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TRANSFER OF LEARNING EFFECTIVENESS: PC-BASED FLIGHT SIMULATION

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ABSTRACT

Sixty college students with no previous flight experience performed a designated aircraft maneuver so transfer of learning between a computer-based training device (CBTD) and an aircraft could be analyzed. Thirty of the subjects were trained in a CBTD before flying; the remaining 30 were taken directly to the aircraft. This study demonstrated a positive transfer of learning between the CBTD and the aircraft: CBTD-trained students took an average of 12 minutes, while the others took 20 minutes to complete the maneuver. The result was a t-value of 5.11 which exceeded the critical t of 2.0, and the transfer of effectiveness ratio formula revealed a 48 percent transfer of learning. Further research is recommended to determine the role of CBTDs in the training of pilots.

TRANSFER OF LEARNING EFFECTIVENESS

PC-Based Flight Simulation

Since 1929, when Edwin A. Link built the first flight trainer, flight simulators and flight training devices have played an increasingly important role in the aviation industry. Link's original purpose was to provide a "safe and inexpensive method for teaching pilots how to fly with the use of instruments" (*Above and beyond*, 1968, p. 852).

Today, over 60 years later, the purpose remains unchanged. The Federal Aviation Administration (FAA) recognizes that the use of flight simulation "results in safer flight training and cost reductions for the operators, while achieving fuel conservation, a decrease in noise and otherwise helping maintain environmental quality" (Federal Aviation Administration, 1992).

With the increasing use of high performance aircraft, flight simulation has gone through an enormous evolution. It has become an integral part of initial and recurrent training from instrument pilot certification to space shuttle crew training (Hallion, 1988). This escalation in flight simulation has been affected by the computer technology explosion, the increasingly crowded skies, scheduling conflicts, the complexity of today's aircraft, and the financial strain under which most aviation companies and flight schools operate.

For years general aviation has enjoyed the advantages of flight simulation as many training devices have been built and approved by the FAA. Modern general aviation training devices, however, though considerably cheaper to operate than the actual airplane, sometimes cost as much as or more than the aircraft itself.

With today's advanced computer technology, software engineers have taken advantage of the faster, more efficient personal computers and have developed several programs that simulate flight. The FAA has not approved any of these software packages for logging of time, however. Furthermore, FAA requirements for acceptable computer simulation are vague at best. Lawrence Basham, FAA general aviation operation specialist, commented at a December 1991 simulator symposium in Atlanta, that "the FAA has evaluated a number of simulation devices in the past decade. While . . . they have many attractive features, there's generally something that precludes each from being found acceptable at present for use by schools operating under FAR Part 61 or Part 141" (Peterson, 1992, p. 76). He says the FAA has not established whether the CBTD is capable of fulfilling current or anticipated requirements.

Several studies involving transfer of learning from simulated to real conditions have been done. Hammerton (1963) performed a study in which two groups of unskilled subjects were trained to control the movements of a trolley moving along a miniature railway. The experimental group was first trained on a CRT, whereas the control group practiced on the real trolley *ab initio*. He found that even though initial transfer was poor, CRT trained subjects required considerably fewer attempts to successfully complete the task on the trolley.

In a more recent study, Lintern, et al (1990) used two groups of beginning flight students from the University of Illinois flight training program. The experimental group was given two sessions of landing practice in a simulator with a computer animated display before going to the real aircraft for landing practice. The control group, on the other hand, went directly to the aircraft. Their research showed that experimental students required significantly fewer pre-solo landings in the airplane, representing a potential savings of about 1.5 pre-solo flight hours per student.

Similar to Hammerton's and Lintern's transfer of learning assessments, the purpose of this study was to determine whether AzureSoft's Electronic IFR Training Environment (ELITE) software program affords transfer of learning when used in conjunction with an actual training aircraft. Based on preliminary discussions, research, and literature review, a positive transfer of learning between the CBTD and the aircraft was expected.

METHOD

Subjects

Sixty individuals from the Introduction to Aviation (AVIA 104) class at Andrews University volunteered for the project which was conducted from September to June of the 1991-1992 school year. Only students with no previous aircraft piloting experience were allowed to participate. The subjects, whose ages averaged 21.7 years, were randomly divided into two even groups: an experimental group (Group 1), and a control group, (Group 2).

