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Runway Safety Training Methods for Runway Incursion Prevention

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Undergraduate Research Project

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Abstract

The Federal Aviation Administration wants to educate pilots about Runway safety to prevent runway incursions. The number of runway incursions increased nearly 83% from 954 in 2011 to 1,744 by the end of 2017 (OIG, 2018). This experimental research project trained 20 pilots using three different methods of teaching (classroom, online, in a flight simulator) to determine which method most effectively taught pilots about a specific topic in aviation. The different training methods change the way the educational content is delivered and this change in delivery could impact how well the pilots learn the material (Cox, 2010). The participants were given a pre-training exam on runway safety to determine their initial knowledge level. Each pilot was assigned one training method and one week after training took a post-test examination. The classroom lecture was created by instructor Taylor, the simulator training regimen was created by the researcher, AOPA's Runway Safety course was created by AOPA sponsored by the FAA (FAA (2), 2018 & AOPA, 2018). It was hypothesized that the simulator training would produce the best results as it is the combination of a situated and dynamic learning environment. The data was inconclusive as to which method trained pilots the most effectively. However, the data from the research did reveal that for the twenty participants, the simulator training did produce the highest average scores in this research. Flight time did not appear to be a factor affecting if the pilots increased their scores.

Runway Safety Training Methods for Runway Safety Education

There are many facets of runway safety from knowing various runway markings and signage to communicating effectively with air traffic control. The focus of this project was aimed at educating and training general aviation pilots about runway safety to prevent runway incursions. A runway incursion, as defined by the Federal Aviation Administration (FAA), is "...any occurrence at an airport involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and take-off of aircraft" (FAA, 2018). Runway incursions pose a significant threat to aviation safety for both commercial and general aviation operations; in general, the term commercial operation refers to airline pilots who are flying for profit while the term general aviation operation refers to pilots not flying for compensation.

Runway safety and runway incursions are problems for the industry. "In the United States, an average of three runway incursions occur daily" (FAA (2), 2018). The number of runway incursions (RI) increased nearly 83% from 954 in 2011 to 1,744 by the end of 2017 (OIG, 2018). One area the FAA began to push was education about runway safety. While education has been emphasized in the last several years, the number of runway incursions is still increasing year over year. Sixty percent of all runway incursions over the last ten years have been caused by pilots, and eighty percent of pilot caused runway incursions are by general aviation pilots (FAA, 2017). Mitigation strategies include figuring out ways to train pilots on runway safety. One aspect of runway safety training is to look at the delivery method of the information taught and how the training method influences the comprehension and retention of the material. This project wanted to deliver the information using three different training methods and compare how the information was best received by the pilots. This experimental project trained twenty general aviation pilots on runway safety using three training methods, and then compared the results.

Research Question

An experimental research project was completed in the Spring semester of 2019. The experiment was designed to better understand the effect that the different training methods (traditional lecture, self-study online approach, or simulated environment) have on runway safety retention and application in general aviation pilots? The different training methods change the way the educational content is delivered and this change in delivery could impact how well the pilots learn the material (Cox, 2010). First, it is important to understand the differences between the three training methods. The traditional lecture method refers to an instructor teaching a student or students in a classroom setting. In this study, Eric Taylor, Instructor for the University of Nebraska at Omaha's Aviation Institute, taught the traditional lecture to the participants in his Commercial Pilot Theory class as a part of the course curriculum. The online, or self-study, approach refers to the use of online training materials for the student to access and complete. The online approach was completed using the "Runway Safety" course sponsored by the Federal Aviation Administration (FAA) and available for free by the Aircraft and Pilots Association (AOPA) (AOPA, 2018) Lastly, the simulated environment offered training to participants and an instructor (the researcher) in a non-motion flight simulator, and its use in the project was provided for free by the University of Nebraska at Omaha (UNO) Aviation Institute. The three training methods were chosen for experimentation based on their use in currently training general aviation pilots for a various ratings/certificates (FAA, 2008).

The experiment involved testing three groups of pilots after they each were trained using a different method on runway safety. To determine a pilot's initial and retained (post-training) knowledge, the participants were given examinations created by the researcher. This project's research on pilot training sought information on which methods effectively train pilots over specific aviation topics.

Industry Literature

Runway Safety

Airport surface operations threats (wrong surface, surface collisions, etc.), which include runway incursions, were raised to the FAA's top five safety issues within the agency in July of 2018 (FAA (1), 2018). The FAA's current plan for the reduction of runway incursions involves two steps: technology and education. The first step is a proactive improvement to the technology within the industry, including new systems to give air traffic controllers more awareness about the aircraft under their control (FAA (1), 2018). The second step is an educational campaign to promote "outreach and collaboration" about the dangers of surface operations threats to all members of the industry (FAA (1), 2018).

Runway Incursion Prevention

The FAA worked to devise new training materials to reduce the number of runway incursions as they continued to increase year by year. They worked on educational campaigns to increase awareness for controllers, for example they created "video programs to heighten awareness of situations that lead to incursions and attendance at flight and air traffic control training to bring focus to prevention of runway incursions" (FAA, 2009). In 2012, the FAA updated and released a free "Runway Safety Section for Pilot's Handbook of Aeronautical Knowledge" for pilots to read (FAA, 2012). They produced a new document on the "Best Practices for Pilot-Airfield Safety" available on their website (FAA (1), 2017). In December of 2017, the FAA sent out a Safety Alert for Operators about the "high risk of runway incursions" to raise awareness for pilots, controllers, and ground operators (NBAA, 2017). The FAA came together with key stakeholders in the industry to find education strategies for the mitigation of runway incursions. The FAA also sponsored a free Runway Safety course through the Aircraft and Pilots Association's website (AOPA, 2018). Education on runway incursions is a key component of how the FAA hopes to decrease their frequency and severity.

Current Pilot Training

The FAA requires flight time with an instructor and ground school training among other requirements to prepare a pilot to pass written and practical examinations (AOPA, 2012). Ground school training can be completed either by taking online classes or in a classroom with an instructor, depending on the certificate or rating the pilot is seeking (FAA, 2015). Doug Stewart, the 2004 FAA Flight Instructor of the Year, believes the best training method involves a "concurrent" flight and ground school as he believes too often if pilots solely take ground school, they rarely learn past what is required to pass the written examination (Wallace, 2010). To fly as the pilot in command (PIC) General aviation pilots must undergo a biennial flight review consisting of an hour of flight training and an hour of ground training (Martin, 2018). The ground training consists of a review of Part 91 (non-commercial flight operations) rules and regulations. The flight review "can be conducted by any current flight instructor" and serve as a "review of those maneuvers and procedures that, at the discretion of the person giving the review, are necessary for the pilot to demonstrate the safe exercise of the privileges of the pilot certificate" (Martin, 2018).

