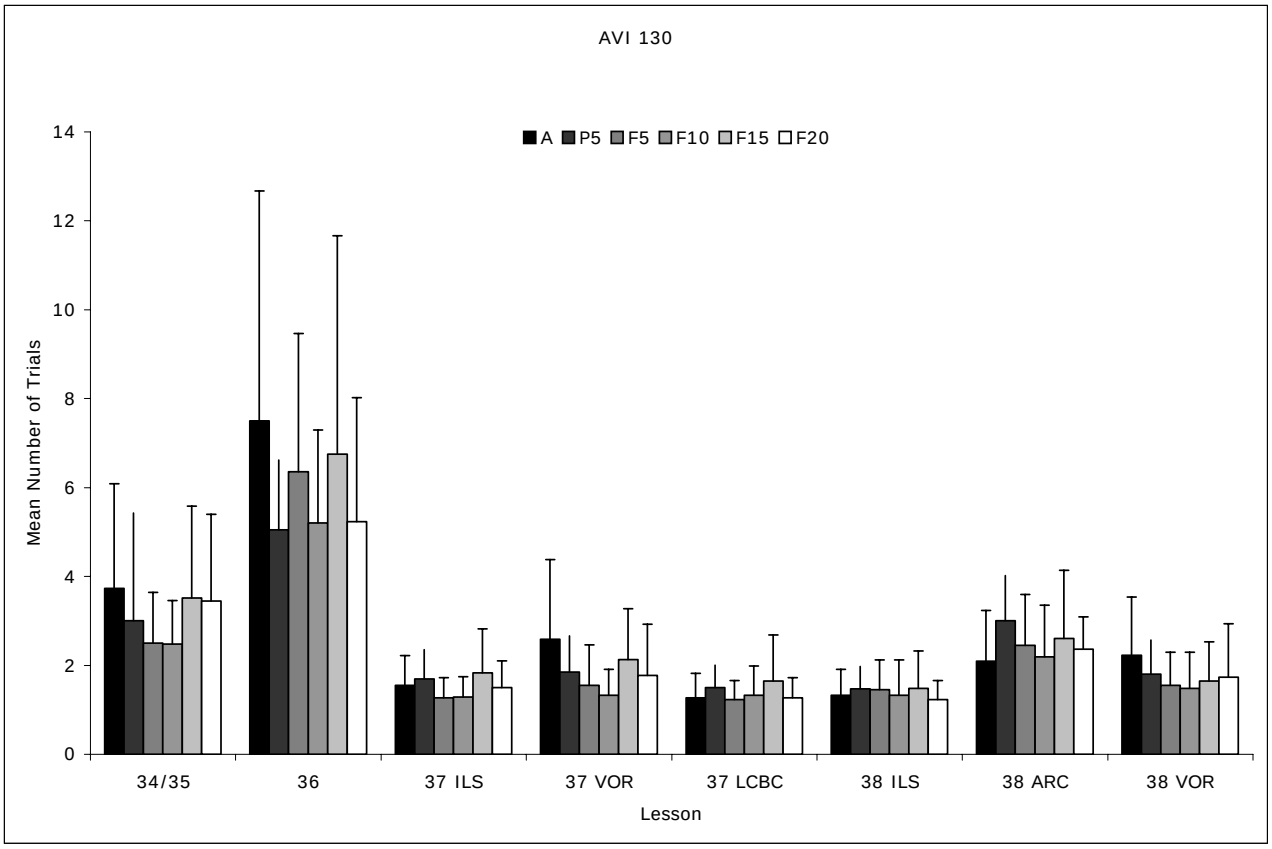

Figure 2. Mean trials in the airplane for the Control group (A), the PCATD 5 hour group (P5) and the FTD 5, 10, 15, 20-hour groups (F5, F10, F15, and F20) for the instrument tasks trained in AVI 130.

To determine the effect of the number of trials in the FTD, mean trials for FTD 5 and FTD 10 were compared. For 5 of the 6 comparisons, additional training trials resulted in fewer trials to reach criterion for the FTD 10 group but the differences were not large; the exception was ILS for lesson 37 where the FTD 5 group required fewer trials than the FTD 10 group. It is interesting to note that the FTD 5 group required fewer trials to criterion than the PCATD 5 group for 5 of the 6 comparisons; the exception was holds for lesson 36.

The data in Table 2 and 3 were used to compute percent transfer, TER and ITER, which are presented in Table 4. All percent transfers for all instrument tasks for FTD 5 and 10 were positive with the exception of four: for the FTD 5 group, both the ILS (-9.02 %) and DME arc (-17.22 %) in Lesson 38; For the FTD 10 group, the LOC BC (-4.72 %) in Lesson 37, and the DME Arc (-4.78 %) in Lesson 38. Four out of eight percent transfers for the PCATD 5 group were negative. When reviewing all 3 groups, the two largest percent transfers found for the trials dependent variable were for the FTD 5 and FTD 10 groups in Lesson 37 VOR (40.15 % and 48.65 % respectively). All other lessons for the three groups had substantial transfer except for the FTD 5 group Lesson 37 LOC BC (3.15%).

Table 4.
Percent transfer, transfer effectiveness ratios (TERs), and incremental transfer effectiveness ratios (ITERs) for trials on selected instrument tasks in AVI 130 for PCATD group (P5) and the FTD 5 and 10 groups (F5, F10).

	Percent Transfer (%)			TER			ITER		
Task	P5	F5	F10	P5	F5	F10	P5	F5	F10
Steep Turns (FL 34/35)	19.57	32.98	33.51	0.73	1.23	0.63	NA	1.23	0.02
Turns in Hold (FL 36)	32.67	15.20	29.47	0.41	0.19	0.18	NA	0.19	0.19
ILS (FL 37)	-9.68	18.06	16.77	-0.15	0.28	0.13	NA	0.28	-0.02
VOR (FL 37)	28.57	40.15	48.65	0.74	1.04	0.63	NA	1.04	0.22
LOC BC (FL 37)	-18.11	3.15	-4.72	-0.23	0.04	-0.03	NA	0.04	-0.10
ILS (FL 38)	-10.53	-9.02	0.00	-0.14	-0.12	0.00	NA	-0.12	0.12
VOR (FL 38)	19.28	30.49	33.63	0.43	0.68	0.38	NA	0.68	0.07
DME ARC (FL 38)	-43.54	-17.22	-4.78	-0.46	-0.23	-0.03	NA	-0.23	0.13

Substantial TERs were found for the PCATD 5, FTD 5, and 10 groups for steep turns (0.73, 1.23 and 0.63 respectively). Moderate TERs were found for the PCATD 5, FTD 5, and 10 groups for turns in hold (0.41, 0.19, and 0.18 respectively). There was little transfer for ILS in Lesson 37, nor for ILS in Lesson 38. Conversely the TERs for VOR were substantial for both Lesson 37 and 38. The TERs for PCATD 5 were 0.74 for Lesson 37 and 0.43 for Lesson 38. The TERs for FTD 5 were 1.04 and 0.68 for VOR Lesson 37 and 38 respectively and for FTD 10 they were 0.13 and 0.38 respectively. No TERs for other instrument tasks were above the 0.30 level and many were negative. The TERs for steep turns, ILS (Lesson 37), and VOR for Lessons 37 and 38 showed the predicted negatively decelerated function for increased number of trials. Examination of the ITERs for FTD 5 and FTD 10 indicates that additional training for trials for the FTD 10 group provided little benefit over the FTD 5 group.

AVI 140. The mean trials to reach criterion in the airplane on the instruments tasks in AVI 140 by the Control group, the PCATD group, and the FTD 5 and FTD 10 groups were computed and are shown in Table 5. The data indicated that the Control group required more mean trials in the airplane than the FTD 5 and FTD 10 groups for all instrument tasks in all lessons. The PCATD 5 group failed to follow this pattern; the Control group required more mean trials in the airplane than the PCATD 5 group for only 5 of the 11 instrument tasks. An ANOVA was computed which compared the treatment effects of mean trials of all instrument tasks to criterion in the airplane of the Control, PCATD, FTD 5, and FTD 10 groups. The results indicated a significant treatment effect; $F(3, 72) = 2.98$, $p < .05$. Post-hoc tests show that the FTD 5 group needed significantly fewer trials than the control group. Individual ANOVAs comparing trials to criterion in the airplane for these four groups were performed for each instrument task. In lesson 48, holds, ILS approach, and VOR approach trials were compared. Only the ILS approach showed a significant main effect for trials to reach completion standards; $F(3, 77) = 2.90$, $p < .05$. Post-hoc tests showed a significant difference between the PCATD 5 group and the FTD 5 group, $p < .05$. No other between-group differences were found for ILS trials. In Lesson 49, NDB approach and NDB hold tasks were compared. No significant differences were found. In Lesson 50, ILS approaches, ILS holds, NDB approaches, NDB holds were analyzed. Only the NDB approach showed a significant main effect; $F(3, 77) = 3.90$, $p < .05$. Post-hoc tests showed

a significant difference between the Control group and both the PCATD 5 and FTD 5 groups; $p < .05$. No other significant differences were found. NDB approaches, NDB holds, GPS approaches were compared in Lesson 52. NDB holds and GPS approaches both showed significant effects; $F(3, 76) = 3.34$, $p < .05$, and $F(3, 75) = 3.14$, $p < .05$ respectively. Post-hoc tests for the NDB hold trials showed a significant difference between the PCATD 5 and FTD 5 groups; $p<=.05$. A trend towards significance was also observed for the NDB approach; $F(3, 75) = 2.42$, $p = .07$.

Table 5.
Mean trials in the Airplane for the Control group), the PCATD group and the four FTD groups, for instrument tasks trained in AVI 140.

