Flight Simulation Based Case Study to Compare Student Learning, Performance and Retention

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Student learning and retention as a function of the mode of teaching is analyzed in this study. Different groups of students are given information about aircraft flight operations either via lecture, through directed study, a combination of the two or through a pre-recorded flight demonstration video. Their level of learning is assessed by evaluating how well they fly an aircraft and perform a predefined mission using a flight simulator. Scores of different groups are compared qualitatively and quantitatively and students are surveyed after the flight. It is found that students that learn through watching a demonstration video tend to perform better than all other groups. Additionally, it is discovered that students that have access to literature beforehand and receive a lecture prior to the flight perform better than those that only review the literature or only receive a lecture before the simulation. So a combination of teaching modes tend to reinforce the concepts and therefore increases student performance. Also, the efficacy of the hands-on learning in a laboratory environment is discussed.

Keywords: flight training, simulation, hands-on learning, laboratory learning, performance

INTRODUCTION

In this IRB-approved (Institutional Review Board) study, student learning and retention is assessed using a motion-based fixed-wing flight simulator. Students are given introduction to the principles of flight. Then they fly the aircraft flight simulator and are asked to complete a pre-defined mission. Points are given for successfully completing several legs of the mission. Four separate and independent groups of students are recruited for the study. Group distribution is shown in Figure 1. Group A is presented with written literature to review before the flight. The literature defines the functions of the flight simulator, flight controls, aircraft principles, instruments and the required mission details. They are then asked to fly the mission with minimal assistance during flight portion. They are free to ask questions during flight. Group B is not presented with any literature for review before flight. A short presentation is given to them that describes the flight controls, basic instruments and the mission. Their first real exposure to flight is when they get on the simulator and begin flying. They are free to ask questions and the instructor guides them as needed during flight. Group C is presented with both the literature for review ahead of time and are given a short presentation before flight. Group D is given access to a pre-recorded five minute video that covers all aspects related to the mission and shows students flying that mission and manipulating the controls of the flight simulator. Students in group D are free to watch the video as many times as they desire before flying the simulator. All four groups are asked to fly the exact same mission. They are graded based on their flight performance and handling and control of the aircraft during flight. The flight is composed of

starting a single engine land based aircraft, taking off while staying center lined on the runway, climbing upwind to an altitude of 1,000ft above the ground level, performing a left traffic pattern including cross wind, downwind, base and final legs. Students are then asked to land the aircraft on the same runway that they took off from. No wind, adverse weather or artificial runway excursions or other emergencies are introduced during the flight. Points are given depending on their performance on each leg based on a pre-defined rubric. Scores for these three groups are compared. Group D was expected to perform better than the other groups and group C to perform better than groups A and B.

FIGURE 1
GROUP DISTRIBUTION
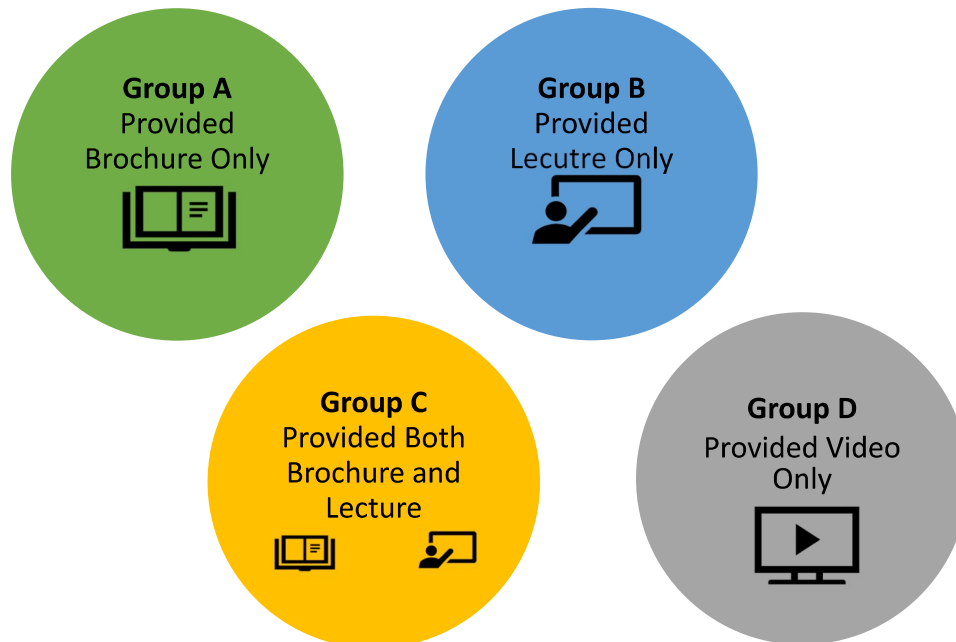
As part of the extended study, all the students are asked to return to fly the same mission several weeks later. Their flight performance along with the scores are recorded again and compared across the four groups.

BACKGROUND AND LITERATURE REVIEW

The intent of this study is to investigate whether various teaching modalities e.g. lectures, videos, self-reading or a combination of these could have an impact on student learning and retention when applied to flying a pre-defined mission on an aircraft simulator. The results of this study might be applicable to other similar scenarios. If it is observed that any one of the chosen modalities e.g. lectures, pre-reading or hands-on training is more effective in student learning than others, then it can be deduced that instructors teaching materials similar to the ones used in this study could apply that modality more often than other modalities to improve learning. This could help improve overall student understanding, progression, long-term retention and application of the learned material. The researchers also want to investigate whether there is significant statistical difference in learning this type of material across students of different years in college e.g. freshmen vs. seniors. The results of this could help instructors tailor teaching methods to better meet student needs and therefore enhance student learning. Flight simulation is chosen as a platform for this study because it is expected that students in general and engineering students in particular are interested in learning about aircraft operations and flying. This would not only naturally draw students to the study but

also present material that students of different majors and years have not received during their time in college. A motion-based flight simulator by precision flight controls is used for this study.

