EVALUATING THE EFFECTIVENESS OF SCENARIO BASED TRAINING IN THE COLLEGIATE FLIGHT TRAINING ENVIRONMENT

Final Report
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OVERVIEW

This report describes the results of two mini-grant projects assigned under *Task 4, FITS [FAA/Industry Training Standards] Joint Training Standards Development for New Technology General Aviation Aircraft, Second Follow-On.* Task 1 involved conversion of the University of North Dakota's (UND) current Part 141 Private Pilot Syllabus from Maneuver Based Training (MBT) to Scenario Based Training (SBT). Task 2 then applied these Scenario Based techniques to students receiving private pilot instruction at UND during the summer of 2006, and compared their performance with a similar group of students who received traditional Maneuver Based Training during the same period.

The purpose of this research was to further evaluate the effectiveness of SBT as one of the key tenants of the FITS philosophy. Previous research conducted at UND (Robertson, Petros, Schumacher, McHorse, & Ulrich: 2006), Embry-Riddle Aeronautical University (ERAU) (French, Blickensderfer, Ayers, Connolly: 2005) and Middle Tennessee State University (MTSU) (Craig, Bertrand, Dornan, Gossett, &Thorsby: 2005 and Dornam, Craig, Gossett & Beckman: 2006) suggests that FITS training methods enhance pilot situational awareness, aeronautical decision making, and development of basic stick and rudder skills. However, Principal Investigators involved in these initial studies agreed that results were inconclusive and that more research was necessary.

Several factors contributed to the inconclusiveness of these previous studies:

#1. The UND and ERAU studies were conducted in laboratory environments using computer based simulators and training syllabi specifically created for those studies. Thus a lingering question remained: Even though SBT showed enhanced performance in this limited research environment, would it necessarily work in an operational environment using actual aircraft and an existing FAA approved syllabus?

#2. Data collected in the MTSU studies showed that students who trained under the FITS methodology experienced fewer setbacks (repeat lessons) when compared to students trained under the typical maneuver-based philosophy. However, no direct comparisons of training costs could be made because each group trained under a different syllabus with different total lessons and varying lesson requirements. General aviation instructors often voice concern that SBT, by its very nature, requires significantly more training time (longer individual flight lessons, more dual-given ground training time, etc), and thus is more expensive than MBT. Members of the FITS team agreed that additional research was necessary to specifically evaluate the difference in training time (and ultimately, costs) between SBT and MBT.

BACKGROUND

UND's current flight training is predominantly maneuver based, which means that the overall skill of piloting an aircraft is broken down into individual sub-skills or sub-tasks, with each sub-task having defined criteria for satisfactory execution. Students are then taught these sub-tasks.

One of the problems with this method of training is that new pilots can often master the individual sub-tasks, but have difficulty correlating these maneuvers with activities required in the real-world flight environment. Scenario Based Training, on the other hand, does not focus on the sub-tasks, but instead teaches the whole flight profile through the use of realistic flight scenarios. These scenarios are actually scripted lessons that present the same sub-tasks as maneuver based training, but introduces them within the context of a realistic flight. The additional realism provided by these scenarios is believed to create a better learning environment for the student and present more real-world decision making opportunities to accelerate development of judgment and decision making skills.

RESEARCH QUESTIONS TO BE ANSWERED

1. Do students trained using SBT methods perform better than students trained under MBT when both groups train under the same syllabus and in the same aircraft?

2. Do students trained using SBT methods display better Aeronautical Decision Making skills compared to students trained under MBT?

3. Does SBT require more training time than MBT?

RESEARCH METHODOLOGY

SBT Study Supplement

This study was conducted within a 14 CFR Part 141 approved training program using an existing FAA approved syllabus. Because of this, all students, regardless of whether training under SBT or MBT, were required to use the Part 141 syllabus as their primary guide for training. Therefore, to provide expanded guidance for the SBT students and instructors, it was necessary to create an *SBT Supplement/Instructor Guide*. (ATCH 1) This supplement was used in conjunction with the regular syllabus to provide direction and guidance for scenario based training.

Scenario development was a critical step in creation of this supplement. Flight instructors are often encouraged to create their own scenarios tailored to individual student needs and requirements. However, for this study researchers felt that stronger guidance was necessary to standardize training for research purposes. To provide sufficient direction for instructors unfamiliar with SBT concepts, three criteria were applied to scenario development:

#1. Each lesson must involve a flight from one airport to another. This puts training in a realistic context because aviation, after all, is primarily a means of transportation—transporting

people or goods from one place to another. By conducting training in a realistic context, students are able to more readily correlate events that occur in flight with real world activities. This also gives the training greater fidelity, which tends to enhance the learning process.

#2. All maneuvers or sub-tasks listed in the Private Syllabus must be *introduced* (accomplished for the first time) during a realistic scenario. Take for example the Steep Turn. The lesson scenario must include a realistic situation that requires execution of this maneuver—perhaps for traffic avoidance. As a result, the student readily correlates when a steep turn would be used in the real world and also experiences realistic consequences if not performed properly. This does not preclude maneuver based or "drill and practice" instruction. There may be occasions when "drill and practice" is necessary to teach fundamental skills (like the mechanics of a Steep Turn), but overall training is more effective or intuitive when conducted within a real world context.

#3. Scenario lessons must begin with a "reason to go" (a purpose or mission)—just like real world air travel. Because each flight has a purpose, every decision made during execution of the flight has consequences that impact the overall success or failure of the mission. This allows students to readily correlate how their in-flight decisions impacted mission accomplishment, and thus enhances development of decision making skills.