Theoretical Literature

Situated Learning Theory

Theories helped guide this project by offering a simpler understanding of education granting a greater understanding of the relationship between the training method and the learner (Tarry, 2018). Two theories were used in the development of the project's hypothesis. The first to be discussed is the situated learning theory. Situated learning theory postulates that learning requires the learner to be an active participation, in a situation or environment, and interacting with others (Learning Theories, 2018). This theory was postulated by Jean Lave and Etienne Wenger. Jean Lave is a social anthropologist at the University of California, Berkeley while Etienne Wenger holds a Ph.D. in artificial intelligence from the University of California at Irvine (Smith, 2009). The two developed the situated learning theory in the early 1990s based on the role of the situation (activity, context, culture) being a key component of learning (Learning Theories, 2018 & Northern Illinois University). Key points of the theory include knowledge being acquired situationally and through social interaction from someone who has experience/expertise to positively facilitate the flow of knowledge for a learner (Culatta, 2018 & NIA). These principles can be applied to the practice of pairing a student pilot with an instructor for flight training per the FAA (FAA, 2008).

Dynamic Learning Method

The dynamic learning theory places the focus of learning and applying the material on the learner (student), instead of placing the focus on the instructor (Cox, 2010). Dynamic learning takes place while involved in a situational environment, and application of knowledge and experience are required to access situations and react properly (Cox, 2010). Principles of dynamic learning include learning through collaboration, communication, the situational environment, critical-thinking skills, and decision-making skills (Bell, 2017 & Cox, 2010). Dynamic learning involves learning how to solve complex tasks in a realistic environment (Cox, 2010).

Experiment

This experiment called for three groups of ten pilots. Recruitment of the pilots took place during the beginning of the Spring semester of 2019. The recruitment process involved visiting Professional Flight (pilot) classes at the University of Nebraska at Omaha. This contained a very valuable lesson about how tough voluntary recruitment can be. Twenty-one students started the class but only twenty finished the course. Several the participants were offered extra credit for participation in certain classes. Otherwise, participants were gathered at will. A Runway Safety Course was created on the University of Nebraska's online learning management system, Canvas. The participants were invited to join the class roster after they completed an Informed Consent process and Demographic Survey. An informed consent form is in Appendix A. The requirements to participate were to be an active student pilot or to hold a Private Pilot's certificate/rating or above. The project required access to an instructor and classroom, AOPA's online runway safety training course, and access to the University of Nebraska at Omaha's (UNO) non-motion flight simulator.

This project's experiment offered UNO pilot training for the betterment of the student's education, but more importantly the experiment collected data about how information being presented can influence what is taken away from training. "Runway safety is a significant challenge and a top priority for everyone in aviation" (FAA (2), 2018). Training is fundamental for the reduction of pilot caused errors and preventing future surface (airport) accidents. Runway safety is an issue that affects airport operations, air traffic controllers, and both general and commercial aviation pilots.

Logic Model

The dependent and independent variables can be defined for this research experiment by reviewing theories and literature surrounding runway incursions and pilot training. The unit of analysis is the pilot, specifically an adult pilot with the minimum of a Student Pilot's Certificate. The dependent variable for this project is the learning, or retained knowledge, from training of the pilots with regards to runway safety. The primary variable is the method of training the pilots receive: traditional lecture, online approach, simulated environment. A graphic of the logic model for this project is in Appendix B.

Hypotheses

Two hypotheses were drawn for the experiment after reviewing situated learning theory, industry literature, and dynamic learning theory**.** The traditional lecture style of education is a social learning environment, as it involves an instructor lecturing to a student or students in a classroom. However, the traditional lecture is likely to be a hierarchical lecture of instructor to student, and therefore does not conform to the principles of dynamic learning theory fully. The self-study style can be an extremely dynamic approach to learning as it places the sole burden of learning and applying the information on the learner and can offer situational problems to solve. However, the self-study style lacks the social component of learning. The simulated environment offers both a social learning environment and a dynamic learning environment. Therefore, the simulated environment should provide the most conducive learning environment that is both situationally and socially stimulating (Learning Theories, 2018 & Cox, 2010). In the simulator, the learner is facing realistic problems requiring their knowledge to be applied as closely to a real flight as possible.

When all other variables that may affect the results are held equal, the pilots will showcase their knowledge from training by increasing their exam scores from the pre-training exam to the post-training exam (AOPA, 2012). In other words, the training methods will have a positive relationship on the results of the post-training exam scores in more than 75% of the participants. Second, if three different methods of training on runway incursions are given to pilots (traditional lecture, online approach, or simulated environment), the simulated environment will provide the best learning platform due to the interplay of environment, both situationally and socially, for learning to take place (Learning Theories, 2018 & Cox, 2010). This will result in the group of pilots trained in the simulated environment to increase their scores on the post-training exam greater than the other two training methods in comparison. The simulated environment should provide a conducive learning environment that is both situationally and socially stimulating (Learning Theories, 2018 & Cox, 2010). Refer to Appendix C for a table showing the training methods compared to each other based on situational and social learning environments.

Data Collection

The experimental data was gained through a demographic survey, a pre-training examination, and a post-training examination. The demographics survey provided information on the participants age, years spent flying, certificates or ratings earned, participation reason, and total number of flight hours. All participants were given two exams regarding runway safety. The intent of the exams was not to test the pilot's absolute knowledge of runway safety, or how much they know about the subject, but to measure the effectiveness of the different training methods by analyzing the change in the score after training. The exams were to be taken alone and closed note (without the use any devices or materials). All the exams were available to the participants on their individual Canvas home pages. Hosting the course on Canvas allowed for the participants to complete the course on their own volition and schedule, and offered all the quizzes, announcements, and grades in a convenient location for the participants.

Examinations

The pre-training exam scores were used as a benchmark for the pilot's initial knowledge. After training, the participants were instructed to wait one week and then take a post-training exam on runway safety. There was an intentional time delay between the training and post-training exam of a minimum of one week. The exams contained a total of twenty questions with a mix of multiple choice and true/false questions, and both exams contained the same questions except the questions were rearranged and recorded. This allowed for comparable results but also made the students more willing to reread the question and reread all possible answers. All exam scores were tabulated for each participant and by each collective training method. This was done by calculating the score achieved on the pre-training exam and the post-training exam to find the change between the two scores. The exam scores are shown as both the total points answered correctly and by their percentage increases. The participants were not told their pre-training exam score until after they had taken the post-training examination.

Training Methods

The participants were trained in their respective methods for a maximum of thirty minutes. Although each runway safety training regimen was created by a different group/individual, the participants were all taught very similar information between the three training methods. The classroom lecture was created by instructor Taylor, the simulator training regimen was created by the researcher, AOPA's Runway Safety course was created by AOPA sponsored by the FAA (FAA (2), 2018 & AOPA, 2018).

Simulator Training. The simulator training regimen was created by the researcher to follow a basic protocol for each participant. The lessons taught were those directly focused on in the FAA Runway Safety Brochure and AOPA's Runway Safety course (FAA (2), 2018 & AOPA, 2018). The simulator training offered participants the chance to practice taxi and runway operations at large commercial airports. Imagine driving your car around a new city every few hours, Google Maps may be giving you instructions, but executing them in a new environment can be quite complex and require a large amount of attention.

