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Improving Training in Aviation: A Theoretical Evaluation and Application

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IMPROVING TRAINING IN AVIATION:

A THEORETICAL EVALUATION AND APPLICATION

by

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ABSTRACT

Pilots are required to go through many hours of instruction and flight training before obtaining certification (FAA, 2016a). This training is designed to teach trainees the relevant concepts and procedures that are needed to complete successful flight operations. However, there are many factors that can impact the effectiveness of this training. The focus of this paper is to investigate, per the request of a faculty member from a University's Department of Professional Aviation, ways in which an aviation training program could be improved. To better understand this training program, a review of aviation training is provided. To determine if active learning via a self-seeking feedback intervention is a viable means of process improvement, previous research surrounding training and feedback are discussed. The current paper outlines the scientific literature that informed, supported, and ultimately justified the choices made during this project. Limitations and additional considerations are also provided.

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CHAPTER 1

INTRODUCTION

In fall 2017, a member of a University's Department of Professional Aviation reached out to our research team with interest in improving their aviation training program. In order to find potential areas of improvement and to determine how to introduce an intervention within this specific training environment, I first reviewed the current state of the training program.

The current aviation training program consists of in-classroom, cockpit, and simulator training. A degree in Professional Aviation at the University requires students to complete the requirements for the private instrument, commercial, and flight-instructor certifications. This program is intended to provide students with flight training and relevant academic coursework to acquire and refine basic airmanship skills, and requires a minimum of 120 semester hours. The objective of the program is for students to acquire the skills and knowledge necessary to successfully and safely operate an aircraft. The classroom and flight instruction in the aviation training program are led by authorized flight instructors (CFIs) and are governed by a regulation called Part 141; both of these will be discussed below.

Pilot certification in the United States is regulated by the Federal Aviation Administration (FAA), a branch of the United States Department of Transportation (USDOT; Federal Aviation Administration, 2021b). The FAA promotes aviation safety

standards through the Code of Federal Regulations (CFR), Title 14: Aeronautics and Space (FAA, 2016a). In the United States, pilot training and subsequent certification are required for an individual to be an aircraft pilot. Pilots may be trained and certified under Title 14 CFR Part 61 or Title 14 CFR Part 141 (Code of Federal Regulations, 2021).

Part 141 pilot schools are granted an Air Agency Certificate by the FAA, which requires use of a structured training program and detailed syllabus that highlights all of the objectives of the program (FAA, 2016a). In order to obtain this FAA approval, a Part 141 pilot school must work with the FAA from initial inquiry through certification issuance to become certified for this aviation training qualification. This process helps ensure that the programs, systems, and intended methods of compliance are thoroughly reviewed, evaluated, and tested in accordance with FAA regulations. Training under Part 61 occurs in a non-certificated flying school and still has knowledge-based training and flight experience requirements, but is more suited for those students who need more flexibility in their learning and training schedule and are interested in, or only available for, training part time rather than full time (FAA, 2016a). The training program in this project takes place at a Part 141 FAA-certified pilot school (FAA, 2016a). Regardless of if a student trains under Part 141 or Part 61, the success of the training depends on the quality of the instruction that a student pilot receives.

A certificated flight instructor (CFI) is FAA authorized to teach others how to operate an aircraft (FAA, 2016a). After demonstrating their aeronautical knowledge, pilot proficiency, and teaching techniques through advanced knowledge and practical tests, the flight instructor is certified to teach relevant subject areas in aviation training to student pilots. In Part 141, these instructors are in charge of the teaching and training that occurs

within the FAA-pre-specified ground-school and flight-school guidelines. The flight instructor is responsible for training student pilots in all subject matter areas, procedures, maneuvers, and tasks for operation to acceptable standards (FAA, 2016b). Ultimately, flight instructors are responsible for training students to be safe and competent pilots.

Flight training consists of two parts: ground school and flight school. Becoming a pilot involves both knowledge and skills, which are obtained through training in ground school and flight school (FAA, 2016b). Ground-school content includes all of the knowledge areas listed in the Airman Certification Standards (FAA, 2021a). As mentioned, Part-141 pilot schools must provide an FAA-approved course description with lesson objectives, standards, expectations, and anticipated time of completion to meet FAA ground-school requirements. In order to assess if these have been met, the program also includes a description of the metrics used to measure students' accomplishments through each specified stage of training (FAA, 2016b). Pilot schools operating under Part 61 do not have these same ground-school requirements and offer a more flexible training environment where the instructor and student can work together to modify the program to meet the needs of the student. Regardless of whether students are trained under Part 141 or Part 61, they must be able to meet the minimum requirements of the intended pilot certificate or rating via an FAA-mandated aeronautical-knowledge test that covers the aeronautical knowledge areas listed in the applicable regulation for the certificate or rating sought (FAA, 2016b).

The goal of the current dissertation is to examine how aviation training can be enhanced without adding excessive demands to students or flight instructors, nor violating the FAA pilot training guidelines. The aviation training program in-classroom

curriculum and required in-aircraft aeronautical skills are determined by the outlined learning objectives of the FAA; these learning objectives have been set to meet FAA pilot certification requirements. Though these requirements cannot be changed, the processes surrounding how the students are trained can be. Creating an intervention related to how training is being implemented could yield positive results for training outcomes. Because the ground-school training curriculum, syllabus, and lesson plans for Part 141 are already determined according to FAA standards, the focus of this project will be on the training that occurs in flight school during flight lessons.