Several studies have been performed to find useful and effective teaching and learning methods that are one of the most important necessities of educational systems in higher and post-secondary education. Enhancing student's learning using advanced technology raises the quality of the course and gives students a better understanding to the principles of their education. Shankar et al. suggested that an effective and positive learning environment can be created by combining visual, auditory, and hands-on techniques. It has been proven that classical teaching methods embedded with visualization of the complicated tasks enables a better understanding of the knowledge of the course being taught. Among many, active learning has been recognized as the best instructive method that elevates student learning as observed by Duch, McConnell and Prince.
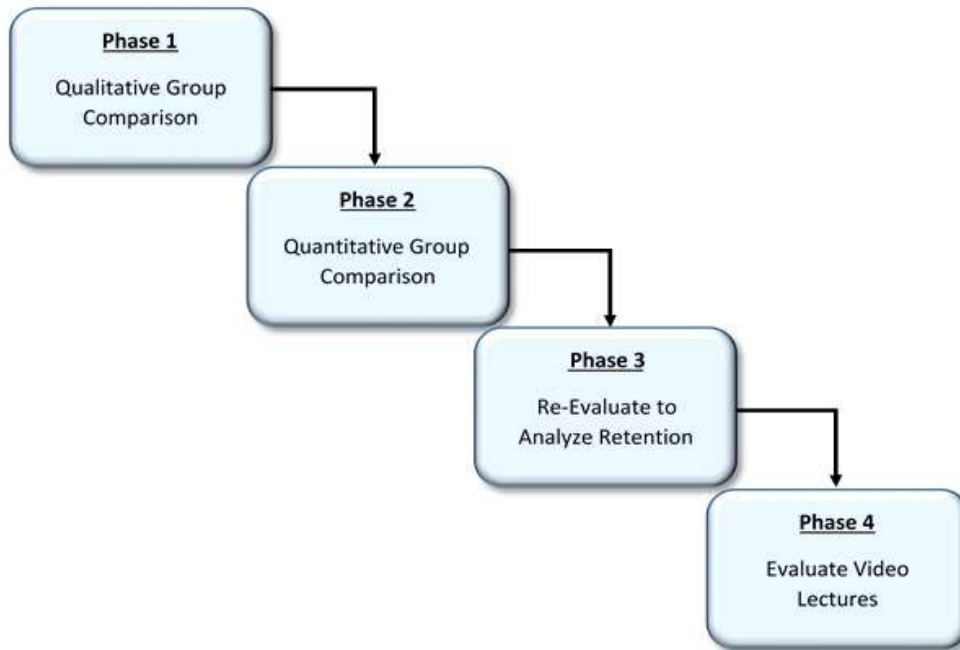
Relating theoretical concepts with real world phenomena has always been a difficult task in most of the engineering courses. While theoretical results and equations, together with the output-plot figures, help students visualize the concept, they usually encounter problems in relating the theory with real world applications.

The idea of using simulators or educational games in engineering courses is not new. 2D driving simulators are commonly utilized in vehicle dynamics courses for motion simulation. Likewise, flight simulators are favorably used in aerodynamics courses. Advances in technology, as evident from the Elite simulators, have empowered pilot test program producers to create effective and real-time simulation based Flight Training Devices (FTDs). Flight simulators draw attention as a training resource in aerospace engineering curriculum. Several studies have been conducted on finding the most effective way of exploiting flight simulators in courses. Meta-analysis was investigated by Hays et al to find effectiveness characteristics of flight simulators. Huet et al. studied the performance of feedback in a fixed-base flight simulator. In a study conducted by Aji, three groups of students were asked to land an aircraft in which the first group was provided concurrent feedback, the second group received the recorded feedback data from the first group by one of the attendees of the former group, and the last group did not receive any feedback. Aerospace, math, electrical engineering and computer science students were recruited to assemble and design a test on a low cost unmanned air vehicle flight simulator to promote student engagement. The surveys completed by the undergraduate students demonstrate a very positive impact on student learning. Hulme et al. presented a methodology to engage students in a traditional course environment by designing a game simulator imitating a road vehicle. A flight simulator training with and without feedback provided by the instructor was studied by Ali to improve the handling of airplane. 36 undergraduate freshmen who passed the flight parameters test were split into six groups. Three tasks were designed. Participants were only allowed to read the instructions before testing. No feedback group participants did not receive any feedback during the training. The instructor verbally explained the deviations from manipulating the controllers to the second group. Consequently, no feedback group scored poorly with respect to the other group since the students were not given the advantage of knowing how well they were doing.

There are several ways to assess the quality of the course. In this study, we are seeking to learn about the impact of various teaching modalities on student learning by exploiting a flight simulator. Four groups of students are given the same tasks with different supplementary materials and instructions. Their performance of using the flight simulator are evaluated and the feedback is collected.