The training protocol included the use of the researcher as both an Air Traffic Controller and an instructor. Each simulator participant was given realistic complex taxi instructions around the airfields at three different airports. The airports commonly used in training were Eppley Airfield (KOMA), Centennial Airport (KAPA), Lincoln Airport (KLNK), Palm Beach International Airport (KPBI), and Chicago O'Hare International Airport (KORD). The participants were expected to communicate effectively with the controller, execute instructions, navigate the airfield using airport diagrams, and deal with arising problems or situations thrown at them (weather, controller addressing aircraft with similar designations, etc.). While taxiing, the researcher both quizzed and instructed them on runway safety best practices depending on the comprehension of the participant on each subject.

Demographic Information Results

Demographic information was collected on each participant's age, ratings/licenses, years he or she have been flying, total flight hours, and total simulator hours. Please refer to Figure 1 for the survey results on the participants total flight time. Please refer to Figure 2 for the survey results on participant age and refer to Figure 3 for the survey results on the highest certificate/rating earned by the participants. Each training method was analyzed by measuring the average point increase and percentage increase for each participant and each training method. Nineteen out of twenty of the participants were UNO students with access to Canvas. Most of the participant's ages were college aged between 18 to 24 years of age with one exception. Information on the participant's total flight time in hours flown revealed over half (11/20) of the participants had between 40 and 120 flight hours. Lastly, over half of the participants (16/20) held their Private Pilot's Certificate/Rating. Four pilots were working towards their Private Pilot's licenses and held active student pilot's certificates.

Figure 1. Demographic Survey: Participation Age Range

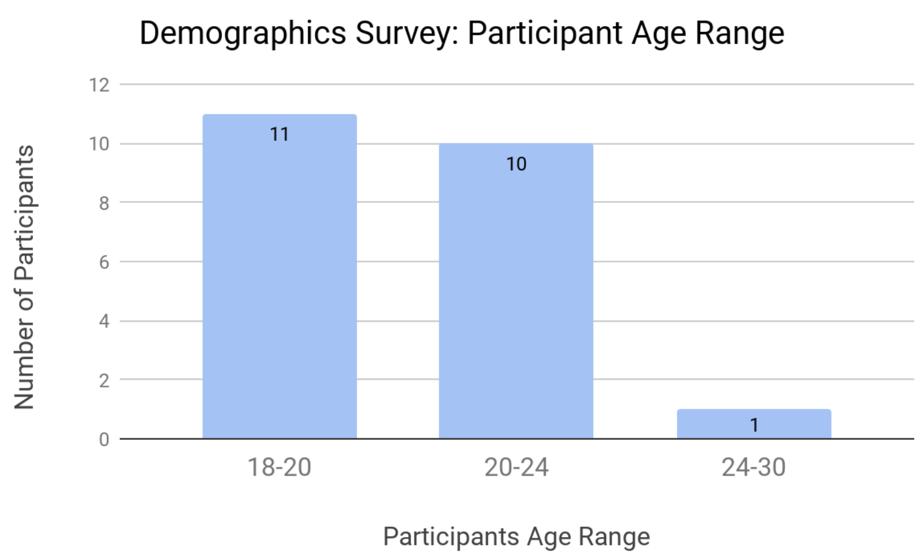


Figure 2. Demographics Survey: Total Flight Time

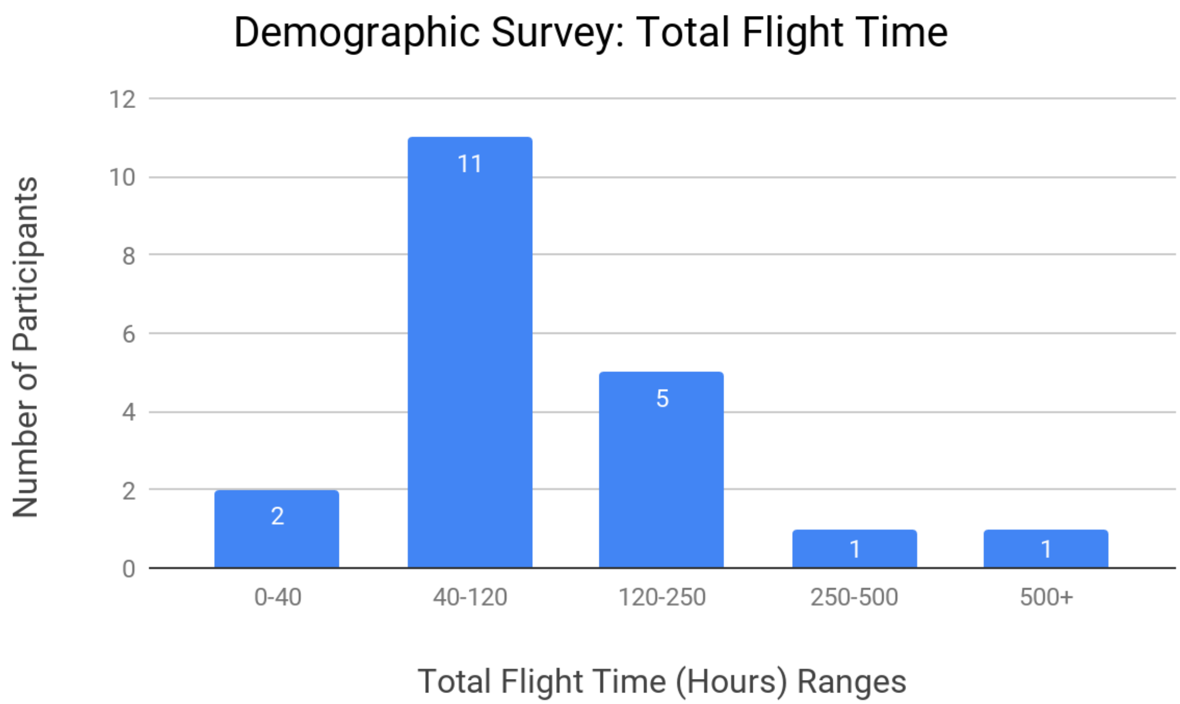
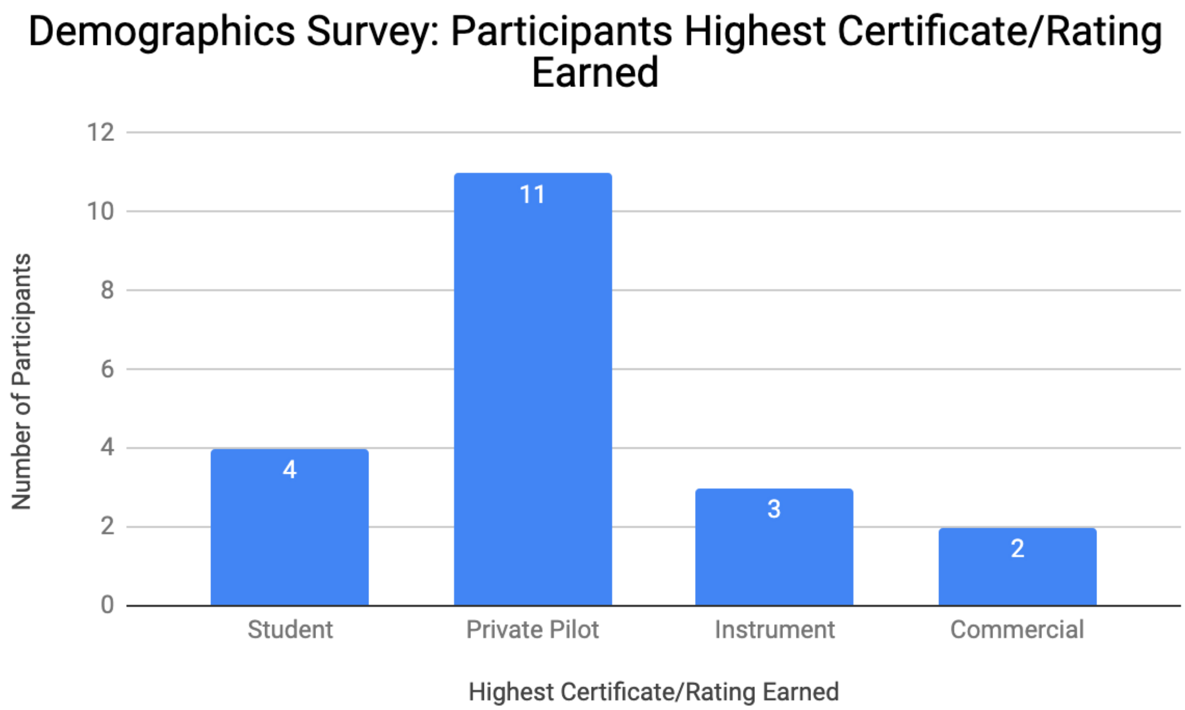