Apparatus

Personal computer: Zenith ZBO 3303 GQ (386-16 Mhz)
Video display: Artview 14" Super VGA Color Monitor
Control Interface: CH Flightstick and Maxx rudder pedals
Software: ELITE
Aircraft: Cessna 150/152

Procedure

The maneuver chosen was a squared pattern involving flying north, east, south, and west headings for 1.5 minutes each, with right turns at the end of each leg, and a 450 degree turn to the right after the west leg, ending on a north heading.

The subjects were required to perform the entire maneuver with only verbal assistance from the instructor, and within the following limits:

Altitude:	$\pm$	100 Feet
Heading:	$\pm$	10 Degrees
Bank angle:	$\pm$	10 Degrees

Subjects in Group 1 were trained in the CBTD until reaching the stated minimums and then taken to the actual airplane to perform the maneuver to the same limits. Subjects in Group 2 were taken directly to

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Table 1
Mean, Standard Deviation, and Standard Error

Group	Number of Cases	Mean	Standard Deviation	Standard error of Mean
1	30	12.3767	24.457	.814
2	30	20.3939	7.347	1.341

Table 2
Variance Estimate

t-value	Degrees of Freedom	2-tail probability
5.11	48	.000

the airplane and given the same instructions as Group 1. In order to minimize instructional technique variances, the same certified flight instructor flew with all students in both groups.

The instructor recorded total time in minutes and seconds taken by each subject to perform the maneuver, and the maneuver was restarted each time the subject exceeded the stated limits. Transfer of learning was analyzed by using the *t*-test at the .01 level of confidence and the transfer effectiveness ratio (TER).

Limitations

This study had the following limitations: First, since the flight was dependent upon weather conditions and scheduling, the time lapse between the simulator session and the actual flight varied for each subject in the group.

Second, flights were performed only in smooth weather conditions.

RESULTS

The overall average time in minutes and seconds for the experimental group was 16:48 (CBTD) and 12:23 (airplane), and for the control group 20:23 (airplane).

***t*-Test**

The *t*-test was used to determine whether the difference between means was significant. If the hypothesis test is to be statistically significant at the .01 level, the calculated *t*-value must exceed the critical *t* of 2.00. **Table 1** shows the mean, standard deviation, and standard error of the mean.

Because the standard deviations of the populations from which these two groups were selected were significantly different (F=2.72, P=.009), a non-pooled variance estimate was used, as shown in **Table 2**.

The above results indicate that the experimental group had a shorter aircraft time requirement that was statistically significant at less than the .01 level.

Transfer Effectiveness Ratio (TER)

In a 1989 study at Bowling Green State University, David A. Lombardo (unpublished) concluded that one hour of practice on a computerized training device saved the student approximately 23 minutes of comparable time in the Link GAT I flight training device.

Lombardo used the following TER formula developed by Stanley N. Roscoe (1980):

TER = Yc - Ye / Xe

Where:

Yc = Average time in minutes required by control group to reach criterion in the GAT I.

Ye = Average time in minutes required by experimental group to reach criterion in the GAT I.

Xe = Average time in minutes required by experimental group to reach criterion in the computerized training device.

The same formula can be applied to the present study, with the exception of using the training aircraft instead of the GAT I.

TER = Yc - Ye / Xe
TER = (20.39 - 12.38) / 16.80
TER = 0.48

The above result implies that one hour of practice on the ELITE saves the student approximately 29 minutes in the training aircraft.

DISCUSSION

The calculated *t*-value far exceeded the critical *t*-value for statistical significance, showing that there was a significant variation in the performance of both groups, indicating that the observed differences in the means did not occur by chance.

The TER (0.48) rendered a positive transfer of learning from the CBTD to the aircraft. This implies that there is a transfer of learning equal to 48 percent.

The experimental group had a definite advantage over the control group. The working hypothesis, therefore, should be accepted since the transfer of learning was positive, and it was confirmed that the ELITE CBTD is effective as a teaching tool for the training of pilots.

The FAA has not approved this particular package or any other on the market today, so the time spent on the CBTD cannot be counted for any certificate or rating.

It is recommended that more research be done by the FAA and institutions of learning using other software/hardware combinations to conclusively determine how best to utilize CBTDs for initial and recurrent training.□

Gustavo A. Ortiz earned his Bachelor of Technology in Aviation and his Master of Sciences in Administration at Andrews University. He holds several FAA licenses and ratings, and is currently employed in the Department of Aviation at Andrews University in the position of Aviation Technology teacher and assistant chief flight instructor.

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