Flight school is where trainees can participate in practical lessons to become proficient in piloting an aircraft. The goal of flight school is to prepare trainees for their practical flight test via in-cockpit and in-simulator flight lessons (FAA, 2016a). In addition to the aeronautical instruction on the skills necessary to perform safety checks, various flight maneuvers, and air-traffic-control communication, a specified number of hours of flight training are set. Students must complete the requirements for the Private, Instrument, Commercial, and Flight Instructor certificates to obtain the Professional Aviation degree offered by this program. Per the FAA, Part 141 schools must complete a minimum designated number of hours of aeronautical skill training depending on the desired pilot certificate or rating (FAA, 2016a). However, this is the bare minimum of hours needed to complete flight school. While the minimum hours needed to complete a private pilot certificate is 35 hours in a Part-141 certificated school and 40 in a Part-61 school, the national average of hours completed for sufficient flight training for that same certificate is between 60-75 hours (FAA, 2016a). As training becomes more specialized and students choose to pursue Instrument, Commercial, or Flight Instructor certificates,

these required minimum hours only continue to increase. Successful completion of flight training largely depends on individual progress, as the ultimate goal of flight training is to achieve the ability to fly under safe operations.

Flight training lessons can occur in an aircraft or in a certified aviation training device (ATD). The ATD is a type of simulator that can represent the aircraft in ground and flight conditions, replicating the aircraft's instruments, equipment, panels, and controls. Henceforth, I will refer to this flight training tool as an ATD or reference it as a simulator. Flight lessons occur under the guidance of an authorized flight instructor who can provide support and serve as a resource to students. In the current training program, students are able to practice simulated tasks within an ATD or in an aircraft, but the use of lectures, books, and class discussions from ground school help create comprehensive training. Training in the ATD allows students to safely and affordably practice their flight skills as if they were within an actual aircraft, helping them gain the knowledge of basic maneuvers they need to safely respond to various flight situations as they would in an in-aircraft flight (Caro, 1988). Practicing within this environment can increase an individual's knowledge of the function, capabilities, and structure of an aircraft and determine how to utilize them in an effective way.

The training program for the current University's aviation students involves operating an ATD that features a replica of aircraft instruments, equipment, panels, and controls (CFR, 2021). This allows students to learn the skills required to pilot an aircraft without having to leave the ground. Because controlling an aircraft is a complex procedure, experiencing the pilot-instrument interaction within a true or simulated environment offers students a chance to process and practice multiple tasks — to train.

Training is integral in developing and strengthening skills that trainees need to learn to perform at their best in future contexts. Because I was unable to change the content of the training program, I considered different factors that impacted the delivery of training. The ATD provides a context where students are able to practice their skills and gain experience in an environment that mirrors the in-aircraft cockpit they pilot. In order to train and assess the intended skills of a flight lesson, ATDs can be programmed with a given flight route. Performance in these predetermined flight patterns can be assessed based on how accurately the student is able to perform various aspects (e.g., takeoff, holding patterns, landing; National Intercollegiate Flying Association, 2019). Performance in these flight lessons ultimately determines the rate of progression through the program. Focusing on how to improve performance during these flight-school lessons can help aviation students become better pilots, express their skills, and progress through the program.

Problem Statement

The evaluation request of this research project was to determine how to improve a University's aviation training program. The aim of the current project is to determine how to improve the training experience. In order to address this, viable interventions that can improve training, require minimal additional work outside of the essential training requirements, and result in no subsequent harm to those involved have been considered.

Training helps individuals develop skills and knowledge intended to improve capabilities, productivity, and/or performance (Salas & Cannon-Bowers, 2001). Knowledge includes subjects or topics of information that contribute to the theoretical or practical understanding of a subject. Skills refer to the technical or manual proficiencies

that are learned/acquired through training or experience and results in competency in performing a task. Abilities are the demonstrated capacity to apply knowledge and skills to complete a task or behavior. By giving trainees an opportunity to acquire knowledge, skills, and abilities (KSAs) through instruction, demonstration, practice, and relevant feedback about their performance, trainees are able to more effectively learn and apply this learning across contexts (Salas et al., 2012). The KSAs that trainees intend to acquire should be related to the tasks and desired outcomes of the job, which develops job-specific skills via training to prepare trainees to handle future job demands (Aguinis & Kraiger, 2009). While the appropriate selection of content for training is critical for training effectiveness, the way that training is designed and delivered also has an impact on its overall effectiveness (Salas et al., 2012).

The Part 141 flight school in this project is regulated by the standards of the FAA and reviewed on a regular basis to ensure consistency and the use of acceptable flight-training practices, resulting in a highly structured training program (FAA, 2021b). Because I was not permitted to update or alter the FAA-regulated curriculum, the University's department of aviation and I chose to focus on the subtleties of the training that occurs in flight school, specifically within the ATD.

Training in a simulator is useful because of its fidelity, cost effectiveness, and safety for learners (Jentsch & Curtis, 2017). Simulators must be able to replicate certain aspects of an aircraft to provide effective training (FAA, 2021b). The ATD in this project features a fully simulated instrument panel, avionics, and flight control, creating a solution for pilots to practice essential skills in a realistic cockpit environment outside of an actual aircraft. ATDs are also useful for training because they have the capability to

collect performance measures that help assess successful and unsuccessful flight operations (FAA, 2021a). Because performance can be used to measure progress during flight training, I investigated ways in which performance could be improved to help students progress through flight lessons more efficiently via enhanced learning and understanding. In order to determine how this objective could be met, I will present an examination of the literature surrounding improving performance via training below.

The literature review for this study will help determine if, considering the requirements and restrictions of Part 141, and, if so, which adaptations to flight training could improve the flight-training experience. When reviewing literature on training I was able to examine the ways that training could potentially be improved. Effective training includes determining the knowledge and skills that should be developed, clarifying how this will be useful in the future for trainees, giving trainees opportunities to practice their skills, and providing constructive feedback throughout the learning process (Salas et al., 2012). Because of the regulations outlined by Part 141, the relevant knowledge and skills have been outlined within the training program, but the training experience itself can be enhanced.