Figure 3. Demographics Survey: Participants Highest Certificate/Rating Earned

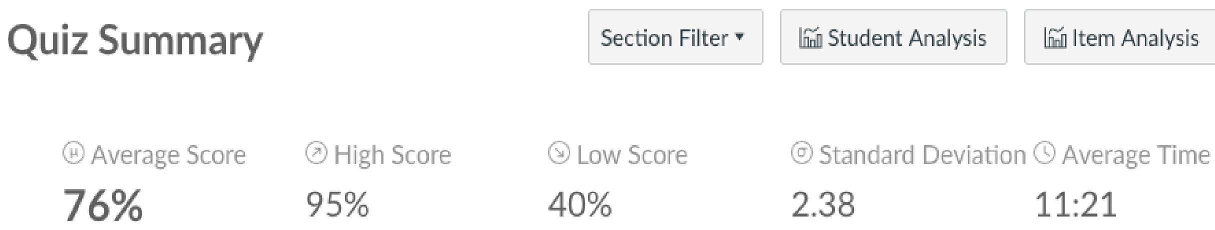


Results

Pre-Training Examination

This twenty-question exam was designed to test the participant's initial knowledge about runway safety. Refer to Figure 4 for the pre-training exam statistic information from Canvas (which contained all 20 participants including the non-UNO student's scores due to a participant dropping out after enrolling). The overall average score was 15.1 points out of 20, or a 76% (rounded). The pre-training exam had a high score of a 19/20 (95%) and a low score of a 8/20 (40%). Canvas offers exam statistics and the exam took individuals an average of 11 minutes and 21 seconds to complete, well below the 20-minute maximum time limit. Please refer to Appendix D for a copy of the questions asked on the exam.

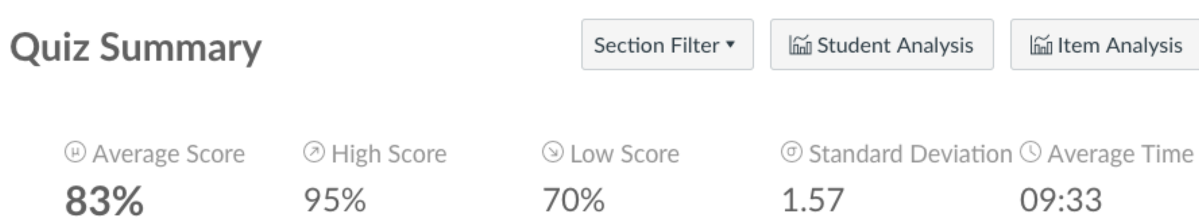
Figure 4. Pre-Training Exam Results Canvas Statistics



Post-Training Examination

This exam contained the same twenty questions as the pre-training exam except the questions and answers were reordered and one question was added to confirm which students were to receive extra credit in what classes. Refer to Figure 5 for the post-training exam statistic information from Canvas. The post-training exam tested the participant's knowledge one week after training for the information they retained from training. The overall average score was a 16.5 out of 20, or an 83%. The post-training exam had a high score of a 19/20 (95%) and a low score of a 14/20 (70%). Participants took the exam in an average of 9 minutes and 33 seconds to complete.

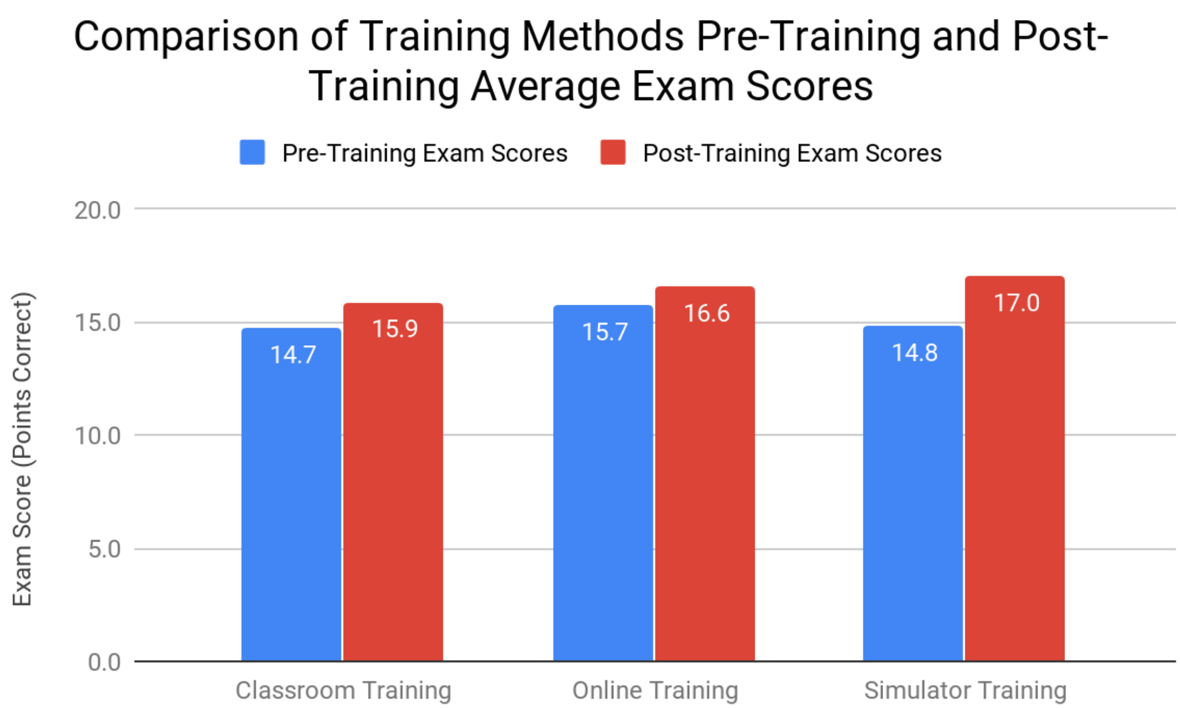
Figure 5. Post-Training Examination Results Canvas Statistics



Training Methods Comparison

A collective average for each training method was used. This means each training methods' average is representative of its participants' scores. The combined averages of the online and simulator pre-training exam results were nearly identical below 15 points while the online training combined average scored the highest on the pre-training exam with 15.7 out of 20 points. The simulator training had the highest combined average score on the post training exam with a 17 out of 20 points. Please refer to Figure 6 for the Comparison of the Training Methods Pre and Post-Training Average Exam Scores.