The current study is divided into four phases as shown in Figure 2. Phases 1 and 2 results i.e. qualitative and quantitative results are for groups A, B and C. Phase 2 includes quantitative analysis and statistical comparison of scores of students in different groups. In phase 3 students are asked to come back for a re-evaluation. They are asked to fly the mission and get re-evaluated to assess their level of retention. In the fourth phase, Group D is introduced to the same information as the other groups but the information is presented in the form of a short video. Students have the option to review the video as many times as they wish before flying the simulation. No other information is presented to them before the flight. The average scores of Group D are compared with the average scores of the other three groups.
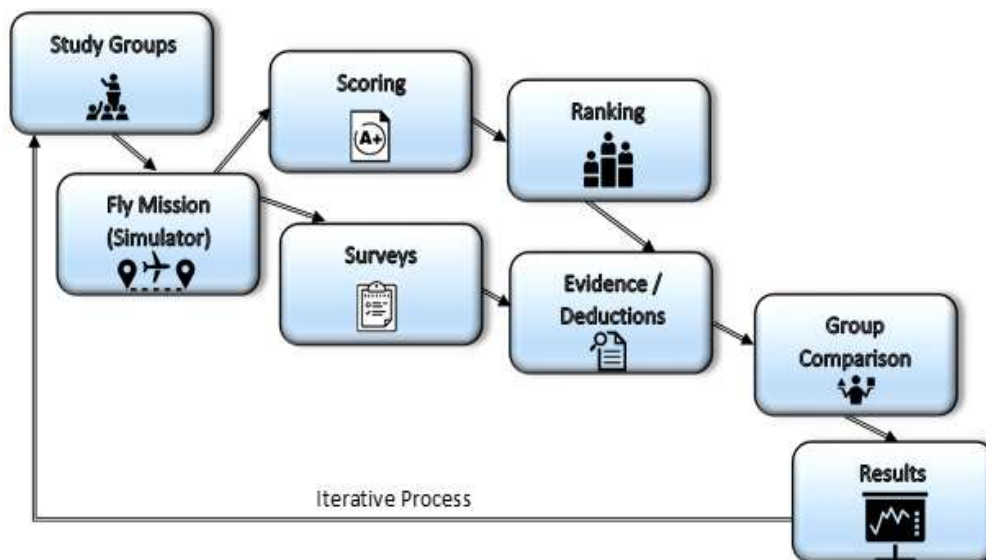
FIGURE 2
PHASES OF THE RESEARCH STUDY

Phase 1
Qualitative Group Comparison

Phase 2
Quantitative Group Comparison

Phase 3
Re-Evaluate to Analyze Retention

Phase 4
Evaluate Video Lectures

METHODOLOGY

The steps of the sequential research methodology, as shown in Figure 3, include setting up the study groups, having them fly the simulator, conducting the surveys and receiving scores depending on their performance, ranking, and group vise comparison.

FIGURE 3
RESEARCH METHODOLOGY

Study Groups

Scoring

Ranking

Fly Mission (Simulator)

Surveys

Evidence / Deductions

Group Comparison

Results

Iterative Process

The flight simulator used in this study is a Flight Training Device (FTD) used for training professional or recreational pilots. The simulator has the capability to simulate the operations of a small single engine aircraft. It consists of the basic flight controls including the yoke, rudder paddles, throttle quadrants, and other switches and knobs. There is a pilot station mounted on a movable platform and a separate instructor station where the environmental flight conditions can be altered. Figure 4 shows a picture of the flight simulator used in this study.

FIGURE 4
CRX PRO-MOTION FLIGHT SIMULATOR BY PRECISION FLIGHT CONTROLS

Students participating in this study are first introduced to the subject matter using different teaching modalities. Students in group A are given a brochure that contains detailed information about the study. The brochure describes the aircraft parts and the basic anatomy of the aircraft they will fly. The brochure also describes the primary flight control surfaces, corresponding airplane movements and axes of rotations. Students learn the operation of yoke, rudder paddles and other controls. The brochure also describes the six basic flight instruments including the airspeed indicator, attitude indicator, altimeter, turn coordinator, heading indicator and vertical speed indicator. They learn the functions and operations of each of these instruments. They also learn how to focus on different instruments during different periods of the flight and how to divide focus between looking inside and outside the cockpit during flight. The flight mission consists of several legs and entails flying a standard flight pattern shown in Figure 5.

FIGURE 5
STANDARD TRAFFIC PATTERN
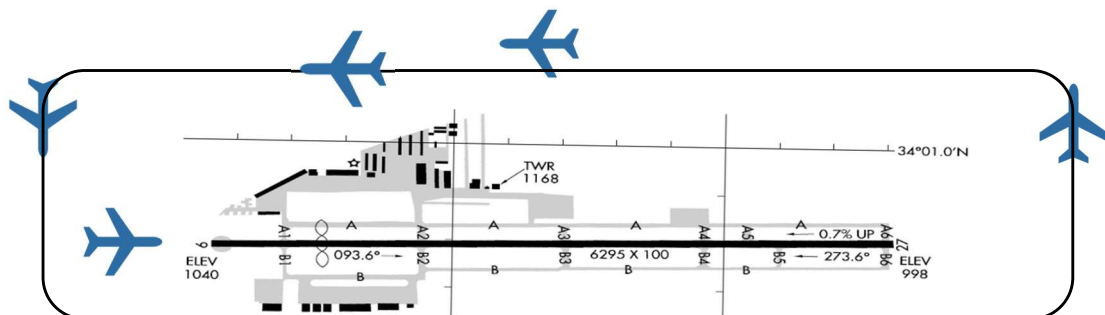
The first leg is to takeoff from a runway at a designated airport on a standard day under calm wind conditions. During takeoff, students have to steer the aircraft using rudder pedals to keep it on the centerline on the runway. They advance the throttle smoothly and let the airspeed buildup while keeping the nose of the aircraft aligned with the runway centerline. Students are then asked to takeoff and stay on the runway heading during upwind leg. They climb up to 500ft Above Ground Level (AGL). They make left turns for left traffic pattern (crosswind, downwind, based and final legs). They climb up to 1000ft AGL and level out for downwind leg. As they pass the runway threshold, they throttle back, slow the aircraft by deploying flaps and start descent. They learn to manipulate the controls of the aircraft while at the same time monitoring all the instruments. They fly the standard left turning pattern and are asked to land back at the same runway they took-off from. On the final turn, they lineup with the runway centerline for final approach. They touchdown on the runway and come to a full stop on the runway centerline by applying brakes at the top of the pedals. The goal is to complete all five legs of the mission while staying within prescribed altitude, airspeed and geographical limitations. Students receive scores based on how well they perform each leg and whether they are able to land the aircraft on the runway and bring it to a complete stop. On the evaluation criteria, students receive points for each portion of the flight and for each flight leg. They can score up to 100 points if they perform all maneuvers within the prescribed standards. The evaluation criteria is shown in Table 1.

