Effect of Active Learning on Instrument Rated Pilots’ Knowledge and Self-Efficacy

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EFFECT OF ACTIVE LEARNING ON INSTRUMENT RATED PILOTS’ KNOWLEDGE AND SELF-EFFICACY

Robert Thomas, Ph.D.
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My Background

- Pilot Experience
  - ATP & Gold Seal CFI
  - 3000+ hours
  - 15+ years
  - Part 141 Check Instructor

- Created Special VFR Productions
  - Produced video and online training aids for the flight department

- Assistant Professor, Aeronautical Science Department ERAU
Introduction & Purpose

• Examined the effect of active scenario-based training on the knowledge and self-efficacy of instrument rated pilots who were not instrument current

• Validated the potential of using at-home personal computer scenario-based flight simulation for instrument currency
Significance of the Study

- Investigate the effectiveness of a carefully designed active learning experience on a personal computer
  - SBT approach
- If effective, pilots could use SBT lessons on any personal computer
  - Take advantage of new and updated training technologies
Hypotheses
3 Experimental Groups

1. Read group – Passive Training Module

2. Fly Only group – PC flight sim P3D flying 4 approaches

3. Fly and Decide group - PC flight sim P3D flying 4 approaches and making decisions
Hypotheses

After completing a lesson about IFR and missed approaches:
1. Better Performance on Knowledge Test
   1. Overall
   2. Active Learning better than passive learning
2. Increased Self-Efficacy
   1. Overall
   2. Active Learning better than passive learning
3. Participants in the active learning methods will have a higher satisfaction of training
Review of Relevant Literature
Passive vs. Active Learning

**Passive Learning**

- Conceptual knowledge
- Facts and theoretical principles which act as building blocks upon for future lessons

- Examples:
  - Reading
  - Instructor Centered Event – Lecture

- Wingfield & Black, 2005

**Active Learning**

- Engages the learner more directly in the learning process
- Learner-centered event
  - SBT

- More effective because:
  - the learning experience is considered to be more intense
  - has a more permanent affect
  - better critical thinking skills
  - higher knowledge retention

- Jones & Jones, 1998
Dale’s Cone of Experience (1969)

- Learners will retain more information by doing a task as opposed to just reading or hearing about that task

- Treichler’s percentages of how much students will retain (1967)
Self-Efficacy

- A person’s individual belief and confidence in their ability to perform both physical skills and higher-order thinking skills

- Powerful mastery experiences can serve as a transformation point in personal efficacy beliefs

- Evidence has shown that a high level of self-efficacy beliefs equates to a high level of motivation and performance of an individual
  - Bandura, 2000; Zimmerman, 2000; Zimmerman & Kitsantas, 2005

- Overconfidence leads to situations where an individual may not devote enough resources to a task to complete it successfully
Measuring Training Effectiveness

- Kirkpatrick’s four-level training evaluation model (2006):
  1. Reactions to training
  2. Learning – knowledge and self-efficacy changes
  3. Behavior – how learners will apply knowledge after training
  4. Results – benefits to organizations or businesses
Methodology
Research Approach

- Quantitative study
- 3 x 2 mixed design
  - Three between subject groups - varying levels of active learning
  - Two within-subject levels of progression
    1. Pre-Training
    2. Post-Training
The Training

- P3D participant desktop test-bed
  - Windows based PC
- Lockheed Martin Prepar3D software
- Saitek Cessna Yoke and Throttle Quadrant
First Training Activity – Instrument Knowledge

- All three experimental groups received the same computer-based training

- Narrated slide based presentation
  - Identifying minimum altitudes on an instrument approach chart
  - Approach categories and speeds
  - Descent rates
  - Visual descent points
  - 14 CFR 91.175, specifically landing from an Instrument Approach Procedure
  - Required visibility on approaches
  - Components of the landing environment
  - Fuel consumption considerations
  - Selecting an instrument approach based on current weather conditions
  - A guided example using instrument approach charts and weather reports
Second Training Activity

- The second training activity differed between the three groups.