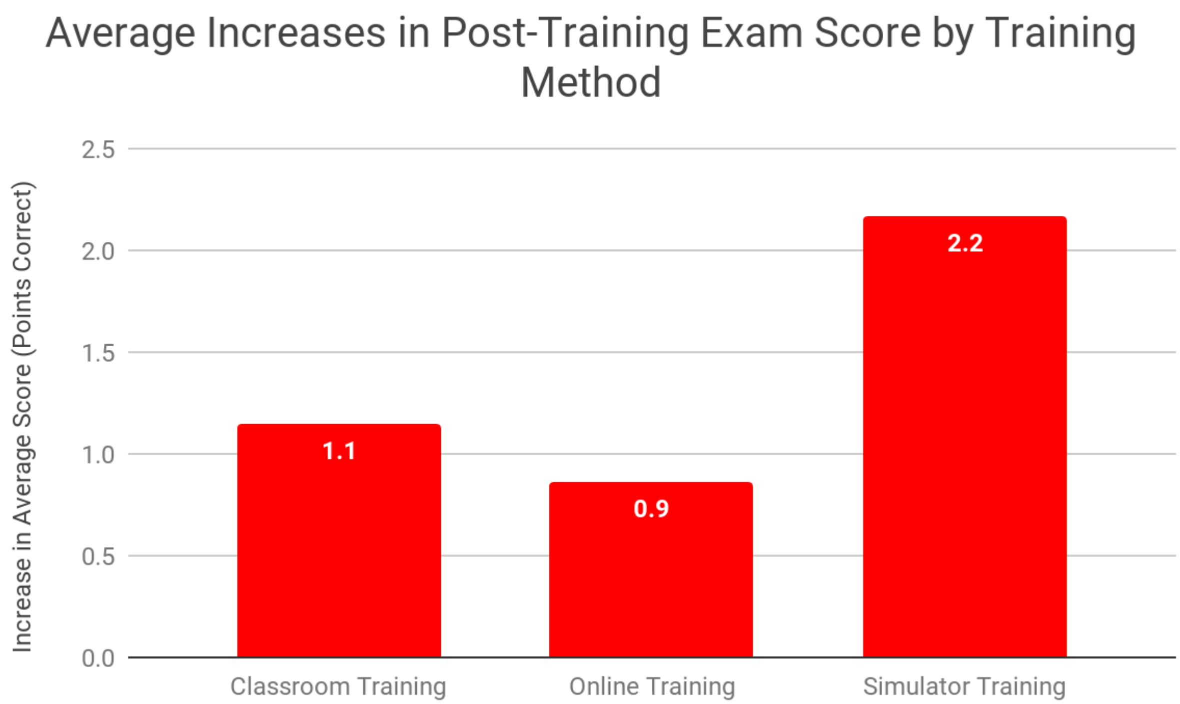
Figure 6. Comparison of the Training Methods Pre and Post-Training Average Exam Scores



Post-Training Score Increase

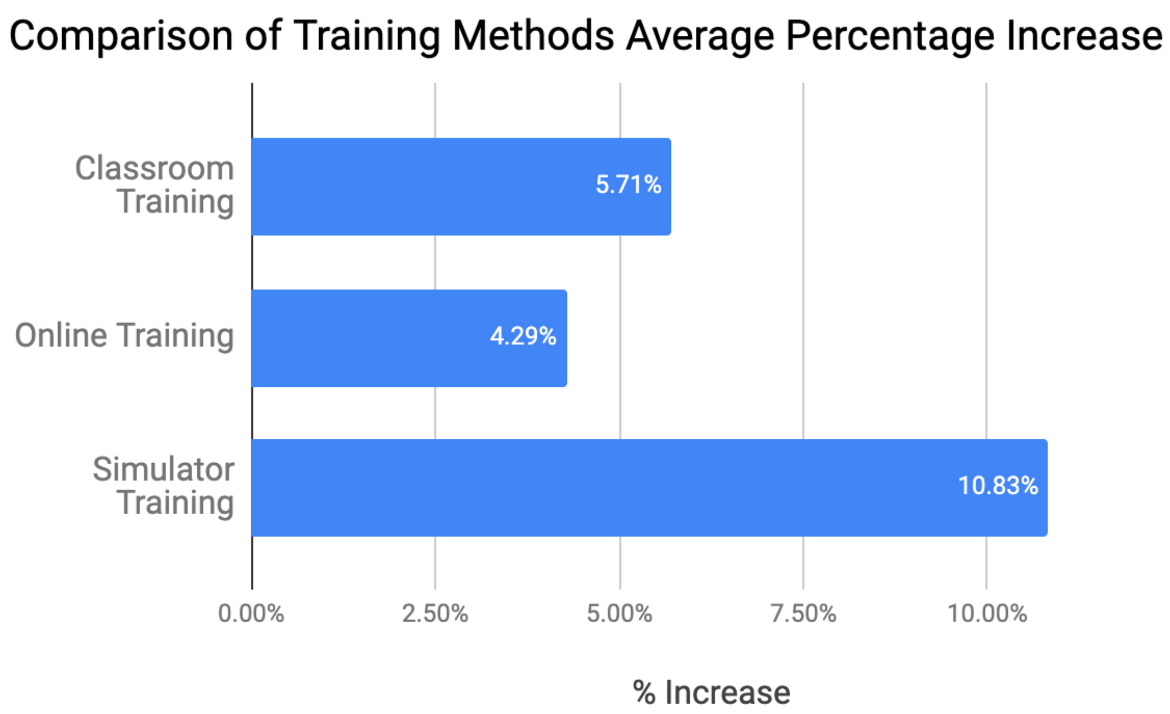
The focus of the project is not to say the highest score is the most effective training method, but to compare the increase in scores on the post-training exam between the training methods. This signifies a greater retention and application of information by comparing the average increase in score. Refer to Figure 7 for the average increases in post-training exam score by training method.

Figure 7. Average Increases in Post Training Exam Scores by Training Method



The simulator training, or simulated environment, had the greatest average increase in post-training exam score with 2.2 points. This was a 10.83% increase in score. The average increase in score for the combined average of classroom trained pilots was 1.1 points (5.71%) and .9 (4.29%) for the combined pilots trained online. Refer to Figure 8 for the comparison of the increase in exam score as a percentage for each training method.

Figure 8. Comparison of the increase in exam score as a percentage for each training method.