Several examples of scenario lessons are included in ATCH 2.

Study Groups

This study involved students enrolled in Aviation 102--Private Pilot Certification during the 12-week summer semester of 2006. An extra-credit incentive was offered to participate. Of the 37 students enrolled in Aviation 102, 30 students volunteered to participate in the study, with 14 assigned to the SBT Group and 16 assigned to the MBT Group. Ages ranged from 18 to 26 years old.

Assignment of the subjects to either the SBT Group or the MBT Group was determined by the individual student's choice of flight lab time. Before recruitment began, the flight labs available for student selection were designated as either SBT or MBT and included both a launch time and an instructor. The goal of this flight lab division was twofold: 1) to have an equal distribution of MBT and SBT flight labs throughout the day, and 2) to have two groups of instructors who would be assigned to teach either SBT or MBT. By designating an instructor as either SBT or MBT, researchers hoped to eliminate any bleed-over of scenario based techniques into the training received by the maneuver based group. The distribution of flight labs was essential to ensure that any difference in performance between the two groups was not due to confounding variables, such as traffic density, general weather patterns, or ground school classes. In addition, both groups were subject to identical flight time constraints driven by the standard two-hour launch window.

To ensure equality between the two groups, participants completed two basic aptitude tests: the Vandenberg Test of Mental Rotation and the Weschler Adult Intelligence Vocabulary Test.

Flight instructors used in this study were employees of the John D. Odegard School of Aerospace Sciences. They were assigned to the flight labs in a random fashion with 15 instructors in the SBT group and 18 in the MBT group.

Each instructor group received a one-hour training session designed to define and explain the methodologies of each type of training. The SBT group's training session consisted of an explanation of the FITS concept, basic study design, the philosophy of SBT, and detailed explanations and examples of how to incorporate the *SBT Supplement/Instructor Guide* into their daily teaching activities.

The MBT group's training session explained the basic study design, defining SBT versus MBT, and the importance of providing training that was maneuver based. Because MBT is the standard methodology employed at UND, no additional training supplements or materials were developed for the MBT instructor group.

For the purpose of maintaining research integrity, instructors in one group were prohibited from allowing instructors from the other group, or instructors not involved in the study, to provide training to their students. Even though temporary instructor changes among the 200-person instructor group are a routine practice, temporary fill-ins outside a particular group were not allowed during this study. A website, email list, and phone directory were developed to enhance coordination within each group.

Data Collection Methods/Procedures

This study evaluated the differences in student performance between SBT and MBT in the following areas:

Ground and Flight Training Times

UND's Private Pilot curriculum is proficiency based. Therefore, one measure of student performance is the amount of training time required to progress through the 30 syllabus lessons, which are divided into three separate blocks of training: Block 1-Pre-Solo, Block 2-Cross-Country, and Block 3-Stage Check Preparation. Each block includes pre- and post-lesson briefing time, Flight Training Device (FTD) time, and actual aircraft time. Researchers were provided access to AIMS (UND's computer based Aviation Information Management System) which records student training times and were able to compare these times between the SBT and MBT groups.

Repeat Lessons

Another means to evaluate performance is by comparing the average number of repeat lessons per student within the two groups. A higher number of repeat lessons would indicate slower progression through the curriculum. Lessons are recorded in AIMS as Satisfactory, Incomplete, or Review. A lesson is identified as Satisfactory when all tasks for a particular lesson have been completed to the standards listed in the AVIT 102, Edition 9, Private Pilot Syllabus. A lesson is marked as Incomplete if one of the tasks fails to comply with the listed completion standards, or if one of the required tasks is unable to be completed. Finally, a lesson is identified as Review

when the lesson is attempted again after all required tasks were previously marked as satisfactory. For the purpose of this study, all lessons recorded in AIMS as Incomplete or Review were counted as a repeat lesson as either grade would indicate slower than normal progression.

Stage Check Performance

To complete Private Pilot training students must complete three stage checks. The three stage checks or practical exams (Stage 14, Stage 26, and Stage 30) are administered by a select group of instructors and consist of an oral and a flight portion with applicable tasks. After the stage check each required task (as listed in the syllabus) is marked by the designated stage check pilot as Not Attempted, Unsatisfactory, or Satisfactory and recorded in AIMS. A comparison can then be made of the average number of unsatisfactory tasks per stage check between the two groups. A lower number of unsatisfactory tasks would indicate enhanced performance.

Aeronautical Decision Making - Pilot Judgment Test (PJT)

A 51-item PJT developed by Dr. Hunter of the FAA (Hunter, 2003) was used in the study to measure Aeronautical Decision Making (ADM) skills. Each test question presented a problem related to a particular flight scenario and subjects were asked to rank order four plausible solutions. Tests were then corrected by comparing student answers to those provided by Dr. Hunter's expert group who rank-ordered the plausible solutions based upon what they felt a VFR-rated private pilot with 500 hours total time should do under the circumstances presented.

The test was administered to the Private students after completion of Lesson 29--the last lesson before the final stage check. In accordance with scoring methods used by Dr. Hunter, subjects whose first choice matched the first choice of the expert group received one point, for a maximum possible score of 51. Total scores for each participant and mean scores for each group were determined and then compared between groups.

GPS Tracks on Final Stage

In an effort to objectively evaluate and compare the airmanship skills of subjects in each group, a Pilotage and Dead Reckoning leg on each participant's final stage check was recorded by an independent hand-held GPS receiver. Performance comparisons were then made between groups.