Like in a traditional classroom setting with teachers and students, the flight instructor is able to provide the trainee with a breadth of information that can increase their aviation knowledge and skills. One of the ways that learning during training can be enhanced is through feedback (Arthur et al., 2003). Constructive feedback from flight instructors allows trainees to know when they are already doing things correctly, but also how to improve when they are doing things incorrectly (Kraiger et al., 1993). As feedback is an integral part of successful training, I chose to focus on how the

student/flight-instructor interaction could be enhanced via feedback in order to improve training outcomes.

The central question to be answered in this project is whether a learner-directed form of feedback is beneficial as an addition to aviation training. The intervention itself involves minimal effort from those involved, but could positively impact the overall training system. More importantly, this project will focus on determining if there is enough information from previous research and the research conducted for this study to conclude if this intervention could be helpful, but will not be harmful to those involved.

Project Question: Is a self-directed form of feedback a viable way to enhance the training experience for students?

Below, a review of the literature supporting choices made for this project and the different ways that training interventions can enhance training outcomes are presented. While improving training with the addition of a self-directed form of feedback may lead to positive outcomes, it is also important to acknowledge whether these interventions could take away from or decrease the efficacy of the training. In order to address the central problem of this project and answer these questions, through previous research and this project, I assess the potential impact of this intervention. In order to substantiate these claims, I provide support from scientific literature.

Review of Literature

Training

Within organizations, training is a systematic process by which employees acquire the KSAs necessary to successfully do their jobs (Goldstein & Ford, 2002). The training process is used to enhance knowledge and capabilities, increase productivity, and

promote learning (Goldstein & Ford, 2002; Tannenbaum & Yukl, 1992). While training can be used to enhance individual capabilities and provide employees with the skills needed to perform complex and dynamic jobs, training can have a larger impact on team and organizational effectiveness (Noe et al., 2014).

Though training is commonly used within organizations to help create more skilled and knowledgeable employees, it can also be used in formal classroom settings or via instructor-led courses to prepare students for a future career. Training content primarily focuses on the practical skills and information necessary for a specific job. This content can be presented through various methods (e.g., lectures, readings, or demonstration) but is intended to prepare students for relevant future application (Baldwin & Ford, 1988). Training programs are available for careers in nursing, commercial transportation, cosmetology, and massage therapy (United States Bureau of Labor Statistics, 2020).

Technology in Training

Early training research involved learning studies that focused on efficiency, but gradually research began to shift to an examination of various methods and instruments that could be incorporated into training environments to promote learning and assess training progress (Bell et al., 2017). While trainer-led classroom instruction has been a longstanding popular way to deliver training, technology has provided opportunities to improve training (Cannon-Bowers & Bowers, 2009). Advances in technology have impacted training costs and the ways in which training can be delivered, including how realistic training is and the accessibility of training (Noe, 2017). Technology allows us to

create learning environments that contain the defined objectives, measures of assessment, and other features that promote effective training (Noe, 2017).

One type of technology that has been integrated in training contexts is simulation. Simulation is an effective educational and instructional tool that helps trainees develop knowledge and skills in an imitated system in the same way they would in the actual system (Hays et al., 1992; Noe et al., 2014). Simulation training and games have been successfully used across business, education, and military settings (Salas & Cannon-Bowers, 2001). Simulation training is especially pertinent to situations where training in an actual environment may be too dangerous or expensive (Jentsch & Curtis, 2017). Training simulations or simulators can reproduce realistic scenarios of everyday life that the trainee may encounter in the future, giving the trainee an opportunity to practice the relevant skills they will need in order to succeed in later application (Jentsch & Curtis, 2017).

Although simulation is a tool that can be used in training, solely experiencing a simulation environment does not equate to effective training (Salas et al., 1998). In order for a simulation to be effective, the environment must facilitate learning and transfer of training (Noe et al., 2014). Simulations are best used as an effective supplement to another instructional method, especially when they foster active engagement between the learner and the training content and allow for unlimited learner access to practice (Noe et al., 2014; Sitzmann, 2011). Instructional methods can be broadly categorized as teacher-centered, learner-centered, content-focused, and interactive/participative (Treagust, 2007). Classroom lectures, demonstrations, discussions, and group learning are all types of instructional methods. Training programs should utilize simulators to apply principles

from theories of learning, training, and performance to ensure useful training outcomes (Jentsch & Curtis, 2017).

Training Outcomes

In an organization, training outcomes often include employee retention, reskilling and upskilling, process improvement, and increased performance (Ford et al., 2010). In order to assess if the objective of training has been met, training outcomes should be observable, measurable, and clearly outlined. Outcomes are generally action-oriented, relating to the doing or knowing of something, which can be expressed via learning (Ford et al., 2010).

Learning, a desired outcome of training, is the process of acquiring knowledge, skills, and behaviors through practice, study, or experience (Aguinis & Kraiger, 2009). Information presented in training is intended to increase trainee proficiency, which is exhibited by a designated learning outcome. Learning outcomes can be viewed as cognitive, behavioral, and affective in nature (Ford et al., 2010; Kraiger et al., 1993).

Cognitive outcomes can be used to determine how familiar trainees are with the facts, techniques, and processes that have been emphasized in the training program (Kraiger et al., 1993). While the information being presented in training is critical for learning, how the trainee stores, organizes, and recalls this information will also impact the effectiveness of the learning (Gagne, 1965). Cognitive transfer, or the ability to apply previously learned knowledge to new situations or contexts, is one way to exhibit this cognitive learning (Gully & Chen, 2009).

Behavioral outcomes include technical- and/or motor-skill development (Kraiger et al., 1993). These behavioral outcomes are linked to skill acquisition, compilation, and

transfer of training (Baldwin & Ford, 1988). In initial skill acquisition, trainees use their knowledge to transform information into actions. These actions then become compiled into routines where behaviors are task-focused and completed in succession (Kraiger et al., 1993). Over time, trainees are able to integrate previously learned procedures together to execute more complex behaviors. Transfer of training occurs when the KSAs acquired during training are successfully applied on the job or in the relevant context (Baldwin & Ford, 1988).