Lesson / Group	A	P5	F5	F10	F15	F20
Holds (FL 48)	4.38	3.80	3.57	3.84	3.80	3.60
ILS (FL 48)	1.33	1.40	1.00	1.32	1.15	1.15
VOR (FL 48)	1.33	1.42	1.14	1.16	1.10	1.20
NDB HOLD (FL49)	5.43	4.50	4.52	4.74	4.70	4.30
NDB APPROACH (FL 49)	2.19	1.70	1.71	2.11	1.90	1.75
NDB HOLD (FL 50)	3.95	4.35	3.57	3.89	4.30	3.25
NDB APPROACH (FL 50)	1.81	1.15	1.19	1.37	1.50	1.20
ILS HOLD (FL 50)	3.90	3.75	3.29	3.74	3.50	3.80
NDB APPROACH (FL 52)	1.50	1.60	1.05	1.17	1.40	1.10
GPS APPROACH (FL 52)	1.53	2.45	1.48	1.47	1.89	1.80
NDB HOLD (FL 52)	4.90	6.25	3.86	4.84	4.35	4.35

The data in Table 5 are presented graphically in Figure 3. To determine the effect of the number of trials in the FTD, the results for the FTD 5 and FTD 10 groups were compared. For only one task, GPS approach in flight lesson 52, did additional training trials resulted in fewer trials to reach criterion for the FTD 10 group.

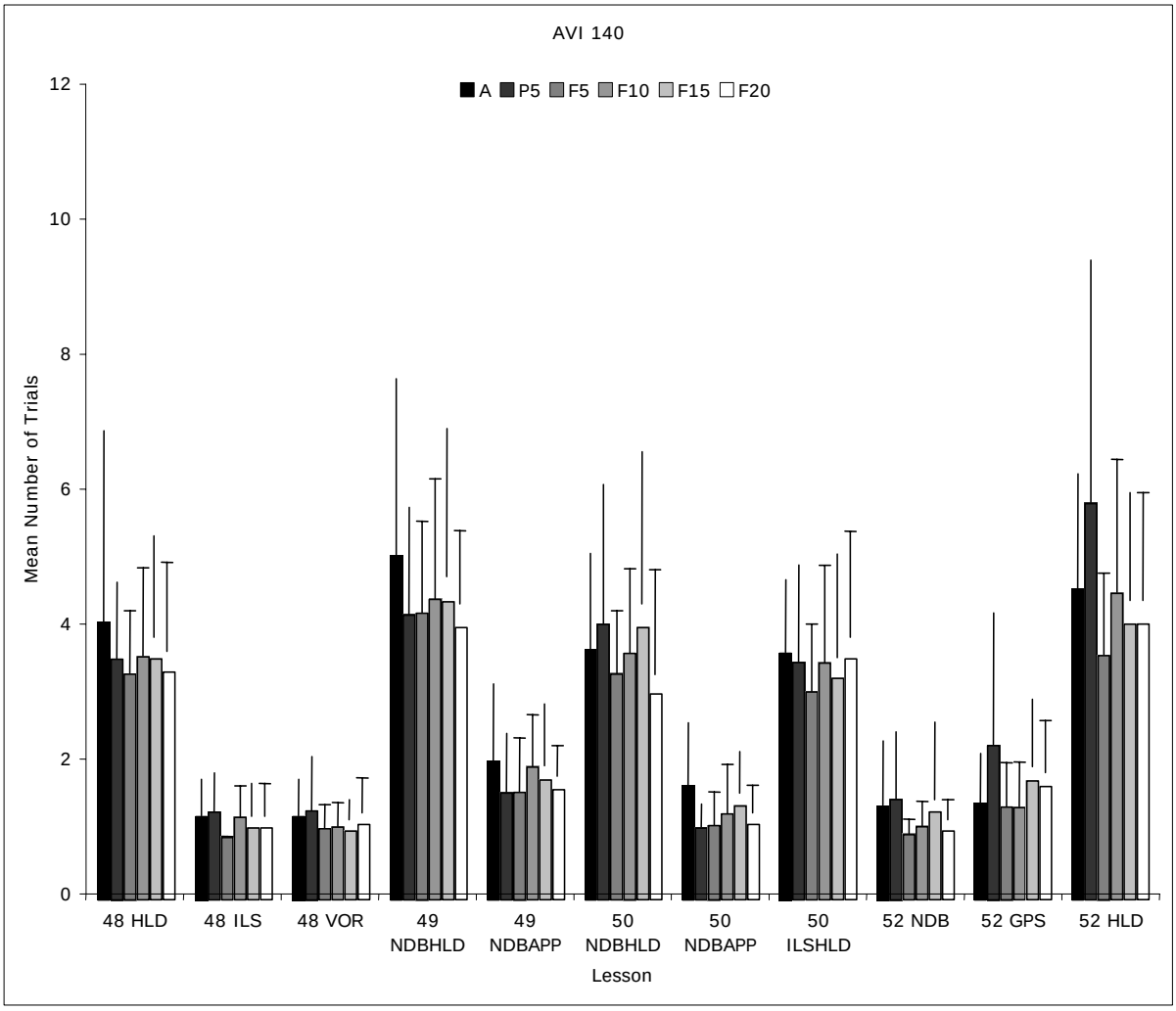

Figure 3. Mean trials in the airplane for the Control group (A), the PCATD 5 hour group (P5) and the FTD 5,10, 15, 20 hour groups (F5, F10, F15, and F20) for the instrument tasks trained in AVI 140.

The data in Table 2 and 4 were used to compute percent transfer, TER and ITER; the results are presented in Table 6. All percent transfers for all instrument tasks were positive with the exception of five percent transfers for the PCATD 5 group, but these transfers were generally small. The five largest percent transfers found for the trials dependent variable for instrument tasks trained in AVI 140 were for the three groups on Lesson 49 NDB Approach, 36.46%, 34.25% and 24.31% for the PCATD 5, FTD 5, and FTD 10 groups respectively, and on Lesson 52 NDB approach (30.00%), and on Lesson 48 ILS (24.81%) for the FTD 5 group. Only four of the remaining 22 observed transfer results were considered substantial (above 20%). These were the Lesson 49 NDB for the PCATD 5 and FTD 5 groups (22.37% and 21.92% respectively), the Lesson 52 NDB for the FTD 10 group (22.00%), and the Lesson 52 Turns in Hold (21.22%).

Table 6.
Percent transfer, transfer effectiveness ratios (TERs), and incremental transfer effectiveness ratios (ITERs) for trials on selected instrument tasks in AVI 140 for the PCATD group (P5) and two FTD groups (F5, F10).

	Percent Transfer			TER			ITER		
Task	P5	F5	F10	P5	F5	F10	P5	F5	F10
Turns in Hold (FL 48)	13.24	18.49	12.33	0.19	0.27	0.09	NA	0.28	-0.09
ILS (FL 48)	-5.26	24.81	0.75	-0.07	0.33	0.01	NA	0.33	-0.32
VOR (FL 48)	-6.77	14.29	12.78	-0.09	0.19	0.09	NA	0.19	-0.02
NDB Turns in Hold (FL 49)	17.13	16.76	12.71	0.31	0.30	0.12	NA	0.30	-0.07
NDB (FL 49)	22.37	21.92	3.65	0.49	0.48	0.04	NA	0.48	-0.40
NDB Turns in Hold (FL 50)	-10.13	9.62	1.52	-0.13	0.13	0.01	NA	0.13	-0.11
NDB (FL 50)	36.46	34.25	24.31	0.66	0.62	0.22	NA	0.62	-0.18
ILS Turns in Hold (FL 50)	3.85	15.64	4.10	0.05	0.20	0.03	NA	0.20	-0.15
NDB (FL 52)	-6.67	30.00	22.00	-0.10	0.45	0.17	NA	0.45	-0.12
GPS (FL 52)	-60.13	3.27	3.92	-0.92	0.05	0.03	NA	0.05	0.01
Turns in Hold (FL 52)	-27.55	21.22	1.22	-0.45	0.35	0.01	NA	0.35	-0.33

Although the TERs were generally positive (seven negative TERS for the PCATD 5 group were found), many were unsubstantial. There were some exceptions. Three groups had 0.66, 0.62 and 0.22 for the PCATD 5, FTD 5, and FTD 10 groups respectively on the Lesson 50 NDB approach. Also, the PCATD 5 and FTD 5 groups had TERs of 0.49 and 0.48 respectively for the Lesson 49 NDB approach. There were also TERs of 0.45 for Lesson 52 NDB approach, and 0.35 for Lesson 52 Turns in Hold for the FTD 10 group. Other substantial TERs observed included the Lesson 49 NDB Turns in Hold for both the PCATD 5 and FTD 5 groups (0.31 and 0.30 respectively), and the Lesson 48 ILS for the FTD 5 group (0.33). The remaining 23 TERs were unsubstantial or negative. All TERs for instrument tasks in AVI 140 showed the predicted negatively decelerated function for increased number of trials.

The TERs for Lesson 52 GPS showed the predicted negatively decelerated function for increase number of trials. Examination of the ITERs indicates that additional training beyond the FTD 5 level provided no substantial benefit for trials for AVI 140.

Time to Complete Flight Lesson

AVI 130. The mean times to complete the flight lesson in AVI 130 are shown in Table 7 and are presented graphically in Figure 4. For all five experimental groups, the mean times to complete each of the four flight lessons were less than the time for the control (airplane) group. For three of the four flight lessons the FTD 5 group had the least time to complete the flight lesson. For Lesson 36 the FTD 10 group had the smallest time. An ANOVA was performed to compare the treatment effect (assignment to group for the PCATD 5, FTD 5, and FTD 10) for mean times to complete the flight lessons among the four groups. The results indicated a significant treatment effect; $F(3, 79) = 8.17$, $p < .05$. Post-hoc tests showed that all three experimental groups needed less time than control group; $p < .05$. Individual ANOVA were performed for each flight lesson in Table 7 comparing the time to complete the flight lesson among the four groups. The results of these ANOVAs indicated a significant treatment effect for

Lesson 34/35, for total time to complete the lesson; $F(3, 81) = 6.63$, $p < .05$. Post-hoc tests showed a significant difference for time to complete Lesson 34/35 between the control group and the PCATD 5, the FTD 5 and the FTD 10 group; $p < .05$. In Lesson 36, a treatment effect was found for mean time to reach lesson completion standards; $F(3, 81) = 3.08$, $p < .05$. Post-hoc tests showed no differences between individual groups. Analysis of Lesson 37 showed a significant treatment effect for time to reach lesson completion standards. The total time main effect was $F(3, 81) = 7.62$, $p < .05$. Post-hoc tests showed significant differences between the control group and both the FTD 5 and FTD 10 groups, $p < .05$. There was no significant treatment effect for lesson 38. The Control group consistently required more time to reach criterion for all four flight lessons in AVI 130 for each of the five experimental groups. To compare the effect of additional FTD training time, the time to complete the flight lessons was compared for FTD 5 and FTD 10. For one of the 4 comparisons (flight lesson 36), additional training time result in smaller time to complete the flight lesson for the FTD 10 group.