Training Method Results Comparison

The results of this experiment reveal that simulator training method resulted in the highest increase in post training score. However, due to a participant drop out, the simulator group of pilots only had six participants instead of seven like the other two methods. The significance of this being that these six individual increases in score are weighted slight above those individuals of the other two methods.

The first hypothesis predicted that more than 70% of the pilots scores would increase after training. This was proven false, as only 13/20 participants showed positive improvement in their scores. The results did reveal that situational learning (simulator training) did yield the greatest average increase in average score. However, this does not conclusively say that situational learning trumps the other training methods. There was an outlier in the simulator training where a pilot increased his or her score from a 40% to a 90% after the training for a 50%

increase in score. This hefty outlier plus the decreased sample size are important factors to consider when comparing the three methods. Based on estimates, if the seventh and outlying participants had both scored an 11% increase in score, the new Simulator training method's average increase drops to a 6%. Therefore, the data collected is inconclusive and does not offer substantive proof that simulator training provided the most effective training. Therefore, the second hypothesis can neither be confirmed nor denied based on the experimental data.

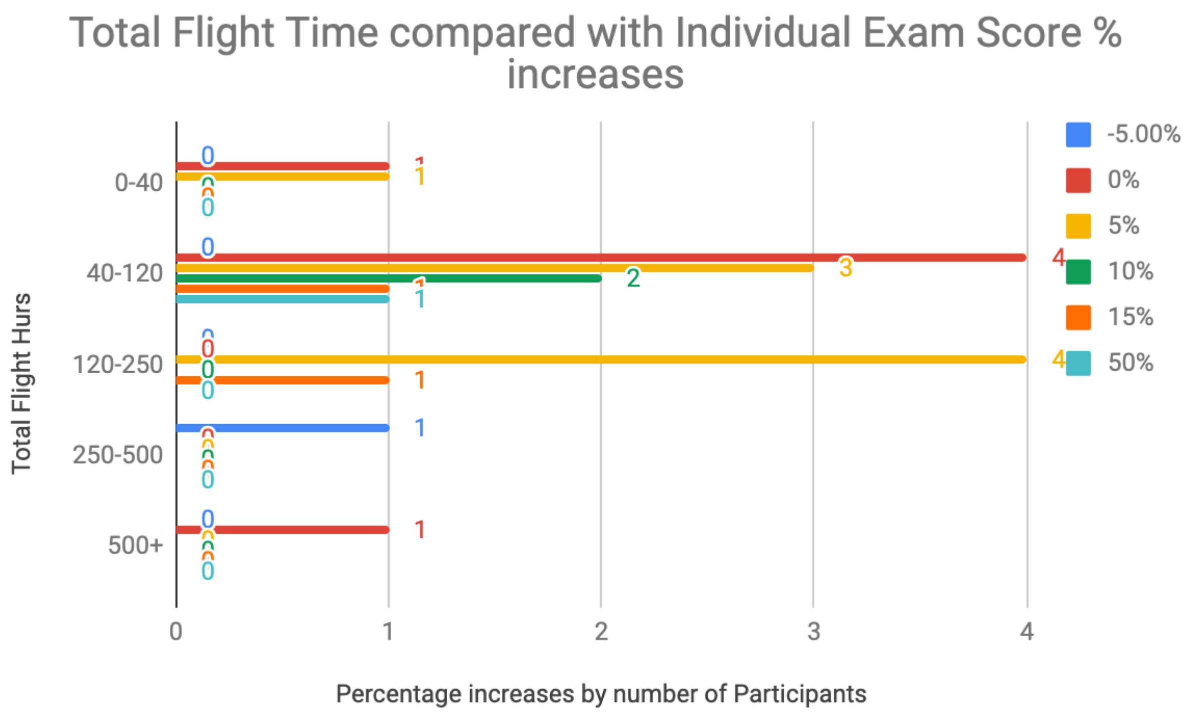
Alternative Explanation

Alternative explanations are factors which influence the dependent variable but are not as important as the independent variables being studied (Tarry, 2018).

Pilot Experience and Demographics. The level of experience in aviation can have an impact on the training success. The measurement of a pilot's experience level used for this project was his or her total number of flight hours. A pilot's experience level can affect how he or she accesses and reacts to a situational and dynamic learning environment (Cox, 2010). The interplay of experience and training offers an ability to draw upon experience to answer questions on the pre-training exam, retrieve past information while in training, and then rely on both to answer questions on the post-training exam. For clarity, all pilots are initially trained on the basics of airport operations and runway safety during their initial flight training towards their Private Pilot certificate (FAA, 2008). Situational learning requires the application of both knowledge and experience; therefore, it would be negligent to solely attribute the change in knowledge to the training regimen. The independent variables will test their knowledge through the exams, but the training they receive may not fully explain their exam scores (Cox, 2010).

Results. Please refer to Figure 9 for the pilot's flight time compared with their exam score increases by percentage. The interplay of pilot experience was difficult to determine. It was measured using only the exam scores with only the one data point of their percentage increase in score. However, all five pilots with between 120-250 flight hours increased their scores. While six out of the 11 pilots with 40-120 hours improved their scores. There was not a discernable pattern of higher flight hours causing a greater increase in score.

Figure 9. Pilot Experience and Exam Score Increases



Limitations and Caveats

A limitation of this research project is the sample size. Time was a limiting factor in this study, as the break between training and the exam was only one week. A longer study may result in whether knowledge retention is present over months or years. The exam only consisted of twenty questions, but if the exam were more comprehensive it could offer valuable data on pilot retention. For this research project, most of the pilot participants were all college age individuals and were not representative of general aviation pilots age even if they match flight time experience. The number of pilot participants needed to effectively determine the effectiveness of the training methods has not been statistically evaluated. Moreover, twenty participants are likely no sample size of an accurate representation of the general aviation pilot population.

There are some assumptions that all pilots will have a general knowledge of runway safety because they have a Private Pilot's License and have obtained some level of training, so the exam increases may not be the best figure to measure by if students performed well and struggled to do any better. The pilots can be also be trained but there is no way for the experimenter to test if they apply the knowledge outside of the experiment. The data collected as a part of this undergraduate research project is likely only representative of the population sampled. The average time used of both the exams could indicate the participants did not fully read each question and answer, and they may have read the question and given same answer without applying the knowledge they learned in training. If future research is to be completed on this subject of training methods, I would suggest a more representative sample of general aviation pilots, a larger sample size, and a more comprehensive examination.

Conclusion

The various training methods all taught the same material, except they required the participants to comprehend and reach to them differently. In the classroom approach, they were expected to listen to the teacher as Instructor Taylor shared his knowledge, in the online self-study approach they had to learn and apply the information without external guidance, and in the simulator approach they were expected to visually identify what they were told and react properly. Each method required something different of the learner.

There is no doubt that runway safety is an issue that needs to be addressed in the aviation industry. This project offered a small-scale sample of proactive involvement from the general aviation community to decrease future runway safety risks through education. Education on runway incursions is an important step towards maintaining a safe industry for all users. Runway incursions are a constant threat to aviation, but their frequency and severity can be reduced. Other mitigation strategies for runway safety are ongoing, but educating pilots is an important component of improving runway safety. Airport operations, specifically involving runway safety, should not be overlooked in training by either instructors or pilots.

