Training the Emerging Pilot Workforce:
Does Generation and Gender Influence Curriculum Development?

by

Kurt Reesman

A dissertation submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

Auburn, Alabama
May 7, 2022

Keywords: learning styles or preferences, generation, gender, pilot, Index of Learning Styles

Approved by

James E. Witte, Chair, Professor, Educational Foundations, Leadership, & Technology
Maria Witte, Professor, Educational Foundations, Leadership, & Technology
Jonathan Taylor, Associate Professor, Educational Foundations, Leadership, & Technology
David T. Marshall, Assistant Professor, Educational Foundations, Leadership, & Technology

Abstract

This study investigated the learning styles of pilots and non-pilots and then focused on the gender and generational differences among the pilots surveyed. Invitations to participate in an anonymous online Qualtrics survey were extended to three institutions of higher education, and published on three LinkedIn pages, one widely circulated aviation newsletter, one well-known aviation blog, and four Facebook pages. Total participants were 706 consisting of approximately three-quarters males. Approximately 75% of the participants were pilots comprised of 80% males and 20% females where 88% of them were white. The Baby Boomer, Generation X, Y, and Z generation participants were nearly equal in distribution. The mean age of participants was 42 years old. The Felder and Soloman Index of Learning Styles questionnaire was used to measure individual learning styles on four continuums: *Active-Reflective*, *Sensing-Intuitive*, *Visual-Verbal,* and *Sequential-Global*. Survey data indicate a statistically significant difference in learning styles of non-pilots and pilots, males and females, and different generations of pilots. Among all participants, pilots scored higher than non-pilots on the *Sensing* and *Visual* side of those two scales, males scored higher on the *Visual* aspect of that scale, and generation variation occurred between Generation X and Y where Generation Y favored the *Sensing* learning style more than Generation X. For pilots, males scored higher than females on the *Visual* preference, Generations Y and Z preferred the *Sensing* learning style and Generation Z favored the *Sequential* learning style more than Generation X. Curriculum design, instructional methodologies used, and technologies selected to deliver course content should focus on *active*, *sensing*, *visual*, and *sequential* learning styles while balancing the other styles in the design to produce learners who can thrive in any educational setting.

Acknowledgements

First, I am compelled to give glory and honor to the God of this universe, His Son who redeems me to Himself, and His Spirit who guides me daily. Without His gifting I would not have been able to accomplish a task so grand. He must increase and I must decrease. I dedicate my work in this world for the good of the Kingdom of God.

Next, to the one who has believed in me and been my encouragement since the day we met over 40 years ago, my wife. Deborah Hancock Reesman, you have been my rock; my cheerleader; and the one who sacrificed herself so that I could attain this dream. To you, I dedicate this work and all the good that may come because of your sacrifice.

I am extremely grateful to the leadership and mentoring I have received from the members of my dissertation committee, Dr. James Witte, Dr. Maria Witte, Dr. Jonathan Taylor, and Dr. David Marshall. Your commitment to excellence drives me to do better and to make you proud. This work is not only a reflection on me, but also a reflection on you and you ensured that anything less than exceptional scholarship was not acceptable. Thank you from the bottom of my heart.

I work hard to provide a scholarly work but by myself it would not happen. I am extremely grateful to my son-in-law Micah Brake who is masterful with the written word. Normally I would flee someone with his command of the English language, but he has made me better and the iron sharpening iron is worth the humility it takes to accept his gentle critique.

Without survey participants this endeavor would have never happened. I want to acknowledge those who participated in the survey, as well as those who used their influence to spread the word about my research effort inviting others to participate in the survey. I am grateful to Curt Lewis & Associates, LLC who used his internationally known newsletter to

bring in people from all around the globe, Karlene Petitt who offered her influence to reach the people that follow her website Flight to Success blog and her LinkedIn profile. I am also appreciative to Rebecca Wedekemper who posted my survey invitation to other social media sites, and finally, I want to thank my colleagues, Dr. Wendy Beckman at Middle Tennessee State University, Dr. Mitch Morrison at Liberty University, and the Institutional Research office at Auburn University for distributing my research recruiting at the respective academic institutions.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AC	Advisory Circular
AMEL	Airplane multiengine land
ASEL	Airplane single engine land
ATP	Airline Transport Pilot
ATP CTP	Airline Transport Pilot Certification Training Program
AU	Auburn University
FAA	Federal Aviation Administration
ILS	Felder & Soloman Index of Learning Styles
KLSI	Kolb Learning Style Inventory
NTSB	National Transportation Safety Board
PTO	Pilot and Technician Outlook

Definitions

Active	Through engagement in physical activity or discussion. (Felder & Silverman, 1988, p. 675)
Andragogy	The art and science of helping adults learn (Knowles, 1980, p. 43)
Experience	"The actual participation in something or the direct contact with; the knowledge or skill acquired from actual participation or training in an activity or event; one's total judgments or reactions based on one's past learning" (Webster's, 2001, p. 235)
Generations	Baby Boomer (year of birth 1946-1964). Generation X (year of birth 1965-1980). Generation Y (or Millennials) (year of birth 1981-1996). Generation Z (year of birth 1997-2012).
Global	In large jumps, holistically (Felder & Silverman, 1988, p. 675).
Intuitive	Based on possibilities, insights, or hunches (Felder & Silverman, 1988, p. 675).
Knowledge	"Acquainted with facts and areas of study; having ability to know facts, information." (Webster's, 2001, p. 400)
Learning	"the process of acquiring knowledge, understanding, or mastery of a study or experience" (Webster's, 2001, p. 409)

Learning Style

Characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment (Felder & Brent, 2005, p. 58).

"Learning style is ‘‘the individual's characteristic ways of processing information, feeling, and behaving in learning situations’’ (Conti, 2009, pp.887-888).

"According to James and Gardner (1995, p. 20), learning styles is the complex manner in which learners most effectively perceive, process, store, and recall what they are attempting to learn" (Dantas & Cunha, 2020, p. 1).

"Learning style is a biologically and developmentally imposed set of personal characteristics that make the same teaching method effective for some and ineffective for others" (Dunn et al., 1989, p. 50).

Master "A person with control or authority in an art, science, or craft; to learn a skill, craft, or job." (Webster's, 2001, p. 435)

Pedagogy The art and science of teaching children (Knowles, 1980, p. 40).

Reflective Through introspection (Felder & Silverman, 1988, p. 675).

Self-Directed Learning:

In its broadest meaning, 'self-directed learning' describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing, and implementing appropriate

learning strategies, and evaluating learning outcomes." (Knowles, 1980a, p. 18)

Sensing — The act of interpreting sights, sounds, physical sensations (Felder & Silverman, 1988, p. 675).

Sequential — Continual steps (Felder & Silverman, 1988, p. 675).

Study — "The process of applying the mind to acquire knowledge" (Webster's, 2001, p. 585)

Understand — "To comprehend; to realize; to know the feelings and thought of" (Webster's, 2001, p. 621)

Use of Technology:

The effective and efficient content delivery techniques available that aid in a more comprehensive understanding of the course material (e.g., Computer-based Lessons, Animations, etc. etc.)

Verbal — Pertaining to written and spoken words and formulas. (Felder & Henriques, 1995, p. 22)

Visual — Pertaining to pictures, diagrams, charts, plots, animations, graphs, demonstrations. (Felder & Silverman, 1988, p. 675).

Chapter 1

Introduction

Commercial airline pilot hiring historically has resembled a sine wave pattern when at times the ability to train pilots limits the number of pilots that can be hired and at other times the pilot supply far exceeds the demand. This pattern dates back to the early 1900s and was briefly explained by Hopkins (2001) in his Air Line Pilots Association, Int'l (ALPA) article "A Short History of Pilot Shortages" (p. 18). *Boeing's Pilot and Technician Outlook* (2020) acknowledges the impact of the COVID-19 pandemic on the commercial aviation industry; however, they report that the post-pandemic need for pilots was only five percent less than pre-pandemic forecasts. How, in the midst of this pandemic, does the aviation industry prepare to meet the hiring and training demands it faces in a post-pandemic environment? What are the points of emphasis and is there a certain process that should be followed? No matter what the answers to these questions may be, every pilot must either be trained or retrained, which means curriculum must be prepared and instructors ready to teach. Regulators, training departments, curriculum writers, and instructors are well served to understand the learning styles or preferences of the pilots they will train.

Statement of the Problem

The continual commercial aviation pilot hiring need was caused by three primary factors: airline fleet growth, mandatory pilot retirements, and normal pilot attrition. The COVID-19 pandemic added furloughs to this list, and the immediate need for pilots has ceased. Some airlines are struggling to stay in business. Boeing (2020), which examined the 2020-2039 timeframe, predicts that despite the pandemic there will still be a need for pilots. With retirements, furloughs, and normal attrition comes a loss of experience that takes time to replace.

Experience mostly comes with flight time, but there may be a way to introduce some of the lost experience through the training process. A look at the military flight training process reveals a curriculum design that provides a greater level of experience that is embedded in the training process. This training approach may not be transferrable to the civilian training environment, but it cannot be overlooked. Well-designed curriculum, which considers pilot learnings styles and preferences, generational differences, and modern technological application, will ensure that pilots are trained to operate safely in the industry. To ensure the learning environment is complete, instructors must be taught to teach curriculum topics in a manner that best fits student learning styles.

Before the COVID-19 pandemic, the *U.S. Bureau of Labor Statistics Occupational Handbook*, which focused on airline and commercial pilot job outlook, anticipated the need for airline pilots, copilots, and flight engineers to grow from 85,500 in 2019 to 87,900 in 2029 (U.S. Bureau of Labor Statistics, 2020). The *Federal Aviation Administration (FAA) Aerospace Forecast Fiscal Years 2020-2040* (2020a) report documented that despite the current slowing of economic growth influenced by COVID-19 and other worldwide current events, "system traffic in revenue passenger miles (RPMs) is projected to increase by 2.5 percent a year between 2020 and 2040. Domestic PRMs are forecast to grow 2.3 percent a year while International RPMs are forecast to grow significant faster at 3.0 percent a year" (pp. 1–2). Boeing's *Commercial Market Outlook 2019-2038* (2019a), pre-COVID-19, forecasted that "airline passenger traffic is expected to grow by an average annual rate of 4.6 percent over the next 20 years" (p. 16). Boeing's *Pilot and Technician Outlook Executive Summary, 2019-2038* (2019), and the revised *Pilot and Technician Outlook, 2020-2039* (2020), which focuses on pilots needed internationally in the commercial and business aviation, as well as civil helicopter industries, projects significant need

during the report timeframes. These two reports, summarized in Table 1, show the North America and World pilot needs prior to and during COVID-19. Boeing reports that "while the current industry downturn, driven by COVID-19 has resulted in a temporary oversupply of qualified personnel, the long-term needs remain robust" (Boeing, 2020, pp. 2–3).

Table 1

Boeing Pilot Need Predictions Before and During COVID-19

Category	Boeing PTO 2019 (2019-2038)	Boeing PTO 2020 (2020-2039)	Difference due to COVID-19
North America Commercial Pilots	131,000	129,000	-2,000
North America Business Aviation and Civil Helicopter Pilots	81,000	79,000	-2,000
North America Total Needed	212,000	208,000	-4,000
World Total Pilots Needed	804,000	763,000	-41,000

Note. Adapted from "Pilot and Technician Outlook (2019-2039) Executive Summary," Boeing, 2019, p. 3, Copyright 2019 by Boeing and "Pilot and Technician Outlook (2020-2039) Executive Summary," Boeing, 2020, p. 7, Copyright 2020 by Boeing.

Regarding training, the Boeing 2019 PTO (2019), pre-COVID-19, noted that "the aviation industry will need to adopt innovative training solutions…Immersive technologies, adaptive learning, schedule flexibility, and new teaching methods will be needed to effectively meet a wide range of learning styles" (p. 1). Also recognized in their report is workforce diversity that will "also require instructors to have cross-cultural, cross-generational, and multilingual skills to engage with tomorrow's workforce" (Boeing, 2019b, p. 1). These reports

reenforce the need to understand the pilot populations' learning styles, generational differences, and compatibility with technology.

The revised Boeing 2020 PTO (2020), which considered COVID-19 effects, acknowledged that the aviation training industry began to adopt some of the innovative solutions mentioned in the 2019 report. "Many providers have transitioned their offerings to online and virtual formats where possible, allowing students to continue their learning safety" (p. 3). Boeing (2020) notes that the industry is going one step further when they observe:

> Immersive technologies, adaptive learning and flexible distance learning methods are also being explored to enable optimum learning and knowledge retention. Investments in technology that are being made today will likely lead to a long-term fundament shift in how training is conducted. Competency-based training and assessment programs are gaining traction, which enables a shift from prescriptive, task-based training to a more holistic approach. Advances in adaptive learning capabilities, artificial intelligence and learner analytics will further personalize training to the individual student so that greater emphasis can be placed on closing knowledge gaps. (p. 3)

Despite the impact of the COVID-19 pandemic and the airline training response, the challenge to train pilots in the most effective way is more important than ever.

Studies focusing on pilot learning styles were last done nearly 20 years ago (Brady et al., 2001; Kanske, 2001; Kanske & Brewster, 2001; Kanske et al., 2003), and many things have changed in that timeframe. First, these studies only focused on the learning styles of college aviation students, except for one study that focused on Air Force pilots. None were found that examined the learning styles of commercial aviation pilots. Other factors that were not examined were the generational homogeneity and gender differences of the pilot population. These may be

significantly different in 2021 than they were in the early 2000s. There have also been significant technological advances, both in aircraft and in training devices. These technologies and the way they can be used in training to match a pilot's learning style should also be examined. This study took a fresh look at some of the areas mentioned above. Learning styles were examined using a different learning styles measurement tool. Commercial airline pilots were included in this study. Flight deck composition was investigated regarding generational and gender differences.

This present study focused on three main components: the individual learning styles or preferences of 1) pilots relative to non-pilots, 2) pilots across different generations, and 3) pilots across the gender spectrum. Findings from this study will inform training curriculum development and instructional styles in aviation training organizations ensuring each pilot has the most opportunity to receive the best training.

Conceptual / Theoretical Framework

Adult learning theorists have focused their research on understanding or explaining what motivates or drives a person to learn. Educators and curriculum designers should focus on what might help a person learn—and how that person might best retain knowledge—when considering how to present material. Several scholars have provided insight into how or why adults learn, but among the most pertinent to this study are the following major contributors:

1) Cyril Houle, a pioneer in understanding how adults learn described a person's orientation to learning as goal, activity, or learning oriented. He came to this conclusion because of interviews he conducted with 22 continuing education participants (Gordon, 1993; Knowles et al., 2015).
2) Malcolm Knowles, identified as the father of adult education, noted a difference in learning styles between children and adults and as a result suggested that teaching

styles be adapted to capitalize on these differences. He differentiates between pedagogy and andragogy and indicates that the major consideration between the two is that pedagogy is teacher-directed while andragogy is student-directed. He later noted that it is the educator's responsibility to determine which approach is most appropriate for the situation. (Knowles et al., 2015).

3) Paulo Freire, a Brazilian educator, "saw the goals and purposes of adult education as societal transformation and contended that education is a consciousness-raising process. From his view, the aim of education is to help participants put knowledge into practice and that the outcome of education is societal transformation" (Knowles et al., 2015, p. 83). The current aviation society needs transformation and Freire theory is helpful here.
4) Allen Tough, who built on the work of Houle, found that his subjects organized their learning efforts around projects and he "was interested in determining what motivated adults to begin a learning project…[he] concluded that adult learners proceed through several phases in the process of engaging in a learning project" (Knowles et al., 2015, p. 37). Is there perhaps a way to identify learning projects in the aviation industry where pilots are motivated to engage?
5) Lastly, Jack Mezirow, who is best known for Transformative Learning, says that individuals must understand the meaning of their experience which will then develop autonomous thinking. This need to understand drives individuals to find the meaning of their experience using methods consistent with their personality. This theory is consistent with the pilot training process where aircrew must understand their experiences to improve their critical thinking skills.

These adult learning theorists have helped in understanding the adult learner; however, there are many other leaning style models which have been developed by several scholars in other educational disciplines. This study focused primarily on the Felder-Silverman learning style model. Felder and Silverman (1988) claim that, in part, the amount a student learns is dependent on the compatibility of the student's learning style with the instructor's teaching style. Their theory argues that each individual has a learning style or preference that is somewhere on each of the four continuums (Active/Reflective, Sensing/Intuitive, Visual/Verbal, and Sequential/Global). The Felder-Soloman Index of Learning Styles (n.d.-a) is the tool they use to determine a person's unique learning style. Dr. Felder discovered during his research that there were components of other learning theories that could be incorporated into the Felder-Silverman learning style theory. Thus, he included portions of other theories as he developed the Felder-Soloman measurement tool.

One such theory that Felder-Silverman incorporated was the Myers-Brigg Personality Type Indicator (MBTI), which "assesses personality types, but MBTI profiles are known to have strong learning style implications" (Felder & Brent, 2005, p. 58). The MBTI was developed so that the insights of this theory were available to all that were interested (The Myers & Briggs Foundation, 2021b, para. 3). The Myers & Briggs Foundation website (2021b) describes the MBTI as follows:

> The purpose of the Myers-Briggs Type Indicator® (MBTI®) personality inventory is to make the theory of psychological types described by C. G. Jung understandable and useful in people's lives. The essence of the theory is that much seemingly random variation in the behavior is actually quite orderly and consistent, being due to basic

differences in the ways individuals prefer to use their perception and judgment. (para. 1)(2013)

Also contributing to the work of Felder-Silverman is Kolb and Kolb (2013) who insist that students learn because of experience. They define learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (Kolb & Kolb, 2013, p. 7). The Kolb Learning Style Inventory is used to determine an individual's style or preference for learning, portions of which were adopted by Felder and Silverman.

Felder and Soloman developed the Index of Learning Styles questionnaire using a variety of theories. Felder (2020) explains that the sensing/intuitive scale was taken from the MBTI, the visual/verbal from modality theory, active/reflective scale from Kolb and the extrovert/introvert preference on the MBTI, and the sequential/global from Silverman, Gregorc, and Pask. With that in mind it seems appropriate that the Index of Learning Styles be used in this study because it is a comprehensive measurement tool. It will also be the first time it has been used to determine if pilots have a different learning style from non-pilots, and if there is a generational and gender difference among pilots.