Affective and motivational outcomes include trainee satisfaction, self-efficacy, expectancy, and perceived utility of training (Kraiger et al., 1993). The extent that trainees liked the training, perceived its organization, and found the training useful can be assessed via reaction measures of training are important, but they do not express the extent to which content was successfully learned (Kraiger et al., 1993). Because all trainees are unique, individual motivation and attitudes can influence the choice of personal actions, which can impact success of training (Gagne, 1984). After developing skills, individuals are more likely to be able to recognize the values of their behaviors, which causes a shift in the attitudes and motivation of the trainee (Kraiger et al., 1993). While trainees are initially interested in their skill development and learning, over time they should be more interested in how they use these skills to display their own performance and capabilities.

In order to assess learning, whether cognitive, behavioral, or affective in nature, training evaluation must occur. Training evaluation is used to determine whether trainees have learned the material covered in training (Campbell, 1988; Kraiger, 2003). Typically, evaluation is used to assess trainee perceptions (i.e., reactions), gauge if training

objectives were achieved (i.e., learning), if the accomplishment of these has had a positive outcome on the job (i.e., transfer), and determine if the intended outcomes were achieved (i.e., results; Kirkpatrick & Kirkpatrick, 2006; Kraiger et al., 1993). Transfer of training requires the application of the knowledge and skills acquired during training to the relevant situation, role, or job (Burke & Hutchins, 2007). Failure to translate training into practice can be due to things such as knowledge decline and the inability to connect new information to existing practices (Aguinis & Kraiger, 2009). In order to better understand how these outcomes can be improved, the factors that contribute to the learning and transfer of skills must be discussed.

Features of Training

In order for training to be considered effective, designated outcomes of training must be met. This involves examining the features of a training program as well as how it is designed and delivered based on the goals of the training. According to Noe (2017), in order for training to be effective, training should be: a) designed around the specific KSAs employees need to do their jobs successfully, b) motivating, interesting, realistic, and clearly outlined, c) related to pre-existing KSAs that trainees possess, d) an opportunity for trainees to practice new skills, while receiving feedback and further support. A highly structured learning environment provides instructions on how to complete tasks and considers the strategies behind doing so, providing an efficient way to develop routine habits and transfer skills in similar environments in the future (Salas & Cannon-Bowers, 2001). The extent of cognitive, behavioral, and affective learning outcomes above can be influenced by different training features including the training design, situational factors, and the individual (Bell et al., 2017).

The creation of a training program requires a planned effort that is designed to enhance competencies, knowledge, skills, and behaviors to ultimately meet specific goals and objectives (Noe, 2017). The training design process refers to the systematic approach used to develop training programs. Training design includes the methods and techniques used to deliver training content to trainees, the sequencing of training objectives, and the tools and strategies that best support learning and transfer (Salas & Cannon-Bowers, 1997).

When selecting the content and design of a training program, ways to increase the overall effectiveness of the training should be considered. The determination of content occurs during the needs assessment where the need and support for training are identified (Kraiger & Ford, 2007). When there is a training target in mind, relevant task requirements to support the development of KSAs can be established and integrated within the training program to help guide the learner to the intended training outcome.

Training development includes determining the training content as well as the parameters and appropriateness of the training method (Kraiger & Ford, 2007). Because training is designed to maximize the learning of job-related KSAs, the content of the training program should be linked to the requirements of the job and exist in a system where learning of necessary skills is promoted. How this content is delivered is another important consideration when creating a training program. Early forms of training techniques such as role-playing and case studies are still used today, though there has been an increase in research on training approaches like goal-directed learning and learner control that focus more on mental processing and motivation to enhance learning and the development of more complex skills (Kraiger & Ford, 2020). The training

context includes the training environment and the perceptions of the environment that can impact participation, learning, and transfer (Bell et al., 2017). Contextual factors such as social support, amount of time and opportunity available to apply new skills, and instructor quality can influence employee motivation and subsequent training effectiveness (Mathieu et al., 1992).

Trainee characteristics, including capabilities, personality traits, values and interests differ across trainees and can impact training effectiveness (Colquitt et al., 2000; Tannenbaum & Yukl, 1992). Success of training is determined by a combination of mechanisms that influence how people process information, focus their attention, direct their efforts, and manage their affect during learning (Kanfer & Ackerman, 2004; Kozlowski et al., 2001) As the goal of training is to promote learning, understanding how learners can impact their own success and improve this process is critical. Colquitt et al. (2000) examined how various trainee characteristics influence learning outcomes and found that training motivation was a primary contributor to learning. Training becomes inherently more motivating when the content is relevant and engaging, trainees are given ample opportunity to train and receive support, and training can be personalized to meet the needs of the individual (Colquitt et al., 2000). Because individual differences between trainees will always exist, focusing on how to increase motivation and promote learning orientation across trainees can provide a way to enhance learning, despite other individual differences. I will now discuss the specific context that serves as a background for this initiative.

Overview of the Aviation Training Context

The continued growth of the aviation industry, and resulting expanding workforce, has increased the need to produce capable pilots (Jentsch, & Curtis, 2017; O*NET OnLine, 2021). The learning that occurs in the context of aviation includes developing an understanding and application of knowledge to handle the routine operations and unpredictable situations that can occur while piloting an aircraft (Telfer & Moore, 1997). As supported by the literature above, the success of teaching the KSAs of these pilots depends on the quality and efficacy of pilots' aviation training, which is based on the content and context of the training program itself.