Table 7.
Mean time to complete the flight lesson in the airplane for the Control group, the PCATD 5 hour group, and the four FTD groups for AVI 130.

Group Flight Lesson	Control	PCATD 5	FTD 5	FTD 10	FTD 15	FTD 20
34/35, Steep Turns	1.41	0.99	0.91	1.00	1.02	1.17
36, Intersection Holds	1.74	1.30	1.59	1.27	1.38	1.50
37, ILS, LOC BC, VOR	2.90	2.54	1.80	1.82	2.44	1.90
38, ILS, VOR, DME ARC	2.41	1.94	1.80	1.91	1.90	1.93

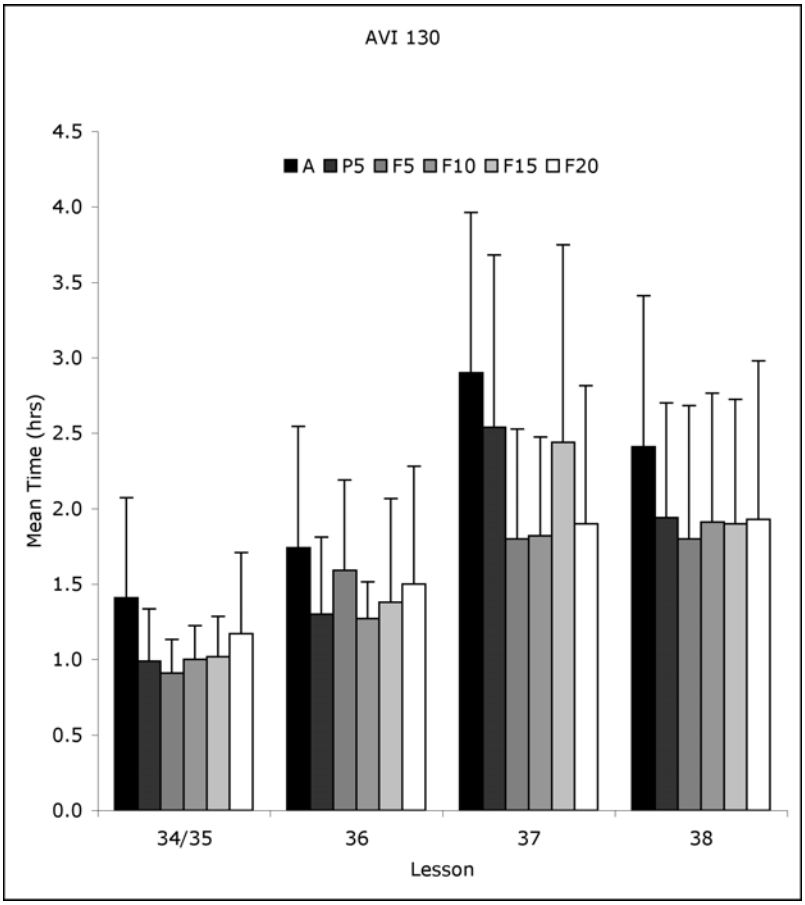

Figure 4. Mean time to complete the flight lessons in the airplane for the Control group (A), PCATD 5 hour group (P5), and the FTD 5, 10, 15, and 20 hour groups (F5, F10, F15, and F20) groups for AVI 130.

The percent transfers were all positive and generally moderate (see Table 8). All but three of the percent transfers were over 20%; these exceptions were for Intersection holds in lesson 36 for the FTD 5 group (8.62%), and for the PCATD 5 group in lessons 36 and 37 (ILS, LOC BC, VOR; ILS, VOR, DME Arc) with 12.41% and 19.50% respectively. The largest percent transfers were for FTD 5 and FTD 10 for lesson 37 (37.93% and 37.24% respectively). The TERs for time to complete flight lesson in AVI 130 for the FTD 5 group for three of the flight lessons were substantial: 1.57, 1.00 and 0.87 for flight lessons 37, 34/35 and 38 respectively. The PCATD 5 group TERs was also substantial, ranging from 0.51 to 0.84 and the FTD 10 TERs ranged from a high of 0.83 to 0.36. Three of the four TERs for FTD 10 showed the predicted negative decelerating function.

Table 8.
Percent transfer, transfer effectiveness ratios (TERs), and incremental transfer effectiveness ratios (ITERs) for mean time to complete flight lessons for PCATD 5 hour (P5) group and the FTD 5 and 10 hour groups FTD5, and FTD 10 for AVI 130.

	Percent Transfer			TER			ITER		
Flight Lesson	P5	FTD 5	FTD 10	P5	FTD 5	FTD 10	P5	FTD5	FTD 10
34/35, Steep Turns	29.79	35.46	29.08	0.84	1.00	0.41	NA	1.00	-0.18
36, Intersection Holds	25.29	8.62	27.01	0.63	0.21	0.36	NA	0.21	0.53
37, ILS, LOC BC, VOR	12.41	37.93	37.24	0.51	1.57	0.83	NA	1.57	-0.03
38, ILS, VOR, DME ARC	19.50	25.31	20.75	0.67	0.87	0.38	NA	0.87	-0.18

AVI 140. The mean times to complete the flight lesson in AVI 140 are shown in Table 9 and are presented graphically in Figure 5. For all experimental groups, the mean times to complete each of the four flight lessons were less than the time for the Control group. For Lessons 49 and 50, the PCATD 5 group required less time to complete the lesson. An ANOVA was performed to compare the treatment effect (assignment to groups) for the PCATD 5, the FTD 5, and the FTD 10 groups for mean time to complete the flight lesson among the four groups. The results indicated a significant treatment effect; $F(3,72) = 5.59$, $p < .05$. Post-hoc tests show that the FTD 5 group needed significantly less time than both the control group and the PCATD 5 group, $p < .05$. Individual ANOVA were performed for each flight lesson for time to complete the flight lesson among the four groups. There were no significant treatment effects for Lessons 48, 49, or 50. There was a significant treatment effect for Lesson 52, $F(3,76) = 5.79$, $p < .05$. Post-hoc tests showed significant differences between the PCATD 5 group and both the FTD 5 and FTD 10 groups; $p < .05$. A comparison of the time to complete the flight lesson was made between FTD 5 and FTD 10 to determine if additional training time resulted in increased time savings in the airplane. For two of the four flight lessons (49 and 52) the FTD 10 group used less time to complete the lesson than FTD 5, but for the other two flight lessons the FTD 5 group required less time. Consequently there was no consistent advantage for the additional 5 hours of training on instrument tasks. Times to complete the four flight lessons were used to compute percent transfer, TERs, and ITERs for AVI 140 shown in Table 10.

Table 9.
Mean time to complete the flight lessons in the airplane for the Control, the PCATD 5 hour(P5) the four FTD groups for AVI 140.

Group	Control	PCATD 5	FTD 5	FTD 10	FTD 15	FTD 20
Flight Lesson						
48, Holds, ILS, VOR	1.79	1.92	1.50	1.63	1.77	1.68
49, NDB Holds, NDB	1.57	1.27	1.23	1.24	1.30	1.28
50, NDB & ILS Holds, NDB	1.75	1.43	1.29	1.45	1.47	1.59
52, NDB, VOR, Holds	2.74	3.30	2.22	2.32	2.40	2.43

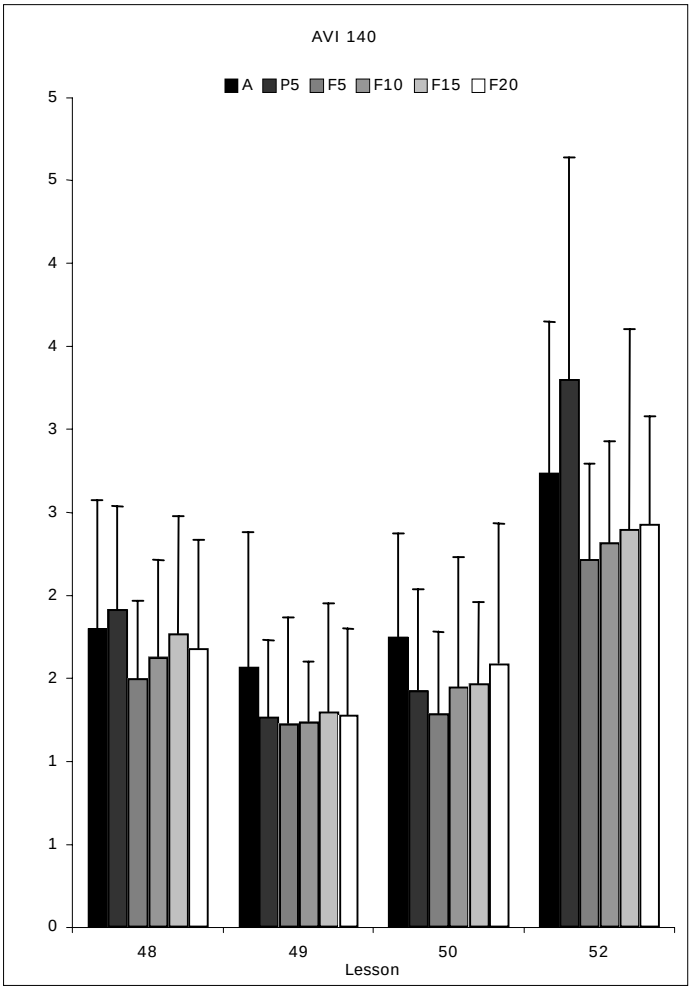

Figure 5. Mean (hours) to complete the flight lessons in the airplane for the Control group (A), the PCATD 5 hour group (P5), and the FTD 5, 10, 15, and 20 hour groups (F5, F10, F15, and F20) groups for AVI 140.