All subjects on Stage 30--Final Stage Check were asked to plan the same cross-country involving a direct route from Grand Forks, North Dakota to St Paul, Minnesota. GPS tracking was conducted during the first 25-mile portion of the route. Subjects were allowed to use any radio navigation aid they desired to help get on course. One minute after getting on course, the stage check pilot took away all navigation aids and asked the subject to navigate using pilotage and dead reckoning only. Ground tracks were saved in the GPS for later analysis utilizing the MapSource PC software developed by Garmin. MapSource allowed the recorded tracks to be compared to the desired course at 15 pre-determined points. Deviations were recorded in tenths of a mile and rounded to the nearest whole tenth.

DATA EVALUATION

This study compared the performance of the SBT group to that of the MBT group using the Statistical Package Software System (SPSS) data evaluation software. Because each group received a different research treatment, data was particularly suited to evaluation using the Independent Groups T-Test methodology. A statistically significant variation in any measure was identified when there was a 95% or greater probability that the variation occurred because of the research treatment (application of either SBT or MBT methods).

Group Equality

To ensure that SBT and MBT student groups had similar capability, a comparison of the two groups was made regarding age, previous flight time, aviation experience, and aptitude. This information was collected from a Student Questionnaire administered before training began (ATCH 3) and through two basic aptitude tests. The GROUP EQUALITY table shows the number of participants in each group (*n*), the mean score in each measure (*M*), plus the standard deviation (*SD*), and "t". The MENTAL ROTATION AND VOCABULARY TEST table shows the results of the basic aptitude evaluations. No significant variation between groups was detected, thus for research purposes, both groups were considered essentially equal in flight aptitude and experience.

GROUP EQUALITY

Measure	*n*	*M*	SD	*t*
Age				
MBT	16	19.38	1.746	-1.627
SBT	14	20.64	2.499	
Logged Flight Time				
MBT	16	2.64	6.375	0.022
SBT	14	2.57	9.621	
Un-logged Flight Time				
MBT	16	4.26	7.546	0.150
SBT	14	3.71	12.206	
Aviation Experience Level				
MBT	16	2.13	0.885	-0.048
SBT	14	2.14	1.167	
Exposure to Flight Environment				
MBT	16	2.06	0.929	0.504
SBT	14	1.86	1.292	

MENTAL ROTATION AND VOCABULARY TESTS

Measure	*n*	*M*	SD	*t*
Mental Rotation Test				
MBT	15	33.73	8.972	-0.062
SBT	14	33.93	7.908	
WAIS III Vocabulary Subtest				
MBT	15	35.13	9.665	-1.123
SBT	14	38.57	6.345	

Ground and Flight Training Times

As an indication of student performance, a comparison was made regarding the mean training hours required per student to progress through the three individual blocks of training (BLK 1-Pre Solo, BLK 2-Cross-Country, and BLK 3-Final Stage Check Preparation). Training time was broken down into aircraft hours, flight training device hours (FTD), and Pre- and Post- lesson briefing times (Pre/Post). (Please note that the Private Syllabus does not include BLK 3 FTD time.) As can be seen by comparing the mean times for each group (*M*) from the TRAINING TIMES charts, SBT students required less time in every category except Block 1 and 2 FTD times. Statistical analysis, however, showed that these variations were not significant.

TRAINING TIMES—BLOCK 1

Measure	*n*	*M*	SD	*t*
Flight Training Time				
MBT	15	20.547	8.9959	0.465
SBT	12	19.250	3.8787	
FTD Training Time				
MBT	15	2.187	0.2100	-1.344
SBT	12	2.308	0.2610	
Pre/Post Lesson Briefing Time				
MBT	15	14.567	5.8060	0.441
SBT	12	13.725	3.4934	

TRAINING TIMES—BLOCK 2

Measure	*n*	*M*	SD	*t*
Flight Training Time				
MBT	15	22.180	5.9800	0.741
SBT	11	20.345	6.7791	
FTD Training Time				
MBT	15	1.147	0.2560	-0.098
SBT	11	1.155	0.1695	
Pre/Post Lesson Briefing Time				
MBT	15	14.60	5.3063	1.027
SBT	11	12.809	2.6334	

TRAINING TIMES—BLOCK 3

Measure	*n*	*M*	SD	*t*
Flight Training Time				
MBT	13	7.100	1.7156	0.028
SBT	10	7.080	1.7313	
Pre/Post Lesson Briefing Time				
MBT	13	3.169	1.3823	0.0522
SBT	10	2.900	0.3095	

Repeat Lessons

The following table shows the mean number of repeat lessons experienced by the two groups throughout each block of training. Even though the SBT group experienced fewer repeat lessons than the MBT group in all blocks of instruction, the variation between groups was not statistically significant.

REPEAT LESSONS

Measure	*n*	*M*	SD	*t*
Block 1				
MBT	15	6.5	6.164	0.665
SBT	12	5.25	2.34	
Block 2				
MBT	15	7.07	4.636	1.423
SBT	11	4.58	4.337	

Block 3				
MBT	13	1.85	1.281	0.787
SBT	10	1.45	1.128	
Total				
MBT		12.92	8.221	0.56
SBT		11.27	5.729	

Unsatisfactory Stage Check Performance

The following table shows the mean number of unsatisfactory tasks per stage check for each group. Each stage check includes both a ground/oral and flight evaluation. Comparing the number of unsatisfactory tasks was deemed more statistically accurate than simply comparing the number of failed stage checks, as the total number of failed stage checks was too small for statistical validity. As the *All Stages* data indicates, the SBT group experienced less than half as many unsatisfactory tasks as the MBT group. However, because of the relatively small group size, this variation was not statistically significant.