Pilot training that is provided through an FAA-certificated pilot school can help ensure overall quality training that meets the expectations of the FAA (FAA, 2021a). For Part-141 flight schools, the FAA is involved in determining what course content meets the requirements of aviation training. Flight training includes both ground and flight instruction, aimed to develop the knowledge and skills required for one to effectively and safely function as an aircraft pilot. The aviation training program in this project consists of in-classroom instruction and flight lessons, which include in-simulator training and in-aircraft training. Aviation training goes beyond acquiring information to incorporating the information skillfully in operations. Training includes instruction on pre-flight procedures, airport operations, aeronautical factors, basic navigation, aviation safety, and emergency procedures (FAA, 2016b). Because Part 141 flight schools must meet standards for equipment, facilities, personnel, and curricula, their aviation training content aligns with the training objectives and flight standards of the FAA.

Learning how to operate an aircraft begins in ground school, where the fundamental information can be taught, and is followed by flight training, where the knowledge can be applied (FAA, 2016a). Both classroom training and flight training is led by CFIs who provide guidance and present academic and flight lessons logically to meet desired training objectives for their students. By presenting lessons in a successive manner, students are able to build upon their existing knowledge and skills to become successful pilots. Traditional classroom instructor-led training, included in ground school for this aviation training program, provides students with the information necessary to master cognitive tasks. In flight school, simulation is used as a tool to enhance training by providing trainees with a high-fidelity environment to practice and develop their skills.

The ATD as a simulation tool is an important feature of this aviation training program. Pilots must learn to navigate within their environment to maintain a flight path, follow procedures, and adapt to any problems that may occur while piloting an aircraft (FAA, 2016b). The ATD replicates the cognitive and physical features of an aircraft and is also more cost effective and safer than use of an airplane for training (Jentsch & Curtis, 2017). Because flying a plane is considered both an expensive and a high-risk situation, the use of simulators to incorporate real-life situations in a low-risk environment is ideal for aviation training. Taking into account things such as the costs of fuel and of aircraft maintenance, simulation training eliminates these and provides reproducible, real-world-equivalent training scenarios (Salas et al., 2012). While a simulator can only artificially recreate aircraft flight, simulation training within an ATD can incorporate elements of basic cockpit procedures that are identical to those that may be found in future flights,

better preparing students with ways to handle these tasks and possible challenges, and allows them opportunities to practice and develop their skills.

Within the ATD, aviation students complete flight lessons, based on a designated flight pattern. This pattern can include a number of skills that will be used in future flights including climbs, descents, and turns (FAA, 2016b). The ATD in the current aviation training program collects data on student pilot performance within the simulator, which can be used as an objective measure to assess which skills and tasks a student is sufficient and deficient in. Because the ATD is able to recreate all situations that the student may need to practice, student pilots have opportunities to repeat lessons and improve their abilities based on their own training needs (FAA, 2016a).

Training in an ATD occurs under the guidance of a CFI. This environment allows the student to develop their skills while the instructor is able to focus on teaching instead of flying the aircraft (Wickens et al., 2004). The instructor serves as a learning resource for students, as they can provide guidance and present information to enhance learning.

Improving the Training Program

The above details the guiding features of the aviation training program. As I wanted to improve the training program, I examined how the current system could be modified to facilitate learning and enhance the training experience for trainees.

Active Learning

Training often focuses on the learner as a passive recipient of knowledge as opposed to an active participant in their training (Bell & Kozlowski, 2009; Ford & Kraiger, 1995). In passive learning the instructor or other training tools are used to provide information to the student, then the student must integrate this information into

their own knowledge (Bell & Kozlowski, 2009). Active learning provides individuals with significant control over their own learning, directly and actively engaging them in the learning process (Bell & Kozlowski, 2009). The concept of active learning includes student involvement, developing skills, higher-order thinking, and engagement in activities (Bell & Kozlowski, 2009).

Active learning goes beyond learning by doing and supports the learning process by focusing on self-regulation in the trainee. Self-regulation enables an individual to guide their own learning through thought, affect, behavior, or attention as circumstances change (Karoly, 1993). Self-regulation can be divided into practice behaviors (e.g., what is done in training), self-monitoring (e.g., how trainees focus their attention and reflect on progress towards outcomes), and self-evaluation reaction (e.g., emotional reactions to goal progress; Kozlowski et al., 2001). Active learning considers formal design elements that support the cognitive, motivational, and emotional processes that impact an individual's attention, direction of efforts, and affect during learning (Bell & Kozlowski, 2008). These three domains focus on the motivational, cognitive, and affective states of the trainee, respectively.

Because learning is a desired outcome of training, I wanted to focus on how students could control their own learning, based on their individual needs. Self-initiated learning involves the motivation of the learner, but helps in developing one's own ideas and discovering how to learn difficult skills (Rogers, 1969). Self-initiated learning, a form of active learning involving the active participation of the student in their own learning, helps students develop their own ideas and work through learning difficult skills based on their own needs (Dismukes & Smith, 2017). Encouraging student engagement

and involvement allows students to process information more deeply, integrate new information within existing frameworks, and apply their learning in relevant contexts.

The active-learning process gives students the ability to determine what they want to know based on their current knowledge and capabilities. Keeping learning relevant, motivating, and interesting helps keep the student stay engaged in the process, encouraging them to continue acquiring knowledge at their own pace and ability. Self-managing helps foster learning, regardless of the individual differences that may exist between students without interfering with the content of the Part-141-certified training program's curriculum. Enabling active learning in the present context requires a specific instrument or mechanism; I will now discuss how feedback can be used as this technique.

Feedback

Feedback is used to help provide information regarding one's progress towards reaching a goal or outcome (Goodman et al., 2004). Incorporating feedback in instruction can be used to motivate and encourage good behaviors and eliminate bad behaviors, helping students improve and develop their KSAs. Constructive feedback should target the skills and knowledge that students are expected to acquire based on learning objectives, but also help them understand how they can improve their performance or enhance their understanding of a topic at hand (Goodman et al., 2004).