TABLE 1
EVALUATION RUBRIC

No.	Task	Maximum Points	Points Earned
1	Advance the throttle smoothly and start roll out	5	
2	Stay center lined (on runway) using rudder pedals during takeoff	5	
3	Fly upwind at runway heading	5	
4	Keep wings leveled	5	
5	Climb up to 500ft AGL	5	
6	Turn 90 degree left crosswind while climbing	5	
7	Fly for approximately 15 second while holding heading	5	
8	Turn 90 degree left downwind – maintain heading	5	
9	Climb up to and maintain 1000ft AGL (+/- 100ft)	5	
10	Fly for approximately 1 minute	5	
11	Reduce throttle and decrease airspeed (75-85kts)	5	
12	Deploy first set of flaps	5	
13	Start descent	5	
14	Turn 90 degree left base	5	
15	Deploy second set of flaps	5	
16	Turn 90 degree left final	5	
17	Deploy third set of flaps	5	
18	Descend while maintaining airspeed (65-75kts)	5	
19	Land on the runway	5	
20	Apply brakes and come to a full stop - stay on the runway centerline	5	
	Total	**100**	

Group B does not receive the brochure – so all this information is conveyed to them through a lecture at the beginning of the flight. Group C receives the brochure and also receives a lecture. Group D does not receive any instruction or demonstration. All this information is presented to them for review several days before the flight.

In addition to evaluating students based on the evaluation criteria shown in Table 1, a post flight survey is conducted. Students taking part in the study are informed that the purpose of the study is to investigate and compare the various teaching and learning methodologies. Students taking part in this study can choose to discontinue at any time. The study requires participating students to fly the mission using the flight simulator device and then take the following survey to rate their experience. The study is expected to take 25-30 minutes for each student. As a requirement of this IRB-approved study, participants are informed that there are no expected risks or discomforts associated with this study and there are no direct or indirect monetary benefits for participating in this study. The results of the study are also anonymous. Students are asked to answer the questions in the survey and rank them on a scale of 0 to 9 where 0 indicates 'strongly disagree' and 9 indicates 'strongly agree'. The survey questions are shown in Table 2.

TABLE 2
POST FLIGHT SURVEY

No.	Question	Score
1	Flying the aircraft simulator and completing the mission was a simple task	
2	I feel that given the information, I was able to complete the mission really well	
3	Taking part in the flight training simulation piqued my interest in aerospace	
4	I found this to be a challenging and exciting experience	
5	I want to fly this mission again to improve my skills	
	Total	

The IRB approval process includes a review of the study details and requirements by the IRB review board. The board wants to ensure that there is minimal or no risk or discomfort anticipated from this study. There are also no direct benefits to the subjects but the researchers may learn about the efficacy of various teaching methodologies and student learning. Participants receive no compensation for taking part in the study. The results of the participation are presented anonymously. Participant names and identifications or other identifiable information is not published or otherwise made publically available. All subjects of this study are 18 years or older. They are required to sign the consent form acknowledging the confidentiality, no compensation, no benefits, no risks or no discomforts and time requirements of the study.

QUALITATIVE RESULTS AND DISCUSSIONS

Qualitative and quantitative results are obtained from this study through post flight surveys and inflight reviews. The qualitative results include student perceptions and the evaluators observations during the flight portion of this study. It was observed that a number of students in Group A either only skimmed over the brochure or did not read it at all even though the brochure was provided well ahead of time of the simulation. This may indicate how some students are conditioned to expect to receive new information through lectures and often do not make an effort to learn new material on their own even if the learning is perceived to be enjoyable or fun. Other students in this group did read the full packet and had good questions and therefore a more fulfilling experience. Students were asked to write general comments about the learning experience with this exercise. Some of the comments are presented here. One Group A student remarked

> "...very enjoyable experience. Would definitely be extremely overwhelming for an absolute beginner"

Another student noted:

> "The info given was straightforward, and should've been easy to follow, but for someone such as myself, who has never flown a plane nor participated in a simulation, it was difficult

> *to pull off successfully. However, it was very interesting, and I would like to try and sharpen my skills through my college career"*

This indicates that the exercise was not so trivial that someone with no prior knowledge would be able to accomplish the task without any preparation. This also indicates that some preparation before the flight helped the students perform better than others. It was also an enjoyable experience for those that came prepared as noted by one student:

> *"Real fun. Learned more about aircraft controls than I ever would have learned"*

Students were given three chances to fly the mission. If they felt that the flight was not going well, they could request a reset. Some students took it as a challenge and did not want to reset while others felt that they got better by repeating the process as observed by one student:

> *"I felt it would have been easier for me had I been able to do it more than once, but my nerves got the better of me on that go"*

Flying, like many other disciplines, is learned by repetition; and repetition often reinforces the concepts. This is also true in general for majority of the engineering concepts that could be reinforced in laboratory experimentation. Some students even wanted to pause the simulation so they could go back and re-read the brochure to clarify some questions or concerns. It was also observed that some students participated in the simulation exercise because they were incentivized to participate for extra credit by their professors. These students, although only a handful, showed little interest in the exercise itself but were mostly interested in the extra credit. Their performance was noticeably lower than the rest of the subjects in the group.