Table 10.
Percent transfer, transfer effectiveness ratios (TERs), and incremental transfer effectiveness ratios (ITERs) for mean time to complete flight lessons for the PCATD 5 hour group (P5), the FTD 5 hour group (FTD 5) and the FTD 10 hour group (FTD 10) for AVI 140.

	Percent Transfer			TER			ITER		
Flight Lesson	P5	FTD 5	FTD 10	P5	FTD5	FTD 10	P 5	FTD 5	FTD10
48, Holds, ILS, VOR	-6.67	16.67	9.44	-0.17	0.43	0.13	NA	0.43	-0.22
49, NDB Holds, NDB	19.11	21.66	21.02	0.60	0.68	0.33	NA	0.68	-0.02
50, NDB & ILS Holds, NDB	18.29	26.29	17.14	0.46	0.66	0.23	NA	0.66	-0.27
52, NDB, VOR, Holds	-20.44	18.98	15.33	-.0.80	0.74	0.32	NA	0.74	-0.17

With the exception of the PCATD 5 group for Lesson 48 and 52, the percent transfers were all positive but generally small. Only three percent transfers were over 20%; these were FTD 5 and FTD 10 for Lesson 49 (NDB holds and NDB approach). These percent transfers were 21.66% and 21.02 % respectively. The largest percent transfer (26.29%) was found for FTD 5 for Lesson 50 (NDB and ILS holds and NDB approach). The TERs for time to complete flight lessons in AVI 140 for the FTD 5 group for each lesson were positive and substantial ranging from a high of 0.74 for Lesson 52 to 0.43 for lesson 48. The TERs for FTD 10 all showed the predicted negative decelerating function. Two of the PCATD 5 group TERs were positive and substantial; 0.60 for Lesson 49 and 0.46 for Lesson 50. The other two were negative. For the time to complete flight lesson variable for AVI 140, all ITERs for the FTD 10 group were negative and showed the predicted negative decelerating function.

Time to Evaluation Flight

AVI 130. A total of 124 participants completed the course of study and took the final check ride for the AVI 130 Basic Instruments course. Table 10 shows the results of the check ride for the six groups. A total of 75 participants passed the check ride on the first attempt and 48 participants passed on the second attempt. Nine participants were recommended for remedial training. The total dual prior to a successful evaluation flight for the six groups is shown in Table 11 and in Figure 6. The average dual flight time to course completion for the Control group was greater than the average time for each of the five experimental groups who had prior training in the PCATD or the FTD. The Control group required 22.35 hours of dual to complete the course while the five experimental groups, after prior training in the PCATD or the FTD, required between 18.31and 20.20 hours of dual in the airplane. An ANOVA was computed to compare the dual time to successfully complete the AVI 130 course for the four groups (control, PCATD 5, FTD 5, and FTD 10). The result indicated a significant treatment effect; $F(3, 80) = 3.67$, $p < .05$. Post-hoc tests for significance indicated a significance difference between the Control group and the FTD 5 group, ($p < .05$). No other significant differences between groups were found.

Table 11.
Flight Lesson 45 Statistics (Fall 2002, Spring, Summer, Fall 2003 and Spring 2004)

Group	Airplane	PCATD	Frasca FTD			
Hours in training device	(NA)	5	5	10	15	20
Number of Students reaching check ride (lesson 45)	22	20	22	20	21	19
% Students taking 1st check ride who passed (numbers of students)	59.00 (13/22)	65.00 (13/20)	45.45 (10/22)	75.00 (15/20)	76.19 (16/21)	42.11 (8/19)
% Students requiring 2nd check ride who passed (numbers of students)	100.00 (9/9)	100.00 (7/7)	100.00 (12/12)	100.00 (5/5)	80.00 (4/5)	100.00 (11/11)
Number of Students requiring 3rd check ride who passed	0	0	0	0	0	0
Students failing 1st or 2nd check ride and not receiving 2nd or 3rd	0	0	0	0	1	0
Mean Total Dual hours (in airplane) to Completion for those passing the check ride on 1st, 2nd, or 3rd attempt (& sample size)	22.35 (n= 22)	20.20 (n=20)	19.27 (n=22)	20.87 (n=20)	18.36 (n=20)	18.31 (n=19)
Variance in Total Dual hours to Completion	9.39	6.40	10.03	14.17	9.87	9.48
Students recommended for remedial training	0	0	1	1	4	3

Note: Lesson 45 is the final check ride for AVI 130

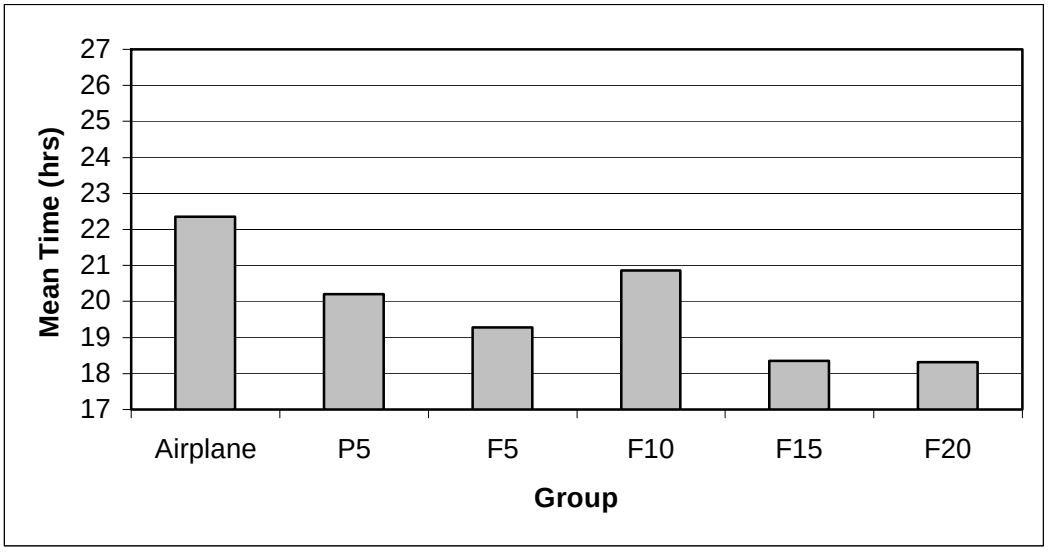

Figure 6. Mean time to successful evaluation flight for AVI 130.

AVI 140. A total of 106 participants completed the course of study and took the final check ride (the instrument rating flight check) for the AVI 140 Advanced Instruments course. Table 12 shows the results of the check ride. A total of 51 participants passed the check ride on the first attempt and 46 participants passed on the second attempt. Nineteen participants were recommended for remedial training. The total dual prior to a successful evaluation flight for AVI 140 was computed for the Control group and for each of the five experimental groups. The mean times to the evaluation flight were less for all five experimental groups than for the Control group. The Control group required 26.02 hours compared to 25.77, 24.55, 23.78, 22.11 and 20.11 hours for the PCATD 5, the FTD 5, the FTD 10, the FTD 15 and the FTD 20 groups respectively. These times are presented in Table 12 and Figure 7. The flight hours saved were 0.23, 1.47, and 2.24 hours respectively for the PCATD 5, FTD 5, and the FTD 10 groups. An ANOVA was computed to compare the time to a successful evaluation flight for these four groups. The results showed a significant treatment effect for total time to reach successful completion of the AVI 140 course, $F(3, 63) = 4.14$, $p < .05$, however, no significant differences were found among the four treatment groups.

Table 12:
Flight Lesson 60 Statistics (Spring, Summer, Fall, 2003, Spring, Summer, Fall 2004)

Group	Airplane	PCATD	Frasca FTD			
Hours in training device	(NA)	5	5	10	15	20
Number of Students reaching check ride (lesson 60)	18	18	20	16	15	19
% Students taking 1st check ride who passed (numbers of students)	44.44 (8/18)	55.56 (10/18)	45.00 (9/20)	43.75 (7/16)	40.00 (6/15)	57.89 (11/19)
% Students requiring 2nd check ride who passed (numbers of students)	100.0 (10/10)	75.0 (6 /8)	88.9 (8/9)	88.9 (8/9)	100.0 (9/9)	62.5 (5/8)
Number of Students requiring 3rd check ride who passed	0	1	1	1	0	2
Students failing 1st or 2nd check ride and not receiving 2nd or 3rd	0	1	2	0	0	1
Mean Total Dual hours (in airplane) to Completion for those passing the check ride on 1st, 2nd, or 3rd attempt (& sample size)	26.38 (n=18)	25.78 (n=17)	24.40 (n=18)	23.60 (n=16)	21.93 (n=15)	20.79 (n=18)
Variance in Total Dual hours to Completion	16.55	6.03	7.92	8.80	10.20	17.89
Students recommended for remedial training	2	3	4	3	5	2