Instructors typically provide feedback to the students regarding their performance, but students can actively seek out feedback to help gain new perspective and open a discussion around what was done, why it was done, and determine how to improve it (Bell & Kozlowski, 2008). Guidance, provided via supplemental information, can enhance self-regulation and facilitate learning and transfer (Bell & Kozlowski, 2002).

Feedback-seeking behaviors are proactive methods of seeking feedback related to trainees' performance, role, or job requirements in order to see if their current behaviors are correct and sufficient to attain goals (Ashford, 1986). This helps them attain and maintain awareness and knowledge of themselves and their abilities (Ashford et al., 2003). This behavior can be considered goal-oriented in nature, meaning the behavior helps to develop and validate progress towards a desired outcome. Feedback regarding one's skills and understanding is a key component of the learning process. As mentioned, finding value in the training content helps promote learning and motivates the trainee. Feedback-seeking is another way to promote engagement, as it is based on the motivations of the student (Hattie & Timperley, 2007).

Traditionally, feedback is conceptualized as a way to leverage information to provide reinforcement that is used to correct errors and encourage effective behaviors (Skinner, 1968). Providing corrective information is a key component of feedback; however, viewing feedback as information gives the learner the ability to adapt their response and understanding based on the information they are presented with (Wisniewski et al., 2020). Feedback of this kind helps learners develop effective information processing strategies and understanding, leading to a higher impact on cognitive and behavioral outcomes than affective outcomes (Hattie & Timperley, 2007; Wisniewski et al., 2020).

Intervention Selection

Feedback itself can be a form of active learning if the student is seeking feedback. Students can solicit feedback about their performance, but can also use the instructor as a resource to clarify content they find unclear or gain further information about a relevant

topic of interest. Students can then incorporate this information into existing knowledge and practices based on their individual perceived needs (Bell & Kozlowski, 2008). Feedback of this kind both encourages learning and promotes learner autonomy (Fletcher, 2018).

Because CFIs have extensive knowledge about aviation, including how to successfully complete various flight operations, they serve as a vital resource to students within the ATD. Within the learning environment, instructors are able to create the conditions that meet the needs and capabilities of the learners and align these conditions with the learning objectives. In the current training protocol, there is no formal process whereby the flight instructor provides feedback to the student. Since feedback can contribute to the efficacy of the training process, I chose to focus on how students could solicit feedback from their instructor based on their individual needs. While pilot students learn and attempt new skills, flight instructors can give specific, detailed feedback to help encourage successful maneuvers and correct unsuccessful ones. Linking the feedback to specific events and learning objectives can help the learner better interpret the feedback and integrate it within their future performance (Oser et al., 1999). Integrating timely and relevant feedback about performance into a training system helps create more effective training (Salas & Cannon-Bowers, 2001).

While the selected intervention is meant to improve the training experience for the student, it also inherently affects the CFI, as they are also included within the training context. Asking questions and seeking feedback are not formally incorporated in the Part-141 curriculum but are not outside of the teaching expectations of the CFI. I did not want to burden flight instructors with more job demands outside of their usual instruction and I

wanted to best control the quality of feedback given by the flight instructor by keeping the flight instructor constant throughout each trial, therefore I chose to focus on what students could do to enhance their own learning. Making this a student-centered as opposed to instructor-led intervention would not infringe upon the guidelines set by Part-141 nor add any unjust demands to the CFIs teachings.

Including a self-initiated form of feedback in the current training system, directed and managed by the student, could positively impact student learning and subsequent performance. Research on technology-based training and active learning focus on learner-controlled training and support the notion that trainee characteristics, training design features, and external support dictate the extent of learning in trainees (Hughes et al., 2013). Active learning goes beyond learners' behaviors and focuses on how they select, organize, and integrate knowledge via cognitive processing (Mayer, 2004). Participating in an exploratory instructional approach, where trainees are able to explore a task and receive guidance, is an inductive learning process that allows for trainees to exert personal control to learn rules, principles, and strategies for effective performance (Bell & Kozlowski, 2009). This encourages exploration and practice by promoting intrinsic motivation and self-efficacy. Students are able to explore their own learning environment, ask questions that help enhance their understanding, and integrate the information into their previously acquired knowledge to further their learning. An active-learning intervention that focuses on self-initiated feedback would allow the student to gain insight or clarity from their flight instructor in accordance with their skill level to foster personal growth.

This project is an attempt to improve the training program for a flight school while staying within the guidelines set by the FAA. The current system has a structured curriculum in place for aviation training but training also occurs outside of the classroom in an ATD. Ideally, students would be able to improve their performance, and subsequently progress through flight training faster, via an intervention of a learner-directed form of feedback. This intervention can motivate students by providing information they find relevant, based on their current abilities, and gives them a chance to apply this newly acquired information in context.

Encouraging active learning and incorporating feedback into the current training program requires minimal effort from the students and flight instructors involved in flight training, does not interfere with training requirements, and can potentially give insight into how to increase learning and improve student ATD performance. Training that is poorly designed or does not meet the needs of the trainee can be potentially harmful and deter learning. It is important to align training needs with training tools and processes in order to avoid this problem. When the student can ask questions about their performance or seek further information from a reliable source, the student becomes an active participant in their own learning. There are not any obvious potential negative implications of introducing the intervention as trainees are able to practice their flight skills, while also guiding their own learning, using their own interests through a personally directed feedback method. Therefore, this intervention is unlikely to have any harmful effects. Per the project's question, however, the viability of the intervention deserves additional exploration, a description of which I now provide.