Students in Group B did not receive the information packet but were briefed shortly before the flight. Many students in this group felt that this was easier for them because they could ask questions and touch and feel the controls as they discussed their functionality. One student remarked:

> *"This was my first time flying and it was the most exciting thing I have experienced this semester and it was difficult but very fun at the same time"*

One could also argue that students could ask questions in this group during the presentation to clarify any doubts or misunderstandings they might have regarding the flight controls or the mission – although the learning of technical jargon may not be accomplished as effectively. This was evident from the following student statement when referring to the airspeed indicator and the directional gyro:

> *"I completely understood and used the airspeed tool and the compass and the artificial horizon"*

The ability to start and restart enabled some students to overcome the anxiety of flying. This could be applicable to other similar scenarios when students work with any new engineering equipment, machines or other apparatus in a laboratory. One student stated:

> *"The instructor explained all of the steps well, however once I was in flight, I started panicking and I struggled a few times to start. Once I started, I used what I had just learned to complete at least 50% of the steps"*

It was observed that some of the students got nervous, some had their hands shaking, and other biting their lips even though it was clarified to them that it was only a simulation. One such student remarked:

> *"My heart was racing"*

One of the secondary purposes of this exercise was to promote interest in the Aerospace Engineering program at the university. Although the simulator is a flight training device, it provides the capability for engineering students to study various designs and observe the flight characteristics and handling qualities of different types and sizes of aircraft. It also provides a visual of lift distribution over the wing and other lift producing devices. This could be used as a valuable teaching tool especially when explaining lift and drag in turns and other maneuvers. One student pontificated:

> *"I look forward to investing more time into not only flying but the aerodynamics of it all as well"*

The Group C students got a chance to review the brochure before coming to the flight simulation and received a brief lecture. Performing a pattern flight, even with the information provided in a short time period, is a non-trivial task. During the flight operation, when one is confronted with trying to make quick decisions and take corrective actions, it might be difficult to recall information especially if that information is newly acquired. The following student statements confirm this:

> *"The hardest part was remembering all the steps and staying focused on the mission"*
> *"Several times during flight: "There is too much to remember"*
> *"I honestly thought that this would be easier. To my surprise, it was hard to even get off the ground"*

Despite the level of rigor required, students that came prepared, were interested in the material; and listened and learned from the presentation ended up learning and doing well. Students who had flown in a simulator before and those who play video games involving aircraft simulation also tend to perform better than other students. This however is not a control variable and did not affect the results because these students were randomly distributed in all groups. Similarly gender of the student was not a control variable in this study. Students commented on how real the simulator felt. Several students indicated how much fun they had and wanted to come back and fly again. One mentioned that this experience was like a dream come true for them because they always wanted to fly. One indicated that in the middle of the flight you forget that it was a simulation because of how real it felt. Another indicated that it made him realize how 'into' aerospace and flight he was. Some students in this group took the self-learning a step further. In addition to reading the brochure, they also watched online videos to learn more about how to fly the aircraft. One student stated:

> *"Great experience! The before presentation and packet were very useful"*

QUANTITATIVE RESULTS AND DISCUSSIONS

Quantitative results are obtained from scores based on how well students perform on the flight portion of this study. A total of 133 students took part in this study over a period of approximately four months. They were evenly and randomly divided into the four groups. Group A had 32 students, B had 34, C had 31 and D had 36. The average scores of the four groups are shown in Figure 6. These scores are based on the criteria provided to them and shown in Table 1. It appears that Groups B and C perform better overall than Group A. This trend indicates that students that receive both the literature for beforehand review and a lecture perform slightly better than the students who only get a brochure for self-study. Also Group D performed better than all the other groups. This indicates that for tasks similar to flying an airplane, students learn best by listening and more importantly watching someone perform the task. The ability to watch the process multiple times through a recorded video also helped reinforce the concepts.

FIGURE 6
AVERAGE FLIGHT SCORES
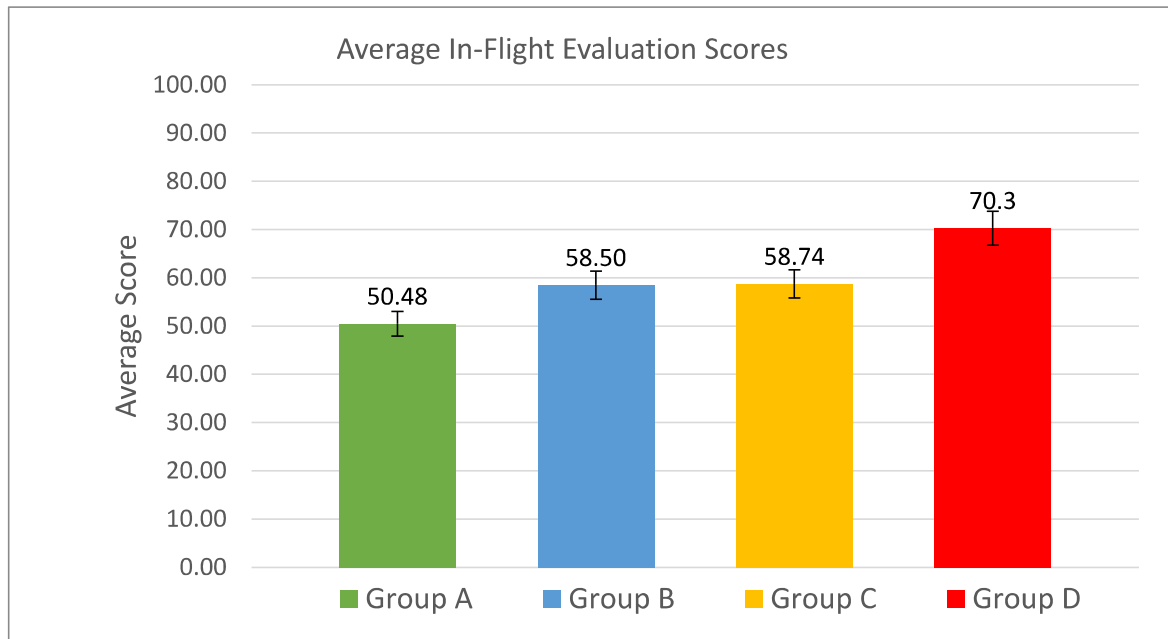
The difference in scores for the four groups is also analyzed statistically using hypothesis testing. Following hypothesis is tested in this study:

> *Students that learn through a combination of written notes, audiovisual lectures tend to perform better than students that learn only through written notes or lectures.*

For statistical analysis, groups are defined as follows:
- Group A: Written notes are provided to students in this group before the simulation exercise
- Group B: A lecture is given to students in this group before the simulation exercise
- Group C: Both written notes and lecture are given to students in this group before the simulation exercise
- Group D: All the material is presented in the form of a recorded video. The video also shows the flight demonstration on the simulator

Null Hypothesis

The Null hypothesis states that there is no significant difference between the average scores of students in Groups A, B, C compared to the average score of students in groups D.

Alternative Hypothesis

The alternative hypothesis states that the mean scores of groups A, B or C are statistically different from the mean score of Group D.

The null hypothesis indicates that the mean scores of groups A, B or C are statistically the same as the mean score of group D. Two analyses are used for data comparison. These include the p-value and t-test. An α value of 0.05 is used in this experiment establishing 95% confidence level. p-value is calculated and compared with α value. As shown in Table 3, the p-value for one-tail and two-tail t-tests is calculated. When groups B and A are compared, the two-tail p-value is 0.086 which is greater than α value. This indicates that we cannot reject the null hypothesis. In other words the means of group A and B are not statistically different. Similarly the p-value for two-tail test when groups C and B are compared is 0.961 which is also

greater than the α value. This also indicates that we cannot reject the null hypothesis. The means of groups B and C scores are not statistically different. The p-value of two-tail test comparing D and C is 0.01 which is lower than the α value. This indicates that we can reject the null hypothesis. In other words, the mean of group D is statistically different (higher) than the mean value of group C.

TABLE 3
RESULTS OF T-TEST TWO SAMPLE ASSUMING UNEQUAL VARIANCES

|	*A*	*B*	*C*	*D*
Mean	50.48	58.50	58.74	70.30
Variance	364.07	335.28	451.93	144.73
Observations	32	34	31	36
		B vs. A	C vs. B	D vs. C
df		63	60	46
t Stat		1.739	0.048	2.681
P(T<=t) one-tail		0.043	0.480	-0.005
t Critical one-tail		1.669	1.670	1.678
P(T<=t) two-tail		0.086	0.961	0.010
t Critical two-tail		1.998	2.000	2.012

In addition to the p-value calculation, two tailed t-tests are analyzed. For these tests, unequal variances are assumed for samples of each group. The difference between the two means in each group vise comparison is hypothesized to be equal to zero. As shown in Table 3, the t-critical two-tail value for groups B verses A is 1.998 whereas the t stat is 1.739. Since t stat is lower than the two sided t-critical, we cannot reject the null hypothesis. Similarly when comparing groups C and B, t-stat (0.048) is lower than two sided t-critical (2.0). This also suggests that the null hypothesis cannot be rejected. However, when groups D and C are compared, the t stat (2.681) is greater than the t-critical (2.012). In this case, the null hypothesis is rejected. This indicates that the mean results of group D are statistically different from that of group C. Similar comparative analyses were performed between groups D vs. A and D vs. B. They all indicated that the average scores of group D are significantly different (higher) than those of all other groups.

The results of the two sided t-test match the results of the p-value test. Comparisons of group A and B, A and C, and B and C are also performed and the results indicate that the difference between the average scores of those groups are not statistically significant. This analysis indicates that even though there are small differences between the average scores of the students that learn the material through self-learning and those that are taught in a lecture based environment, the differences in averages are not statistically significant. However, these results clearly indicate that student learning when measured in terms of their average scores in the flight performance is greater when they learn by a combination of theory, lecture, pictures and especially hands on demonstration. All these aspects of multi-faceted learning are covered in a short five minute video. Student learn and retain information better when they have the ability to replay the video and watch the sections they need most help with. The effort put in to generate the video is a one-time effort. The instructor is available to answer any questions students might have during the flight but does not need to repeat the information for every student. This in turn reduces the amount of total effort required for the instructor and results in the higher level of learning and performance for students. Since Group D perform statistically better than all other groups, while performance of other groups is not statistically different from each other, groups A, B and C are further compared on individual questions presented in post flight surveys.

Student scores are compared using the post flight surveys. Even though the differences in scores between the groups is insignificant, the overall scores of each group are good indicators of the learning and understanding of this experiment in a laboratory environment. As shown in Figure 7, the response to question#1 yielded low average scores indicating that most students did not find flying the aircraft and

completing the mission a simple task. Similar relatively low numbers can be seen for the response to question#2 as shown in Figure 8, where approximately 50% of the students across the three groups felt that they were not able to finish the mission really well given the provided information.