The biannual PIC flight review for general aviation pilots to keep their licenses current could have time required to be designated to runway safety, but it should also be understood that two hours of review is not going to be able to cover everything nor cover every topic fully. This presents a challenge as the cost of requiring dedicated runway safety training in both time and resources would be a burden to many. AOPA’s runway safety course, along with many of their other courses, are excellent resources for the community to have access to and learn from (AOPA, 2018). This self-study approach to learning will require the learners, the general aviation community, to take proactive steps to improve runway safety and reduce incursions. A single step in the right direction was taken at the University of Nebraska in 2019 to help improve runway safety started when twenty general aviation pilots volunteered for runway safety training!

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Appendix A

Capstone Project Informed Consent Form

Student Researcher: Powers Dicus

Pilot Application/Retention of Runway Incursion Training

I am asking for your voluntary participation in my capstone project. Please read the following information. If you would like to participate, please sign in the appropriate area below.

If you have any questions about this study, feel free to contact myself at any time: **Powers Dicus - Cellphone:** (Redacted) **Email: Pdicus@unomaha.edu**

Purpose of the Project: To train pilots about runway incursions through three platforms to test information retention. The three platforms used to teach pilots on runway incursions will be in a classroom, online self-study, or in a simulator.

If you participate, you will be asked to: Within one week, take a multiple-choice Pre-Training Exam on runway incursions. Participate in either a classroom, online self-study, or in a simulator runway incursion training session. Schedule and take a multiple-choice Post-Training Exam on runway incursions. The exams will be taken alone and closed note (without the use any devices or materials). The exams are offered either online or in person at the Aviation Institute.

Time required for participation:

Pre-Training Exam - 20 minute maximum time limit

Training - Classroom - 30 minute maximum

- Online self-study - no maximums/do not have to complete course
- Simulator - 45 minute maximum

Post-Training Exam - 20 minute maximum time limit

General Scheduling - 20 minutes to an hour

Potential Risks of Project: There are no more risks involved in this project than they would encounter in their everyday life as a student pilot.

Benefits: Runway incursion training to potentially increase future personal and industry safety.

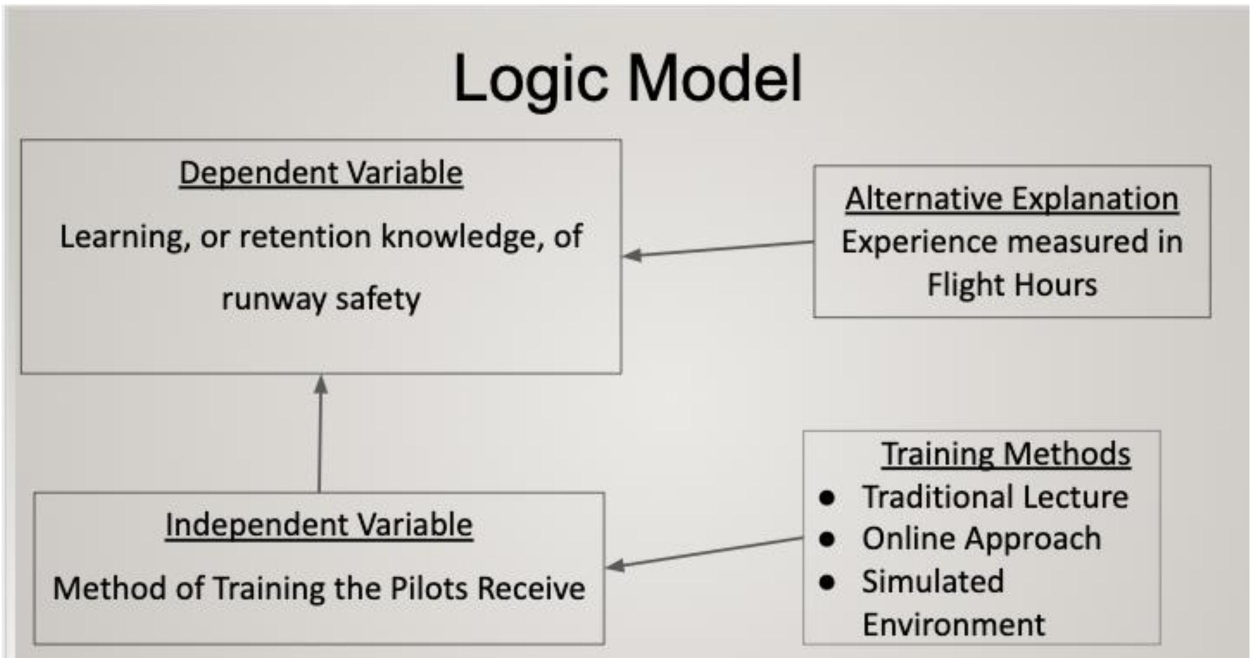
How confidentiality will be maintained: If you wish to participate, there will be Informed Consent Forms in the AVN Institute. The results of each examination will be confidential. No personal information or personal identifiers will be released.

Voluntary Participation: Participation in this project is completely voluntary. If you decide not to participate there will be no negative consequences. Please be aware that if you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

Appendix B

Logic Model

This is a graphic of the logic model for this research project. The arrows indicate the direction and strength of the dependent, independent, and alternative explanations.



Appendix C

Hypothesis Table

This table shows the three training methods compared by the dynamic (situational) learning environment and social environment. This table illustrates why the simulated environment was hypothesized to produce the highest results.

Training Method	**Dynamic Learning (Situational) Environment**	**Social Environment**
Traditional Lecture		X
Simulated Environment	X	X
Online Approach	X	

Appendix D

Runway Safety Exam

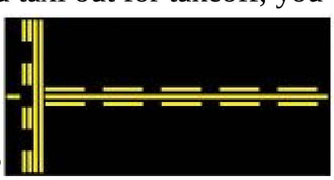
This is a copy of the exam used in both the pretraining and post-training exam. The answers to each question are bolded below.

1. You are approaching this sign. Do you need to contact ATC before proceeding?

   - **a. Yes**
   - b. No

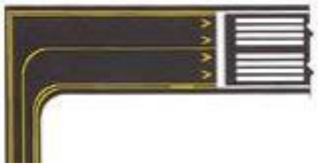
2. You are departing an unfamiliar airport. When the Ground Controller issued your taxi clearance, it seemed very complicated and you did not write it down. What could you do?
   - a. Request "Progressive" taxi instructions.
   - b. Do not taxi until you explicitly understand your taxi instructions.
   - c. Express your uncertainty and ask for direction clarification from ATC your
   - **d. All of these are options of what you could do.**

3. If you become disoriented or uncertain about your location on the airport, what should you do?
   - **a. Make sure you are clear of any runways and stop the aircraft.**
   - b. Attempt to take off on the closest runway you can see.
   - c. Keep going, surely you'll see something familiar.
   - d. Stop the aircraft regardless of where you are.

4. As you taxi out for takeoff, you encounter the depicted taxi line below. What does it mean?
   - **a. You are approaching a runway holding position.**
   - b. The airport had extra yellow paint and decided to use it on the taxiways.
   - c. You are approaching the airport movement area.

   d. You are approaching an ILS holding position.