To differentiate definitions of *cognitive styles* from *learning styles*, Armstrong et al. (2012) note "the findings from a Delphi study designed to establish consensus on the definitions of cognitive style and learning style amongst an international style researcher community" (p. 449). As a side note, a review of the literature on learning styles did not find definitions consistent with this Delphi study. Nonetheless, these definitions are noteworthy and need to be mentioned here. Below are the definitions that were finally agreed upon in this Delphi study:

> *Cognitive styles* refer to individual differences in peoples preferred way of processing (perceiving, organizing, and analyzing) information using cognitive brain-based mechanisms and structures. They are assumed to be relatively stable and possibly innate. Whilst cognitive styles can influence a person's behavior, other processing strategies may at times be employed depending on task demands – this is because they are only preferences.
>
> *Learning styles* are individuals' preferred ways of responding (cognitively and behaviorally) to learning tasks which change depending on the environment or context. They can affect a person's motivation and attitude to learning and shape their performance. (pp. 451–454)

It is interesting to observe in the two definitions above certain statements that speak to what this Delphi study is trying to determine; what learning styles should be looked at and how should the material be presented so that they understand it? First, *Cognitive Styles* focuses on "people's preferred way of processing information" and *Learning Styles* targets "individuals' preferred ways of responding to learning tasks." Both are essential components in the educational process.

Given that there are a large number of educators studying individual learning styles, Felder and Brent (2005) note that:

> The concept of learning styles is not universally accepted. The simple mention of the term arouses strong emotional reactions in many members of the academic community (notably but not exclusively the psychologists), who argue that learning style models have no sound theoretical basis and that the instruments used to assess learning styles have not been appropriately validated. (pp. 58–59)

It is not surprising that there is opposition to learning style models, some with good cause, but that does not mean that the learning styles or preferences do not exist. It potentially only means that accepted scientific practices were not followed when conducting research into this area of study. One such objection is Pashler et al. (2008), when after a review of the literature, found that there is not enough evidence to demonstrate a relationship between an individual's learning style with a specific instructional approach to increase the likelihood of learning. They conclude that "the contrast between the enormous popularity of the learning-styles approach within education and the lack of credible evidence for its utility is, in our opinion, striking and disturbing" (Pashler et al., 2008, p. 117).

Cuevas (2015) notes that:

> Despite a great deal of literature having been published on the concept of learning styles since 2009, the empirical evidence for the validity of the learning styles hypothesis seems to have gotten weaker in recent years. While several studies suggest that learning styles may have some impact on behavior, only two (Hsieh et al., 2011; Hung, 2012) reported an interaction effect supporting the matching hypothesis, indicating that learning styles had a positive impact on learning. (p. 328)

More recently, Wininger et al. (2019) conclude that "notable problems with using learning styles to inform classroom instruction include a lack of empirical support and potential negative effects on student learning and motivation" (p. 221). They add that "A review of literature indicates a lack of empirical evidence demonstrating improved learning outcomes for students whose instruction matches their learning styles. There has also been minimal research conducted to establish the validity or reliability of learning styles instruments" (Wininger et al., 2019, p. 234). While the observations of Pashler et al., Cuevas, and Wininger et al. are valid, a

note of why the research is lacking and suggestions for how to improve the quality of research studies would be a more helpful conclusion to guide future research.

While the lack of scientific evidence reportedly exists, it does not necessarily mean there is no relationship between a person's preference for learning and a method of delivery which enables a person to grasp information in a more comprehensive manner. It may be that the research design necessary to meet such scientific rigor is not possible due to the complexity of how humans process information. Or perhaps, the research design may not meet the ethical requirements of human subject research. For those who have pointed out that there is a lack of research which shows justification of matching an individual's learning style with a particular teaching style that improves academic comprehension and performance, they also have not suggested a research approach that will help educators understand how to best help students learn. A lack of research correlating student academic success with matching the learning style with a teaching style does not demonstrate that students do not process information differently, nor does it shown that teachers do not teach in a particular way. Researchers who do not agree that matching a teaching style to a learning style would have to agree that they themselves prefer how material is presented to them. Experienced teachers would report that students learn in unique ways. Students would certainly comment that no two teachers teach the same way. This divide needs to be bridged with solid research by those who are passionate about student learning.

There are many theories that focus on an individual's learning style or preference, and all have valid observations and applications to the learning experience. However, for purposes of this study, the emphasis will be on the Felder-Silverman Learning Style approach and will use the Felder-Soloman Index of Learning Styles tool to measure individual learning styles.

Purpose of the Study

The purpose of this quantitative correlational study was to examine the learning styles of pilots versus non-pilots, generational similarities and differences, and gender differences in learning styles among the pilot group. This study addressed the development of commercial pilot training curriculum and instructional styles. An understanding of learning styles that are thought to be unique to pilots will guide how curriculum is developed. It identified the best approach, pedagogical or andragogical or a combination of the two, when designing training curriculum, as well as training the instructors who will deliver the training. The findings also identified the best use of current technology in the learning process and highlighted the possible advantages and disadvantages for the given generational differences that currently exist in the commercial aviation industry pilot population. The goal was to build training programs that best suit how pilots learn. Despite the severe negative impact COVID-19 has had on the commercial aviation industry, this period of reduced airline activity and pilot hiring may provide researchers an unexpected opportunity to identify ways to ensure the impeccable safety record enjoyed by the commercial aviation industry is not impacted. The end of the pandemic is hopefully in sight and the airlines are preparing to resume normal operations in this new paradigm of commercial aviation operations.

Research Questions

1. What is the relationship of pilot status, gender, and generation on learning styles?
2. What is the relationship of gender on learning styles for pilots?
3. What is the relationship of generation on learning styles for pilots?

Significance of the Study

It has been nearly two decades, almost a generation since a study has been accomplished focusing on the learning styles of pilots. Most of the studies that were undertaken used Kolb's Learning Style Inventory. This study will use Felder and Soloman's Index of Learning Styles (Felder & Soloman, n.d.) questionnaire to determine if there is a difference between non-pilot and pilot students, as well as note any difference of learning style between Baby Boomer, Generation X, Generation Y, and Generation Z generations. Findings from this study can be used to inform future curriculum development and instructional styles to enhance pilot training at all levels.

Limitations

There were several limitations to this study:

1. The non-pilot data were collected from a representative sample of students not majoring in aviation, but who are attending universities that have Aviation Accreditation Board International (AABI) certified aviation programs. Non-pilot students attending these AABI schools may be attending because of an interest in aviation, but who lack the aptitude to fly. They may still demonstrate learning styles of pilots but lack the skillsets necessary to become a pilot.
2. The pilot data were collected from a representative sample of students attending universities that have AABI certified aviation programs and did not include flight students from Part 141 non-AABI certified aviation program or pilots trained by independent flight instructors using FAA Part 61 training requirements.
3. Sufficient gender data may not exist to produce findings that can generalized to the entire pilot population. While progress has been made toward gender equity in the pilot

population, it still may fall short in this study. Nonetheless, findings from this study may be the impetus for future studies.

4. The international commercial airline industry was not adequately represented in this study.
5. Individual learning style tools were limited to the Index of Learning Styles (Felder & Soloman, n.d.-a) questionnaire by Felder and Soloman.

Assumptions

The following assumptions were made prior to conducting this study:

1. Pilots have different learning styles than non-pilots.
2. There are generational differences among pilot learning styles.
3. The learning styles between genders is the same.
4. Current curriculum development uses a pedagogical approach rather than an andragogical approach to curriculum development. (Either a switch of approaches or a blending of approaches may be better suited).
5. The use of current technology may not be effective with all pilot generations and may need to be selectively used among the generations.

Organization of the Study

This study is organized into five chapters. The first chapter introduces the study, the problem, its purpose, significance, research questions, assumptions, limitations, and definition of terms. Chapter two is a review of literature that provides data and perspectives that were useful, informative, and important to this study. These sources ranged from scholarly journals, other dissertations, publications from proceedings, government documents, relevant and credible professional publications, and others. The third chapter addresses the procedures, data collection,

and data analysis of the research. It includes the design of the study, research questions, reliability, validity, population sample, data collection, and data analysis. Chapter four presents the data collected and the findings of the study as it relates to pilot learning styles, curriculum development, instructor delivery, and the use of technology in the teaching process. The fifth and final chapter concludes the dissertation with a summary, conclusions, and recommendations for further research.

Chapter 2

Literature Review

Introduction

The flight deck of the future will be occupied by a diverse group of pilots. There will be multiple generations, genders, and ethnicities working together to safely deliver passengers to their destination. The training industry needs to be ready for these differences. Curriculum design, use of technology, and instructor preparation are just a few of the things pilot training organizations need to consider for the diverse flight deck composition. Almost a generation has passed since researchers have examined pilot learning styles and never has anyone used Felder and Soloman's Index of Learning Styles (n.d.-a) to assess pilot learning preferences. The time has come for aviation training organizations to know if what they are doing is still effective. Further research will determine if flight crew diversity requires a change in training pedagogy to meet the demands of the 2021 and beyond flight deck crew composition.

Purpose of the Study

The purpose of this quantitative correlational study was to examine the learning styles of pilots versus non-pilots, generational similarities and differences, and gender differences in learning styles among the pilot group. This study addressed the development of commercial pilot training curriculum and instructional styles. An understanding of learning styles that are thought to be unique to pilots will guide how curriculum is developed. It identified the best approach, pedagogical or andragogical or a combination of the two, when designing training curriculum, as well as training the instructors who will deliver the training. The findings also identified the best use of current technology in the learning process and highlighted the possible advantages and disadvantages for the given generational differences that currently exist in the commercial

aviation industry pilot population. The goal was to build training programs that best suit how pilots learn. Despite the severe negative impact COVID-19 has had on the commercial aviation industry, this period of reduced airline activity and pilot hiring may provide researchers an unexpected opportunity to identify ways to ensure the impeccable safety record enjoyed by the commercial aviation industry is not impacted. The end of the pandemic is hopefully in sight and the airlines are preparing to resume normal operations in this new paradigm of commercial aviation operations.

Research Questions

1. What is the relationship of pilot status, gender, and generation on learning styles?
2. What is the relationship of gender on learning styles for pilots?
3. What is the relationship of generation on learning styles for pilots?

Aviation Industry

Flight Deck Demands

Pre-COVID-19 and Mid-Course Correction

Before the COVID-19 pandemic emerged on the international scene, there was consensus among a variety of reporting organizations that a need for pilots would arise in the next 10 to 20 years that might possibly exceed the available supply (Airbus, 2019; Boeing, 2019b; CAE, 2019). Amid the pandemic Boeing and CAE revised their forecast of pilots needed to meet the demands of the commercial airline industry but the revisions only showed a slight decrease. Even though the need is less than pre-pandemic predictions, Table 2 demonstrates that there remains a need for pilots in the commercial aviation industry (Boeing, 2020; CAE, 2020).

Table 2

Pre-COVID-19 & Revised Pilot Need Outlook

Company	Time Frame	North America	Latin America	Europe	Russia & Central Asia	Asia-Pacific	Middle East	Africa	Total
Airbus	2019-2038	71,845	47.552	114,054	22,255	223,214	50,080	20,997	549,997
	2020-2039	Not Reporting This Period							
Boeing	2019-2038	212,000	54.000	148,000	27,000	266,000	68,000	29,000	804,000
	2020-2039	208,000	50,000	147,000	24,000	248,000	63,000	23,000	763,000
CAE		Americas		Europe		Asia-Pacific	Middle East & Africa		Total
	2019-2028	85,000		50,000		90,000	30,000		255,000
	2020-2029	81,000		42,000		91,000	29,000		*246,000

Note. *Includes movement of 21,000 business pilot to airlines. Adapted from "Airbus Global Market Forecast 2019-2038," Airbus, 2019, p. 80. Copyright 2019 by Airbus S.A.S. "Pilot and Technician Outlook (2019-2039) Executive Summary," Boeing, 2019, p. 3. Copyright 2019 by Boeing. "Pilot and Technician Outlook (2020-2039) Executive Summary," Boeing, 2020, p. 7. Copyright 2020 by Boeing. "CAE Airline Pilot Demand Outlook 10-Year View," CAE, 2019, p. 3. Copyright 2016 by CAE. "Airline and Business Jet Pilot Demand Outlook 10-Year Review 2020 Update," CAE, 2020, p. 4. Copyright 2020 by CAE.

Current Population

The pilot population in the commercial aviation industry has grown, from 145,590 Airline Transport Pilot (ATP) certificates issued in 2012 to 164,193 ATP certificates in 2020 (Federal Aviation Administration [FAA], 2020b). The U.S. Bureau of Labor Statistics reported in the current population survey that of the 155,000 aircraft pilots and flight engineers employed only 5.6% were women, 94% white, 3.4% Black or African American, 2.2% Asian, and 5.0% Hispanic or Latino (U.S. Bureau of Labor Statistics, 2020).

Flight Deck Composition

Generations

Generational theory suggests that each generation is shaped by its own social environment. Typically, generations are grouped into a range of birth years that are identified by a unique set of events that form shared ideas and beliefs (Dimock, 2019; Howe & Strauss, 1991; Williams et al., 2014). As a result, the generation develops a common stereotype that may or not be true to nature for all members of that group. There are differences in the actual year groupings of each generation, but the intent is to identify the common characteristics of that group (Carlson, 2009; Dimock, 2019; Howe & Strauss, 1991; Niemczyk, 2020). The exception to this grouping technique is the Baby Boomer generation which was named and bound with beginning and ending years by the U.S. Census Bureau. Dimock's (2019) generational stratification will be used for this study, and it is defined as follows: Baby Boomer Generation (1946-1964); Generation X (1965-1980); Generation Y or Millennials (1981-1996); and Generation Z (1997-2012).

It is important to note that the generational characteristics which define each generation are not the same as individual personality traits or types. For example, the literature suggests that Baby Boomers are idealistic, optimistic, self-confident, and communicative, while Generation X is viewed as pessimistic, cynical, and socially insecure. Generation Y are viewed as optimistic and confident, and able to multitask (Lissitsa & Laor, 2021; Tolbize, 2008). More about each generation will be discussed in a later section.

Efforts by the airlines to meet the demand for pilots will result in a more diversified crew compliment on the flight deck. In fact, CAE (2019; 2020) highlights a generational dispersion of pilots in their 2019 and 2020 reports. While they fail to cite a specific age range, they do identify

three categories: less than 35, 35 to 50, and greater than 50 years old. While this breakdown does not necessarily fit the generational divisions of this study, it does demonstrate a potential concern.

Of the 164,193 active ATP certificates held, the total reported by age group between 20 and 64 was 146,037 (Federal Aviation Administration [FAA], 2020c). Using the totals reported by the FAA, Table 3 shows an approximate breakdown, by generation, of the ATP certificated pilots. As those in the Baby Boomer generation are forced to retire at age 65, Generations X, Y, and Z will fill the voids created by the older generations. The FAA reported (2020c) that the average age for men was 51.2 and for women 46.6 for those who currently hold an ATP pilot certificate. Therefore, in the next 15 years, approximately 33% of the current ATP certificate holders will be replaced by a younger generation pilot who may also be from an underrepresented population.

Table 3

Active Airline Transport Pilot Certificates Held by Age

Generation	Percentage Overall	Percentage Female
Baby Boomer	33%	23%
Generation X	43%	45%
Generation Y	24%	30%
Generation Z	1%	1%

Note. Adapted from Federal Aviation Administration 2020 U.S. Civil Airmen Statistics.

The FAA regulations require pilots to possess an Airline Transport Pilot (ATP) certificate to be hired by an airline. The minimum age to obtain an ATP certificate is 21 years old (Eligiblity Requirements: General, 2021). In 2007 Congress changed the mandatory retirement age for commercial airline pilots from 60 to 65 years of age (H.R. Resolution 4343, 2007). The pandemic resulted in several early retirements, but those seats will need to be filled with qualified pilots. Upgrades and pilot hiring from the regional airlines, corporate flight

departments, and the military will be the source of those hired. The realistic age range that might occupy a commercial airline flight deck ranges from 25 to 64 years old. This spans three generations, Baby Boomers, Generation X, and Generation Y or Millennials. Beginning in 2022, a fourth generation, Generation Z, will be added to the age diversity on the flight deck.

Gender

While no one is specifically mentioning additional diversity factors on the flight deck, it stands to reason that gender will become more diversified. The 2020 FAA U.S. Civil Airmen Statistics report indicated a greater number of females, 5,818 ATP certificates issued in 2012 to 7,549 (5%) in 2020 ATP certificates issued (FAA, 2020c). Many of these women will end up in a commercial airline flight deck. Several commercial airlines are actively working to expand their efforts regarding diversity and inclusion at every level of the company. Generational and gender impacts potentially bring additional considerations for the training component of the airline industry.

Learning and Personality

Learning: Style or Preference

The difficulty with defining learning may be attributed to the individual learning styles or preferences of each student (Conti, 2009; Dunn et al., 1989; Felder and Silverman, 1988). The terms style and preference have been used interchangeably but mean the same thing. Chui et al. (2020) use both terms throughout their report but are referring to the same thing. They imply these terms as an individual's preference [or style] for the way information is presented. Felder and Silverman (1988) refer to a learner who prefers or favors a particular way of receiving information to facilitate learning. Conti (2009) defines learning style as ''the individual's characteristic ways of processing information, feeling, and behaving in learning situations''

(pp.887-888). Dunn et al. (1989) suggest that “learning style is a biologically and developmentally imposed set of personal characteristics that make the same teaching method effective for some and ineffective for others” (p. 50). Felder and Brent (2005) described learning styles as "characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment (p. 675, and Author's Preface, June 2002, p. 2). Smith (1993) defined them as "the individual's characteristic ways of processing information, feeling, and behaving in learning situations" (Conti, 2009, pp.887-888). Dunn et al. (1989) noted “learning style is a biologically and developmentally imposed set of personal characteristics that make the same teaching method effective for some and ineffective for others." (p. 50). The common threads in each of these definitions are the cognitive, affective, and psychological aspects of learning styles. James and Blank (1993) stated it most simply when they said learning styles are "the complex manner in which learners most effectively perceive, process, store, and recall what they are attempting to learn" (p. 47-48). These defined learning styles need to be measured and evaluated to improve the educational process.