STAGE CHECK PERFORMANCE

Measure	*n*	*M*	SD	*t*
Stage 14 Ground				
MBT	15	0.20	0.775	0.891
SBT	12	0.00	0.00	
Stage 14 Flight				
MBT	15	2.33	4.012	1.631
SBT	12	0.42	0.669	
Stage 26 Ground				
MBT	15	0.13	0.516	-0.611
SBT	11	0.27	0.647	
Stage 26 Flight				
MBT	15	2.00	3.566	0.215
SBT	11	1.73	2.611	
Stage 30 Ground				
MBT	13	0.08	0.277	0.872
SBT	10	0.00	0.00	
Stage 30 Flight				
MBT	13	1.23	3.876	0.999
SBT	10	0.00	0.00	
All Stages				
MBT	13	5.92	6.589	1.618
SBT	10	2.30	2.869	

Aeronautical Decision Making

Mean scores achieved on Dr. Hunter's Pilot Judgment Test were compared between the two groups. A perfect score would have been 51 points. The score for the SBT group was approximately one point higher than the MBT group, but was not enough to be statistically significant.

AERONAUTICAL DECISION MAKING

Measure	*n*	*M*	SD	*t*
PJT Questionnaire				
MBT	8	24.25	8.049	-0.318
SBT	7	25.29	3.200	

GPS Tracking

The following table shows deviations from course centerline during the navigation leg on Stage 30. Deviation is expressed as a ratio of time outside 2NM and 3NM from the desired route compared to total time for the route. *Percent On-Course* is the ratio of time spent within 2NM of the route centerline compared to the total time for the route. Technical difficulties arose when downloading data from the hand-held GPS units and as a result, only eight of 23 final stage checks were scored. As the *Percent On-Course* data indicates, the MBT group deviated less overall from the route than the SBT group, but the variation between groups was not statistically significant.

GPS TRACKING

Measure	*n*	*M*	SD	*t*
Ratio Outside 2nm				
MBT	3	0.26	0.456	-0.310
SBT	5	0.35	0.355	
Ratio Outside 3nm				
MBT	3	0.23	0.398	0.592
SBT	5	0.10	0.228	
Percent On-Course				
MBT	3	0.74	0.456	0.310
SBT	5	0.65	0.355	

DISCUSSION

The accumulated research data shows that students who received Scenario Based Training out-performed the Maneuver Based group in six out of seven measures. Examination of the *Ground and Flight Training Time* data shows that SBT students required 3.1 fewer aircraft hours and approximately 2.9 fewer pre- and post-lesson briefing hours than the MBT group. They also experienced fewer repeat lessons and demonstrated higher performance on stage checks, Aeronautical Decision Making, and dead reckoning navigation. The only area in which the SBT group did not excel was in FTD hours, where they required approximately .13 hours more than the MBT group. Statistical analysis has shown that none of these variations was significant; however, the preponderance of scores favoring SBT implies that Scenario Based Training may have had a positive impact. The data also suggests that SBT can indeed be accomplished without incurring a significant training time penalty, and as evidenced by this study, may actually be accomplished in less overall time.

Regarding pre- and post-lesson briefing times, it is interesting to note that SBT students required .8 hours less than the MBT group in Block 1; and this advantage more than doubled to 1.8 hours in Block 2. A possible explanation for this widening lead on the MBT group between Blocks 1 and 2 is the requirement to front-load cross-country principles to SBT students in Block 1; which then streamlines the presentation of this same information in Block 2 (the cross-country block). The requirement to front-load information when conducting Scenario Based Training is a theme previously acknowledged in other FITS activities.

Even though the results of this study generally favored SBT, more definitive results may have been obtained with a larger sample size. In addition, several other confounding variables may have been present and are worthy of discussion. For example, this study makes the assumption that the teaching abilities between the two flight instructor groups (SBT and MBT) were equal and that instructors conducted their assigned type of training as instructed. However, as previously noted, UND has traditionally employed a maneuver based approach to training, and considering that this study was conducted in an operational environment with a large group of instructors, it was difficult to ensure that SBT principles were fully embraced by the SBT instructor group. It is likely that as the UND instructor group becomes more educated and experienced on SBT concepts, the overall benefits of SBT would be more apparent.

Another factor that may have inhibited scenario based performance was the requirement to conduct SBT while adhering to a Part 141 maneuver based syllabus. It seems logical that training time could be reduced by developing a syllabus that employs SBT from the beginning, allowing course developers to select maneuvers that blend more favorably into a particular scenario—rather than converting a maneuver based lesson into a scenario. It should also be noted that both MBT and SBT students were evaluated in accordance with the current FAA Private Pilot Practical Test Standard (PTS)--which is maneuver based. To complicate matters, students were also evaluated on their adherence to UND standard set-up procedures for each maneuver. As one instructor explained, "*Missing these items will get them in just as much trouble on the stage check as fumbling the maneuver."* Instructors, therefore, had to ensure that their students received sufficient "drill and practice" to pass the stage check successfully. This

undoubtedly had an additional negative impact on SBT training times. Researchers predict that a stand-alone SBT syllabus, in conjunction with a scenario based PTS, would enhance the SBT advantage.

In addition to the statistical analysis, it is also interesting to consider qualitative feedback that researchers acquired through interviews with SBT instructors conducted during both the early stages of student training and at the end. The purpose of these interviews was to assess instructor opinions regarding scenario based training and to ensure some level of standardization in methodology. Here is a compilation of some of their responses:

Have you experienced any positive aspects of Scenario Based Training?