CHAPTER 2

METHOD

Materials and Procedure

The purpose of this project was to apply I-O principles to ascertain whether an intervention could be justified to improve a flight training program. I define viability of an intervention generally as (a) possessing theoretical justification for benefit; (b) consisting of evidence of ability to be deployed within the current training environment within the practical constraints; and (c) is free from evidence of negative effects of deployment. Above, theoretical backing was used to isolate an intervention that could be executed within the current training context. The support from previous research provided reason to believe a learner-directed form of feedback could be effectively deployed. I wanted to test the feasibility of this selected intervention within the training program with an experimental design, using the preliminary data to examine if the intervention had any negative effects, including making training more difficult for students, interfering with their learning, or causing other unnecessary harm. Details regarding the design and deployment of the intervention will be discussed below.

The literature was used to help support the introduction of an intervention within a very specific context. This intervention was pilot-tested on 14 out of the available 22 aviation trainees to see what may happen within the training environment without violating any theoretical assumptions. Unfortunately, the COVID-19 pandemic impacted

the data collection for this project. For the safety of the students and flight instructors, flight lessons within the simulator ceased before further data collection could take place, which resulted in a smaller than anticipated sample size. To address the factors that impact training efficacy, I considered interventions that could enhance elements of training design, control situational factors, and overcome individual factors. I chose to focus on the *processes* surrounding flight instruction to avoid interfering with the regulations that dictate the program's training content. In order to better control the training environment, I selected the training that occurs within the ATD, which remains constant across all trainees; this had the added benefit of avoiding the more high-stakes training environment of actual flight. Individual differences (e.g., cognitive ability, goal orientation) dictate how individuals make choices in active, learner-controlled training, ultimately influencing how much they learn based on their own perceived needs and abilities. When students are active learners, they are able to participate in the learning in a way that keeps them engaged and motivated, promoting learning content based on their underlying abilities. In order to best mitigate these individual differences, I examined the trainee as an active learner.

In order to assess how feedback alters training, students enrolled in the instrument flight instruction sequence at a University's Part-141 flight school completed a standardized flight pattern in the ATD. A CFI assisted as a research associate on this project. They designed the flight pattern, monitored student performance in the ATD across all trials, and collected feedback from students about the intervention. An important consideration in this study was to include students who were required to practice training within the flight simulator, but who had basic skills that would allow

them to complete a flight sequence; therefore, students from the instrument flight instruction sequence were used for this study. Instrument rating requirements for a pilot, outlined by 14 CFR 61.65, include: holding or simultaneously obtaining a private pilot certificate, ground training and logged required flight training hours from an authorized flight instructor, and an endorsement from an authorized instructor to take, and pass, the instrument rating knowledge test. Because of these training requirements, the students included in these trials had the skills and understandings required to successfully operate within an ATD. The students in the instrument flight instruction sequence are taught basic instrument procedures to develop the skills necessary to control and maneuver an airplane based solely on reference to flight instruments within the instrument flight rules (IFR) flight (FAA, 2017).

The students were separated into two different groups, (a) a control group that received no additional tasks, and (b) a group of students that were instructed to formulate three questions pertaining to what they were learning or skills they were practicing in the simulator in order to receive feedback from their flight instructor. Because students were at different stages in the instrument training program, these questions were based on the student's individual progress within the program, allowing them to solicit relevant feedback in accordance with their skill levels and understanding of content. During their simulation session, these students asked their flight instructor these questions. These questions included: "What is the best way to handle wake turbulence?", "What are the most important preflight procedures?", and "Can you give me some examples of ways to mitigate risk during flight?" All students participated in the same predetermined flight pattern, mentioned above. Performance data from the ATD was used to determine

whether some unexpected dynamic caused this intervention to hinder the experimental group participants' performance.

CHAPTER 3

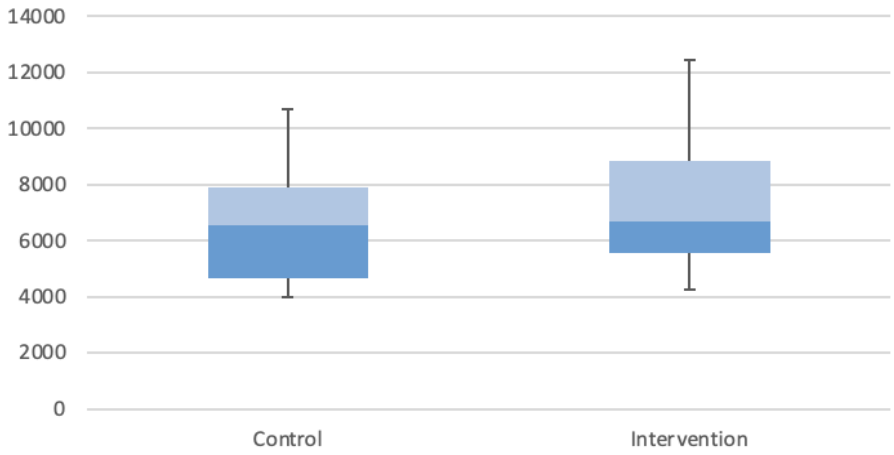
RESULTS

ATD Data

The quantitative data collected from this intervention provide important information about the intervention's viability. Participation in a National Intercollegiate Flying Association (NIFA) module that followed the protocol for instrument flight training on the ATD was used to score participants on accuracy for a flight pattern, which consisted of level flight, constant rate climbs, turns, and descents at specified airspeeds. The NIFA score is a "penalty" score, with higher numbers representing less accurate performance with more deviation from the pattern specifications outlined above.

Using the data collected from the ATD, students' performance could be assessed and compared to determine if there were any differences between those who participated in the intervention and those who did not; the focus was for any negative trend or unexpected consequences of implementing the intervention that would warrant recommending against a full-scale deployment. Data from the ATD trials is presented in **Figure 1** below.

Figure 1: *Aviation Training Device Scores for Control and Intervention Groups*



Note. The median score of the control group was 6528, while the median score of the intervention group was 6684. The lowest score in the control group was 4004 and the highest was 10676. The lowest score in the intervention group was 4225 and the highest was 12413.