Personality Inventory

Personality inventories have been used to determine and individual’s personality and learning style. These learning styles were determined to be the result of a person’s personality traits and types. The difference between personality *trait* and personality *type* must be made before moving forward. Dewey (2018) explains that “personality *traits* are durable characteristics of a person that produce an effect on behavior. [Personality] *types* are collections of traits that occur together in some individuals” (Dewey, 2018, Chapter 11). Roberts and Mroczek (2008) define personality traits “as relatively enduring patterns of thoughts, feelings,

and behaviors that distinguish individuals from one another" (p. 31). They argue recent research demonstrates that personality traits can change at any age, however each individual manifests this change in unique patterns of development at all stages of life. It is important to understand the role learning styles have in education. Understanding the relationship between student personality and learning styles can lead to more efficient and effective curriculum design for aviation education programs and flight training (Fussell et al., 2018). To better understand one's personality, two personality inventories, the Five Factor Personality Inventory, and the Myers-Briggs Type Indicator (MBTI), have been utilized the most in aviation research and will be briefly discussed in a later section.

Learning Theories Applied to Adult Learners

The airline industry is made up of adult learners, each with a variety of backgrounds and experiences, who will attend initial and recurrent training for the company in which they are employed. Many educators have developed theories that outline how adults learn best and their observations should guide new instructional methodologies. Merriman (2001) summarized best the dilemma that faces researchers trying to understand adult learners:

> The central question of how adults learn has occupied the attention of scholars and practitioners since the founding of adult education as a professional field of practice in the 1920s. Some eighty years later, we have no single answer, no one theory or model of adult learning that explains all that we know about adult learners, the various contexts where learning takes place, and the process of learning itself. What we do have is a mosaic of theories, models, sets of principles, and explanations that, combined, compose the knowledge base of adult learning. (p. 3)

This study focused on a small number of theorists and educators who are well known in the educational landscape. An attempt to identify consistencies throughout their theories that could then be applied to the adult educational process, specifically in the commercial aviation environment, was done.

John Dewey (1859-1952)

John Dewey's philosophy of education was not popular, but instead labeled progressive by some because it diverged from the popular pedagogical methods that were teacher-centered. He believed that students were not blank slates who brought nothing to the educational process, but rather confronted situations and learned because of their engagement (Westbrook, 1993). Westbrook (1993) added that Dewey believed children "brought with them to the educational environment these four basic 'native impulses' – the 'impulse to communicate, to construct, to inquire, and to express in finer form'" (p. 479). This early theory changed the way the educational process was viewed. The learner was now a participant and no longer just a recipient of new information. The teacher needed to understand how new information fit into the learner's framework of information and then deliver it in a manner that engaged the learner.

Cyril Houle (1913-1998)

Unlike Dewey, who maintained that child and adult students learned the same, Cyril Houle was one of the first educators to distinguish a difference between the child and adult learner. He conducted in-depth interviews with a small group of 22 adults to understand how they learn. Dewey focused only on adult learners because he believed a need to identify two separate groups of learning was in order. From these interviews, Houle devised a typology which concluded that adult learners are oriented to learn in one of three ways and will approach the

educational environment from one of these perspectives; 1) Goal-oriented, 2) Activity-oriented, and 3) Learning-oriented (Houle, 1961; Knowles et al., 2015).

Goal-oriented learners are those who use education as a means of accomplishing clear-cut objectives. Continuing education is not a continuous process. Instead, it is engaged because of a purpose or interest in something, and engagement is how to meet that need. Activity-oriented learners take part in learning primarily for reasons unrelated to the content of the teaching, but instead primarily for human interaction or social reasons. Learning for this group of individuals is primarily related to the need to be with others. Learning-oriented people engage in an activity with a goal. They seek knowledge for knowledge's sake because they just love learning. These learners are different from goal-oriented learners in that there is continuity and flow in their learning efforts (Gordon, 1993; Houle, 1961; Knowles et al., 2015).

Malcolm Knowles (1913-1997)

Knowles, a student and contemporary of Houle, was recognized as the Father of Adult Education and the person given credit for defining and popularizing the term *andragogy* here in the United States after it was imported from Europe. Knowles et al. (2015) defined *pedagogy* as the art and science of teaching children and *andragogy* as the art and science of helping adults learn. The term *pedagogy* is used throughout the educational discipline and is defined as "the study of the methods and activities of teaching" (Cambridge University Press, 2021). This definition is broadly used for all educational settings. Knowles introduced the term *andragogy* and redefined *pedagogy* to differentiate learning styles between children and adults. Kanske and Brewster (2001) asserted that learning styles focus on how students learn and not on the subject matter being taught. The focus was not how well the teacher knows the subject matter, but how well they are able to help the student learn what is being taught.

Knowles et al. (2015) described the pedagogical model of instruction as one in which the teacher decides what will be learned, how it will be learned, when it will be learned, and if it has been learned. Another way of describing this approach is teacher-directed. The learner's role in this model is to follow the teacher's instructions. Knowles noted that at some point in students' developmental process, they became adults and a shift in focus needed to occur. Conti (2009) identifies that shift by pointing out that "one of the distinguishing characteristics of adult learning is that it is learner-directed" (p. 887).

Knowles (1973) identified four key assumptions or differences between pedagogy and andragogy. Merriman and Baumgartner (2020) note that two additional assumptions were later added by Knowles. Each of the assumptions and a brief explanation of each follow:

1. Changes in self-concept – a move from total dependency to self-directedness with growth and maturity. This is the point where an individual psychologically becomes an adult.
2. The role of experience – with development, the well of experience deepens and provides a reservoir to draw from and relate new material. "The use of lectures, canned audio-visual presentations, and assigned reading tend to fade in favor of discussion, laboratory, simulation, field experience, team project, and other action-learning techniques" (Knowles, 1973, p. 46).
3. Readiness to learn – as an individual matures, learning is seen as needed to assume one's role in society instead of an academic exercise.
4. Orientation to learn – the focus shifts from a subject-centered to a problem-centered orientation. Pedagogy is oriented to future application of information while Andragogy is focused on the immediate application of knowledge.
5. Motivation to learn – the shift from external to internal motivation to learn.

6. Need to know why the material needs to be learned – this is a shift from pedagogy which does not ask this question because the teacher informs them why it is necessary to learn.

As noted above, Knowles mentioned several definitions of what it means to be an adult and chose the psychological view for his andragogical model of adult learning. This view holds that "we become adults when we arrive at a self-concept of being responsible for our own lives, of being self-directing" (Knowles et al., 2015, p. 43). Initially, Knowles held that the need for a pedagogical versus andragogical approach to instruction occurred when a person became an adult. He later revised his theory and admitted that self-concept and self-directedness are processes that begin early in life and continue as we mature which would necessitate flexibility for when to apply pedagogy and andragogy approaches in education (Merriam, 2001). Knowles (1980) said "as I see it, whenever a pedagogical assumption is the realistic one, then pedagogical strategies are appropriate regardless of the age of the learner—and vice versa" (p. 43). This flexibility in strategies extended from children to adult learners. Conti (2009) notes that "while either approach may be appropriate depending on the situation, the overall goal of the teaching–learning transaction is to move the learner toward greater self-direction regardless of age" (p. 887). An adult may need a pedagogical approach while a child may be ready for an andragogical approach to learning depending on the level of self-directedness.

Understanding the differences between pedagogy and andragogy is helpful when trying to determine which approach is best suited for the situation. Knowles (1980) portrays the difference in assumptions, only the initial four assumptions, between Pedagogy and Andragogy in Table 4.

Table 4

A Comparison of the Assumptions of Pedagogy and Andragogy

Regarding:	Pedagogy	Andragogy
Concept of the learner	The role of the learner is, by definition, a dependent one. The teacher is expected by society to take full responsibility for determining what is to be learned, when it is to be learned, how it is to be learned, and if it has been learned.	It is a normal aspect of the process of maturation for a person to move from dependency toward increasing self-directedness, but at different rates for different people and in different dimensions of life. Teachers have a responsibility to encourage and nurture this movement. Adults have a deep psychological need to be generally self-directing, although they may be dependent in particular temporary situations.
Role of learner' experience	The experience learners bring to a learning situation is of little worth. It may be used as a starting point, but the experience from which learners will gain the most is that of the teacher, the textbook writer, the audiovisual aid producer, and other experts. Accordingly, the primary techniques in education are transmittal techniques – lecture, assigned reading, AV presentations.	As people grow and develop, they accumulate an increasing reservoir of experience that becomes an increasingly rich resource for learning – for themselves and for others. Furthermore, people attach more meaning to learning they gain from experience than those they acquire passively. Accordingly, the primary techniques in education are experiential techniques – laboratory experiments, discussion, problem-solving cases, simulation exercises, field experience, and the like.
Readiness to learn	People are ready to learn whatever society says they ought to learn, provided the pressures on them are great enough. Most people of the same age are ready to learn the same things. Therefore, learning should be organized into a fairly standardized curriculum, with a uniform step-by-step progression for all learners.	People become ready to learn something when they experience a need to learn it in order to cope more satisfyingly with real-life tasks or problems. The educator has a responsibility to create conditions and provide tools and procedures for helping learners discover their "needs to know." And learning programs should be organized around life-application categories and sequenced according to the learners' readiness to learn.
Orientation to learning	Learners see education as a process of acquiring subject-matter content, most of which they understand will be useful only at a later time in life. Accordingly, the curriculum should be organized into subject-matter units (e.g., courses) which follow the logic of the subject (e.g., from ancient to modern history, from simple to complex mathematics or	Learners see education as a process of developing increased competence to achieve their full potential in life. They want to be able to apply whatever knowledge and skill they gain today to living more effectively tomorrow. Accordingly, learning experiences should be organized around competency-development categories. People are performance-centered in their orientation to learning.

	science). People are subject centered in their orientation learning.

Note. Reprinted from "The Modern Practice of Adult Education: From Pedagogy to Andragogy, Revised and Updated," by M.S. Knowles, 1980, pp. 43-44. Copyright 1980 by Malcolm S. Knowles.

Allen Tough (1936-2012)

Allen Tough worked closely with Cyril Houle but focused his research on the learning projects of adults, specifically the ones that were self-initiated or self-directed. Knowles (1980) also used the term *self-directed learning* and described it as a process "in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources, for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (p. 18). Similarly, Tough noticed "that his subjects organized their learning efforts around 'projects…defined as a series of related episodes, adding up to at least seven hours. In each episode more than half of the person's total motivation is to gain and retain certain fairly clear knowledge and skill, or to produce some other lasting change in himself'" (Knowles et al., 2015, p. 36). Tough wanted to know what motivated adults to become engaged in learning projects. An understanding of these motivational factors would inform adult learning activities. Tough concluded that adults proceed through several phases when beginning a new project. The first phase is simply deciding when to begin, however the steps involved in deciding when to begin is far from simple. Tough notes that it can be very complex consisting of as many as 26 sub-steps. The second step is selecting the planner for the project which is not always the learner. The planner should be the one best suited for the activity. The final phase is the learner's engagement with the plan and the elements chosen for the activity. "The critical elements here are the variety

and richness of the resources, their availability, and the learner's skill in making use of them" (Knowles et al., 2015, p. 37). Tough suggested that adult learners do not need to be passive in the learning process as the pedagogical approach holds; they need to be more involved and engaged.

Jack Mezirow (1923-2014)

Jack Mezirow, a contemporary of the previously mentioned educators, was best known for his work with *Transformative Learning.* Mezirow (1997) said "a defining condition of being human is that we have to understand the meaning of our experience" (p. 5) and this experience he defined as *transformational learning.* Mezirow believed that to understand the meaning of one's experience led to the ability to think on one's own. Mezirow (1997) held that adults built *frames of reference* that defined their world and these *frames of references* were structured from the experiences of life. He maintained that to change a *frame of reference,* an individual must take time to reflect on the assumptions that are foundational to these beliefs (Mezirow, 1997). For Mezirow life was a continuous process of learning from experiences and redefining *frames of references* that led to an individual's transformation.

Mezirow (1997) alleged there were four processes of learning; 1) expand an existing point of view, 2) establish new points of view, 3) transform the current point of view, and 4) transform our ethnocentric habit of mind by becoming aware and critically reflective of our generalized bias in the way we view groups other than our own. The first three of these techniques can be used in the educational process. Teachers could present new material added to an individual's current knowledge about the subject or offer a completely new insight or approach to subject matter that had never been considered before to generate a new point of view or present a different perspective on an existing point of view to bring about a transformative learning experience. Mezirow felt that it was the responsibility of adult educators to understand

what learners wanted and then help them achieve their objective such that they became more autonomous (Mezirow, 1997). Mezirow (1997) summed up his thoughts on transformative learning and its role in adult education as follows:

> Transformative learning is not an add-on. It is the essence of adult education. With this premise in mind, it becomes clear that the goal of adult education is implied by the nature of adult learning and communication: to help the individual become a more autonomous thinker by learning to negotiate his or her own values, meanings, and purposes rather than to uncritically act on those of others. (p. 11)

Carl Jung (1875-1961)

Carl Jung, a contemporary of Alfred Adler and Sigmund Freud, needed a way to define the differences between Adler's and Freud's theories of personality. To do so, he used the terms introversion and extraversion and then labeled Adler as an introvert and Freud as an extravert. Jung found merit in the theories of both contemporaries because they both had something to offer (Dolliver, 1994) but needed a way to differentiate what each proposed regarding an individual's personality. The labels he attached to each of them serves as the foundation of his theory of personality type. Barbuto (1997) noted that a psychological type, according to Jung, consisted of two attitudes and four functions. He describes the two attitudes as *introverted* or *extraverted* and the four functions or *sensing*, *intuitive*, *thinking*, or *feeling*. *Extroverts* proclaim, "I get my energy from active involvement in events" while *Introverts* declare "I get my energy from dealing with the ideas, pictures, memories, and reactions that are inside my head" (The Myers & Briggs Foundation, 2021a). The individual's focus and driving motivation, or attitude, is either external or internal and is explained by these terms. The four functions are explained as follows. *Sensors* pay attention to the physical world and those things that involve the senses.

Intuitors attend to impressions or the meaning and patterns of the information around them (The Myers & Briggs Foundation, 2021d). *Thinkers* follow the rules and are less concerned with the feelings of others. *Feelers* consider the feelings of others when making decisions (The Myers & Briggs Foundation, 2021e). The various combinations of these identify eight psychological types (Barbuto, 1997). The Myers-Briggs Type Indicator personality inventory was developed to make Jung's theory of psychological types understandable and useful in people's lives (The Myers & Briggs Foundation, 2021b, para. 1).

David Kolb (1939-Present)

David Kolb's Experiential Learning Theory (ELT), a theory of adult learning and development, supported his Experiential Learning Model (Conti, 2009; Dantas & Cunha, 2020). The Experiential Learning Theory was developed from the work of scholars like William James, Kurt Lewin, Carl Rogers, Carl Jung, John Dewey, Jean Piaget, Lev Vygotsky, Paulo Freire, and Mary Parker Follett (Kolb & Kolb, 2013).

Dantas & Cunha (2020) summarized Kolb's definition of learning and all the factors that contribute to learning as:

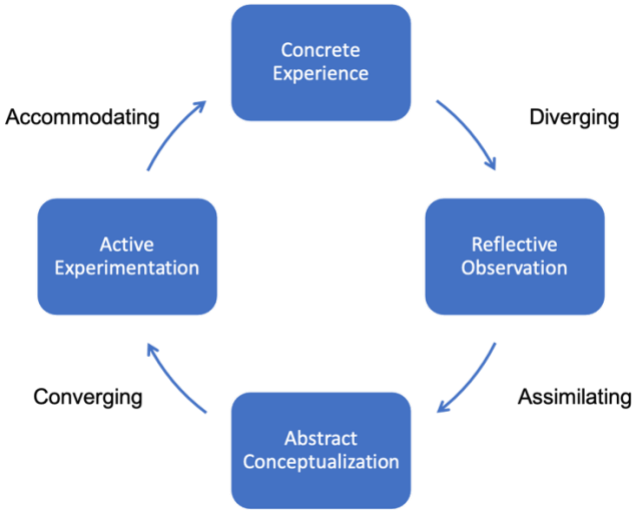
> a holistic process of adaptation to the world that requires the ability to resolve dialectically conflicts between modes of adaptation to the world - reflection/action and feeling/thinking. Learning is therefore the process of knowledge creation which requires the synergy between social knowledge and personal knowledge. (p. 2)

Kolb & Kolb (2013) noted that "knowledge results from the combination of grasping and transforming experience" (p. 7). Kolb's ELT process of learning is depicted in Figure 1 (Dantas & Cunha, 2020). This pictorial representation demonstrates the cycle of how an individual

attempts to resolve experiences (reflecting/acting) and how to transform those experiences into knowledge (experiencing/thinking) (Dantas & Cunha, 2020).

Figure 1

Kolb's Experiential Learning Cycle



Note. Adapted from "The Kolb Learning Style Inventory 4.0, A Comprehensive Guide to the Theory, Psychometrics, Research on Validity and Educational Applications," A.Y. Kolb and D.A. Kolb, 2013, p. 8. Copyright 2013 by Experience Based Learning Systems.

Kolb & Kolb (2013) developed the Kolb Learning Style Inventory (KLSI) to fulfill two purposes: 1. To serve as an educational tool to increase individuals' understanding of the process of learning from experience and their unique individual approach to learning, and 2. To provide a research tool for investigating experiential learning theory (ELT) and the characteristics of individual learning styles. He later expanded these four learning styles to nine. Learning style research used in this present study referred only to the original four learning styles but the five additional learning styles will be mentioned later to bring awareness to the new learning styles.

Richard Felder, Linda Silverman, & Barbara Soloman

Richard Felder was a professor of Chemical Engineering at North Carolina (N.C.) State University. After a decade of teaching, he began to identify gaps in his pedagogy and set out to examine learning styles that would inform teaching style improvements (Felder, 1998). After some time researching learning styles, he decided to borrow concepts from many of the theories to create his own learning style principles and approach to teaching. During his search he reconnected with his lifelong friend Linda Silverman, an educational psychologist at the University of Denver. They collaborated to identify better ways to teach engineering students that could then be offered to other engineering professors (Felder & Brent, n.d., Question 6; Felder & Silverman, 1988, Author's Preface section). Felder and Silverman (1988) admitted that student preparation played a part in what was learned in class but also noted that there must also be a compatibility between the students' learning style and the instructor's teaching style. Their collaboration resulted in a learning-style model that would place each learner somewhere on each of the five continuums; *sensing/intuitive* (from the MBTI), *visual/auditory* (from modality theory and neurolinguistic programming), *inductive/deductive* (from various sources in cognitive and educational psychology), *active/reflective* (from Kolb and the extravert/introvert preference on the MBTI), *and sequential/global* (from Silverman, Gregorc, and Pask) (Felder, 2010; Felder & Silverman, 1988). Felder (1998) later eliminated the *inductive/deductive* scale and changed the *auditory* dimension to *verbal* because of further research discoveries. To determine a student's learning style, he worked with Barbara A. Soloman, then the coordinator of advising for the N.C. State First-Year College, to revise the 44-question measurement instrument that was refined over time to its current format where it can be accessed for free on the web. (Felder & Brent, n.d., Question 6; Felder & Soloman, n.d.-a).