"I like it. Student likes it—seems more motivated than previous students. Learns good from SBT methods."

"Yes, my student seems to possess better judgment, and make decisions based on the goals of the flight and not just on what I want to hear. In the past, the decisions the student would make would have no basis. Now the decisions do because the student has somewhere to be or a reason to make the flight."

"I think it gives the student an idea of why we do some of the maneuvers and gets them into the mindset that when they fly outside of UND that things aren't going to be the same."

"It was good to talk about some weather decisions in marginal weather, because the majority of the summer has been great weather and my student has not had to make tough weather decisions.

"The (improved) correlation level on most of my students was noticeable, for most of the questions I asked."

"Student seems to learn better. Seems more enthusiastic—looks forward to each lesson (may also be because he's an engineering major and taking Private Pilot as a focus area)."

"Much more realistic in that each flight had a purpose. Just like in the real world, you almost always have a purpose to fly—not just to tool around in the local area around your home airport."

"I really like SBT. The pace is starting to pick up—not requiring as much additional time as earlier. Student will be on cross country phase by this Friday."

"I'm really starting to see the benefits of SBT. Student seems more excited about flying than some of my earlier maneuver based students---maybe because he sees the purpose of everything we practice. He's progressing rapidly now on each lesson—again, because a lot of the stuff was front loaded during the early stages. I like SBT."

"Students like SBT because it shows a purpose for each maneuver, and they are more enthusiastic about their training because of this."

Did you experience any negative aspects of Scenario Based Training?

"You run out of time when restricted to UND's two-hour launch window--especially when you try to taxi to the ramp and shutdown every time you go to another airport. When I have to make the choice to either let the student do one or two more landings, or have enough time to taxi to the ramp—I will almost always choose to let the student do the landings."
Note: One of the challenges researchers experienced was convincing the instructors that they still had the flexibility of choosing whether to follow the scenario religiously, or adjust the scenario based on student progress/requirements. Even though we encouraged them to taxi to the ramp as a signal of "mission accomplished", we also emphasized that this was to be based on "time and conditions permitting". This is simply one of the challenges we encountered in "getting the word out".

"It takes a significant amount of time and effort to employ all the things in each scenario, and it can be somewhat distracting. It also takes more time at the beginning of each lesson to explain what will be done, which is fine, but there are days when you just don't have any extra time."

"No. You are still able to drill and practice where needed, and that comes in handy."

"It took some of the students a while to "go along" with the scenarios. It also seemed at times like the only thing on their minds was keeping the airplane upright, and I would have to ask technical questions they did not comprehend that early in their training."

"I don't think that there needs to be a scenario for absolutely every maneuver. I think that some maneuvers should just be introduced as maneuvers, such as ground reference maneuvers for example."

"It's a little confusing figuring out how everything is supposed to work, especially because most everything we do here at UND is maneuver based."

"Student does not get as many opportunities to practice individual maneuvers (because they are done during scenarios), and even though the student may master the "maneuver", he misses opportunities to practice the setups—like clearing turns, boost pumps on, proper configuration, etc—all the other things that UND expects them to do in conjunction with the maneuvers. Missing these items will get them in just as much trouble on the stage check as fumbling the maneuver. For this reason, it is hard for the instructor to figure out how to get the student up to speed for the stage checks (without using additional time for maneuver training)."

"Student is often clueless about some of the details presented in scenarios—like Lesson 8 calls for clouds broken to overcast at 4000—I had to explain to him that 4000 means AGL, and that broken to overcast means it's a ceiling. This all takes more time."

"SBT seems to be working okay. But it takes longer to get each lesson done. It's hard to get away from maneuver based training when you are preparing the student for a checkride that will be maneuver based. I have a responsibility to the student to teach him what will be expected on the stage."

"I like SBT, but feel it should not be introduced until the second block because I like to keep things really basic in the beginning."

"Some of the scenarios have too much to do on each lesson (especially for a weaker student). For example, a weaker student might be struggling with just the basics (like maintaining their altitude during cruise) and to add anything else at this time (like a discussion of the weather at their destination) is just overwhelming. Scenarios should offer more flexibility."
Note: Scenarios were provided to give the instructors a "playbook" to go by, especially considering that SBT is a new concept at UND and many instructors were unsure of how to construct an SBT lesson. An instructor familiar with SBT could obviously create his own scenarios—tailored specifically for a certain student (based on individual student needs).

SUMMARY

This study compared the performance of Private Pilot students trained under scenario based concepts with students trained using traditional maneuver based techniques. The Scenario Based students out-performed the Maneuver Based students in six of the seven research measures. Though the variation between groups was not statistically significant, the positive trend in accumulated data, in conjunction with highly favorable instructor comments, does suggest that Scenario Based Training had a positive impact on student performance. Additionally, a comparison of the required training times between SBT and MBT students showed that Scenario Based Training can be conducted without incurring a penalty in training time or cost. Researchers are confident that further studies, incorporating a larger sample size, in conjunction with refined instructor standardization and curriculum guidance, would enhance the SBT advantage.

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DEFINITIONS

Cross Country Time. Time acquired during flight conducted by a person who holds a pilot certificate conducted in an aircraft that includes a landing at a point other than the point of departure and that involves the use of dead reckoning, pilotage, electronic navigation aids, radio aids, or other navigation systems to navigate to the landing point. (FAA 2006, FAR/AIM).