- Each group received a different training method with varying levels of active learning.
  1. Read Group - passive learning
  2. Fly Only Group - active learning
  3. Fly and Decide Group - highest degree of active learning
Read Group

• Passive learning

• Read a selection of material from FAA publications relating to instrument approaches and missed approaches
  ▫ 14 CFR 91.175
  ▫ FAA’s Instrument Flying Handbook
  ▫ FAA’s Instrument Procedures Handbook
Fly Only Group

• Active learning - flying 4 simulated approaches on P3D software

• Airplane was placed 5nm prior to the Final Approach Fix

• Participant provided airport weather info for the approach
  ▫ Both text and audio

• Approach flown until landing or missed approach point where simulation ended and next approach began

• If the participant exceeded approach tolerances (off course/altitude) Simulation would pause and reset allowing one additional attempt
Fly Only Group
Fly and Decide Group

- Highest degree of active learning
  - flying 4 approach scenarios requiring decisions

- Similar process as the fly only group

- However, if the participant performs a missed approach the simulation pauses and:
  1. The participant was presented with 4 alternate airports and the weather for each
  2. Asked to select which airport would allow the best chance for a legal landing
  3. After selection, participants were provided feedback on their choices
Fly and Decide Group
Results
Demographic Information

- The sample consisted of 60 instrument rated pilots that were not instrument current
- 55 were male and 5 female
- Age - 19 to 81
- Total flight hours - 160 to 7250 hours
- Experience - 3 years to 50 years
- Various training and geographic backgrounds
- 19 held a private pilot certificate
- 41 held a commercial pilot certificate
  - 31 of the commercial pilots held a flight instructor certificate.
Knowledge Test Scores - possible scores ranging from 0 to 30

Pre-Training Knowledge Score ranged from 15 to 27 with a mean score of 22 (SD = 2.732).

Post-Training Knowledge Score ranged from 19 to 30 with a mean score of 26 (SD = 2.023)
Hypotheses 1 and 2

• The ANOVA determined that the main effect of training on knowledge scores between pre-training and post-training was significant
  ▫ $F(1, 57) = 184.977, p < .001, \eta^2 = .764$.

• The interaction effect between training type and knowledge scores did not have a significant effect
  ▫ $F(2, 57) = 2.038, p = 0.140, \eta^2 = .067$. 
Hypotheses 1 and 2

- Hypothesis 1 is supported
- Hypothesis 2 is not supported

Mean knowledge test scores by experimental group

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-Training Knowledge</th>
<th>Post-Training Knowledge</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>21.40</td>
<td>25.55</td>
<td>4.15</td>
</tr>
<tr>
<td>Fly Only</td>
<td>21.55</td>
<td>25.90</td>
<td>4.35</td>
</tr>
<tr>
<td>Fly and Decide</td>
<td>23.05</td>
<td>26.10</td>
<td>3.05</td>
</tr>
<tr>
<td>Total</td>
<td>22.00</td>
<td>25.85</td>
<td>3.85</td>
</tr>
</tbody>
</table>
Self-Efficacy Scores- possible scores ranging from 0 to 1700

Pre-training self-efficacy scores ranged from 474 to 1660 with a mean of 1198.87 (SD = 329.424)

Post-training self-efficacy scores ranged from 760 to 1697 with a mean of 1350.13 (SD = 252.550).
Hypotheses 3 and 4

• The ANOVA for the main effect of training on self-efficacy score was significant
  ▫ $F(1, 57) = 299.409, p < .001, \eta^2 = .840$

• The ANOVA interaction effect between training type and self-efficacy scores was also significant
  ▫ $F(2, 57) = 7.883, p < .001, \eta^2 = .217$. 
Hypotheses 4

- 3 independent samples t-tests were conducted

- Bonferroni adjustment was applied to the p-value
  - original p-value of .05 was divided by 3 and a new p-value threshold of .017