Felder (1996) noted that while matching a teaching style to a learning style is valuable, he admitted it was nearly impossible to do in a class full of students who have different learning styles. He concluded that it was not necessary to know the learning style of each student; instead, it was much more important to help all students build their skills in both their preferred and less preferred modes of learning because they will all be needed to function effectively in any profession (Felder & Brent, 2005). Felder and Brent (2005) suggested that for students:

> to function effectively as engineers or members of any other profession, students will need skills characteristic of each type of learner: the powers of observation and attention to detail of the sensor and the imagination and abstract thinking ability of the intuitor; the abilities to comprehend information presented both visually and verbally, the systematic analysis skills of the sequential learner and the multidisciplinary synthesis skills of the global learner, and so on. If instruction is heavily biased toward one category of a learning style dimension, mismatched students may be too uncomfortable to learn effectively, while the students whose learning styles match the teaching style will not be helped to develop critical skills in their less preferred learning style categories. The optimal teaching style is a balanced one that sometimes matches students' preferences, so their discomfort level is not too great for them to learn effectively, and sometimes goes against their preferences, forcing them to stretch and grow in directions they might be inclined to avoid if given the option. (p. 62)

The search to understand individual learning styles has been a topic of scholars for a long time. Insight into how humans receive, process, and interpret information varies with each person. No two individuals have the same life experiences which means they will not process external stimuli similarly and arrive at the same conclusion. Presently learning theorists more

thoroughly understand how and why individuals learn. A need to measure an individual's unique learning style was necessary so a variety of theorists created instruments to capture and explain individual learning styles as they have been theorized. The individual findings of this vast body of research confirms that the human is too complex to make definitive statements about how they perceive, interact, and respond to the world around them. It may be possible to recognize what characteristic describes an individual and what does not. In doing so, the learning process can be enhanced. Each of these learning theories are unique and have their own merit. What we know is significantly less than what can be known so building on each discovery gets us one step closer to understanding how to improve the educational process for both the learner and the teacher. For now, all that can be done is use what has been discovered and continue to look for more information that helps to improve the educational experience. For teachers, the educational process should be intentional and deliberate and approached with an attitude of continual learning. Instructors should avoid becoming complacent in their job of educating students.

Learning Style Theory Opposition

Improvement in any endeavor requires a critical analysis to provide a fair and honest assessment of the process or results. Learning style theories and their claims are not protected from criticism and should welcome observations that help these theories eliminate bias and faulty analysis or assumptions. Critics of matching an individual's learning style with a teaching style to effect improved academic performance abound and each has gladly shared their critical analysis of this belief.

The meshing hypothesis claims that matching (or meshing) a learner's preferred learning style with a similar teaching style should result in improved comprehension and higher academic performance. There are scholars on both sides of this discussion. Some say this hypothesis is

valid (Andres & Akan, 2015; Williams et al., 2014) while others contend there is no evidence to support such a claim (Pashler et al., 2008). The work of Pashler et al. in 2008 seems to be the most often cited (Cuevas, 2015; Wininger et al., 2019) research to disprove the meshing hypothesis. The focus of their effort was to determine if research that claims there is validity in the meshing hypothesis is supported by scientific evidence. They found that individuals, if asked, would state they have a particular preference for how they process information. Likewise, they found evidence to support the fact that people vary in degrees for how they think and process information. Ultimately, they found that "very few studies have even used an experimental methodology capable of testing the validity of learning styles applied to education" (Pashler et al., 2008, p. 105). In fact, Pashler et al., (2008) summarized their findings in this rather direct way:

> The contrast between the enormous popularity of the learning-styles approach within education and the lack of credible evidence for its utility is, in our opinion, striking and disturbing. If classification of students' learning styles has practical utility, it remains to be demonstrated. (p. 117)

This opinion seems to be consistent among those who find the meshing hypothesis unprovable or unsupported by scientific evidence.

Felder (2020) acknowledged there are those who claim the meshing hypothesis is invalid (Kirschner, 2017; Knoll et al., 2016; Newton & Miah, 2017; Pashler et al., 2008; Willingham et al., 2015) but he suggested that insufficient research existed to support the claim. Felder (2020) noted, however that the inability to find evidence to support the meshing hypothesis does not invalidate the concept of learning styles and that "most proponents of learning styles explicitly reject the meshing hypothesis" for a variety of reasons including the impossibility of matching a

teaching style to a classroom of students with different learning styles. Felder (2020) held that finding a teaching style that matched a student's learning style missed the point of teaching. An understanding of learning styles informed teachers who should then strive to find a balance in how material is presented to facilitate learning for all students. Felder and others contend that students who are forced to learn in a manner different than they prefer helps them build skills that would have not been built had they been taught only in their preferred style. Learning how to learn in less than preferred ways make an individual a better student and lifelong learner. Williams et al. (2014) pointed out that "research conducted by Cassidy (2004), Kolb and Kolb (2005) and Felder and Silverman (1988) demonstrate that increasing the understanding of the educational practitioner to the varied student population entering higher education provide[d] for the establishment of stronger educational practices" (p. 36). Felder suggested that if educators delivered educational material in a balanced manner and educated students about their own preferences to learning then all students fared better academically and tended to become lifelong learners. Felder (2010) firmly held to the belief that "as long as learning styles are viewed in this moderate manner, they will continue to be widely used in education, and no one – neither students, teachers, nor disapproving psychologists – will be any the worse for it" (p. 5).

Measurement Tools

This study examined a variety of learning style models and assessment tools: "Myers-Briggs Type Indicator (1956), Pask (1976), Kolb (1984), Felder and Silverman (1988), and Honey and Mumford (1992)" (Williams et al., 2014, p. 33). This study used the Felder-Soloman Index of Learning Styles (ILS) questionnaire to gather learning style preferences because 1) a review of the literature did not indicate that it had ever been used in the aviation industry, 2) it contains concepts from both the MBTI, the Kolb LSI, and elements from other theorists, and 3) it

had been used in other industries to study generational differences which makes it appropriate to use for this study as well. There have been previous studies that focused on pilot learning styles, but they used the original four learning style Kolb LSI to measure the results however those studies were nearly 20 years ago. Using the ILS to assess the learning styles of pilots will either validate the findings of those earlier studies or produce new information to improve the current educational process.

The VARK, MBTI, KLSI, FFM, & ILS

Five commonly used measurement tools to determine student learning styles are the Visual, Auditory, Read/Write, Kinesthetic (VARK), Myers-Briggs Type Inventory (MBTI), Kolb Learning Style Inventory (KLSI), Five-Factor Model (FFM), and the Felder-Silverman Index of Learning Styles (ILS) (Felder & Silverman, 1988; Felder & Soloman, n.d.-a; Kolb & Kolb, 2013; Richmond & Cummings, 2005; Richmond & Liu, 2005; Thiele, 2003). Even though the MBTI and FFM were created as personality inventories, they can also be used to discover a student's learning style or preference. The Index of Learning Styles (ILS), initially created by Felder and Silverman (1988), was updated in 1991 by Felder and Soloman and is also referred to as the Felder and Soloman (n.d.) Index of Learning Styles (ILS) (Williams et al., 2014). Felder and Brent (2005) suggested that using any of these three measurement tools to discover the learning style of a class enables instructors to prepare delivery methods, determine what technology would work best, and can provide additional support for effective instructional design.

Visual, Auditory, Read/Write, Kinesthetic (VARK)

The Visual, Auditory, Read/Write, Kinesthetic (VARK) assessment tool and a similar version known as the Visual, Auditory, Kinesthetic (VAK) have been used to illustrate an

individual's learning preference as visual, auditory, reading/writing, or kinesthetic, and sometimes a combination of any or all these dimensions. Chui et al. (2020) suggests that the VARK model is "one of most popular and widely accepted learning style models … refers to the sensory modality which the learner is most comfortable acquiring information" (p. 3). Table 5 highlights each modality.

Table 5

VARK Modality

Modality	Learn by	Examples
Visual	Seeing	Charts, Graphs, Outlines, Pictures, PowerPoints
Auditory	Hearing	Read-aloud, Verbal instructions, Auditory books, Discussions
Read/Write	Reading/Writing	Books, Pamphlets, Websites, Note-taking
Kinesthetic	Doing	Tactile-touch & feel, hands-on, body movement

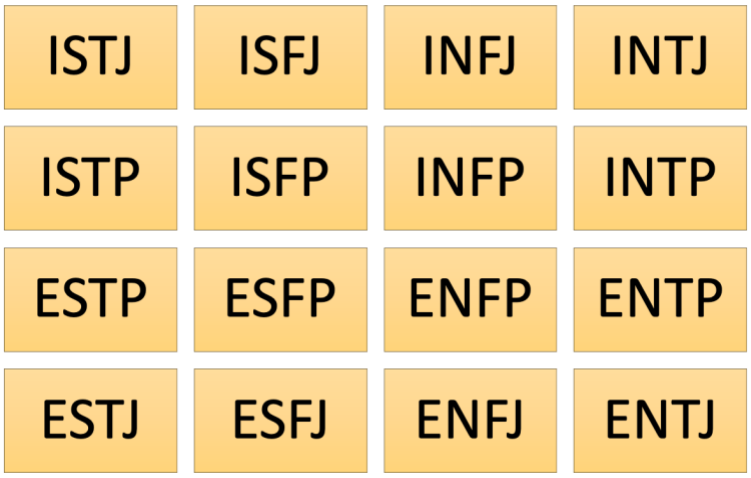
Myers-Brigg Personality Inventory (MBTI)

The Myers-Briggs Personality Inventory (MBTI) is a 93 forced-choice question assessment that identifies an individual's preference on four different preference pairs (Felder & Brent, 2005). The *Extraversion-Introversion* scale identifies where individuals invest their time and how they are energized. An *Extravert* prefers to be out with other people while an *Introvert* is more contemplative and reserved (The Myers & Briggs Foundation, 2021a). The *Sensing-Intuitive* scale describes an individual's preference for taking in information. A *sensor* will focus on the information that is received via the five senses while an *intuitive* person will pay more attention to the patterns and possibilities, they see in the information they receive (The Myers & Briggs Foundation, 2021d). The *Thinking-Feeling* scale identifies an individual's decision-making preference. *Thinkers* weigh more heavily objective principles and impersonal facts. *Feelers*, however, are more concerned with personal concerns and the others involved (The Myers & Briggs Foundation, 2021e). The last scale focuses on the *Judging-Perceiving*

personality trait which is concerned with structure. *Judgers* live a more structured and decided lifestyle, while *Perceivers* are more flexible in lifestyle choices (The Myers & Briggs Foundation, 2021c). The MBTI type preferences can be combined to form 16 different learning style types as shown in Figure 2. For example, an Introspective Sensing Thinker Judger (ISTJ) is a person who prefers to live in his own world and receives the most strength there, processes information that comes through the five senses, makes decisions based on the facts, and lives a structured life. Unlike the MBTI, the Kolb Learning Style Inventory (KLSI) focuses specifically on an individual's learning style as opposed to someone's personality type.

Figure 2

The 16 MBTI Type Preferences



Note. Adapted from "MBTI Basics," by The Myers & Briggs Foundation, 2021. All Rights Reserved 2021 by The Myers & Briggs Foundation.

Kolb Learning Style Inventory (KLSI)

The Kolb Learning Style Inventory (KLSI) version 4.0 is an 80 forced-choice, agree-disagree questionnaire. As with any questionnaire, the accuracy of the findings depends on the individual's honesty when answering the questions. Kolb and Kolb (2013) originally identified

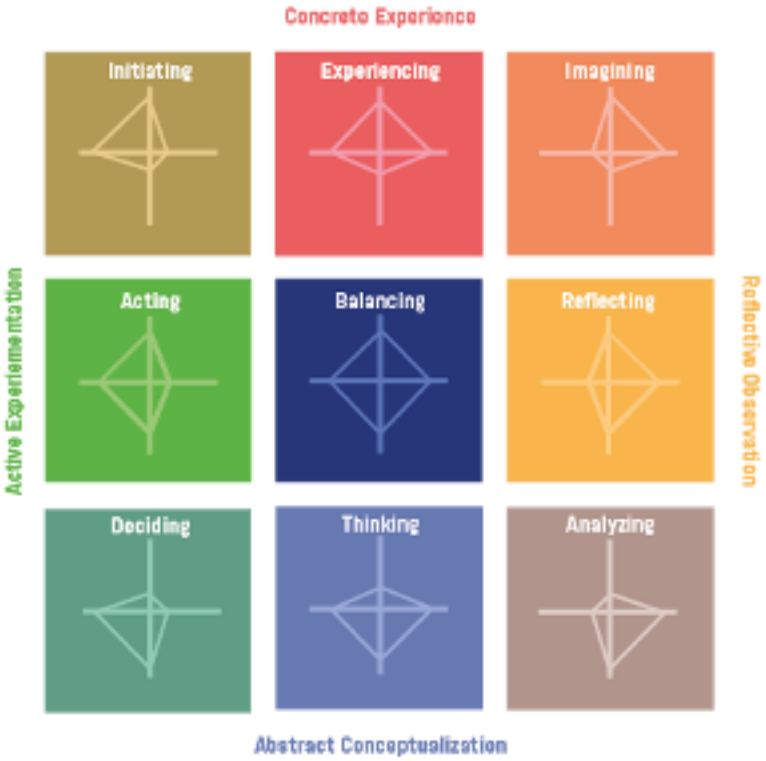
four learning styles: diverging, assimilating, converging, and accommodating. He later admitted that “learning styles are influenced by culture, personality type, educational specialization, career choice, and current job role and tasks” (Kolb & Kolb, 2013, p. 10) and expanded his original four learning styles to nine learning styles in the KLSI 4.0. Earlier studies that focused on the learning styles of pilots referenced only the original four learning styles of the KLSI. The findings in these studies arranged learners as a *Diverger*, *Assimilator*, *Converger*, or an *Accommodator*. *Divergers*, whose dominant learning abilities are *Concrete Experience* and *Reflective Observation*, can evaluate situations from several points of view. *Assimilators*, whose dominant learning abilities are *Abstract Conceptualization* and *Reflective Observation*, can process a wide variety of information and organize it into a logical, concise format. *Convergers*, whose dominant learning abilities are *Abstract Conceptualization* and *Active Experimentation*, are good at problem solving and finding solutions to problems. Lastly, *Accommodators*, whose dominant learning abilities are *Concrete Experience* and *Active Experimentation*, learn best by doing. They are hands-on learners and may act on a gut feeling rather than facts (Felder & Brent, 2005; Kolb & Kolb, 2013).

Felder (1996) admitted that traditional engineering instruction focuses almost exclusively on formal presentation of material (lecturing), a style comfortable for only *abstract, reflective* learners. He asserted that to reach all types of learners, teachers should explain the relevance of each new topic (*concrete, reflective*), present the basic information and methods associated with the topic (*abstract, reflective*), provide opportunities for practice in the methods (*abstract, active*), and encourage exploration of applications (*concrete, active*). The term "teaching around the cycle" (p. 19) was originally coined to describe this instructional approach.

In the KLSl 4.0, learning styles are still arranged on the two-dimensions of *Concrete Experience-Abstract Conceptualization* and *Active Experimentation-Reflective Observation* and the nine new learning styles are arranged as seen in Figure 3. The diagram in the middle of each box indicates the influence each of the four sides has on that particular learning style.

Figure 3

The Nine Learning Styles in the KLSI 4.0



Note. Reprinted from "The Kolb Learning Style Inventory 4.0, A Comprehensive Guide to the Theory, Psychometrics, Research on Validity and Educational Applications," A.Y. Kolb and D.A. Kolb, 2013, p. 4. Copyright 2013 by Experience Based Learning Systems.

Kolb said that an individual's learning style is defined by the way an individual combines experience and reflection (action) to arrive at feeling and thinking (knowledge) (Kolb & Kolb, 2013). Because Kolb added five new learning styles, he revised this learning cycle to resemble Figure 4. In this figure, we can see the four original learning styles on the outer part of the circle

in each of the corners, the extremes of the two dimensions at the top, bottom, and sides of the circle, and the nine new learning style classifications in the nine circles that form the wheel.

Figure 4

The Nine Learning Styles and Four Dialectics of the Learning Cycle

Note. Adapted from "The Kolb Learning Style Inventory 4.0, A Comprehensive Guide to the Theory, Psychometrics, Research on Validity and Educational Applications," A.Y. Kolb and D.A. Kolb, 2013, p. 16. Copyright 2013 by Experience Based Learning Systems.

Kolb and Kolb (2013) described each of the nine new styles as follows. An individual with an *experiencing* style finds meaning from a deep involvement in the experience. A person with an *imagining* style is characterized by the ability to imagine possibilities through observation and reflection on their experiences. Someone who is known to have a *reflecting* style can connect

experience and ideas through sustained reflection. Those with an *analyzing* style have the ability to integrate and systematize ideas through reflection. The person who demonstrates a *thinking* style has demonstrated capacity for disciplined involvement in abstract and logical reasoning. The individual exercising a *deciding* style can use theories and models to decide on problem solutions and courses of action. The person with the *acting* style is known to have a strong motivation for goal directed action that melds people and tasks. An individual in the middle of both continuums will have a *balancing* style and can adapt easily by weighing the pros and cons of acting. The final style is one of *initiating*. This person will initiate action to deal with experiences and situations. The original KLSI may be the most used instrument when discovering an individual's learning style and follow-up studies using the new nine learning style model may reveal additional insight into improving the educational process.

Big Five Personality Test (FFM)

"The five-factor model of personality is a hierarchical organization of personality traits in terms of five basic dimensions: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience" (Goldberg, 1992; McCrae & John, 1992, p. 175). Assessment is based on the results of a 50-question Likert style questionnaire using response choices of Very Inaccurate, Moderately Inaccurate, Neither Accurate nor Inaccurate, Moderately Accurate, and Very Accurate. Ibrahimoglu et al. (2013) explain that *agreeableness* includes personality traits such as reliability, sacrificing, and humility; *conscientiousness* is known for hard work, determination, ambition, and to be success-oriented; *openness* involves the highest cognitive aspect and features creativity, imagination, and originality; *extraversion* is made up of assertiveness, ambition, talkativeness, and the desire to be social, and lastly; *neuroticism* includes traits of anxiety, anger, insecurity, and mistrust.