FAA/Industry Training Standards (FITS). A joint government-stakeholder initiative designed to reduce the total number of general aviation accidents. (Glista, 2006)

Flight Training Device (FTD). A device that is a full size replica of the instruments, equipment, panels, and controls of an aircraft, or set of aircraft, in an open flight deck area or in an enclosed cockpit, including the hardware and software for the systems installed, that is necessary to simulate the aircraft in ground and flight operations. (FAA 2006, FAR/AIM).

Maneuver Based Training (MBT). The flight and ground training that involves the teaching of specific maneuver tasks, traditional GA training method (Robertson et al., 2006).

Scenario Based Training (SBT). A training system that uses a highly structured script of "real world" scenarios to address flight-training objectives in an operational environment. (Ayers et al., 2005)

Technically Advanced Aircraft (TAA). A general aviation aircraft that combines some or all of the following features: advanced cockpit automation system (moving map GPS/Glass Cockpit) for IFR/VFR flight operations, automated engine and systems management, and integrated auto flight/autoflight systems. (FAA 2006, FITS Master Instructor Syllabus).

ATCH 1

SCENARIO BASED TRAINING SUPPLEMENT/INSTRUCTOR GUIDE
To be used in conjunction with:
AVIT 102—Private Pilot Airplane – SEL Certification Course, Edition 9

Purpose: The purpose of this study is to validate the effectiveness of Scenario Based Training (SBT) when applied to UND's Part 141 Private Pilot Course. The data collected from this study will help support the benefits of SBT as a major component of the FAA Industry/Training Standards (FITS) program.

Background on FITS: As you are probably well aware, there is a movement in the FAA and the flight training industry to abandon conventional training methods that rely on the teaching and evaluation of specific maneuvers. Professionals in the industry have come to the realization that maneuver based training fails to fully prepare pilots for real-world flying—especially in the areas of decision making and judgment. Therefore, the FAA spawned the creation of FITS, which advocates Scenario Based Training, Single Pilot Resource Management (SRM) and Learner Center Grading as the preferred format to improve development of aeronautical decision making skills. It is the feeling of many industry professionals that FITS will become the new way of training general aviation pilots. The FAA is eagerly integrating the FITS philosophy into the training environment and plans to soon alter its evaluation standards to match this new concept. In other words, FITS and SBT is the direction the industry is headed. By taking part in this study, you will be afforded the opportunity to be at the forefront of this movement. It is our hope that this study will help you learn to incorporate SBT into your daily training techniques, and will improve the overall quality of instruction we give at UND.

What is SBT: As previously stated, SBT is a major component of the FITS program and uses realistic scenarios as a script for daily flight training lessons. The following two elements help define SBT: First, flight lessons should be conducted to another airport. This helps put maneuver practice in the proper context—how a particular maneuver contributes to the overall mission of air travel—getting from point A to point B. Secondly, each maneuver should be introduced in a realistic format so that the student readily correlates how that maneuver fits in the overall mission scenario. SBT *does* allow for the repetitive practice of maneuvers to increase student proficiency if needed, but only after the maneuver has been introduced in a realistic context.

Use Steep Turns as an example. Under current Maneuver Based instruction, the instructor would take the student out to a practice area, clear the area, slow to recommended airspeed, trim the aircraft, pick a cardinal heading, and teach the elements of the maneuver. Often times the student does not truly understand why he or she is practicing this maneuver. Contrast this with SBT. Under SBT, the instructor would introduce the maneuver in a more realistic context by presenting a "scenario situation" that requires a steep turn. For example, while en-route to Crookston, the instructor calls out traffic at 12:00, opposite direction, at the same altitude, and directs a hard turn to the right for avoidance. The student immediately cranks the aircraft into a right hand turn—not too concerned about maintaining a set airspeed or altitude. And maybe, because it is the student's first attempt at a steep turn—it isn't too pretty. But now the student

knows what a steep turn is all about (when it might be used, the aerodynamics involved, and what can go wrong) —because it was introduced in a realistic context. The instructor can later demonstrate the individual elements of a steep turn and allow the student to polish required techniques.

It is the belief of the FAA and industry professionals involved in FITS that using SBT will produce better pilots. It forces students to think and helps develop their aeronautical decision making skills. It also gives students a definitive reason or purpose for mastering each maneuver (why do I need to know this?)---one of the major fundamentals of learning.

How to use this supplement: This supplement was designed to facilitate your transition to scenario based instruction. It should be used in conjunction with the syllabus, and other UND directives and guidance, to plan and execute syllabus lessons. It provides scenarios for each lesson of the AVIT 102 Edition 9 Syllabus. It should be considered *guidance* for introducing new maneuvers and completing lesson requirements, but should not be treated as the bible. If instructors come up with better SBT methods for introducing particular maneuvers, they should try them and share their methods with their colleagues. This study affords instructors the chance to incorporate SBT into daily instruction techniques. Have fun, be creative, and fly safe.

Please note: The SBT Supplement/Instructor Guide contains lesson scenarios for 26 individual lessons. To streamline this report, only two lesson scenarios were included (see ATCH 2). The entire SBT Supplement is available as a separate document.

ATCH 2---SBT SUPPLEMENT/INSTRUCTOR GUIDE.

Please note: *This is an example of the scenarios provided in the SBT Supplement/Instructor Guide. Flight Lesson 2 is conducted in the Flight Training Device (simulator) and is the student's first "flight lesson" (Lesson 1 is a Ground Briefing).*

FLIGHT LESSON 2

STUDENT PREPARATION:

1. Practice Warrior checklists using the online trainer on HTMLEZ.
2. Review Syllabus for lesson content.
3. Complete appropriate sections of Workbook.
4. Draw Practice areas on VFR sectional.