Note: Lesson 60 is the final check ride for AVI 140

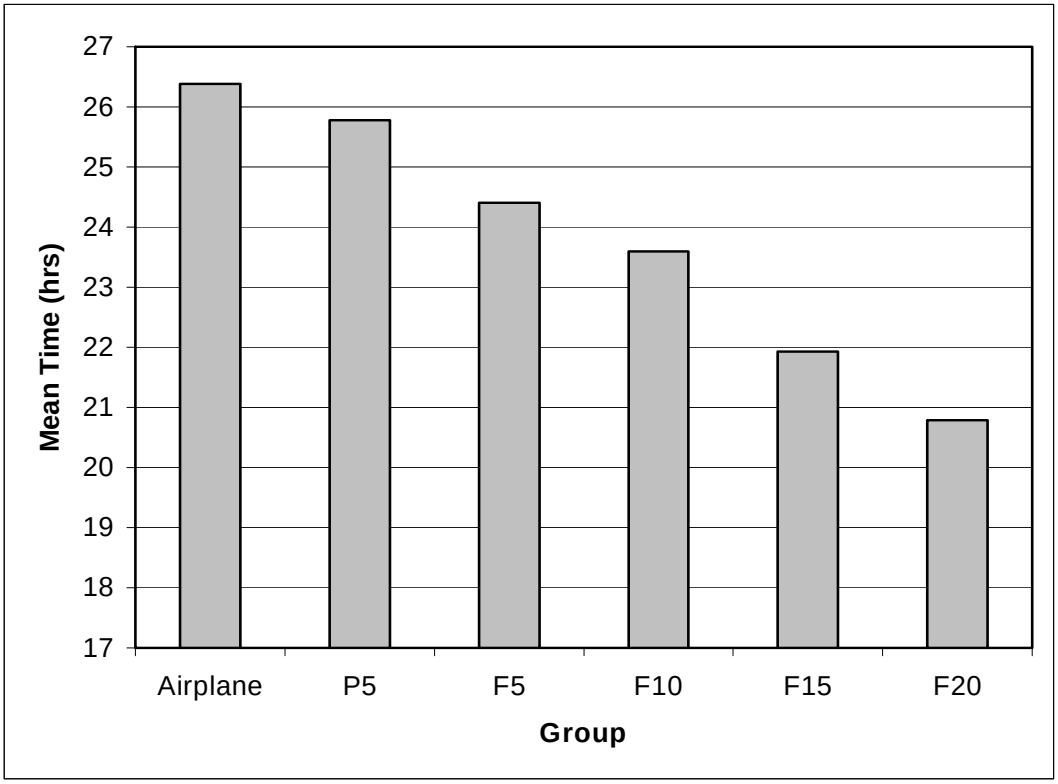

Figure 7. Mean time to a successful instrument proficiency check for AVI 140.

Overall Time Saved

In the current study, the time to a successful evaluation flight was less for the PCATD 5, the FTD 5 and the FTD 10 groups compared to the control group for both AVI 130 and 140. The total savings, time saved in the airplane for each of the experimental groups compared to the Control group, for both AVI 130 and 140 was 2.75, 5.06, and 4.26 for the PCATD 5, the FTD 5 and the FTD 10 groups respectively. The current study found that savings in the airplane fail to support the prediction that more training in the FTD is better. The results also indicted that reduced transfer for the FTD occurred for trials and for time to complete the flight lessons in AVI 140 as compared to AVI 130.

Effectiveness of Using the FTD for Cross-Country Training

The effectiveness of the cross-country FTD training time can be estimated by establishing a baseline by subtracting the control group time from the FTD 10 group time (FTD 10 group time saved in the airplane compared to control group time). The baseline can then be used to evaluate the effectiveness of the FTD 15 and 20 groups cross-country training in the FTD. Table 13 shows the time by group to an evaluation flight, the time saved by group, total time saved and cross-country time saved for AVI 130 and 140. The time saved in the airplane (Control group time – FTD group time) for the FTD 10, 15 and 20 groups for AVI 130 and 140 is presented in Table 12. To estimate the effectiveness of FTD cross-country training the baseline time saved (FTD 10 group time) is subtracted from the time for the FTD 15 and 20 group time saved. These times are computed as follows: FTD 15 time – FTD 10 time = time saved by the FTD 15 group: 7.44-4.26= 3.18; FTD 20 time –FTD 10 time = time saved by the FTD 20 group: 9.63-4.26 = 5.37.

Table 13.
Time by group to an evaluation flight, time saved by group, total time saved and cross- country savings for AVI 130 and 140.

	Time to Evaluation Flight		Time Saved by Group		Total Time Saved	X-C Training Savings
Group	AVI 130	AVI 140	AVI 130	AVI 140		
Control	22.35	26.38	NA	NA	NA	NA
FTD 10	20.87	23.60	1.48	2.78	4.26	NA
FTD 15	18.36	22.93	3.99	3.45	7.44	3.18
FTD 20	18.31	20.79	4.04	5.59	9.63	5.37

DISCUSSION

Mean Trials

AVI 130. The results from the current study indicate that the FTD is effective for teaching basic instrument tasks to private pilots. The current study systematically replicated the finding from a study by Taylor et al. (2002b), which found that the PCATD was effective in teaching basic instrument tasks in AVI 130 to private pilots. Taylor et al. (2002b) found that prior training in the PCATD in AVI 130 resulted in a smaller number of trials in the airplane for each of the PCATD groups for 21 of the 24 instrument tasks tested. The present study shows that compared to the control group prior training in the FTD resulted in a smaller number of trials in the airplane for 10 of 12 tasks tested as well as a significant treatment effect (assignment to group). Post-hoc tests indicated that the control group required significantly more trials than the FTD 10 group. No other differences were statistically significant. This partially replicated the findings of Taylor et al. (2002b), which also showed a significant treatment effect due to differences between the control and the PCATD 5 and the control and the PCATD 15 groups. In the present study, individual tests of significance for instrument tasks found a treatment effect for the ILS and the VOR tasks for Lesson 37 and for the for VOR and DME Arc tasks in Lesson 38. Taylor et al. (2002b) found a significant treatment effect for ILS and VOR for Lesson 38 and significant differences for the ILS task for Lesson 37 but not for Lesson 38 when a PCATD group, trained to proficiency, was compared with a control group trained only in the airplane (Taylor et al., 1996). These differences may be explained by differences in experimental design. Taylor et al. (1996) trained the experimental group to proficiency in the PCATD prior to training to proficiency in the airplane while the design in the Taylor et al. (2002b) study called for a fixed number of trials, which varied from 1-3 for the three experimental groups. One can infer that the flight instructors in the Taylor et al. (2002b) study trained to a higher proficiency standard for the ILS task in Lesson 38 compared to Lesson 37. It should also be noted that the flight instructors in the Taylor et al. (2002b) study had less teaching experience on average than the instructors in the Taylor et al. (1996) study.

For the current study, the prediction that an increased number of trials in the FTD on selected instrument tasks would save more time in the airplane was found for 5 of 6 comparisons between FTD 5 and FTD 10 in AVI 130. This is similar to the Taylor et al. (2002b) finding that additional training in the PCATD on the selected instrument tasks saved more trials in the airplane in AVI 130 for only six of the sixteen instruments task comparisons. In that study, for two of the eight

instrument tasks, the PCATD 5 group had the least trials in the airplane, for two tasks the PCATD 10 group had the least trials in the airplane and the PCATD 15 group had two tasks with the least trials in the airplane.

In the current study the percent transfer for trials ranged from 48.65% for VOR in Lesson 37 for FTD 10 to – 43.54% for Lesson 38 DME Arc for the PCATD 5 group. In the study by Taylor et al. (2002b), the percent transfer for trials ranged from a high of 41.00% for the PCATD 5 group for Lesson 38 ILS in to a low of – 6.80% for Lesson 37 LOC BC for PCATD 10. In the current study a TER of 1.23 and 1.04 for the FTD 5 group for Lesson 34/35 Steep turns and Lesson 37 VOR respectively indicates a savings of over one trial in the airplane for each trial in the FTD. In the Taylor et al. (2002b) study the PCATD 5 group had a TER of 0.84 which indicated that for Lesson 38 almost one trial in the aircraft was saved for each trial in the PCATD. The results of Taylor et al. (1996) showed the opposite effect. The percent transfer and TER for ILS were 33.30% and 0.28 respectively for Lesson 37 but only 11.80% and 0.12 for Lesson 38. It should be noted, however, that in the Taylor et al. (1996) study, the subjects were trained in the PCATD to a proficiency standard and trained to the same proficiency standard in the airplane in Lesson 37. Training in the PCATD for Lesson 38 was a review lesson. In the Taylor et al. (2002b) study the subjects received only 1, 2, or 3 trials respectively for the PCATD 5, 10, 15 groups in each of the two flight lessons and were trained in the airplane to a completion standard. For the current study, the TERs for all instrument tasks for flight lesson 34/35, 36, and 37, and VOR flight lessons 38 showed the predicted negatively decelerated function for increased number of trials. Examination of the ITERs for FTD 5 and FTD 10 indicates that additional training for trials for the FTD 10 group provided little benefit over the FTD 5 group. Taylor et al. (2002b) reported that two of the five ITERs for the trial variable (steep turns and VOR Flight Lesson 38) showed the predicted pattern of a negatively decelerated function (Roscoe, 1971; Flexman et al., 1972). The increased number of trials in the PCATD for the PCATD 10 group compared to the PCATD 5 group failed to save additional trials to criterion in the airplane. With the exception of PCATD 10 for steep turns, there was little ITER for either PCATD 10 nor PCATD 15, which indicated that additional training beyond the training for the PCATD 5 group saved few trials in the airplane.

AVI 140. For mean trials to criterion in the airplane in AVI 140, the control group required on average more trials than the FTD 5 and the FTD 10 for all instrument tasks for all lessons. Significant treatment effects were found for the Lesson 48 ILS approach, Lesson 50 NDB approach, and Lesson 52 NDB holds and GPS approaches. This provided a systematic replication of Taylor et al. (2002b) who found that prior training in the PCATD in AVI 140 resulted in a smaller number of trials in the airplane for each of the PCATD groups for 27 of the 33 instrument tasks tested, but these differences were small and none were significant. The PCATD 5 group in the current study failed to follow the pattern found for the two FTD groups since for only 5 of the 11 instrument tasks the control group required more mean trials in the airplane than the PCATD 5 group. In previous research, Taylor et al. (1996) found significant differences for the VOR task for Lesson 48, NDB holds for Lesson 50, NDB approach in Lesson 49 and 50, and for LOC BC holds for Lesson 50, when a PCATD group, trained to proficiency, was compared with a control group trained only in the airplane**.** The differences between the Taylor et al (2002b) and Taylor et al. (1996) results may be explained by differences in experimental design. As discussed above, Taylor et al. (1996) trained the experimental group to proficiency in the PCATD prior to training to proficiency in the airplane while the design in the current study calls for a fixed number of trials which varies from 1-3 trials for the three

experimental groups. The lack of effectiveness for the PCATD 5 group in the current study compared to the two earlier studies is most likely due to the reduced power due to a smaller number of participants.