McCrea and John (1992) note that:

> The appeal of the model is threefold: It integrates a wide array of personality constructs, thus facilitating communication among researchers of many different orientations; it is comprehensive, giving a basis for systematic exploration of the relations between personality and other phenomena; and it is efficient, providing at least a global description of personality with as few as five scores. (p. 206)

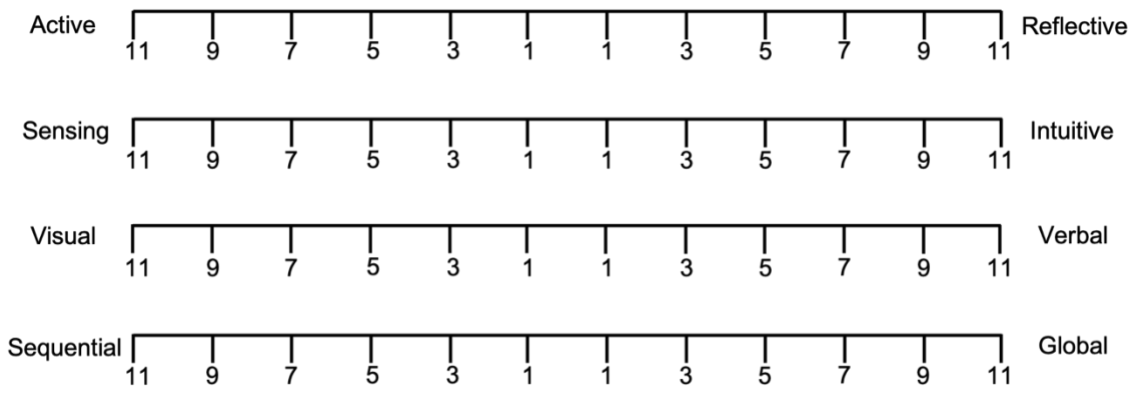
Felder and Soloman Index of Learning Styles (ILS)

The Index of Learning Styles® (ILS) (Felder & Soloman, n.d.-a), developed in 1991 by Richard Felder and Barbara Soloman, is a forty-four-item forced-choice questionnaire used to assess learning style preferences that are measured on the four scales of the Felder-Silverman model (Felder & Brent, 2005). When constructing the initial version of the ILS, Felder and Spurlin (2005) explained that the *Active-Reflective* dimension was like the KLSI *Active Experimentation-Reflective Observation* dimension and the *extravert/introvert* on the MBTI. They also noted that the *Sensing-Intuitive* dimension was taken directly from the MBTI and may have a counterpart in the *concrete/abstract* scale in the Kolb LSI model. Looking to other theories, Felder and Spurlin admit that both the *active/reflective* and *visual/verbal* dimensions contain analogies to the *visual-auditory-kinesthetic* modality theory and neurolinguistic programming. Finally, they pointed out that the *visual/verbal* discrimination is also rooted in cognitive studies of information processing (Felder & Silverman, 1988). Graf et al. (2007) indicated that each learner has a personal preference on each of the four dimensions. Each scale is expressed in the same way, -11 to +11 in increments of $\pm$2 (i.e., -11, -9, -7, -5, -3, -1, +1, +3, +5, +7, +9, +11) as demonstrated in Figure 5. This range configuration is the result of the 11 questions that are posed for each dimension. When answering a question, for instance, with an

active preference, +1 is added to the value of the active/reflective dimension whereas an answer for a reflective preference decreases the value by 1. Therefore, each question is answered either with a value of +1 (answer *a*) or -1 (answer *b*). Answer *a* corresponds to the preference for the first pole of each dimension (active, sensing, visual, or sequential), answer *b* to the second pole of each dimension (reflective, intuitive, verbal, or global). As an example, reference the *active-reflective* scale in Figure 5. An individual who answered "a" for four of the questions related to that scale would have a four on the *active* side of the scale. If that person also answered "b" for seven of the questions related to that scale, then they would have a seven on the *reflective* side of the scale. The preference that would be displayed for that person would be a three on the *reflective* scale and indicate a moderate preference for active learning. An aggregate score of 1-3 indicates a mild preference for that learning style and can be interpreted as a balanced preference for both styles on that scale. If the score is a 5-7 then an individual would favor that style and would learn better in an environment that had this teaching style. A person with a 9-11 score shows evidence of a strong preference for that particular learning style and a classroom environment that does not utilize this style will present real difficulty in learning for that individual.

Figure 5

Felder and Soloman's Index of Learning Styles



Note. Adapted from "Index of Learning Styles – Report of Results," R.M. Felder and B.A. Soloman, 1991 & 1994, (n.p.). Copyright 1991, 1994 by Educational Designs, Inc., Chapel Hill, NC.

Felder and Brent (2005) note that a student's learning style may be defined by the answers to four basic questions:

1. What type of information does the student preferentially perceive: sensory or intuitive?
2. What type of sensory information is most effectively perceived: visual or verbal?
3. How does the student prefer to process information: actively or reflectively?
4. How does the student characteristically progress toward understanding: sequentially or globally?

How the student responds to ILS questions related to the first basic question will determine to what degree they are *sensing* or *intuitive. Sensing* learners tend to be concrete, practical, methodical, and oriented toward facts and hands-on procedures, while *intuitive* learners are more comfortable with abstractions and are more likely to be rapid and innovative problem solvers. The answers to the ILS questions which align with the second basic question will show if a person is *visual* or *verbal* by nature. *Visual* learners remember best what they see, and *verbal* learners get more out of words. Those ILS questions that are geared to measure a person's

standing on the third basic question reveal if the individual is *active* or *reflective. Active* learners tend to retain and understand information best by doing something active with it – discussing or applying it or explaining it to others. By contrast, *reflective* learners prefer to think about it quietly first. Lastly, responses to specific ILS questions that focus on the final scale will determine if they are *sequential* or *global*. Sequential learners tend to think in a linear manner and can function with only partial understanding of material they have been taught. *Global* learners on the other had learn in large jumps. They may not be able to apply new material until they fully understand it and see how it melds with what they already know. *Global* learners will learn large amounts of information without understanding and then suddenly get it.

Felder (1996) noted that most engineering instruction was biased toward intuitive, verbal, reflective, and sequential learners. However, a small number of engineering students fell into all four of these categories. As a result, most engineering students received instruction that was mismatched to their learning styles. The concern was that performance was negatively affected, and worse yet was negative attitudes toward their courses and engineering as a curriculum and career.

This current study used the ILS to assess the learning styles of non-pilots and pilots to note any difference. Additionally, it examined age among pilots, as well as gender differences.

Index of Learning Styles Reliability and Validity

The Index of Learning Styles questionnaire was designed to understand the learning styles of engineering students. This information would then inform the teaching style that would best facilitate learning for this group of learners. Using this information, the instructor would organize class activities and delivery methods that addressed all types of learners to ensure each student would not only learn from his or her preferred style, but also learn to learn in a non-

preferred style. In doing so, students would be better prepared to function in the world after college. It was never intended to predict academic performance as some studies have sought to do (Felder & Spurlin, 2005; Zywno, 2003). Van Zwanenberg (2000) used the ILS to predict academic performance and concluded that its use beyond informing the student and teacher of preferred learning styles was not advised. Nevertheless, the Index of Learning Styles must live up to the same standards that other measurement instruments live up to when measuring what they were designed to measure. Measurement instruments must be both *reliable* - measurement yields consistent, repeatable results, and *valid* - it measures what it is supposed to measure. (Cook, 2005, October Supplement; Litzinger et al., 2007; Van Zwanenberg et al., 2000; Zywno, 2003).

Reliability and Validity

Shannon and Davenport (2001) stated that "the more consistent the results from a measurement instrument are, the more reliable they are" (p. 119). Therefore, it was important to establish the Felder and Soloman Index of Learning Styles as reliable. Several studies have used various techniques that measure *reliability* and have concluded that if the ILS was used as it was intended, to measure learning styles or preferences, then it is a reliable measurement instrument. There are a few methods to test for an instrument's reliability, but this literature review will only focus on two: test-retest and internal consistency. *Test-Retest* examines the consistency of a measure over time and *Internal Consistency* analyzes the consistency of a measure across items.

Test-retest looks for an instrument's ability to provide similar results for individuals who are given the instrument at different times. Zywno (2003) warned that timing of retest is critical for this approach. If the time between tests is too short the subjects can remember their responses from one test to the next and invalidate the results (Felder & Spurlin, 2005), however the longer

the time between test and retest, the lower the correlation. Felder and Spurlin (2005) agreed that the 4-week interval used by Seery et al. is ideal for test-retest. The timing between test and retest for Zywno was eight months which was dictated by classroom realities. Livesay et al. elected to retest four times, the first at four months, the next at seven months, the third at twelve months and the final test at sixteen months (Zywno, 2003). The data in Table 6 indicated that both Zywno (at eight months) and Livesay et al. (at seven months) found higher *Active* and *Sensing* scores than they did for the *Visual* and *Sequential* scores. In addition, like Van Zwanenberg et al., some evidence of overlap was found between the *Sensing-Intuitive* and *Sequential-Global* domains. Zywno (2003) concluded that the strong to moderate reliability of all scales in the test-retest validate the internal reliability of the scales. When Felder and Spurlin (2005) examined the intervals between test and retest for Seery et al. (four weeks) and Zywno (eight months), as well as the findings, they concluded that the test-retest reliability is satisfactory.

Table 6

Test-Retest Correlation Coefficients

Δt	Active-Reflective	Sensing-Intuitive	Visual-Verbal	Sequential-Global	N	Source
		No Test-Retest Done				Van Zwanenberg *et al.*
4 wk.	0.804**	0.787**	0.870**	0.725**	46	Seery et al.
7 mo.	0.73*	0.78*	0.68*	0.60*	24	Livesay *et al.*
8 mo.	0.683**	0.678**	0.511**	0.505**	124	Zywno
		No Test-Retest Done				Spurlin

*Note. *p < .05, **p < .01.* Adapted from "Applications, Reliability and Validity of the Index of Learning Styles," by R.M. Felder and J. Spurlin, 2005, *International Journal of Engineering Education, 21*(1), p. 107. Copyright 2005 by TEMPUS Publications.

For *internal consistency*, (reference Table 7) the expectation that all items measure a certain variable is necessary. If each of the parts are consistent and point to what is to be measured, then it will be reliable. Cronbach's *alpha* is a test used to estimate the reliability, or

internal consistency, of a set of test items. Higher *alpha* scores indicate a more reliable measure or one that produces consistent results. Van Zwanenberg et al. (2000) noted that Cronbach's *alpha* (+0.80 or more) is normally the preferred measure of internal consistency for psychometric instruments. It is because their research yielded *alpha* values of less than 0.80, they suggest that because of the low internal reliability of the ILS scales, this assessment tool be used only for informative purposes and nothing beyond that. Litzinger et al. (2007) agreed that Cronbach's *alpha* is a good test for internal consistency reliability, however, they hold +0.50 should be used as the minimum standard for attitude and preference assessments as recommended by Tuckman (Zywno, 2003). Zywno (2003) stated that the acceptable minimum *alpha* for social science is +0.70 because at this level, the standard error of measurement will be more than half of the standard deviation. However, Zywno mentioned that their *alphas*, which are higher than Van Zwanenberg, do exceed the acceptable standards recommended by Tuckman and ultimately agrees that the ILS is a suitable psychometric tool to assess learning styles. Zywno (2003) pointed out that Livesay et al., in a study of 255 engineering students at Tulane University, found acceptable *alphas* and high test-retest reliability to conclude that the ILS was an appropriate and statistically acceptable tool for characterizing learning preferences. While the Livesay et al. study was only referred to from Zywno's (2003) study, it is worth noting that they also concluded that the ILS is an appropriate assessment for identifying learning preferences.

Table 7

Cronbach's Alpha Coefficients for the ILS

Active-Reflective	Sensing-Intuitive	Visual-Verbal	Sequential-Global	N	Source
0.51	0.65	0.56	0.41	284	Van Zwanenberg *et al.*
0.56	0.72	0.60	0.54	242	Livesay *et al.*
0.60	0.70	0.63	0.53	557	Zywno
0.61	0.77	0.76	0.55	448	Litzinger *et al.*

0.62	0.76	0.69	0.55	584	Spurlin

Note. Adapted from "Applications, Reliability and Validity of the Index of Learning Styles," by R.M. Felder and J. Spurlin, 2005, *International Journal of Engineering Education, 21*(1), p. 108. Copyright 2005 by TEMPUS Publications and "A Psychometric Study of the Index of Learning Styles©," by T.A. Litzinger, S.H. Lee, J.C. Wise, and R.M. Felder, 2007, *Journal of Engineering Education, 96*(4), p. 314.

Validity can be described as the extent to which the measurement scale, or variable, represents what it is supposed to and yields the type of information you need (Shannon & Davenport, 2001). Litzinger et al. (2007) found that factor structure of the ILS provides evidence of construct validity and the data provided strong evidence of construct validity. Felder and Spurlin (2005) examined the learning style preferences of engineering students at ten academic institutions and found convergent construct validity on all ILS scales, except the sequential-global scale, which had lesser results.

Felder and Spurlin (2005) conclude that as long as teachers use the ILS to arrive at balanced course instruction and to help students understand their learning strengths and weaknesses, and based on the analysis of other studies, the ILS may be considered reliable, valid, and suitable.

Training Considerations

Adult Learners

This study focused on the adult learner, and it began with the college student. These students were considered adult learners, primarily as defined by age. However, they have traditionally been exposed to a pedagogical educational model which can be described as teacher-directed. Information was primarily given in a lecture format and students were told what they needed to learn. This generalization does acknowledge that a small percentage of college

students arrive from different educational experiences and backgrounds (e.g., homeschool, Montessori, international schools, etc.) and may not fit this pedagogical stereotype as the majority of college students do. Lectures are usually effective and essential for disseminating a large amount of information particularly when the learners have little or no knowledge of the subject matter, but the byproduct of learning material strictly through lecture may be a superficial learning of the material which leaves students unprepared for future academic endeavors. Once these learners arrive on campus, it then becomes the job of university educators to help students transition from a pedagogical model of learning to an andragogical, or self-directed model of learning (Brady et al., 2001; Karp, 2000) .

Brady et al. (2001) pointed out that several research findings indicate that pedagogy and andragogy make up a continuum (Davenport & Davenport, 1985; Knowles, 1980; Rachal, 1983) and that a combination of pedagogical and andragogical methods are needed depending on student needs (Beder & Carrea, 1988; Hawkins & Kapelis, 1993; Richardson & Birge, 1995).

Learning Styles Research

Students who know their preferred learning style normally seek instruction that matches how they learn best. These students are also aware of the styles of learning that are less preferred but understand they may be required to engage these styles because that is the only option offered to them in that situation. For teachers, knowing the student learning style is treated differently. No teacher can teach a class of students and expect to match a teaching style to the learning preferences of all students. Instead, the instructor will need to structure classroom activities in a balanced format to reach all students equally. The teacher should attempt to engage students in all the model categories during each class. Felder referred to this as “teaching around

the cycle" (Felder, 1996, p. 18). Learners will be required to learn from their preferred and non-preferred learning styles. Felder (1996) suggested that "functioning effectively in any professional capacity…requires working well in all learning style modes" (p. 18). Karp (2000) asserted that "each student must understand his or her dominant learning style and maintain more focused attention to the information when it is being presented in a teaching style which is not easily compatible with their learning style" (pp. 4–5).

Learning in Medicine

Understanding individual learning styles to inform the types of training programs that are most effective is not restricted to the study of aviation. The medical field is an example of a non-aviation field of study that has examined employee learning styles when designing training curriculum. Baeten et al. (2013) conducted a study that looked at the learning environment and its effect on student motivation for learning. The four learning environment scenarios included in this study were (1) lecture only, (2) case-based learning (CBL) only, (3) alternating Lecture and CBL, and (4) gradual transition from lecture to CBL (p. 484). They demonstrated that "student's autonomous motivation for learning can be influenced by the learning environment…. [it] is significantly higher in a learning environment in which lectures gradually make way for CBL" (Baeten et al., 2013, p. 496). The aviation industry may be able to apply the lessons learned from the medical industry to improve educational environments in portions of the aviation industry.

Antepohl and Herzig (1999) pointed out there is general agreement among experts in medical education who say problem-based learning produces better overall results than a conventional, lecture-based curricula and found there have been numerous studies which indicate that an active-learning teaching approach can improve student attitudes and produce better results than the standard lecture format. These "students perceive their learning as

relevant…spend more time in self-learning…make more use of various information sources…may retain knowledge over a longer period of time…and may be better prepared for life-long learning" (Antepohl & Herzig, 1999, p. 106). These types of learning environments share similarities with scenario-based learning scenarios currently being used by aviation training department delivery techniques. The medical industry is just one industry that the aviation industry can adapt lessons learned from in producing better educational environments.

Learning in Aviation

Aviation versus Non-Aviation Students.

Aviation is a dynamic field that requires dedication from those who choose professional flying as their career (Clark, 2001). Students pursuing aviation careers must obtain a great amount of knowledge including technical data, procedural information, and social skills (Clark, 2001). Researchers have sought to relate the learning characteristics of aviation students to the well-established concepts of andragogy and pedagogy (Brady et al., 2001). Current research suggests that the traditional lecture format is not always effective for today's students, especially when used as the only method of relaying information (Campbell, 1997). Traditional lecture formats follow Knowles's (1980) teachings of the pedagogical teacher-centered model and are not necessarily influenced by the needs or interests of the students. The andragogy principles of active learning may be more appropriate.

Brady et al. (2001) compared the learning styles of aviation and non-aviation college students and found a difference between collegiate aviation students and students seeking other degrees. They asserted that aviation students are not searching for a career like many students and, therefore, approach the learning environment as an adult.

Brady et al. (2001) sought to relate aviation student learning characteristics to "Knowles' four constructs in the adult learning (andragogy) of model: (1) Self-concept, (2) Experience, (3) Readiness-to-learn and (4) Orientation-to-learning" (p. 34). Table 8 highlights Brady's hypothesis before conducting the study.