SCENARIO

You and a friend want to go to Fargo to see a Red Hawks' baseball game. Your plan is to land at the Fargo airport two hours before game time in order to allow enough time for lunch.

INSTRUCTOR INFORMATION

NOTE: Consider using the simulator GS-Plus feature to accelerate the flight (located bottom right hand corner of track screen).

Preflight Discussion – Discuss scenario and how normal operations such as checklist usage and basic flight maneuvers are used on day-to-day flights like this one. Ask student to locate FAR on map and give basic navigation ideas on how to get there.

Ground Ops – Show student how to input a basic flight plan GFK to FAR in the GPS. Guide student through normal checklist procedures.

GFK Departure – Conduct a normal takeoff and climb, show effects of coordinated and uncoordinated climb (refer to Aero Demo).

Simulate Departure Control requesting a level-off at 3500 ft during climb and current airspeed (79 KIAS) to avoid inbound DC-9 traffic.

At this point, show effects of all control surfaces; highlight dutch roll with rudder (refer to Aero Demo).

Shortly after level off, Departure instructs you to continue your climb. Show effects of uncoordinated and coordinated climb (refer to Aero Demo).

Level off and Cruise – Level off at 5500 ft, do cruise checklist, and trim for approximately 100 KIAS.

Discuss how to maintain straight and level flight (refer to Aero Demo).

Show effects of elevator input and discuss aircraft stability (refer to Aero Demo).

At this time, Departure warns of opposite direction traffic at your same altitude and suggests altering course to the right.

Show effects of turns (shallow, medium, and steep) and how to keep those turns level (refer to Aero Demo).

Departure informs you that traffic is no longer a factor, radar service terminated, squawk VFR and proceed on course.

Proceed back on course using the GPS. Show effects of adverse yaw when maneuvering back on course and the effects of too much and too little rudder (refer to Aero Demo).

Approach and Arrival at FAR – Start the descent checklist, get Fargo ATIS, and contact Fargo Approach.

NOTE: Make sure a generic airport has been positioned at FAR. If GS-Plus feature is being used, be sure to turn it off).

FAR Approach advises to expect a 5 mile final for Runway 17, and to start a descent at pilot's discretion to 2000 feet.

Show effect of descent with and without power, level off at 2000 feet, and set-up for a long final to Runway 17 (refer to Aero Demo).

Add flaps on final and discuss effects of each additional setting. As you approach the runway, Tower directs a go-around because of traffic on the runway (Sim feature may be used to put an aircraft conflict on the runway). Conduct a normal go-around and show effects of each notch of flap retraction (refer to Aero Demo).

Go around the pattern at Fargo to a normal full-stop landing. Taxi to the ramp and complete all appropriate checklists. Emphasize that "Mission is complete—we made a routine flight from A to B".

Assign scenario for next lesson

(Approx. lesson time 1.0 hour)

Note: This is the Part 141 Private Pilot Syllabus description of Lesson 2.

LESSON 2
DUAL, VISUAL FLIGHT TRAINING DEVICE

Objectives
The purpose of this lesson is to introduce the airplane cockpit and fundamental flight maneuvers. In addition, the student will practice normal checklist procedures.

Completion Standards
The instructor will guide the student through cockpit familiarization and the correct control inputs for fundamental flight maneuvers in the appropriate configurations. This lesson will be complete when the student is able to conduct normal checklist procedures with little input from the instructor.

Content

1. Preflight Discussion
A. Discuss lesson objective and completion standards
B. Normal checklist procedures
C. Taxiing
D. Straight and level, climbs, turns, and descents
E. Aerodynamics Demonstration

2. Introduction
A. Cockpit familiarization
1. Instruments
a. Flight
b. Engine
2. Avionics
3. Controls
a. Flight
b. Engine
B. Use of checklist
1. Normal checklist procedures
C. Power plant operations
1. Engine starting and warm-up
2. Pre-takeoff and run-up procedures
D. Proper use of the radio for two-way communication
E. Taxiing
F. Normal takeoff and climb-out
G. Effect and use of controls
H. Climbs and climbing turns
I. Straight and level flight
1. Set cruise power

2. Use of mixture control
J. Turns
1. Shallow
2. Medium
K. Descents
1. Power-on
2. Power-off
L. Level off from climbs and descents
M. Aerodynamics Demonstration
N. Pre-landing procedures
O. After landing, engine shutdown and securing procedures

3. Post-flight Discussion
A. Critique student performance, preview next lesson and give study assignment

Assignment
FAA-H-8083-3, Pilot's Operating Handbook
1. Collision avoidance procedures
2. Wake turbulence avoidance procedures
3. Wind shear avoidance procedures
4. Tracking a straight line
5. Airport traffic patterns
6. Normal and crosswind landings
7. Pilot's Operating Handbook - aircraft speeds

Please note: This is the student's first lesson in an actual aircraft.

SBT SUPPLEMENT/INSTRUCTOR GUIDE
FLIGHT LESSON 3

STUDENT PREPARATION

1. Review syllabus contents for lesson.
2. Complete appropriate sections of the workbook.
3. Practice Warrior Checklists using the on-line trainer on HTMLeZ.
4. Review Warrior Stan Manual for standard airport traffic pattern, normal takeoff and landing, and preflight procedures.
5. Locate the Crookston Airport on the map and give consideration on how you will get there.

SCENARIO

You are a crop insurance salesman and a client of yours has a hail damage claim in one of his fields outside of Crookston. You will fly to Crookston, and while en-route, you will survey his field by air to assess the damage. After discussing the claim with him at Crookston, you will return to Grand Forks.