The percent transfer for AVI 140 ranged from a high of 36.46% for the PCATD 5 group for Lesson 50 NDB approach to –60.13% for the Lesson 52 VOR approach for the PCATD 5 group. A number of percent transfers ranged between 34.25% and 21.22% for the FTD 5 and FTD 10 groups. Taylor et al. (2002b) found that the percent transfer for trials in AVI 140 ranged from a high of 20.44% for PCATD 10 for Lesson 52 NDB, 18.66% for the PCATD 5 group for Lesson 52 VOR and ILS, and 18.27% for Lesson 48 Turns in Hold for PCATD 15, to a low of –16.62% for Lesson 50 ILS Turns in Hold for PCATD 10. Compared to the present study and to the Taylor et al. (2002b) study, substantial higher percent transfers were found for comparable instrument tasks for Flight Lessons 48, 49 and 50 in the earlier study (Taylor et al., 1996). These ranged from 28.10% for Lesson 50 NDB approach to 14.60% for Lesson 48 VOR approach. In addition, only two of seven of the previous percent transfers were below 20.00% (Taylor et al., 1996). The current study had 7of 14 TERs that ranged form 0.28 to 0.62 for the FTD 5 group and 3 of 14 TERs for the PCATD 5 group. With the exception of the PCATD 5 group for NDB Lesson 49 (TER of 0.31), the TERs for trials in AVI 140 were smaller for the Taylor et al. (2002b) study compared to the current and to the Taylor et al. study (1996).

Mean Time to Complete the Flight Lesson

AVI 130. The mean times to complete each of the four flight lessons were less than the time for the control (airplane) group for the PCATD 5 and the FTD 5 and 10 experimental groups. This systematically replicated the finding of Taylor et al. (2002b) who found that the mean times to complete the flight lesson in the airplane for the four flight lessons, in which there was prior training in the PCATD, were less for all three PCATD groups than for the airplane group. Taylor et al. (1996) found the same result for these four flight lessons. The current study found a significant treatment effect (assignment to groups) for time to complete the flight lesson. Post-hoc tests showed that all three experimental groups needed less time than control group to complete the four lessons. This provided a systematic replication of the results of Taylor et al. (2002b) that found a significant treatment effect for time to complete the four lessons for the three PCATD groups. Post-hoc tests in the Taylor et al. (2002b) study also showed that the experimental groups needed less time than the control group to complete the four lessons. The current study found a significant treatment effect for lessons 34/35, 36, and 37 but not for lesson 38 for total time to complete the lesson. This systematically replicated the findings of Taylor et al. (2002b) and Taylor et al. (1996). Taylor et al. (2002b) found significant differences for flight Lessons 36 and 38 when the combined experimental groups were compared with the Control group for each of the four flight lessons, while Taylor et al. (1996) found significant differences in the mean time to complete the flight lesson for all four of the flight lessons.

The present study found that the percent transfer for time to complete the flight lesson for AVI 130 for the FTD 5 and FTD 10 groups ranged from 37.93% for lesson 37, to 8.62% for lesson 36. Seven of the eight percent transfers were above 20.75%. These results were consistent with the percent transfer for time reported by Taylor et al. (2002b) for the PCATD, which ranged from 12.90% for lesson 34/35 (steep turns) for PCATD 5, to 37.20% for lesson 38 (ILS, VOR, DME Arc) for PCATD 10. The percent transfer for the PCATD 5 group in the current study ranged from 12.41% to 29.75%, which directly replicated the findings of Taylor et al. (2002b)

for the PCATD 5 group (percent transfer ranged from 12.00% to 33.90%). The percent transfer for Taylor et al. (1996) ranged from 37.50% for steep turns to 22.70%.

The TERs ranged from 0.21 to 1.57 for the FTD 5 and FTD 10 groups in the current study. Seven of the eight TERs were above 0.38. The TERs for the PCATD 5 group in the present study ranged from 0.51 to 0.84. These findings systematically replicated the results of Taylor et al. (2002b) who reported TERs which ranged from 1.17 to 0.25 for the PCATD 5 and 10 groups and directly replicated the findings of the PCATD 5 group (TERs ranged from 0.38 to 1.17). In the current study the TERs for the time to complete the flight lesson showed the negatively decelerated function predicted by Roscoe (1971), and Flexman et al. (1972) for three of the four lessons. The exception was lesson 36. These results replicated the findings of Taylor et al. (2002b) that for all four flight lessons the TERs for the time to complete the flight lesson variable showed the negatively decelerated function. In comparing the FTD 5 and 10 groups in the current study, the largest amount of average transfer was found for FTD 5 for 3 of 4 comparisons. This systematically replicated the results of Taylor et al. (2002b) that the largest amount of transfer was found for all four flight lessons for PCATD 5 and the smallest for PCATD 15.

In the current study, 3 of 4 of the ITERs showed the predicted pattern of a negatively decelerated function (Roscoe, 1971; Flexman et al., 1972) for time to complete the flight lessons. Taylor et al. (2002b) found that for the four flight lesson the ITERs for time to complete the lesson exhibited the negatively decelerated function. In the current study there were substantial time savings (transfer) for three of four of the flight lessons for FTD 5, the incremental savings were found for only lesson 36 for the FTD 10 group. Taylor et al. found that there were substantial time savings for all four of the flight lessons for PCATD 5, the incremental savings for the PCATD 10 group was minimal.

AVI 140. In AVI 140 the mean times for all three experimental groups to complete each of the four flight lessons were less than the time for the control (airplane) group. This systematically replicated the finding of Taylor et al. (2002b) who found that for all four flight lessons in AVI 140 the control group required more time to complete the flight lesson in the airplane when compared to the three experimental groups in which there was prior training in the PCATD. The same result was found by Taylor et al. (1996) for three of the four flight lessons (Lessons 49, 50, and 52) in which there was prior training in the PCATD. In the current study, a significant treatment effect was found for the mean times to complete the flight lessons among the four groups. Post-hoc tests show that the FTD 5 group needed significantly less time than both the control group and the PCATD group. Taylor et al. (2002b) found a significant treatment effect among the four groups, but post-hoc tests found no significant differences between the Control group and any of the three experimental groups. In the current study, tests of significance for each of the flight lessons found a significant treatment effect for Lesson 52 but not for Lessons 48, 49 or 50. This replicated the findings of Taylor et al. (2002b) who reported that individual tests of significance for each lesson found a significant treatment effect for lesson 52. Post-hoc tests indicated significant differences between the Control group and the PCATD 5 group and the Control group and the PCATD 10 group. These findings were similar to those of Taylor et al. (1996) who found significant differences for Lessons 49 and 50 between the Control group who trained only in the airplane and the PCATD group who had prior training in the PCATD.

In the current study, the percent transfer for time to complete the flight lesson ranged from 19.11% for Lesson 49 (NDB holds and approaches) for the PCATD 5 group, to -20.44% for Lesson 52 (partial panel ILS, VOR, and holds) for the same group. Taylor et al. (2002b) found similar results for the PCATD 5 group; the percent transfer ranged from 6.59% for Lesson 50 (NDB holds and approaches and ILS holds) to 28.63% for Lesson 52 (partial panel ILS, VOR, and holds). The percent transfer for Taylor et al. (1996) was similar ranging from 1.50% for lesson 52 to 26.40% for lesson 49.

In the current study, the TERs for the time to complete the flight lesson the four flight lessons in AVI 140 were substantial ranging from 0.43 to 0.74 for the FTD 5 group; the TERs for FTD 10 were smaller for all four lessons. This systematically replicated the findings of Taylor et al. (2002b) who reported that the TERs ranged from 0.17 to 0.93 for PCATD 5 group and from 0.22 to 0.52 for the PCATD 10 group; the TERs for the PCATD 15 group were smaller ranging from 0.13 to 0.24. Taylor et al. (1996) reported TERs which ranged from 0.01 to 0.24. For the PCATD 5 group in the current study, the TERs showed substantially more variability than the same group in the Taylor et al. (2002b) study; the TERs ranged from -0.80 to 0.60 compared to 0.17 to 0.93. In the current study for the TERs for the time to complete the flight lesson variable showed the negatively decelerated function predicted by Roscoe (1971), and Flexman et al. (1972) for all four lessons. Taylor et al. (2002b) reported that for three of the four flight lessons the TERs for the time to complete the lesson showed the negatively decelerated function; Lesson 50 was the exception.

The ITERs for FTD 10 in the current study are all negative which indicated that the additional training time for FTD 10 compared to FTD 5 provided no benefit to time saved in the airplane. Taylor et al. (2002b) found that increased training time beyond the PCATD 5 level made no substantial contribution to reducing the training time in the airplane in AVI 140.

Time to a Successful Evaluation Flight

AVI 130. The mean dual flight time to course completion for the airplane group was greater than the average time for each of the five experimental groups that had prior training in the PCATD or the FTD. These results systematically replicated the results of Taylor et al. (2002b) who found that time to a successful evaluation flight for AVI 130 was less for all three PCATD groups compared to the control group. In the current study the flight hours save were 2.15, 3.08 and 1.48 for the PCATD 5, the FTD 5 and the FTD 10 groups respectively. These results are similar to the results of Taylor et al. (2002b) who reported that the flight hours saved were 2.03 hours, 3.10 hours, and 1.44 hours respectively for the PCATD 5, 10, 15 groups for AVI 130. A significant treatment effect was found for the current study but post-hoc analyses found no significant difference among the groups. Taylor et al. (2002b) found a significant treatment effect for the time to a successful evaluation flight in AVI 130 for the four groups. Post-hoc tests indicated a significant difference between the PCATD 10 group and the Control group but not between the Control group and the PCATD 5 and 15 groups. Taylor et al. (1996) found a time savings of 2.1 hours for the PCATD group for AVI 130.