Table 8

Learning Model Hypothesis

Type of Learner	Self-Concept	Experience	Readiness to Learn	Orientation to Learning
Pedagogy	From Others	Low	Extrinsic	Subject-focused
Andragogy	Within	High	Intrinsic	Problem-focused
Aviation Student	Within	Low+	Intrinsic	Subject-focused

Note. Reprinted from "A Comparison of the Learning Styles of Aviation and Non-Aviation College Students," by T. Brady, A. Stolzer, B. Muller, and D Schuam, 2001, *Journal of Aviation/Aerospace Education & Research, 11*(1), p. 34. Open Access by the Journals at Scholarly Commons.

Brady et al. (2001) found a "significant difference between aviation and non-aviation students in the self-concept construct … aviation students relate significantly more to the andragogical model than do the non-aviation students" (p. 37). Aviation students were more self-directed because of a higher self-concept than first-year college students which aligns more with the andragogical approach to learning. As it pertains to Knowles' experience construct, Brady et al. (2001) again found that "a significant difference exists between the aviation and the non-aviation student … the aviation student is more closely associated with the adult learner than the pedagogical one" (p. 38). Some of these students brought with them to the collegiate learning environment a level of experience that bolstered their self-confidence to elevate their performance in this new educational setting. When it concerns a readiness-to-learn, both aviation

and non-aviation students were both intrinsically motivated to learn, which corresponds with Knowles' andragogical model of learning. Lastly, Brady et al. (2001) found a significant difference between aviation and non-aviation students in the orientation-to-learn construct which was not expected. Their findings suggest that aviation students "relate to learning as a means of solving problems that occur in the flow of life and like adult learners, need the opportunity to apply and try out learning quickly" (Brady et al., 2001, p. 39). Aviation students were more likely to be problem solvers as opposed to the other students. A final unexpected finding was that non-aviation first year students, who were predicted to rely on extrinsic motivation regarding the readiness to learn construct, behaved like the aviation students who were intrinsically motivated to learn. The data in Table 9 indicates the findings of the study, with the results in bold as different than hypothesized.

Table 9

Modified Learning Model

Type of Learner	Self-Concept	Experience	Readiness to Learn	Orientation to Learning
Pedagogy	From Others	Low	**Intrinsic**	Subject-focused
Andragogy	Within	High	Intrinsic	Problem-focused
Aviation Student	Within	**High**	Intrinsic	**Problem-focused**

Note. Differences between hypothesis and findings are shown in bold. Reprinted from "A Comparison of the Learning Styles of Aviation and Non-Aviation College Students," by T. Brady, A. Stolzer, B. Muller, and D Schuam, 2001, *Journal of Aviation/Aerospace Education & Research, 11*(1), p. 39. Open Access by the Journals at Scholarly Commons.

Visual, Auditory, Read/Write, Kinesthetic (VARK).

The VARK / VAK indicate and individual's preference for which modality he or she receives information. It does not indicate a learning style per se. The acronym stands for *visual* (V), *auditory* (A), *read/write* (R), and *kinesthetic* (K) with the (R) omitted for the VAK model.

Chui et al. (2020) used the VARK model, developed by Fleming, to understand the effect on learning that the visual and auditory systems contribute to the learning process. The sample for this study was Generation Z students (Mean age = 21.89 years). A visual learner best acquires information via the visual system (i.e., images, graphs) while the auditory learner prefers a verbal engagement (i.e., lecture, group discussion) (Chui et al., 2020).

Significant learning occurs after a flight when a thorough debrief of the events is discussed. This feedback has a meaningful impact on the learning process and is often not taken advantage of. Chui et al. (2020) cite others who mention four attributes of feedback: 1) nature of the feedback (i.e., content – "what"); 2) the temporal dimension of the feedback (i.e., frequency and timeliness – "when"); 3) source of the feedback (i.e., person or apparatus delivering the feedback – "who"); and 4) cognitive engagement which entails coming up with a decision or decisions that are critical to the success of a task. Feedback is a very important aspect of aviation training specific to the debrief of a maneuver or flight.

The focus of this study was the relationship of the type of feedback, visual or auditory, provided to the pilot that was identified as either a visual learner or auditory learner based on the VARK results. The findings from the Chui et al. (2020) study show that: "during the test flights, when feedback was matched to an individual's preferred learning style, differences in pilot performance was observed (i.e., crossover interaction), and these differences were most notable for auditory learners. Specifically, when auditory learners were presented visual feedback, their performance was adversely affected. Conversely, when the same auditory learners received auditory feedback, their performance improved. For visual learners, when they were presented visual feedback, their performance also improved. However, when visual learners received auditory feedback, there was no significant adverse effect. While these

results do provide a clear cross-over effect, it is not perfect. For visual learners, auditory feedback did not adversely affect performance" (p. 12). While visual learners are not significantly affected by the type of feedback they receive, visual or auditory, the auditory learner is at a disadvantage if they only receive visual feedback.

Chui et al. (2020) note that a limitation of this study was that only two of the four VARK learning dimensions were addressed. It remains unknown if the read/write and kinesthetic styles would have been affected similarly.

Karp (2000) noted a difference in learning style preferences of 117 pilots and the type of classroom instruction they received. He used visual, auditory, and hands-on (kinesthetic) as the predominate learning styles and his findings revealed that nearly one-half were hands-on learners and almost two-thirds were either hands-on or hands-on/visual learners. He also noted that the classroom instruction technique for these students included auditory and visual methods with little to no hands-on learning styles which suggests that course designers were not aware of the student learning styles or that matching the teaching style to the learning style provided the best educational experience.

Myers-Briggs Type Indicator (MBTI).

The personality assessment tool that is utilized the most is the Myers-Briggs Type Indicator (MBTI). The MBTI identifies eight different personality characteristics which make up four pairings: *Extrovert* (E) - *Introvert* (I), *Sensing* (S) - *Intuition* (N), *Thinking* (T) - *Feeling* (F), and *Judging* (J) - *Perceiving* (P). An individual's test result will indicate which characteristic is strongest for each pair. There are 16 different personality types, or combinations, possible. Brownfield (1993) identifies learning styles or preferences that relate to each of the four different dimension pairs. *Extroverts* think and learn best when they are talking, prefer group work, and

are more trial-and-error while *introverts* prefer quiet learning environments and would rather work alone. *Introverts* also prefer lecture-based instruction and do not do as well in a discussion format because it limits their time to process information before speaking (Sakamoto and Woodruff, 1992). *Sensing* students are fact and detail oriented while *intuitive* students prefer the larger picture and examining the relationships between concepts (Brownfield, 1993). Lawrence (1993) suggests that *thinking* students are often impersonal and use logical decision-making when problem solving while *feeling* students consider the impact on others when arriving at a conclusion. *Thinking* students prefer a more structured classroom while *feeling* students like group work, want to understand how the material will benefit mankind, and how they can use the information to improve their world (Brownfield, 1993). The learning environment is an important part of the educational process, and the *judging-perceiving* scale addresses this aspect. *Judging* students prefer a more structured learning environment, concrete assignments, while the *perceiving* student prefers a more flexible and spontaneous learning environment with discussion and open-ended assignments (Brownfield, 1993).

Kutz et al. (2004) used the MBTI to determine the predominant personality type of aviation management and professional pilot students. They found that most aviation management students were ESTJ while the professional pilot students were ESTP. Both liked group work, talking and trial and error, as well as dealing with facts in a logical and structured manner. The only real difference between the two where that professional pilot students preferred a less structured, more flexible learning environment. Robertson and Putnam (2008) found that the population of student pilots surveyed in their study most preferred the ENFP, ISTP, ISTJ, ENTP, and INFP personality types which does not correspond to the Kutz et al. (2004) findings. Fussell et al. (2018) found that the predominant student pilot MBTI personality type was ISJT.

While the MBTI is used to assess an individual's personality type, Lawrence (1993) broadly defines learning styles derived from the MBTI, to cover four aspects of an individual's psychological makeup:

1. Cognitive style in the sense of preferred or habitual patterns of mental functioning: information processing, formation of ideas, and judgments
2. Patterns of attitudes and interests that influence what a person will attend to in a potential learning situation.
3. A disposition to seek out learning environments compatible with one's cognitive style, attitudes, and interests, and to avoid environments that are not congenial.
4. Similarly, a disposition to use certain learning tools, to use them successfully, and avoid other tools. (p. 39)

Wiggins (1998) assessed personality types, using the Myers-Briggs Type Indicator (MBTI), and attitudes toward teaching methods of students enrolled in a professional pilot program (as cited in Fussell et al., 2018). Fussell et al. (2018) tested if personality type is a predictive factor of aviation student learning preference. Recognizing the learning preferences of students allows an instructor to adapt lesson plans to student strengths and teaching to multiple learning styles challenges students to learn in multiple ways and prepares them for a professional world that will not always cater to their needs (Felder & Brent, 2005). According to Fussell et al. (2018), the goal is adopting a balanced approach that allows the instructor to accommodate the needs of the students while ensuring course objectives are met.

Experiential learning is a learning theory that assumes learning is influenced by the individual's accumulated experiences which must be adaptive (Fussell et al., 2018). Kolb uses the experiential learning model to measure an individual's behavior throughout the learning

process (Kolb & Kolb, 2013). The theory stresses that effective learning will occur only when the learner passes through all four stages of the model (Kolb & Kolb, 2013).

Fussell, et al. (2018) was the only study identified that examined a pilot's personality type and learning style to see a relationship was present. The Myers-Briggs Type Inventory (MBTI) was used to identify personality and the Kolb Learning Styles Inventory was used to characterize a learning style. They studied aviation students enrolled in the aeronautical science degree program at Embry-Riddle Aeronautical University. To be eligible to participate in the Fussell et al. (2018) study, students must have already completed their first solo flight. The sample size was 41 students, 31 males, nine females, and one who did not identify gender, there were nine freshmen (22.0%), 13 sophomores (31.7%), eight juniors (19.5%), and 11 seniors (26.8%) in the sample and the average age of the students was 21 (Fussell et al., 2018).

The MBTI can be used to assess the personality type of an aviation student, providing information on focusing attention, information processing, decision-making, and orientation to the environment. The MBTI type most prevalent among the participants in this study had preferences of introverted, sensing, thinking, and judging, or ISTJ. People with this personality type are characterized as practical and systematic; they use logic and trust the known processes and procedures they have used in training to accomplish tasks (Fussell et al., 2018).

The data from the Fussell et al. (2018) study revealed that the CE scores of 19 aviation students were in the 80th percentile or higher when compared to population norms and those who begin the learning cycle at the CE stage prefer to learn by being involved in an experience and working with feelings as opposed to theories. The scores of 16 aviation students were in the 80th percentile or higher of the RO stage meaning these learners prefer to observe a situation, reflect on the meaning and implication, and consider the perspective of others as well as their judgment

before moving forward (Fussell et al., 2018). The significantly high scoring of CE and RO orientation within the study aligns with the *diverging* learning style. These learners typically analyze situations from many perspectives, observe their environment, and assess possible outcomes rather than just merely reacting in any situation (Fussell et al., 2018). This suggests that they rely on a balance of intuition, experience, and rote knowledge (e.g., emergency procedures in a flight) and thrive when the curriculum is less focused on theory in lecture-based instruction, and instead is more practical and hands-on with time for observation (Fussell et al., 2018).

When Fussell et al. (2018) reviewed the characteristics of the prevailing personality type, learning styles, and general preferences associated with the types (i.e., ISTJ, *diverging*, CE and RO orientation), many similarities emerged. From these findings, a profile of aviation students can be created; the results suggest these students are observant of their surroundings, can adapt as situations change and trust known procedures they have learned, especially when they have successfully used them or seen them in use (Fussell et al., 2018). Aviation students prefer to use logical and objective methods to reach a solution as opposed to theories and to make decisions aviation students rely on their observations, their experience, and objective analysis to create a whole picture (Fussell et al., 2018). There is a preference for hands-on learning and an appreciation of input from other people, these students are practical and analytical, preferring facts and the concrete over the theoretical (Fussell et al., 2018).

Instruction for aviation students should include the discussion of situations, alternative solutions, and ensuring procedures become second nature so students can be reliable in a dynamic environment; scenario-based training is also vital for these learners to have an excess of experience to draw upon (Fussell et al., 2018). Understanding type theory and learning styles can

aid educators in creating a better learning environment while giving students the tools to enrich their learning experience (Felder & Brent, 2005). Fussell et al. (2018) suggest when designing a course or learning experience for aviation students, an instructor should incorporate information on systems and procedures, should encourage discussion of past experiences so students may learn from their peers, and should engage students in practical exercises to strengthen skills. It must be pointed out however that in this study, Fussell et al. (2018) found no significant relationship to indicate that personality preference, obtained from the MBTI, predicted learning style, as indicated from the KLSI. In addition, Brownfield (1993) suggests that because of the vast number of variables involved, a perfect correlation between personality type and learning style is not possible but goes on to note that the MBTI can identify a variety of factors that encourage or hinder learning. Other research with aviation students suggests no significant relationship indicating that personality preferences and learning style are related (Niemczyk, 2020).

Kolb Learning Style Inventory.

While the MBTI is the most used personality type indicator tool used, the Kolb Learning Style Indicator is the most learning style instrument used in studies with pilots. Kanske (2001) used the Kolb Learning Style Inventory (KLSI) to identify the preferred learning style(s) of 233 U.S. Air Force pilots. Analysis of the completed KLSI revealed that the predominant learning style of these pilots was the *converger* or *convergent* learning style. Kanske explains that *convergent* learners prefer to know how something works and are not as interested in someone who says it works. These learners want to do it themselves as opposed to someone showing them how to do it. Curriculum designers should consider these preferences when designing course material and the technology used. *Convergent* learners want to know how the system fits

together and why it works the way it does rather than just being told that it works (Kanske, 2001).

Kanske identified a secondary learning preference in these pilots. The *assimilative* style is facts driven and will look at the learning experience as a whole. These pilots like abstract ideas and do not focus as much on a practical application of the information. Both the *converger* and the *assimilator* prefer abstract conceptualization over concrete experience. Kanske (2001) concludes that the current demonstration/performance mode of teaching works well for both styles.

Kanske references the importance of understanding the *convergent* learner in CRM training because these learners prefer to work on technical tasks and problems than deal with social and interpersonal issues (Kanske, 2001). Identifying the unique characteristics of each learning style will demonstrate that there may be more ways to solve a problem than just one which will enhance CRM training results.

Kanske and Brewster (2001) researched learning style preferences of college aviation students and used Kolb's four learning styles: (1) *accommodator*, (2) *diverger*, (3) *converger* and, (4) *assimilator*. Kanske and Brewster (2001) found that the predominant college aviation student learning style was *assimilator* followed by *converger*, then *accommodator*, and lastly *diverger* and that the first two learning styles made up nearly two-thirds of college students in this study. When compared to Air Force pilots who also participated in this study, the *assimilator* and *converger* made up over two-thirds of the Air Force pilot population which mirrored that of the college students. Kanske et al. (2003) reported the results of a longitudinal study based on the 2001 study and found similar results. The only change was a switch between the *converger*, now number one, and the *assimilator*, now number two, preference. Both studies found that

approximately two-thirds of the students favored a *Converger/Assimilator* preference instead of a *Diverger/Accommodator* style. These findings suggest that college aviation students can process a wide variety of information, organize it into a logical concise format (*assimilator*) and then use the information to solve problems (*converger*).

Kanske and Brewster (2001) observed a shift in learning styles after the freshman year but were not able to determine if the shift was due to the elimination of students that displayed a learning style that was not suited for aviation studies or if the student learning style changed. Kanske et al. (2003), following the Kanske and Brewster (2001) study, designed a longitudinal study to help determine "if the difference in learning styles shown between class levels is a result of changing learning styles among students, or if student who have dissimilar learning styles leave the program" (p. 83). Kanske et al. (2003) explained that "current aviation curricula are designed with a building block approach to prepare students for operations in a professional aviation environment" (p. 83). They also note that previous studies indicate that most students prefer the building block approach to learning. They were unable to determine why there was a shift after the freshman year possibly due to the small sample size.

Fanjoy and Gao (2011) administered the KLSI to 293 aviation students at a Chinese university and their findings were different from those of Kanske et al. Fanjoy and Gao (2011) identified "shifts from predominantly *assimilator* and *converger* learning styles towards *diverger* and *assimilator* learning styles, implying a developed preference for reflective observation over abstract conceptualization" (p. 57). This difference in learning styles found in Chinese students need to be considered in U.S. training programs that focus on this student population. Gao et al. (2013) conducted a similar study with Australian aviation students and had similar findings as Kanske who studied American students. The different findings between U.S., Chinese, and

Australian student preferences suggest that cultural backgrounds do influence student learning styles.

Fanjoy (2002) notes that a sequential and prescriptive aviation program presentation may not address all the cognitive needs of each student which makes it necessary for aviation training programs to consider all learning styles and avoid focusing on just a few. Fanjoy (2002) suggests that "flight faculty members must be sensitive to learning style differences among their student population as well as their own bias. Teaching methodologies should support and challenge individual learning styles through a varied instructional format. In addition, students should be appraised of the strengths and weaknesses associated with their preferred learning styles and the expected value of educational experiences that task their non-dominant areas" (p. 43).

Five Factor Model (FFM)

The Five Factor Personality Inventory is used by personality psychologists in the study of personality. The inventory is composed of the *extraversion*, *agreeableness*, *conscientiousness*, *neuroticism*/*emotional stability*, and *openness* factors (Ibrahimoglu et al., 2013). A review of the literature related to commercial pilot personality traits indicated that this group scored higher in *extraversion* and *conscientiousness* and lower in *neuroticism* (Chaparro et al., 2020). The two higher traits indicate that these individuals are focused on their external environment and thrive on the stimulation they receive in return. They are also purpose driven to accomplish a goal. The low *neuroticism* score is a strength because it indicates that they are less affected by negative events that may occur in their environment (Chaparro et al., 2020). Gao and Kong (2016), using the Australian Personality Inventory, a five-factor-type model of personality, found that student pilot personality scales were highest for *agreeableness* and *conscientiousness*. *Openness to experience* and *extraversion* were next, and *neuroticism* was last. The *agreeable* trait generally

means one has a more optimistic view about human nature and will get along with others. The *conscientiousness* trait exemplifies the desire to do well and usually indicate a high level of organization and efficiency. Low *neuroticism* shows that these student pilots were less anxious or worried and were able to cope with high levels of stress (Gao & Kong, 2016).