FIGURE 7
**SURVEY RESULT – ABILITY TO COMPLETE THE MISSION**

Q#1: Flying the Aircraft and Completing the Mission was a Simple Task
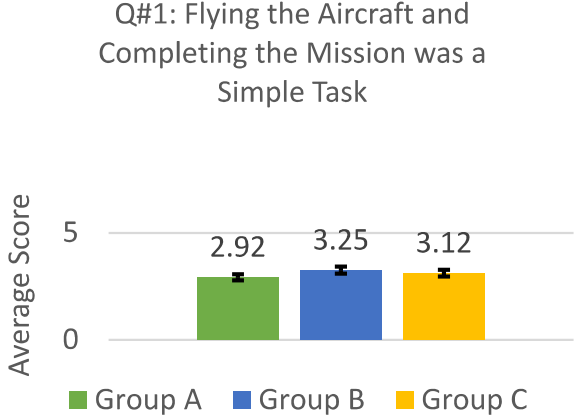
FIGURE 8
SURVEY RESULT – SIMPLICITY OF THE MISSION

Q#2: I Feel that Given the Information, I was Able to Complete the Mission Really Well
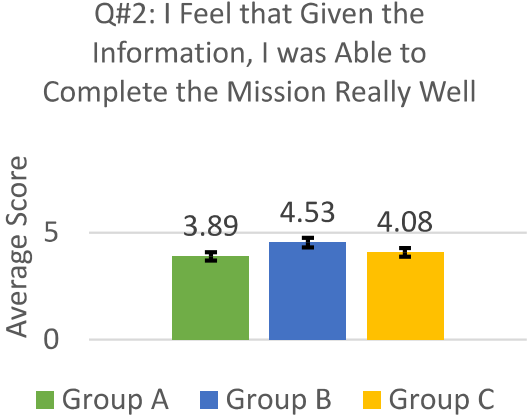
The results indicate a promising trend in the responses of the remaining questions. For example in Question#3, majority of the students across all groups indicated that taking part in the flight simulation study piqued their interest in Aerospace and Aviation. Several students wanted to continue to fly or return for more flights even after the official data collection of this phase of the study was complete. Majority of the students also indicated that they found this study to be a challenging and exciting experience as shown in Figure 9 through Figure 11. Even though the differences in average scores across the three groups are not statistically significant, there are subtle differences and the overall scores across the three groups are high. Students in Groups B and C found this exercise to be more challenging and exciting and indicated higher level of interest in returning for more flights. These two groups also showed a higher degree of interest in pursuing aerospace education or related careers.
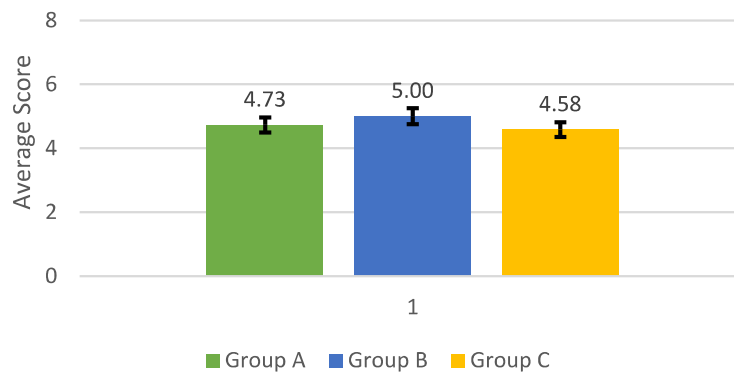
FIGURE 9
SURVEY RESULT – SIMPLICITY OF THE MISSION

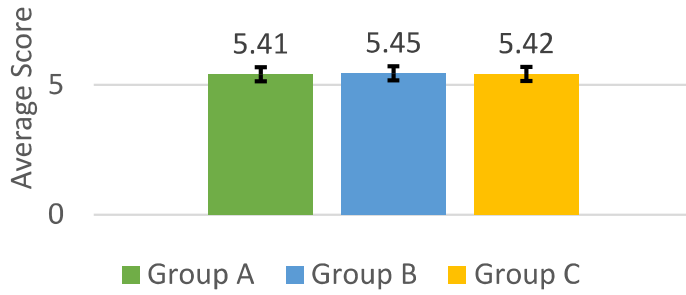Q#4: I Found this to be a Challenging and Exciting Experience
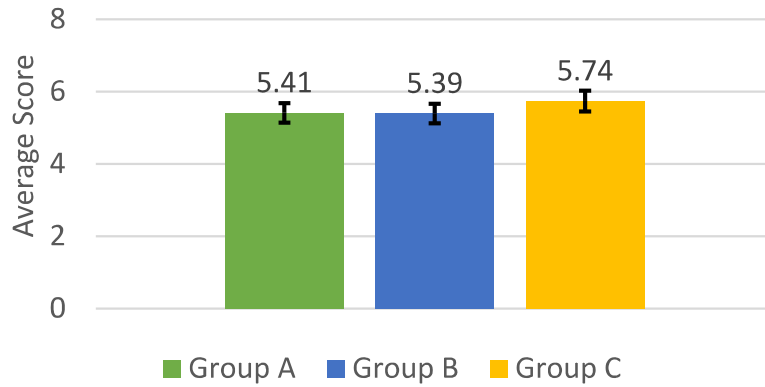
FIGURE 10
SURVEY RESULTS – CHALLENGING AND EXCITING EXPERIENCE

Q#3: Taking Part in the Flight Training Simulation Piqued my Interest in Aerospace