While the lowest score and highest score in the intervention group were both higher than that of the control group, this does not mean that participation in the intervention guarantees a higher score. Collecting data from a small sample of students allows us to make inferences about the potential effects this intervention could have on a larger population; however, collecting more data via additional trials should be done in order to make more accurate inferences about the effects of the intervention as it is rolled out on a full-scale basis.

Student Feedback

In addition to the performance data collected from the ATD, the CFI helped gather feedback from students about the intervention. I wanted to determine if students perceived this intervention as being harmful in any way to their performance or learning or if it had other detrimental effects. Students who participated in the intervention noted

that the formulation of questions did not take long to complete, was not a distraction from the ATD lesson, and would be beneficial if completed during a lesson where they did not understand the content being taught. Based on this information we received from the students, there were no unexpected or unintended consequences.

The information collected during this project via ATD data and student feedback indicated no harm and provided support for the viability of the training experience. Students were able to solicit feedback from their instructor, gathering explanations about relevant content that could be integrated in their understanding and applied in context, and did not experience a decrease in performance as a result of this.

CHAPTER 4

DISCUSSION

Implications

Actively seeking information, whether it be through feedback or another method, has resulted (in previous research) in greater insight and understanding about a learner's current state. Feedback offers informational value that can help people meet their goals, regulate their behaviors accordingly, and ultimately enhance their performance (Hattie & Timperley, 2007). The intervention in this project gives trainees an opportunity to guide their own learning by soliciting personal, relevant feedback that can be applied directly to their training.

Because training context matters, as training cannot be isolated from the specific system it supports, it is important to consider how specialized interventions can improve already existing training systems. By encouraging learner-centered feedback-seeking behaviors within a training context, students have the ability to gather information and be an active participant in their learning. Students can practice skills and receive feedback in the areas they feel are important to aid in their personal learning and development. This project examined whether and how active learning via a self-directed form of feedback can motivate trainees to invest in their own learning and understanding without taking away from the training experience. On the basis of the trial deployment of the intervention, I concluded that the intervention was viable for full-scale deployment in the

current training context. In the future, these methods may be applied in other contexts outside of simulator training to enhance training outcomes.

Recommendations

Based on the theoretical research and preliminary data collected for this project, a learner-centered feedback intervention does not result in any deleterious effects and could potentially be used to improve an aviation training program. Because of this, I recommend deploying this intervention in the current system. To assess the impact of the intervention over time, ongoing training evaluation is also recommended. Training evaluation helps improve the quality of training by analyzing the system to determine what aspects of the training are already successful, what areas can be improved, and how to utilize better methods for training design and delivery. Modifying the methods as necessary, based on supporting evidence from trials, can result in overall process improvement.

Limitations

While the overall purpose of this project was to enhance the training program, this preliminary, pre-launch phase of the project cannot provide reliable support for performance improvement. A viability test is a preliminary study used to support theoretical fidelity and evaluate the feasibility, practical implementability, and adverse effects of an experiment to improve the study design before launching a full-scale intervention (Shadish et al., 2002). These types of testing can be used to provide preliminary evidence about intervention effects. This initial data collection showcases the viability of the intervention, but more data must be collected in order to verify that this intervention will have positive outcomes.

This trial phase also revealed opportunities for improvement that could be integrated into the current system to enhance the intervention before deployment. In particular, an increased focus on the student experience could positively impact the success of the intervention.

One aspect of the student experience that could be enhanced is the extent that students felt informed about the training. Focusing on the trainee orientation, which includes the attributional and motivational aspects of training, dictate the way that the trainee perceives the training experience (Bell & Kozlowski, 2009). A more comprehensive explanation of the training intervention and its intentions should be provided to the students, which could lead to an improved quality of questions that the students ask their flight instructors. Though the intervention allows the student to formulate the questions they ask their instructor based on their own understanding and perceived needs, motivation to learn and the quality of the information solicited is still based on the individual. Preparation for training can impact trainee motivation and the extent that trainees set goals and objectives for themselves, guiding their learning. Trainees who receive greater support and opportunities to participate are more likely to be interested in activities that support their development (Colquitt et al., 2000). Providing trainees with an explanation as to why the intervention directly relates to their learning and performance helps increase their likelihood of participation.

Though this first phase involved a general gauge of the students' experience with the intervention, collecting additional feedback from students to assess their reactions to the intervention could also offer useful insight into how to improve their training experience. Reactions to training including perceptions of usefulness, enjoyment,

difficulty, and motivation to learn (Kraiger & Ford, 2007). Beyond determining the extent that students liked, disliked, or felt neutral towards the intervention (as I did in the current work), gathering additional suggestions for improvement from students can help provide insight on how to incorporate elements that increase enjoyment during training, which can subsequently affect students' engagement and motivation to participate in the intervention.

Conclusion

The objective of this project was to determine if an intervention could be introduced within an aviation training program to improve the training experience. In order to determine if this was possible, I explored the nuances of the specific training environment. The guidelines set by the FAA influence the extent to which interventions can be introduced within aviation training. In Part-141 flight schools, the content and context of training are clearly outlined to help students develop the necessary KSAs to meet the objectives required by the FAA; therefore, the viability of an intervention within this space involves thinking about the other factors that can impact the success of a training program outside of the given content and context.

Using the information I gathered from the literature, I chose to focus on how trainees could be a catalyst for their own learning by continuing to develop desirable skills and knowledge utilizing an active form of learning with self-initiated feedback. This intervention was intended to give students a greater opportunity to collect pertinent information that could be directly incorporated into their practices and did accomplish this goal.

This intervention was a viable way to improve the training experience; it took little time to complete, did not cause any undue stress, and gave students a chance to increase their skills and knowledge within a content area that they are interested in. Implementing this intervention on a full-scale and continuing to evaluate the process, in order to modify and enhance it, could provide support for the incremental improvement of the training process, resulting in improved performance and learning in aviation trainees.

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