Gender

Gender and Learning Style

Karp et al. (2001) stated that "gender also plays an important role in learning success in the aviation classroom or on the flight line. Research has shown that women do not learn the same as men" (p. 93 as cited in Turney, 1995). Turney (1994), summarizing the work of Gilligan (1982), Belenky et al. (1986), Emanuel and Potter (1992), and Bannister (1990), noted that women preferred more collegial learning environments where participation was valued. She also noted that women thought in a manner that included interconnectedness among a variety of subjects instead of a more linear line of thinking that was limited in the relationships among topics (Turney, 1994). These findings indicate that gender considerations should influence curriculum development because of the way information is processed between genders. Individual personalities are influenced by a number of factors such as gender, religion, family, work history, socioeconomic class, and areas of specialization to name just a few. These factors also influence an individual's learning style and require further study.

Gender and Kolb LSI Results

Philbin et al. (1995) noted some interesting findings in their study of gender differences and learning styles which reenforces other findings that men and women do learn differently. They suggest that to try and match a Kolb Learning Style to higher education teachers, *assimilators* are best suited for academic careers according to Philbin et al. (1995). If this is true,

then it follows that a traditional approach to education would be an *assimilating* approach. According to Kolb, *assimilators*, who are a balance of Abstract Conceptualization and Reflective Observation, tend to prefer lectures, understand, and create theoretical models and work alone rather than be around people. Philbin et al. (1995) gave the Kolb LSI to a small group of males and females to identify dominant learning styles. These data suggest a difference between the gender's preferred learning styles. Males were identified as *assimilators* while females identified equally as *divergers* and *converger*s. In fact, females were very close to being balanced on all dimensions of the Kolb LSI. Males rated lowest on the *diverger* dimension, which was a strength for females. A secondary means of testing gender differences was the administration of twelve Educational Dialectic Questions to both males and females. These were forced-response questions with only two options for answers. The response to the question, "*Is 'concern for self' vs. 'concern for others' an issue in your educational decision making? Yes or No"* was notably different between males and females. Two-thirds of women answered this question "yes" while nearly two-thirds of the males answered "no" which corresponds with males identifying as *assimilators* on the Kolb LSI. One final attempt to identify a difference between males and females learning styles was the use of a subjective question. Each participant was asked *"How did your learning style 'fit' with your educational experience(s)?"* (Philbin et al., 1995, p. 489). Even though the findings were not statistically significant, more males did report that their learning style fit with their educational experience while more females reported just the opposite. It could be argued, given the sum of evidence presented, that the traditional approach to education favors male's learning styles more than it does for females. More research is needed to confirm this suspicion.

Emanuel & Potter (1992) agreed that there is a difference between male and female learning styles. They found that females were relaxed communicators who demonstrated communication styles that were friendly, attentive, impression leaving, and dramatic. In addition, they described women as more collaborative, participatory, and competitive than males. While not completely related to the previous research, the findings again demonstrate a difference between genders in learning styles.

Gender and VAK Results

Karp et al. (2001) pointed out that women need to master an entire concept before moving on to new information. They require a big picture approach to learning when compared to men. These findings suggest that women tend to be *global* thinkers in Felder and Soloman's learning style model.

Karp et al. (2001) found that collegiate men and women shared dominant learning styles when focusing on *visual*, *auditory*, and *kinesthetic* or *hands-on* preferences in learning. Both genders were nearly identical regarding a *hands-on* preference to learning which aligns with the *active* learning style from the ILS. In addition, men and women shared a secondary preference for *visual* learning and tertiary learning style of *auditory*. These findings suggest that classroom instruction should ensure these learning styles are used to engage both genders in the learning experiences. The *hands-on* approach to learning may be the least used in most classrooms for a variety of reasons but further research in this area may be needed. Unlike Karp et al. (2001), Mašić et al. (2020) found that female students scored higher on all three learning styles, *visual*, *auditory*, and *tactile*, than their counterparts.

Gender and ILS Results

Van Zwanenberg et al. (2000) found a difference on the ILS *visual-verbal* scale between male and female respondents. Their findings noted that females appeared to be less *visual* and more *verbal* than males. They also mentioned that females were under-represented in this study, but this may be because it is an engineering student sample which was a male-dominated field at the time. In general, research data are limited regarding gender and learning style preference but especially in this study.

Generational Characteristics

Generational theory suggests that each generation is shaped by its own social environment. Typically, generations are grouped into a range of birth years that are identified by a unique set of events that form shared ideas and beliefs (Williams et al., 2014). As a result, the generation develops a common stereotype that may or not actually be true to nature for all members of that group.

Generational differences have been the focus of several studies in a variety of disciplines. Robinson et al. (2012) found learning style preferences among different generations of nurses. They administered Kolb's Learning Style Inventory (KLSI) to 122 nurses which consisted mostly of Baby Boomer and Generation X nurses; however, the Silent and Millennial generations were represented. This study found that the entire sample favored the *diverger* followed by the *assimilator* learning styles. The preferred learning styles by generation that pertain to this study are shown in Table 10. Baby Boomer and Generation X shared *diverger* and *assimilator* as the top two learning style preferences and the small group of millennials each had a different learning style. The silent generation, which is not considered in this present study, was underrepresented in the Robinson et al. study and made little impact on the findings. Additionally, the millennial generation had the fewest of all the generations and little can be

learned from the data gathered by that group. Robinson et al. (2012) concluded that younger nurses display a learning style that is consistent with learning skills required at an academic institution, while the more experienced nurses can think more abstractly because of their experience, so they favor the *diverger* learning style. Recommendations from this study note that "nurse educators need to consider generational differences in learning style" (Robinson et al., 2012, p. 170) and understand that these generational considerations are guided by three factors: first is the level of education, second is the time since being in a formal education setting, and third is the amount of experience as a nurse (Robinson et al., 2012).

Table 10

Generational Learning Styles Among Nurses

Generation	*n*	Converger (%)	Diverger (%)	Assimilator (%)	Accommodator (%)
Baby Boomer	73	14.38	**38.60**	25.70	21.40
Generation X	40	17.90	**41.10**	28.20	12.80
Generation Y (Millennial)	3	**33.33**	**33.33**	**33.33**	0.0

Note. Adapted from "Generational Differences and Learning Style Preferences in Nurses from a Large Metropolitan Medical Center," by J. Robinson, M. Scollan-Koliopoulos, and M. Kamienski, 2012, *Journal for Nurses in Staff Development, 28*(4), p. 168. Copyright 2012 by Lippincott Williams & Wilkins.

Williams et al. (2014) studied the generational influences on learning styles for students enrolled in higher education online academic courses. Of the measurements instruments available, they choose the Felder and Soloman Index of Learning Styles (ILS) questionnaire. This tool identifies a learner's preference for receiving and processing information along four continuums: 1) Active-Reflective, 2) Sensing-Intuitive, 3) Visual-Verbal, and 4) Sequential-Global. Those who participated in this study were weighted more heavily in the Millennial group

followed by Generation X and then the Baby Boomer generation. The study found that Baby Boomers exhibited preferences toward Reflective, Sensing, Verbal, and Sequential learning styles. Generation X on the other hand showed a preference for Active, Sensing, Visual and Global learning styles. Lastly, Millennials (or Generation Y) favored Active, Intuitive, Visual and Global learning styles.

Tolbize (2008) documented that "the majority of Xers and Yers prefer to learn both *hard skills* and *soft skills* on the job, while the majority of Traditionals and Boomers, prefer to learn *soft skills* on the job, and learn *hard skills* through classroom instruction" (p. 7). *Soft skills* include like effective communication, being a team player, problem-solving or critical-thinking ability, and work ethic. In other words, they are not technical skills. *Hard skills* are the technical skills. These are the skills required to accomplish a specific task or job. Tolbize (2008) noted that when formal training is needed, *soft skills* are best taught using multiple modes of instruction. When it comes to teaching *hard skills*, "it may not be necessary to differentiate that type of training for workers of different ages" (Tolbize, 2008, p. 14).

McGlynn (2005) suggests that Millennial students gravitate toward group activity and incorporating group work in the curriculum will enhance the learning experience for this group of learners. She notes what Raines (2002) wrote in the book *Managing Millennials* that "these students appreciate teamwork, experiential activities, structure, and the use of technology" (p. 14). McGlynn (2005) maintains that successful teachers of millennial students focus on the psychosocial development of the students and the integration of cognitive theory into teaching practice.

Wilson and Gerber (2008), recommend that higher-education instructors consider the following when teaching Generation Y or Millennial students "1) strive for greater clarity in

course structure, assignments, and grading expectations; 2) provide significant opportunities for student initiative, participation and choice; 3) incorporate stress-reduction mechanisms; and 4) engage students in a significant, course-long conversation on the ethical dimensions of taking a college class" (p. 32).

Limited studies have been conducted trying to understand the emerging pilot workforce, specifically Generation Z, in the aviation industry. The medical field, nursing specifically, has taken a closer look at this generation and may help the aviation industry anticipate the learning styles of this new generation of aviation students who are about to enter the workforce. Chicca and Shellenbarger (2018) noted that this generation was truly a digital generation and as a result have "underdeveloped social and relationship skills and are at risk for isolation, insecurity, and mental health issues, such as anxiety and depression" (p. 181). They go on to say that Generation Z individuals have a limited attention span, bores easily, desire convenience, and immediacy. These students want practical and relevant information; however, they also 'desire learning that is individualized, immediate, exciting, engaging, technologically advanced, and visually based" (Chicca & Shellenbarger, 2018, p. 181). Other ways to engage these students include electronic learning materials and internet learning activities since they learn best by viewing images as opposed to solely reading text. Chicca and Shellenbarger (2018) suggest that "classrooms may need to shift from dissemination of information to a focus on more learning that is self-directed, individualized, or project based" (p. 181). They add that this generation prefers active, learner-centered, immersive, multidimensional approaches to learning. Finally, Chicca and Shellenbarger (2018) point out that Generation Z students want teachers to listen to and consider their ideas and perspectives, as well as involving them in decision-making. These are traits characteristic of an adult learner who is self-directed.

Seemiller et al. (2019) compared the learning methods and styles of Generation Z student in the United States and Brazil. Learning method is how student engage learning material while learning style is how they take in and process information. The top three learning methods for both groups were: 1) *intrapersonal*, 2) *Kinesthetic*, and 3) *logical-mathematical*. The four learning styles identified ranked the same for both groups however, the U.S. students were significantly higher in the first three styles. They ranked as follows: 1) *Logic*, 2) *Experience*, 3) *Practicality*, and 4) *Imagination*. The low ranking of imagination may support the eroding critical thinking skills identified by Hampton et al. (2019). Seemiller et al. (2019) explain that *logic* refers to clearly defined and spelled out instructions and a logical and organized path to learning. The emphasis on clarity may relate to this generations desire to meet expectations. *Experience* relates to the kinesthetic method of learning. This generation learns best when they are hands-on and can engage the material. Seemiller et al. (2019) noted that creativity has risen since 2015 from the tenth most essential career skill to the third most essential career skill meaning that this generation of students will require assistance with creative thinking.

More recently, Hampton et al. (2019), in addition to the findings of Chicca and Shellenbarger (2018), have noted a few other characteristics of Generation Z. They point out that the convivence of technology and the ability to find an answer quickly, critical thinking skills and an understanding of the information is eroding. This generation prefers to learn independently but also enjoys group work. They do not like being "lectured at" and want to be involved in learning. Generation Z students expect that the information presented is practical and useful for real world application. Hampton et al. (2019) identified the preferred and most effective teaching methods for this generation are: 1) Lecture with audience response clickers, 2) Lecture, 3) Video or audio-enhanced PowerPoint presentations, 4) Simulation, and 5) Case

studies. Student preferred the traditional classroom to the flipped classroom, visual followed by active learning methods of teaching, and traditional lectures enhanced with video and audio. The least preferred was reading assignments (Hampton et al., 2019).

Niemczyk (2020) focuses this research effort specifically on Generation Z. She highlights that "neuroscience research has shown that the availability and rapid delivery of digital information has caused the brains of Gen Z members to develop differently than the brains of individuals in previous generations" (p. 121). With this in mind, it is critical that educators understand how Generation Z students learn best and develop curriculum that accommodates the learning preferences associated with this group. Niemczyk (2020) points out that most Generation Z students rely on memorization as their primary learning strategy possibly because access to information is so readily available electronically. She notes that the information stored is only placed into short-term memory but needs to be put into long-term memory to be effectively used in the future. Generation Z lacks an effective learning strategy, and she recommends using "the 4 As of learning." Niemczyk (2020) notes that successful learners will *actively* engage with the material they are presented with and try to *associate* the new information with what is already known. Once this is done, then they will be able to *anticipate* how this new information can be used in the future. Lastly, an *awareness* is created that enables learners to know if they are learning or not learning the material under examination.

Niemczyk (2020) points out that members of Generation Z have a strong desire to be *actively* engaged in the educational process which may not fit in traditional educational settings. She suggests that teachers utilize a distributive learning strategy where students are required to learn a little bit every day, eliminating the practice of cramming at the last minute which is characteristic of this generation. Generation Z students require some assistance with *associating*

new material with what is already known, therefore teachers should employ association strategies when introducing new material which will facilitate the learning process. Generation Z students *anticipate* using new information learned, so it becomes necessary for educators to make the new information personal, relevant, and contextual as quickly as possible. If these students can imagine the use of this new information in a future career goal it becomes more meaningful and promotes learning. The idea of lifelong learning can be enhanced through helping Generation Z individuals become metacognitive of their learning. Niemczyk (2020) says this "starts with focusing on the learning objectives, assessing whether they have any prior knowledge of the knowledge and skills, evaluating the learning strategies they should use, and determining whether their study process is effective" (p. 129).

Since workplace environments can contain multiple generations of employees, Urick (2016) recommended three training initiatives that would be best suited for the majority, if not all workers. First, offer different formats for personnel to choose from. Second, examine the different forms of training to see which forms can be combined to meet the preferences of the work force. And third, examine the outcome of the training to see if this approach even works and adjust future training on what is discovered.

Clark (2001) contended that cooperative educational techniques are required to ensure today's students become achieving learners and that cooperative education in the classroom has a practical application in teamwork. He insisted that "these learners tend to be very competitive, with egos that can only be satiated by a higher standard of learning" (p. 29).

Clark (2001) claimed that "cooperative education…is more suited to the aviation industry because pilots will be dealing with others throughout their entire careers – specifically, through Crew Resource Management (CRM)" (p. 30). Clark (2001) also advised that student pilots who

work cooperatively will learn critical skills need to success in the airline industry. These students will learn more in a shorter period of time and enhance their social and teamwork skills. In addition, Clark (2001) maintained that students who embrace teamwork will help the individuals who are not comprehending the material quite as quickly as the rest of the group. There is a dynamic in groupwork that creates synergy and makes everyone better.

Clark (2001) noted that cooperative education methodologies were best suited for the aviation industry because pilots would be working closely with others, specifically through Crew Resource Management (CRM) (p. 30). Cooperative education in the classroom is known to promote teamwork and create deeper learning which benefits aviation students. Clark's study was aimed at transitioning the college student's pedagogical mindset, where the student followed the directions of the teacher and critical thinking was not required, to an andragogical mindset where critical thinking and autonomy were encouraged. Clark (2001) contended that "when they learn together, student aviators acquired more information and skills in a shorter time while enhancing social skills and developing teamwork skills, all of which are important for successful candidates in the airline industry" (pp. 30-31). While this information is helpful for generations Y and Z, little is known about how generation X and Baby Boomers learn best. This knowledge could be used to assist in the development of new training for experienced pilots.

Niemczyk and Ulrich (2009), in a study of 290 aviation personnel, identify that Millennials, or Generation Y, were the first generation accustomed to a wide range of technologies that provided unprecedented freedoms and access to information instantaneously. They also note that this generation is very self-confident which is sometimes mistaken as entitled. This generation is accustomed to receiving praise no matter the performance level and having parents who were involved in their daily lives more than previous generations (Niemczyk

and Ulrich, 2009). In the educational environment, teachers must understand the emotional needs and expectations of these students to facilitate a more productive learning experience.

Generations and Technology

Baby Boomers have been forced into a world of advanced technology where some choose to adapt while others resist learning what is needed to survive effectively. To some extent Generation X has grown up with technology and can navigate their world more comfortably than Baby Boomers when it comes to using this technology. Generations Y (Millennials) and Z have only known a world that is replete with technology. The assumptions that resulted from this dynamic are that Millennials and Generation Z adapt more easily to technological advances and their use in the educational environment than do Boomers and Gen Xers. Thompson (2013) used the term 'digital native' that was coined by Prensky in 2001. What is captured in this new term is the fact that Generations Y and Z have grown up in a digital world and as such will function more effectively in that world. In fact, many assumptions have been made to say those who did not grow up in the digital age will have a difficult time with the new technologies and the advances in education they bring. At the other extreme are those who say that digital natives cannot function without their technological devices and experience more stress when they are deprived of them. Thompson (2013) found that digital natives were more aware of the advantages and disadvantages of technology than they had been given credit for. In fact, the participants were able to be more situation specific about the appropriate use of technology in their daily lives.

Lester et al. (2012) examined the actual versus perceived generational differences that exist in the workplace. They examined five different areas where generational differences emerged as actually making a difference: 1) email communication, 2) social media, 3) fun at

work, 4) continuous learning, and 5) professionalism. The first two areas fit into the technology category and are examined more closely, as will continuous learning. It was discovered in this study that Generation Y placed more emphasis on continuous learning than originally thought. Older generations first believed that Generation Y beliefs about continuous learning was contrary to the findings in this study. The research also found that Baby Boomers placed a greater value on technology that the other generations attributed to them (Lester et al., 2012). From these findings, it appears that there may be fewer actual differences among the generations than what was once perceived. Macky et al. (2008), when examining the generational differences at work concluded that "there may be more variation among members within a generation that there is between generations" (p. 860). Troester (2018) sees collaborative learning, virtual reality, and gamification as training formats that will best prepare Generation Z for the future job market but makes no mention of the other generations. Berge and Berge (2019) concluded their study by noting "there may be differences in people's work attitudes, behaviors, and values across generations, but there are more important commonalities across the generations than differences" (p. 50). Lai and Hong (2014) examined the relationship between technology use and learning characteristics across generations of higher education students. They concluded that, even though Generation Y is constantly in touch with technology, how they use it is not the same for all. Lai and Hong (2014) did not find anything that would support a unique learning style for the current generation of young people.