- Only one t-test was significant
  - The increase in post-training self-efficacy score of the Fly and Decide group was significantly larger than the increase in self-efficacy of the Read Only Group
    - $t(38) = -2.653, p = .012, r = .395$. 
Hypotheses 3 and 4

- Hypothesis 3 is supported
- Hypothesis 4 is partially supported

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-Training Self-Efficacy</th>
<th>Post-Training Self-Efficacy</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>1035.25</td>
<td>1241.15</td>
<td>205.90</td>
</tr>
<tr>
<td>Fly Only</td>
<td>1052.75</td>
<td>1342.45</td>
<td>289.70</td>
</tr>
<tr>
<td>Fly and Decide</td>
<td>1049.20</td>
<td>1416.80</td>
<td>367.60</td>
</tr>
<tr>
<td>Total</td>
<td>1045.73</td>
<td>1333.47</td>
<td>287.73</td>
</tr>
</tbody>
</table>

**Mean self-efficacy scores by group**
Hypothesis 5

- Participants in the Fly Only and Fly and Decide group will have a higher satisfaction of training compared to participants in the Read group.
- The overall reaction to the training was positive
- Mean overall score of 6.33 (SD = 0.184).
- One-way ANOVA conducted
  - there was no significant difference in the reaction score between groups
    - $F(2, 58) = .505, p = .612 (r = .050)$
- therefore Hypothesis 5 is rejected.
Conclusions and Recommendations
Missed Approaches

• Performing a missed approach due to weather conditions does not occur often.
  ▫ 60 participants reported flying a total of 17,566 instrument approaches
  ▫ Only 11 of the participants performed a missed approach due to weather
    • Estimated total of 123 approaches
    • 0.7% of the total approaches

• The low frequency from this sample highlights the potential for a lack of pilot proficiency and, therefore, the need for refresher training on missed approaches and decision making.
Knowledge Scores

• All 3 training types increased knowledge scores

• No significant difference between the 3 groups
  ▫ Conflicts with the literature

• Highlights the effectiveness of the first-training activity

• Indicates the second training activity did not effect knowledge gain

• The style of the first training is an effective method refresher training of GA pilots instrument knowledge
Self-Efficacy Scores

- All 3 training types increased self-efficacy score
  - Significant difference in the increase of post-training self-efficacy score between the Fly and Decide Group and the Read Only group

- The type of training provided in the Fly and Decide group was an effective way for a pilot using SBT on a personal computer to increase self-efficacy.
Self-Efficacy Scores

- 6 participants reported a lower self-efficacy after the training

- Some of the comments:
  - “I didn’t realize how much I had forgotten”
  - “My memory isn’t as good as it used to be.”

- In some cases the training helped to reset the participant’s self-efficacy to the correct level and reduce an over-confident state.
Reaction

• All participants reported a positive reaction during the training

• many of the participants felt that the simulation and scenarios were:
  ▫ “realistic”
  ▫ “had enough detail to knock the rust off”
  ▫ “the missed approaches were a good way to make me think what would come next.”

• Several asked for more information about the hardware and software used
Recommendations for Future Research

• Conduct a similar study however add additional time intervals to test longer term retention

• Test pilots from other geographic regions

• Test with simpler flight control setup (joystick) to see if same effect occurs
  ▫ How much skill transfers from at-home setup to the airplane

• Test various levels of fidelity in the SBT scenario to see how much level of detail is needed to produce a positive effect
Conclusions

• This study validated the potential of at-home personal computer based SBT
  ▫ Enjoyable way to review and refresh instrument pilot instrument knowledge
  ▫ Improve self-efficacy
  ▫ Without the associated cost and availability of an airplane

• A properly designed lesson was proven to increase knowledge in instrument rated pilots regardless of the level of active learning that took place.

• The varying levels of active learning that participants experienced had an impact on the increase in post-training self-efficacy.

• Increased self-efficacy may result in improved pilot performance

• In the future, further scenario development and an online repository of personal computer flight simulation scenario files could be created to allow pilots to download and fly instrument SBT at home on a regular basis to increase knowledge and self-efficacy
Questions & Thank you