FIGURE 11
SURVEY RESULTS – INTERESTED IN FLYING AGAIN

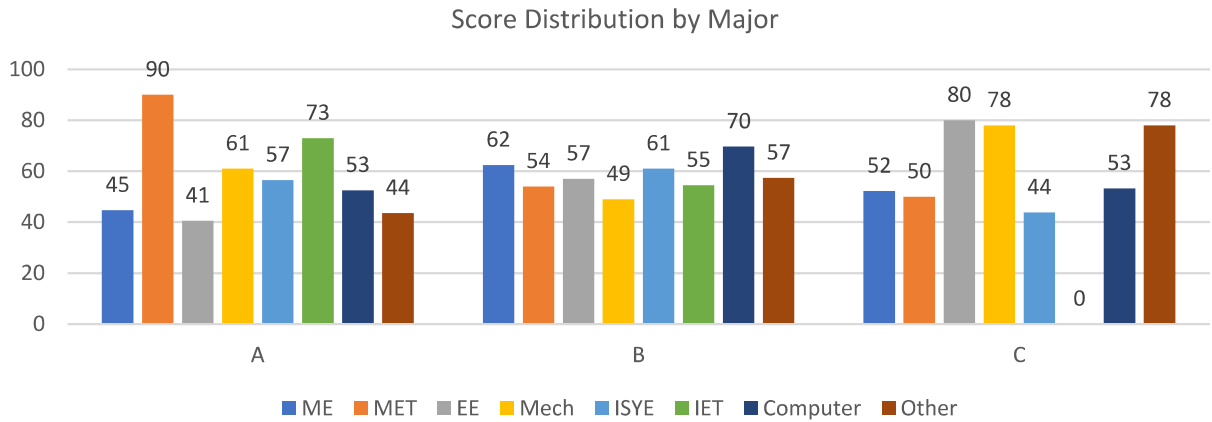Q#5: I Want to Fly this Mission Again to
Improve My Skills

Students are also asked to list their year in college and major. Scores across the three groups are compared by majors and year in college and the results are shown in Figure 12 and Figure 13.

FIGURE 12
SCORES BY YEAR IN COLLEGE

Score Distribution by Major
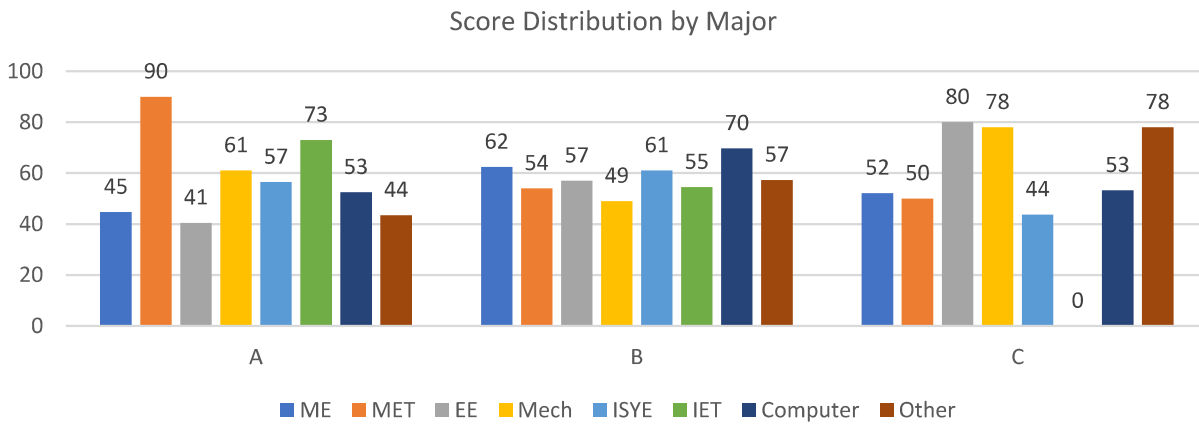
FIGURE 13
SCORES BY MAJOR

Score Distribution by Major

As can be seen from Figure 12, the scores are fairly evenly distributed across the students in the four years of college. The average scores of groups B and C are marginally higher than the average score of group A, which is indicative of the overall results of this study. Similarly as shown in Figure 13, the major that the student is pursuing does not seem to be a good predictor of how well the student performs in the flight simulation regardless of the modality of instruction received. It can be deduced that the method of teaching does not have a significant influence on the learning across all years of college in all engineering disciplines.

CONCLUSIONS

In this study, student learning is compared when four groups of students are presented the same material using different styles of teaching. Students are introduced to the basics of aircraft mechanics, flight principles, controls and operations. They are asked to fly a prescribed flight mission and achieve the goal of flying a single engine aircraft in a standard flight pattern using a simulator. Qualitative and quantitative results are presented. Students in each group indicate that this hands-on method of teaching greatly enhanced their learning. They are excited to take advantage of this opportunity and want to spend more time flying the simulator. The quantitative results show that, although not statistically significant, there are minor differences between the average scores of the three groups with groups B and C performing better than group A. In other words, students that are given lectures and those that are given both the lectures and have access to the literature before the simulation tend to perform marginally better in a laboratory exercises than those that are only given the literature for review. Students that are presented the same information in a recorded video format and see the flight simulation mission being performed by a fellow student, perform and retain information statistically significantly better than all other groups. Students indicated qualitatively that flying the simulator, which is analogous to hands-on laboratory experimentation, helped them appreciate and reinforce the theoretical knowledge they obtained from the literature and lectures. In conclusion, it is observed that all modalities of teaching help improve student learning although some help some students more than others. Instructors should apply a combination of the modalities discussed in this study to help improve overall student understanding, progression, long-term retention and application of learned material.

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