AVI 140. For AVI 140, the current study found that the mean dual flight time in the airplane to course completion for the control group was greater than the mean time for each of the five experimental groups that had prior training in the PCATD or the FTD. These results systematically replicated the results of Taylor et al. (2002b) who found that the time to a successful evaluation flight for AVI 140 was less for all three PCATD groups compared to the

Control group. In the present study the flight hours saved were 0.60, 1.98, and 2.78 hours respectively for the PCATD 5, the FTD 5 and the FTD 10 groups. In the Taylor et al. (2002b) study the flight hours saved were 2.05 hours, 2.39 hours, and 1.75 hours respectively for the PCATD 5, 10, 15 groups. Since the PCATD 5 group in the current study was a direct replication of the PCATD 5 group in the Taylor et al. (2002b) study the comparative small number of hours saved for the present study requires explanation. The principle reason for the differences is most likely due to the low power in the current study as a result of a comparatively small number of subjects. A significant treatment effect was found for the present study for time for the groups to reach successful completion of the AVI 140 course; $F(3, 63) = 4.14$, $p <= .05$, however, no significant differences were found between the four groups. Taylor et al. (2002b) found a significant treatment effect for the time to complete the evaluation flight in AVI 140 for the four groups. However, post-hoc tests indicated no significant difference between any of the PCATD groups and the Control group. Taylor et al. (1996) found a significant treatment effect and a time savings of 1.8 hours for the PCATD group for AVI 140.

Effectiveness of Using the FTD for Cross Country Training

One objective of the current study was to investigate the effectiveness of the FTD for cross-country training. The FTD 10, 15 and 20 groups received ten hours of prior FTD training on instrument tasks (see Table 1). In addition, the FTD 15 and 20 groups received an additional 5 and 10 hours respectively of cross-country training in the FTD. The FTD 15 group received 2 hours of cross country time in AVI 130 and 3 hours in 140; the FTD 20 group received 4 hours of cross country time in AVI 130 and 6 hours in 140. With the exception of the cross-country time the treatment of the FTD 10, 15 and 20 groups was identical. Although this study failed to show an hour for hour replacement of aircraft cross-country training with FTD cross-country training, savings of approximately 50% were realized by the FTD 15 and FTD 20 groups. This indicates that, while the FTD may be used effectively for cross-country training, there are some aspects that do not transfer 100%. The current study did not investigate the variables affecting the amount of transfer for the cross-country training in the FTD. It should also be noted that there was no test of cross-country skills on the Lesson 60 check ride, so it is impossible to determine if any student deficiencies on these skills were present.

CONCLUSION

The current study found that FTDs are useful to teach instrument tasks to private pilots training towards the instrument rating. This finding systematically replicated the findings of the Taylor et al. (2002b) and the Taylor et al. (1996, 1999) that PCATDs are useful to teach instrument tasks to private pilots. As a result of prior training in a FTD, trials to a specific criterion, time to complete the flight lesson and time to a successful evaluation flight were less when compared to a control group trained only in the airplane. The same result was found by Taylor et al. (2002b) for PCATDs. The current study found the greatest transfer for the FTD 5 group compared to the FTD 10 group for trials in AVI 130 (6 of 8 comparisons), trials in AVI140 (14 of 14 comparisons), time to complete the flight lesson in AVI 130 (3 of 4 comparisons), and time to complete the flight lesson in AVI 140 (4 of 4 comparisons). Taylor et al. (2002b) found that the greatest transfer effect was found for the PCATD 5 group. The incremental transfer of training theory of Roscoe (1971) predicted both of these findings. In the current study the prediction that increased trials/ time in the FTD would save trials/time the airplane was found for trials in AVI 130 (5 of 6 comparisons) but not for trials in AVI 140 (1 of 11 comparisons); the prediction was not found for time to complete the flight lesson in AVI 130,

(1 of 4 comparisons), nor for time to complete the flight lesson in AVI 140 (2 of 4 comparisons). Taylor et al. (2002b) found that increased trials/ time in the PCATD failed to save trials/time in the airplane compared to the control group. In some cases the results indicate a complex pattern of time savings. For the current study, the TERs for all instrument tasks for flight lesson 34/35, 36, and 37, and VOR flight lessons 38 showed the predicted negatively decelerated function for increased number of trials. Examination of the ITERs for FTD 5 and FTD 10 indicates that additional training for trials for the FTD 10 group provided little benefit over the FTD 5 group. Taylor et al. (2002b) reported that two of the five ITERs for the trial variable, showed the predicted pattern of a negatively decelerated function (Roscoe, 1971; Flexman et al., 1972).

The current study and the study by Taylor et al. (2002b) show that savings in the airplane fail to support the prediction that more training in the FTD or the PCATD is better. The results in the current study indicted that reduced transfer for the FTD occurred for trials and for time to complete the flight lessons in AVI 140 as compared to AVI 130. The results systematically replicated the findings of Taylor et al. (2002b) which indicated reduced trials/time saved for the PCATD for AVI 140 when compared to AVI 130. The negatively decelerated function of the ITER predicts reduced transfer for instrument tasks introduced during later stages in the instructional sequence (Roscoe, 1971). Taylor et al. (1999) also found less transfer during AVI 140 than AVI 130. They noted that “the evident reason for this is that what is learned while mastering one task in a training device generalizes (i.e., transfers to some extent) to other tasks introduced later, thus reducing the remaining potential for transfer” (Taylor et al., 1999).

In the current study, the time to a successful evaluation flight was less for the PCATD 5, the FTD 5 and the FTD 10 groups compared to the control group for both AVI 130 and 140. The total savings for both AVI 130 and 140 was 2.75, 5.06, and 4.26 for the PCATD 5, the FTD 5 and the FTD 10 groups respectively. Taylor et al. (2002b) also found that time to a successful evaluation flight was less for the three PCATD groups when compared to the control group for both AVI 130 and 140. The total savings for both AVI 130 and 140 was 4.08, 5.49, and 3.19 for the PCATD 5, 10 and 15 groups respectively. For the current study, the total time savings for both AVI 130 and 140 was 2.75 for the PCATD 5 group compared to 4.08 hours for this group in the Taylor et al. (2002b) study. Again these differences are likely due to the comparatively low power of the current study. These findings systematically replicated the findings of Taylor et al. (1999) who found overall savings of 3.90 hours.

Generally, the current study found little additional time/trials were saved by the FTD 10 group compared to the FTD 5 group replicating the findings of Taylor et al. (2002b). Practically no incremental transfer was found for the additional hours of training by the PCATD 15 group compared to the PCATD 10 group. One purpose for conducting an incremental transfer of training study is to determine at what point additional training in the PCATD in no longer effective. Based on the results of the current study no appreciable benefit was found for more than 5 hours of FTD training on instrument tasks. These results provide support to the current FAA policy of permitting FTD time in lieu of time in an airplane and permitting PCATD time to be used in lieu of time in an approved training device or airplane, but the results indicated that only 5 hours of training time on instrument tasks in the FTD or PCATD was effective. Although the current study failed to show an hour for hour replacement of aircraft cross-country time with FTD cross-country time, savings in the airplane of approximately 50% were realized by the FTD 15 and FTD 20 groups.

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APPENDIX A: PUBLICATIONS AND PRESENTATIONS

Taylor, H. L., Talleur, D. A., Emanuel, T. W., Jr., & Rantanen, E. M. (2005). Transfer of training effectiveness of a flight training device (FTD). Paper presented at the 13th International Symposium on Aviation Psychology, Oklahoma City, OK, April 18-21, 2005.

Taylor, H. L., Talleur, D. A., Emanuel, T. W., Jr., & Rantanen, E. M. (2005). The effectiveness of flight training devices (FTDs) in instrument training. A paper presented at the Mid Year meeting of APA Divisions 19 and 21 and Potomac Chapter of the HFES, at George Mason University, VA, March 4, 2005.

Taylor, H. L., Talleur, D. A., Emanuel, T. W. Jr., and Rantanen, E. M., Incremental transfer of training effectiveness of a flight training device. A paper presented at the Technology Enhancements for Aviation Classrooms Seminar, University Aviation Association Fall Education Conference, Dayton, OH, October 22, 2003.

Taylor, H. L., Talleur, D. A., Emanuel, T. W. Jr., and Rantanen, E. M. Transfer of Training Effectiveness of an FTD. A paper presented at the Federal Aviation Administration's Human Factors Research and Engineering Division (AAR-100) FY03 Aviation Maintenance, General Aviation, and Vertical Flight program review at the University of Nevada, Reno, NV, September 10-11, 2003. The paper was published a CD.

Taylor, H. L., Talleur, D. A., Emanuel, T. W. Jr., and Rantanen, E. M., Incremental Transfer of Training Effectiveness of a Flight Training Device (FTD). A paper presented at the Research Roundtable, University Aviation Association Fall Education Conference, Dayton. OH, October 24, 2003.

Taylor, H. L., Talleur, D. A., Emanuel, T. W. Jr., and Rantanen, E. M., Incremental Effectiveness of Personal Computer Aviation Training Devices (PCATDs) and a Flight Training Device (FTD), A paper presented at the annual meeting of the American Psychological Association, Honolulu, HI, July 2004.

Taylor, H. L., Talleur, D. A., Emanuel, T. W. Jr., and Rantanen, E. M., The Effectiveness of personal computer aviation training devices (PCATDs) and flight training devices (FTDs) in instrument training, maintaining currency and instrument proficiency checks. A paper presented at the Institutional Workshop, University Aviation Association Fall Education Conference, Toronto, Ontario, Canada, October 9, 2004.

Taylor, H. L., Talleur, D. A., Emanuel, T. W. Jr., and Rantanen, E. M., The Effectiveness of Personal Computers (PCATDs) and Flight Training Devices (FTDs) on Instrument Training for Pilots. A paper presented at the Aerospace Medical Association 75th Annual Scientific Program Meeting, Anchorage, AK, May, 2004.

Taylor, H. L., Talleur, D. A., Emanuel, T. W. Jr., and Rantanen, E. M., Incremental transfer of Training effectiveness of Personal Computer Aviation Training Devices (PCATDs) and a Flight Training Device (FTD**).** A paper presented at the Research Roundtable, University Aviation Association Fall Education Conference, Toronto, Ontario, Canada, October 8, 2004.