5. The yellow painted marking at the beginning of this runway indicates:



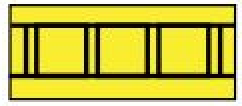
   a. The pavement can be used for takeoff only.
   b. The pavement can be used for landing only.
   c. The runway threshold has been relocated.
   d. Only applies to vehicles.

6. Due to traffic or other reasons, the tower controller cannot issue an immediate take off clearance, but he wants you on the runway ready to start your takeoff roll. According to the current best practices what would the instruction be?
   a. "Taxi onto the runway and be ready."
   b. "Line up and wait."
   c. "Taxi into position and hold."
   d. None of the above.

7. On initial contact with Ground Control, according to the current best practices, pilots should state which of the following:
   a. Who you are calling.
   b. Where you are located on the airfield
   c. Who you are.
   d. All of the above.

8. Best practices when communicating with Tower Control to enter a specific runway are to:
   a. Read back all clearances/instructions, including runway designator.
   b. Read back all takeoff and landing clearances, including the runway designator.
   c. Clarify any misunderstanding or confusion concerning ATC instructions or clearances
   d. All of these.

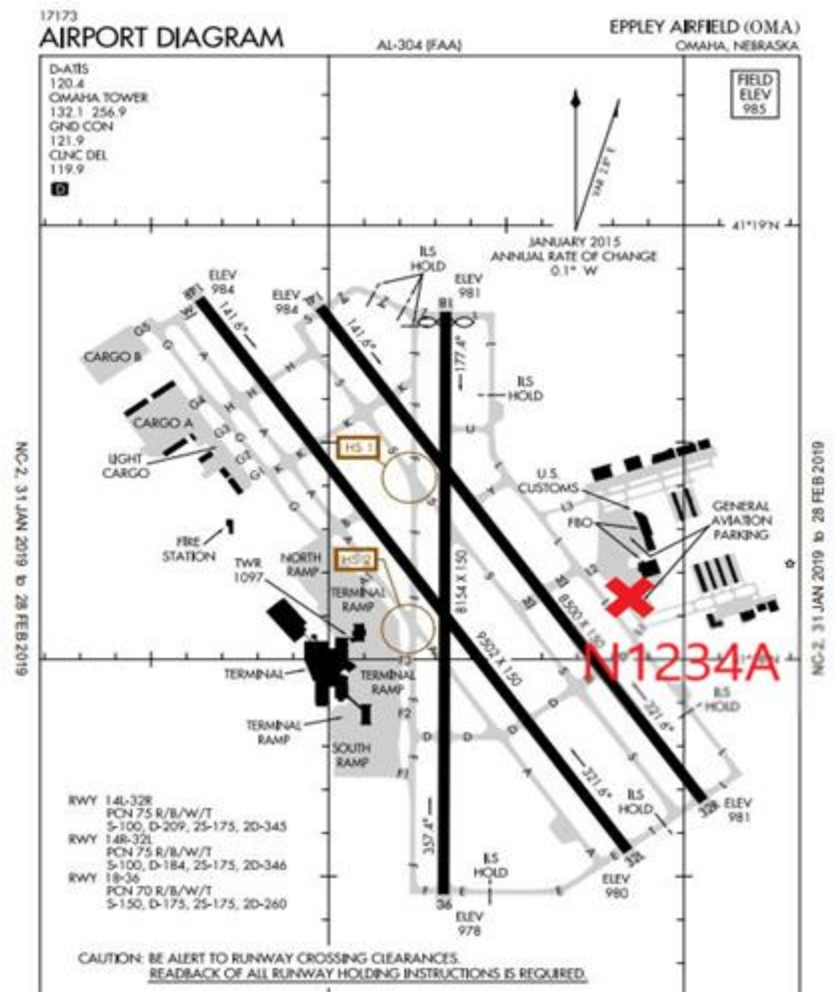
9. You are approaching an airport and have received a landing clearance. As you continue your approach, you notice an aircraft sitting on the runway you are cleared to land on. What should you do?
   a. Land your aircraft immediately over the aircraft on the runway
   b. Land on a different runway of your choice immediately; ATC must have told you the wrong runway
   c. Prepare to, and if needed, execute a go-around
   d. Communicate with Ground Control about the aircraft on the runway you are cleared for



10. What does this **SIGN** identify?
    - **a. ILS Boundary Sign**
    - b. Non-Movement Area Boundary Markings
    - **c. ILS Critical Area Holding Position Signs and Markings**
    - d. Runway Safety Area Boundary Sign

11. This sign indicates:
    - a. Runway 15/33 is ahead.
    - b. That you are located on a taxiway.
    - c. Runway Holding Position Sign.
    - **d. All of these.**
12. What does "Explicit Runway Crossing Clearance" mean?
    - a. "Taxi to" clearance will allow you to cross multiple runways.
    - **b. Typically, instructions to cross a runway will be issued individually for each runway encountered.**
    - c. It replaced "Position and Hold."
    - d. It is a trick question; no such instruction exists.
13. As you are crossing a runway, you notice that an aircraft at the approach end of the runway has turned on its landing lights. This means this aircraft has _______________.
    - a. Just landed.
    - b. Yet to communicate with Tower Control.
    - **c. Received a takeoff clearance.**
    - d. Not received takeoff clearance.
14. It is necessary for the entire aircraft to be completely past the hold short line to be considered clear of the runway.
    - **a. True**
    - b. False
15. You have landed at a tower-controlled field, slowed your airplane, but have not heard from ATC where to turn to exit the runway
    - a. Continue to the end of the runway before turning off.
    - b. Switch to the Ground Control frequency for instructions on which taxiway to turn on to.
    - **c. Turn off at the first available taxiway, ensure you are clear of the runway and wait for further instructions from the Tower Control.**
    - d. Continue on the runway until Tower Control tells you where to turn off.
16. You are the pilot of N1234A communicating with ground and receive the following instruction, "N1234A, Runway 36 taxi via taxiway Delta, permission to cross Runway

32R and 32L." Using the Diagram below, can you cross Runway 32R and 32L?



a. Yes, you were given permission by ATC.
b. No, ATC can only clear you to cross one runway at a time.
c. Yes, after a correct readback.
d. No, to do so would be considered a runway excursion

17. After you perform an engine runup, you contact the control tower to let them know you are ready for takeoff. Tower responds with, "Archer 21K, Runway 23, line up and wait." How should you respond to these instructions?
    a. Taxi to the hold line for the runway, but do not taxi onto the runway without further clearance
    b. Taxi into position immediately behind the aircraft in front of you
    c. Taxi onto the runway and wait for your takeoff clearance
18. By responding to an ATC transmission with "Roger," what are you saying?
    a. "Yes, that is correct."
    b. "I will follow your instructions."
    c. The controller's first name

   d. **"The message has been received and understood."**

19. A hotspot is a location on an aerodrome movement area with a history or potential risk of collision or runway incursion, and where heightened attention by pilots/drivers is necessary.
    a. **True**
    b. False
20. The portion of a displaced runway can be used for landing but not for takeoff.
    a. True
    b. **false**

END OF THE EXAM