INSTRUCTOR INFORMATION

Ground Ops – Guide the student through obtaining a weather brief, pre-flight planning, and risk assessment. Discuss the scenario during the pre-flight discussion, showing where the hail damaged field is (suggest two miles south of Eldred). Show the student how to obtain info on Crookston using the AFD.

Leg 1 GFK – CKN

GFK Departure – Conduct a normal takeoff and climb-out.

En-route to CKN – Review basic aircraft handling introduced on Lesson 2. After level-off, discuss and demonstrate how to track a straight line to the farmer's field (appropriate point on map). Discuss scanning techniques and how to avoid other aircraft. Pretend you see an aircraft converging straight on---challenge student to take appropriate action. Discuss aerodynamic effects of whatever maneuver was executed. Once over the target field, make several turns to survey suspected damage and practice aircraft maneuvering. Perform the Aero Demo and other maneuvers as appropriate. Proceed to Crookston.

CKN Airport – Listen to the Crookston ASOS and CTAF. Discuss current traffic and weather situation. Complete appropriate pattern entry and full stop landing. If time allows, taxi to the ramp for validation of scenario. Observe other aircraft in the pattern and discuss separation standards and wake turbulence separation. Taxi for takeoff and to practice normal takeoff and landings as time and fuel permit. Demonstrate and discuss methods for wake turbulence avoidance.

Leg 2 CKN – GFK

CKN Departures – Conduct a normal takeoff and climb-out.

En-route to GFK – Practice maneuvers previously introduced as per the syllabus to ensure student understanding. When listening to ATIS, simulate a gusty wind condition. Discuss techniques for dealing with gusty winds and wind shear.

GFK Airport – Fly the pattern as though gusty winds and wind shear actually exist. Also simulate the need to follow a DC-9 on final; reinforce the appropriate methods for avoiding wake turbulence.

Post Flight Debrief – Discuss accomplishment of the hail survey mission to put all maneuvers and activities in the proper context. Assign Lesson 4 scenario. Have the student obtain an outlook briefing for GFK to TVF for the scheduled time of Lesson 4-Ground Briefing.

Please note: This is the Part 141 Private Pilot Syllabus description of Lesson 3.

FLIGHT LESSON 3 (Approx. lesson time 1.0 hour)

DUAL AIRPLANE

Objectives
The purpose of this lesson is to review the listed maneuvers and procedures in an aircraft and introduce the elements associated with conducting flight within airport traffic patterns and approach to landings.

Completion Standards
This lesson will be complete when the student (1) can track a straight line and conduct traffic pattern procedures with instructor guidance, (2) is able to conduct normal checklist procedures with little input from the instructor, (3) is able to maintain directional control at all times during the takeoffs and landings with instructor guidance, (4) is able to identify and avoid areas of possible wake turbulence and wind shear with instructor guidance, (5) maintains continuous vigilance for other aircraft with extra precautions taken in areas of congested traffic, (6) is able to maintain altitude ±250 feet, airspeed ±20 knots, heading ±30 degrees and roll out on headings within ±30 degrees of that desired while conducting fundamental flight maneuvers.

Content

1. Preflight Discussion
A. Discuss lesson objective and completion standards
B. Preflight planning and preparation
C. Aircraft weight and balance considerations
D. Tracking a straight line
E. Airport traffic patterns
F. Normal and crosswind landings

2. Review
A. Cockpit management
B. Use of checklist
C. Power plant operations
1. Engine starting and warm-up
2. Pre-takeoff and run-up procedures
D. Proper use of the radio for two-way communication
E. Taxiing
F. Normal or crosswind takeoffs and climb-outs
G. Effect and use of controls
H. Climbs and climbing turns
I. Straight and level flight
J. Turns

1. Shallow
2. Medium
K. Descents with and without turns, using high and low drag configurations
L. Level off from climbs and descents
M. Aerodynamics Demonstration
N. Pre-landing procedures
O. After landing, engine shutdown, securing and post-flight inspection

3. Introduction
A. Aircraft preflight and post-flight
1. Interior and exterior
2. Aircraft servicing
B. Collision avoidance procedures
C. Wake turbulence avoidance procedures
D. Wind shear avoidance procedures
E. Tracking a straight line
F. Airport traffic pattern entry and departure procedures
G. Normal or crosswind landings

4. Post-flight Discussion
A. Critique student performance, preview next lesson and give study assignment.

Assignment
AC 00-45E, FAA-H-8083-25, Pilot's Operating Handbook, AIM

1. Weather briefings
2. Preflight planning
3. Risk assessment

ATCH 3

SBT STUDENT QUESTIONAIRE

NAME_____

What is your age?_____

Approximately how much flight training time have you logged (this is flight time you have logged in your logbook with a flight instructor in an aircraft)?_____

Approximately how much flight time do you have (this includes time not officially logged but in the front seat of an aircraft manipulating the controls)?_____

Is anyone in your immediate family an active certificated pilot (active is defined as operating an aircraft more than 50 hours a year)? Please circle response: YES NO

On a scale of 1 to 5 (with one being the lowest and five being the highest) how would you rate the amount of previous aviation experience you have had (this includes everything from reading aviation books to riding in the backseat of an aircraft to playing Microsoft FlightSim)? Please circle appropriate response:

1 2 3 4 5

On a scale of 1 to 5 (with one being the lowest and five being the highest) how would you rate the amount of time you have been exposed to the actual flight environment (this includes any time riding in an airplane where the flight controls/cockpit were visible)?

1 2 3 4 5