APPENDIX B: SAMPLE SCORE CARDS FROM FLIGHT LESSONS 36 AND 48

Student_____ Instructor_____ Date_____

FLIGHT LESSON 36
5.0 HOUR PCATD GROUP
This portion of the lesson will be conducted in the PCATD.

Holding Pattern
Set a direct crosswind of 15 knots to the holding pattern.

Student entered 2 intersection holds during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) ____

****

Date_____

This portion of the lesson will be conducted in the airplane.

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	$\pm$10 kts	_____	_____
Altitude	$\pm$100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	$\pm 10^{o}$	_____	_____

Number of intersection holds entered during this lesson to reach completion standards _____

Number of times holding fix crossed from inbound leg (complete turns in holds) _____

Amount of time flown in airplane during this lesson until student performs intersection holds to completion standards _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 36
5.0 HOUR FRASCA GROUP
This portion of the lesson will be conducted in the FRASCA.

Holding Pattern
Set a direct crosswind of 15 knots to the holding pattern.

Student entered 2 intersection holds during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) ____

****

Date_____

This portion of the lesson will be conducted in the airplane.

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Number of intersection holds entered during this lesson to reach completion standards _____

Number of times holding fix crossed from inbound leg (complete turns in holds) _____

Amount of time flown in airplane during this lesson until student performs intersection holds to completion standards _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 36
10.0 HOUR FRASCA GROUP
This portion of the lesson will be conducted in the FRASCA.

Holding Pattern
Set a direct crosswind of 15 knots to the holding pattern.

Student entered 4 intersection holds during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) ____

****

Date_____

This portion of the lesson will be conducted in the airplane.

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Number of intersection holds entered during this lesson to reach completion standards _____

Number of times holding fix crossed from inbound leg (complete turns in holds) _____

Amount of time flown in airplane during this lesson until student performs intersection holds to completion standards _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 36
15.0 HOUR FRASCA GROUP
This portion of the lesson will be conducted in the FRASCA.

Holding Pattern
Set a direct crosswind of 15 knots to the holding pattern.

Student entered 4 intersection holds during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) ____

****

Date_____

This portion of the lesson will be conducted in the airplane.

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Number of intersection holds entered during this lesson to reach completion standards _____

Number of times holding fix crossed from inbound leg (complete turns in holds) _____

Amount of time flown in airplane during this lesson until student performs intersection holds to completion standards _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 36
20.0 HOUR FRASCA GROUP
This portion of the lesson will be conducted in the FRASCA.

Holding Pattern
Set a direct crosswind of 15 knots to the holding pattern.

Student entered 4 intersection holds during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) ____

****

Date_____

This portion of the lesson will be conducted in the airplane.

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Number of intersection holds entered during this lesson to reach completion standards _____

Number of times holding fix crossed from inbound leg (complete turns in holds) _____

Amount of time flown in airplane during this lesson until student performs intersection holds to completion standards _____

Student_____ Instructor_____Date_____

FLIGHT LESSON 36
AIRPLANE-ONLY GROUP

Holding Pattern
Check "completed" when the student's performance meets the criteria.

Measure	Desired	Completed
Tune and Ident Proper Navaids		_____
Recognizes Arrival at Holding Fix		_____
Initiates Prompt Entry		_____
Uses Recommended Entry Procedure		_____
Properly Reports Entry		_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg		
Airspeed	±10 kts	_____
Altitude	±100 ft	_____
On Inbound Leg		
Maintains Desired Course	±10°	_____

Number of intersection holds entered during this lesson to reach completion standards _____

Number of times holding fix crossed from inbound leg (complete turns in holds) _____

Amount of time flown in airplane during this lesson until student performs intersection holds to completion standards _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 48
5.0 HOUR PCATD GROUP
This portion of the lesson will be conducted in the PCATD.

ILS Approach
Please test the first ILS approach of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Task	Yes	No
Tune, Ident Localizer	_____	_____
Before Final Approach Segment:		
Altitude ±100 ft	_____	_____
Heading ±10°	_____	_____
Less Than Full-Scale CDI Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Intercepts Glide Slope	_____	_____
Starts Time	_____	_____
On Final Approach:		
Less Than 3/4 Scale CDI Deflection	_____	_____
Less Than 3/4 Scale Glide Slope Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Identifies MAP	_____	_____

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Student entered 1 intersection hold during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) _____

Student performed 1 ILS approach during this lesson _____

Student performed 1 VOR approach during this lesson _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 48
5.0 HOUR FRASCA GROUP
This portion of the lesson will be conducted in the FRASCA.

ILS Approach
Please test the first ILS approach of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Task	Yes	No
Tune, Ident Localizer	_____	_____
Before Final Approach Segment:		
Altitude ±100 ft	_____	_____
Heading ±10°	_____	_____
Less Than Full-Scale CDI Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Intercepts Glide Slope	_____	_____
Starts Time	_____	_____
On Final Approach:		
Less Than 3/4 Scale CDI Deflection	_____	_____
Less Than 3/4 Scale Glide Slope Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Identifies MAP	_____	_____

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Student entered 1 intersection hold during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) _____

Student performed 1 ILS approach during this lesson _____

Student performed 1 VOR approach during this lesson _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 48
10.0 HOUR FRASCA GROUP
***This portion of the lesson will be conducted in the* FRASCA.**

ILS Approach
Please test the first ILS approach of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Task	Yes	No
Tune, Ident Localizer	_____	_____
Before Final Approach Segment:		
Altitude ±100 ft	_____	_____
Heading ±10°	_____	_____
Less Than Full-Scale CDI Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Intercepts Glide Slope	_____	_____
Starts Time	_____	_____
On Final Approach:		
Less Than 3/4 Scale CDI Deflection	_____	_____
Less Than 3/4 Scale Glide Slope Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Identifies MAP	_____	_____

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Student entered 2 intersection holds during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) _____

Student performed 2 ILS approaches during this lesson _____

Student performed 2 VOR approaches during this lesson _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 48
15.0 HOUR FRASCA GROUP
***This portion of the lesson will be conducted in the* FRASCA.**

ILS Approach
Please test the first ILS approach of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Task	Yes	No
Tune, Ident Localizer	_____	_____
Before Final Approach Segment:		
Altitude ±100 ft	_____	_____
Heading ±10°	_____	_____
Less Than Full-Scale CDI Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Intercepts Glide Slope	_____	_____
Starts Time	_____	_____
On Final Approach:		
Less Than 3/4 Scale CDI Deflection	_____	_____
Less Than 3/4 Scale Glide Slope Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Identifies MAP	_____	_____

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Student entered 2 intersection holds during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) _____

Student performed 2 ILS approaches during this lesson _____

Student performed 2 VOR approaches during this lesson _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 48
20.0 HOUR FRASCA GROUP
***This portion of the lesson will be conducted in the* FRASCA.**

ILS Approach
Please test the first ILS approach of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Task	Yes	No
Tune, Ident Localizer	_____	_____
Before Final Approach Segment:		
Altitude ±100 ft	_____	_____
Heading ±10°	_____	_____
Less Than Full-Scale CDI Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Intercepts Glide Slope	_____	_____
Starts Time	_____	_____
On Final Approach:		
Less Than 3/4 Scale CDI Deflection	_____	_____
Less Than 3/4 Scale Glide Slope Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Identifies MAP	_____	_____

Holding Pattern
Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Student entered 2 intersection holds during this lesson _____

Student crossed holding fix from inbound leg 3 times in each hold (complete turns in hold) _____

Student performed 2 ILS approaches during this lesson _____

Student performed 2 VOR approaches during this lesson _____

Student_____ Instructor_____ Date_____

FLIGHT LESSON 48
PCATD AND FRASCA GROUPS
This portion of the lesson will be conducted in the airplane.

ILS Approach

Please test the first ILS approach of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Task	Yes	No
Tune, Ident Localizer	_____	_____
Before Final Approach Segment:		
Altitude ±100 ft	_____	_____
Heading ±10°	_____	_____
Less Than Full-Scale CDI Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Intercepts Glide Slope	_____	_____
Starts Time	_____	_____
On Final Approach:		
Less Than 3/4 Scale CDI Deflection	_____	_____
Less Than 3/4 Scale Glide Slope Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Identifies MAP	_____	_____

Holding Pattern

Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Number of intersection holds entered to reach Instrument PTS criteria _____

Number of times holding fix crossed from inbound leg (complete turns in holds) _____

Number of ILS approaches performed to reach Instrument PTS criteria _____

Number of VOR approaches performed to reach Instrument PTS criteria _____

Amount of time flown in airplane to reach completion standards _____

Student_____ Instructor_____Date_____

FLIGHT LESSON 48
AIRPLANE GROUP

ILS Approach

Please test the first ILS approach of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Task	Yes	No
Tune, Ident Localizer	_____	_____
Before Final Approach Segment:		
Altitude ±100 ft	_____	_____
Heading ±10°	_____	_____
Less Than Full-Scale CDI Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Intercepts Glide Slope	_____	_____
Starts Time	_____	_____
On Final Approach:		
Less Than 3/4 Scale CDI Deflection	_____	_____
Less Than 3/4 Scale Glide Slope Deflection	_____	_____
Airspeed ±10 kts	_____	_____
Properly Identifies MAP	_____	_____

Holding Pattern

Please test the first holding pattern of this flight. Check "yes" or "no" to indicate whether the student's performance met the criteria.

Measure	Desired	Yes	No
Tune and Ident Proper Navaids		_____	_____
Recognizes Arrival at Holding Fix		_____	_____
Initiates Prompt Entry		_____	_____
Uses Recommended Entry Procedure		_____	_____
Properly Reports Entry		_____	_____
From Initial Arrival at Holding Fix to Crossing Fix on 1st Inbound Leg			
Airspeed	±10 kts	_____	_____
Altitude	±100 ft	_____	_____
On Inbound Leg			
Maintains Desired Course	±10°	_____	_____

Number of intersection holds entered to reach Instrument PTS criteria _____

Number of times holding fix crossed from inbound leg (complete turns in holds) _____

Number of ILS approaches performed to reach Instrument PTS criteria _____

Number of VOR approaches performed to reach Instrument PTS criteria _____

Amount of time flown in airplane to reach completion standards _____