Urick (2016) examined how modifying technological training practices in the workplace might appeal to generations differently and enhance the training environment. He suggested these three recommendations:

1. Offer different formats of training as options for all employees, regardless of age.

2. Examine the optimal combination of different forms of training and development in light of trainees' preferences.

Examine the outcomes of training to establish whether this more-tailored style of training results in training being more effective. (pp. 57–58)

Curriculum Design and Delivery

Williams et al. (2014) contended that knowing student learning styles and teaching strategies that complement the learning styles is not enough. They argued that the classroom is a dynamic and changing environment which requires the instructional approach to be adaptable as well. Instructional designers are continually challenged to develop curriculum that matches student learning styles and technological advances. Instructors also need to be aware of modern teaching methodologies that ensure effective content delivery. "The large educational gain associated with these diverse generational groups comes when new technologies are combined with new ways of teaching" (Williams et al., 2014, p. 46). Dunn et al. (1989) suggested that understanding student learning styles informs how the learning environments can be improved. Classroom lighting, temperature control, sound proofing, seating arrangement flexibility, and space for group work are other items that complement the learning environment to make the learning experience better. Dunn et al. (1989) asserted that educators should also be more aware of patterns where people learn best – alone, in groups, with certain teacher-types, and specific combinations of any of these. Felder and Silverman (1988) noted that, like learning styles, teaching may be defined in terms of the answers to four questions:

1. What type of information is emphasized by the instructor: *concrete* – factual, or *abstract* – conceptual, theoretical?

2. What mode of presentation is stressed: *visual* – pictures, diagrams, films, demonstrations, or *verbal* – lectures, readings, discussions?
3. What mode of student participation is facilitated by the presentation: *active* – students talk, move, reflect, or *passive* – student watch and listen?
4. What type of perspective is provided on the information presented: *sequential* – step-by-step progression (the trees), or *global* – context and relevance the forest)?

Felder and Silverman (1988) suggest teaching styles that correspond to the preferred learning style, see Table 11, that educators can use to enhance the learning experience.

Table 11

Modified Dimensions of Learning and Teaching Styles

(Modified) Dimensions of Learning and Teaching Styles			
Preferred Learning Style		*Corresponding Teaching Style*	
Sensory Intuitive	Perception	Concrete Abstract	Content
Visual Verbal	Input	Visual Verbal	Presentation
Active Reflective	Processing	Active Passive	Student Participation
Sequential Global	Understanding	Sequential Global	Perspective

Note. Adapted from "Learning and Teaching Styles in Engineering Education," by R.M. Felder and L.K. Silverman, 1988, *Engineering Education*, *78*(7), p. 675.

The aviation industry is at a point in history where another look at the pilot training process is needed. Generational, gender, and ethnicity diversity on the flight deck may require a modification to the way pilots are trained. Advanced technology, and the ability to adapt to the demographic groups previously mentioned needs to be examined. The discoveries from further investigation may yield great advances in performance and efficiency on the flight deck. The

future of the aviation industry is exciting, and it is time to make sure that all is being done to seize the opportunities of moment that is here.

Chapter 3

Methods

Introduction

Changes in the airline industry, because of the COVID-19 pandemic, mandatory retirements, airline expansions, and other factors created challenges in airline training departments (Boeing, 2020; FAA, 2009; FAA, 2020a). Some of the challenges brought on by these changes are a younger pilot population than before and the training of new instructors to keep us with the demands on training and re-training. With the presence of four generations and a more diverse complement of pilots comes different life experiences and individual learning preferences, training organizations must adapt to these unique training challenges. Understanding these challenges will bring clarity in how to move forward in the training process.

Purpose of the Study

The purpose of this quantitative correlational study was to examine the learning styles of pilots versus non-pilots, generational similarities and differences, and gender differences in learning styles among the pilot group. This study addressed the development of commercial pilot training curriculum and instructional styles. An understanding of learning styles that are thought to be unique to pilots will guide how curriculum is developed. It identified the best approach, pedagogical or andragogical or a combination of the two, when designing training curriculum, as well as training the instructors who will deliver the training. The findings also identified the best use of current technology in the learning process and highlighted the possible advantages and disadvantages for the given generational differences that currently exist in the commercial aviation industry pilot population. The goal was to build training programs that best suit how pilots learn. Despite the severe negative impact COVID-19 has had on the commercial aviation

industry, this period of reduced airline activity and pilot hiring may provide researchers an unexpected opportunity to identify ways to ensure the impeccable safety record enjoyed by the commercial aviation industry is not impacted. The end of the pandemic is hopefully in sight and the airlines are preparing to resume normal operations in this new paradigm of commercial aviation operations.

Research Questions

1. What is the relationship of pilot status, gender, and generation on learning styles?
2. What is the relationship of gender on learning styles for pilots?
3. What is the relationship of generation on learning styles for pilots?

Research Design

The survey design was used for this study. It was administered to a population sample of non-pilots and pilots in a variety of career fields. The survey sought to obtain data that might identify unique learning preferences for a non-pilot and a pilot. In addition, in the pilot category, this survey would reveal learning styles or preferences that may vary by gender and generation. Because the lifestyle of the target audience is hurried, the Felder and Soloman Index of Learning Styles (ILS) with the demographic questions was used because the time required to complete the survey is less than 10 minutes. Revilla and Ochoa (2017) found that the ideal survey length permitted the participant to complete the survey within 10 minutes and would increase participation rates. The online Qualtrics survey design was cost effective and easily accessible by participants. This survey design also made data collection, interpretation, and protection of the data easier to accomplish.

Data Collection and Instrumentation

This quantitative correlational research study used a Qualtrics online survey that included demographic questions and the Felder and Soloman Index of Learning Styles (ILS) questionnaire (Appendix A). The demographics collected included gender, ethnicity, race, birth year, educational level, student status, higher education institute attending, major or area of study, FAA certificated status, FAA certificates and ratings held, total flight hours, FAA instructor status, FAA instructor certificates held, total instructor hours, employment status, and place of employment. Some of the requested data was specifically tailored for the four airlines invited to participate but was not used since none of the airlines chose to participate. The remaining demographic items were used to answer the research questions and provided information about where further research might be needed. A review of the literature indicates that the Index of Learning Styles questionnaire has not been used to understand the learning preferences of aviation professionals. This ILS questionnaire was comprised of concepts from the Myers-Briggs Type Indicator, the Kolb Learning Styles Inventory, Modality Theory, and the sequential/global subscale from Silverman, Gregorc, and Pask (Felder, 2020) and its comprehensive nature was appropriate for this study. The ILS questionnaire consisted of 44 forced-choice questions that identified an individual's learning style or learning preference on each of the four continuums measured. Litzinger et al. (2007) describe the Index of Learning Styles (Felder & Soloman, n.d.) instrument as "an online questionnaire designed to assess preferences on four dimensions…. The ILS consists of four scales, each with 11 items: sensing-intuitive, visual-verbal, active-reflective, and sequential-global" (p. 310).

Sampling

The three variables of interest for this study included individuals represented in the FAA pilot certification (i.e., yes or no), gender (i.e., male or female), and generations (Baby Boomer, Generation X, Generation Y or Millennial, and Generation Z) categories and were found in the research sample group. The sampling frame in the original design consisted of four institutions of higher education who also had an aviation training program, as well as four major U.S. commercial airlines, however, three of the four universities and none of the airlines chose to participate. In response to loss of participants from the anticipated airline pilot population, specific social media platforms (i.e., LinkedIn, Facebook, blogs, websites) were chosen that could increase sample for this study.

Higher Education Participants

Students from Auburn University College of Liberal Arts, which includes the Department of Aviation, Middle Tennessee State University Department of Aviation, Hampton University Department of Aviation, and Liberty University School of Aeronautics were invited to participate in this study (see Appendix C). The university programs that accepted the invitation were Auburn University, Middle Tennessee State University, and Liberty University. These higher education institutions also have approved Federal Aviation Administration Part 141 flight training programs and share common training curriculum and methodologies. All three institutions were able to provide non-pilot, pilot, male, female, and at least one of the generations under investigation.

Airline Participants

Four commercial airline companies were invited to participate; however, none chose to participate. The main reason for non-participation by the airlines was lack of time to coordinate

approvals by both the airline organization and the pilot unions. One airline, however permitted the *email invitation for online survey* (Appendix C) to be posted on an internal discussion board that company pilots had access to, but neither the airline nor the union endorsed the research project. Unfortunately, this airline was unable to post the *email invitation for online survey* (Appendix C) during the timeframe the survey was open. As a result of these primary groups electing not to participate, social media sites were used to solicit participation.

Social Media Participants

The social media platforms selected included LinkedIn, Facebook, Flight to Success blog by Karlene Petitt, and the Flight Safety Information newsletter by Curt Lewis & Associates, LLC. On the LinkedIn platform, the researchers personal page, Karlene Petitt, Ph.D., MBA, MHS, and The Strike Eagle Network pages were selected to distribute the *social media invitation for online survey* (Appendix D) which also include the link to the survey. The Facebook pages used to invite participation included the researchers personal page, Female Aviators Sticking Together, The Pilot Network, and Widget Pilots. Finally, the Flight to Success blog by Karlene Petitt, and the Flight Safety Information newsletter distributed by Curt Lewis & Associates, LLC participated by posting the *social media invitation for online survey* (Appendix D) for the survey through their respective mediums. This later addition of the social media outlets to the participant groups impacted the need to extend the time period that the survey remained open but increased the number of participates and provided more data to help answer the research questions.

Invitation to Participate

Each of the groups was sent an invitation to participate in the research effort. The higher education institutions and airlines were sent the approved *email invitation for online survey*

(Appendix C) wording and survey link to email members within their organization. For social media platforms, the researcher and select representatives for each of the other social media sites were sent approved alternate *social media invitation for online survey* (Appendix D) and survey link to solicit responses. Most of the social media pages selected to post the invitation were geared toward an aviation audience due to an affiliation or familiarization of the researcher with the sites selected.

This survey was opened approximately six weeks after the fall semester began so university students who were invited to participate were less likely to ignore the email invitation or choose not to participate because of the number of activities that generally happen at the beginning of each semester. The survey was open for four weeks, approximately ten days longer than originally planned, to allow participation opportunity for those who accepted the invitation. Some universities needed more time to send out the invitations due to local approval processes. Another reason that the deadline was extended was on the need to solicit additional participants due to airline non-participation. The time to recruit their participation was underestimated and not able to be accommodated in the available timeframe. This extra ten days did allow for more data to be collected.

The Qualtrics online survey began with an *Information Letter* (Appendix E) containing greater detail about study participation. Participants were informed of the voluntary nature of participation, any risks or discomforts, benefits to participant or others, compensation or costs for participation, ability to withdraw at any time by closing the internet browser, and the protection of privacy because of no personal data being gathered, as well as no IP addresses being captured. This information is required for Human Subject research guidelines. Each participant was required to consent to voluntary participation by selecting an *agree* button which provided access

to the survey. Lastly, researcher contact information was provided in the event the participant needed ask for additional information.

Each of the final target audiences (universities and social media) were able to solicit participation from the non-pilot and pilot groups, the four generational groups, and both gender groups providing data to answer each of the research questions. The minimum desired sample size was 400, 50 participants in each of the target groups (non-pilot, pilot, male, female, Baby Boomer, Gen X, Gen Y, Gen Z).

Data Analysis

Non-probability convenience and snowball sampling were used to collect data for this research effort that used an online anonymous Qualtrics survey. Survey data were collected and analyzed using IBM SPSS Statistics, Version 27 (V27). Consistent with Williams et al. (2014), the research questions for this study analyzed data using descriptive statistics and multivariate analysis of variance (MANOVA). Descriptive statistics were used to describe the participants in the study. A MANOVA was used to determine participant learning styles by pilot qualifications, gender, and generation. Finally, the "Chi-square tests for independence were used to measure demographic variables of gender, race/ethnicity, and differences in preferred learning style distributions among and between the generational cohort groupings" (Williams et al., 2014, p. 37). Tests performed on the reliability of the Index of Learning Styles (Felder & Soloman, n.d.) using a Cronbach's alpha by Felder and Spurlin (2005), as well as Cook (2005), support the instrument's internal consistency. This study attempted to identify learning styles or preferences that may be unique for each of the groups identified.

The independent variables in this study included the generational demographics as determined by the reported age of the respondent, the gender identification as reported by each

respondent, and the pilot qualification of each respondent as revealed during survey completion. The dependent variables included the placement on each of the four different learning scale continuums (Active-Reflective, Sensing-Intuitive, Visual-Verbal, Sequential-Global) as identified in the Felder and Soloman Index of Learning Styles (ILS) (Felder & Soloman, n.d.) questionnaire. To determine the generation of each respondent, this study placed each participant in one of the following categories based on reported age; Generation Z (born between 1997 and 2012); Millennials or Generation Y (born between 1981 and 1996); Generation X (born between 1965 and 1980), and Baby Boomers (born between 1946 and 1964). The ILS assessed eight learning style criteria, measured in opposing pairs on four dimensions. To determine if there were significant differences in learning styles and preferences based on non-pilot/pilot, generation assigned, and gender, a MANOVA was conducted. For significant differences and heterogeneity of variances, post-hoc tests were used to determine in which pilot qualification, assigned generation, and gender the differences reside. A factorial ANOVA was conducted to determine if differences existed in style preference based on the combination of generation assignment and gender. Coding on the Qualtrics survey was done as follows: Gender: 1-Male, 2-Female, 3-Other or Non-Binary, and 4-Prefer not to answer; Pilot: 1-Yes and 2-No; and Generation by birth year given and recoded for each of the four generations: 1-Baby Boomer, 2-Generation X, 3-Generation Y or Millennial, and 4-Generation Z. The ILS questionnaire consisted of 44 forced-choice questions where 11 questions per scale were designed to show a learning preference on each scale. A score of 1 was the minimum score and an 11 was the maximum score on each scale. The ILS was designed so that all (a) answers refer to the Active, Sensing, Visual and Sequential questions, and all (b) answers refer to the Reflective, Intuitive, Verbal, and Global questions. As an example, if a participant answered (a) on nine out of eleven

on the visual-verbal questions, then (b) was selected on the remaining two questions. To determine the participant's preference on the visual-verbal scale the two score would be subtracted from the nine score and the balance of seven would fall to the visual scale. Therefore, this individual's preference would then be a moderate visual learning style. Since the ILS reports style preferences based on the difference between the scores on each scale, a category was created for each of the eight learning styles in Qualtrics and all (a) answers were coded as 1 and (b) answers were coded as 0 for Active, Sensing, Visual, and Sequential questions. All (a) answers were coded as 0 and (b) answers were coded as 1 for Reflective, Intuitive, Verbal, and Global questions. To determine a preference on each scale, compute variable was configured in SPSS to subtract results of all (b) answers from results of all (a) answers. If the result was a positive number, then the preference is for the Active, Sensing, Visual, and Sequential learning style. If the result was a negative number, then the preference is for the Reflective, Intuitive, Verbal, and Global learning style. This configuration will ensured that all MANOVA assumptions of variance and covariances were properly met.

Limitations

The population and sample selection consisted of participants who may have had more familiarity with the aviation industry, which could have influenced the non-pilot/pilot results. It is not known if surveying a broader population (i.e., an entire university, non-aviation industry organizations, international populations) might produce different results.

Not enough time was allocated to gain airline and pilot union approval to distribute the invitation to participate in the research survey. Another aspect that should be included in the planning process is to allow enough time needed for any legal disclaimers to be crafted and signed allowing for distribution of the survey to the potential participant pool.

The target populations for this study were FAA certificated pilots and non-pilots. Within these two groups, both gender and generational classification were examined. The survey instrument did not allow for military or internationally certificated pilots to be identified in the pilot group if they did not also contain an FAA pilot certificate. If they answered the questions as written and intended, their data would have been captured in the non-pilot group. However, if they more broadly interpreted the FAA pilot certificate question and answered yes, then their data would have been captured in the pilot population. There is no way to identify either of these two scenarios because the survey did not allow for those options and were not intended to be in the participant population.

The non-pilot samples were gathered from populations with greater familiarity with the aviation industry except for the Auburn University College of Liberal Arts students not enrolled in the Department of Aviation. This assumption was solely based on the major selected and may not be entirely true. All social media sites used had a connection to the aviation industry in some way. The LinkedIn and Facebook pages targeted for inviting participants were all pilot or pilot group oriented and the newsletters, websites, and blogs were those of prominent influencers direct their content to the pilot population.

The Index of Learning Styles questionnaire identifies an individual's learning preferences but may not reflect the styles in which the individual best learns. Pilot education takes place in both an academic setting (i.e., classroom) as well as a non-academic setting (i.e., flight training device or airplane). Each of these learning environments utilizes an individual's senses in different manners. Some individuals may prefer a verbal method for an academic environment but use a visual style in the airplane or training device. One other unaccounted for aspect of aviation training is the time factor. Many flight situations require timely decisions. Global

learners may sometimes need an extended period of time to arrive at a preferred decision. In a time restricted circumstance an individual who prefers a global learning style may have to use a sequential style to adapt.

The non-participation of originally identified airlines may limit data collection in underrepresented demographic and generational category participation. The choice of social media platforms and pages was meant to offset this limitation. More than 70% of the participants were identified as non-university students which suggests that social media solicitation was potentially successful.

The assumption of no multicollinearity is only partially met which suggests that the MANOVA be abandoned in favor of multiple factorial ANOVAs while using a correction to protect against Type I errors. However, since the outcome variable are subscales from the same instrument, the MANOVA was utilized to learn which subscales matter for different groups recognizing a vulnerability for Type II errors.

Summary

This study determined the extent to which relationships exist in learning styles between non-pilots and pilots, between gender groups, and among the different reported generations. A Qualtrics online survey was the instrument used to collect data were demographic information and the Index of Learning Styles (Felder & Soloman, n.d.) questionnaire provided the data needed to examine the desired relationships. A comparison to previous studies using other learning style tools (e.g., Kolb LSI and MBTI) can be done with the findings of this study which used the ILS.

Research Question Matrix

Research Questions	Survey Instrument Used to Address Question	Analysis of the Data
What is the relationship of pilot status, gender, and generation on learning styles?	Questions 1-44, +61	- Descriptive statistics – *N*, min, max, mean, standard deviation. - Distribution – skew and kurtosis - Multivariate normality - Multicollinearity - Linear relationship - Homogeneity of variance-covariance matrices - Homogeneity of variance - Estimates of effect size - MANOVA - Post Hoc
What is the relationship of gender on learning styles for pilots?	Questions 1-44, +55	- Multivariate normality - Multicollinearity - Linear relationship - Homogeneity of variance-covariance matrices - Homogeneity of variance - Estimates of effect size - MANOVA - Post Hoc
What is the relationship of generation on learning styles for pilots?	Questions 1-44, +52	- Multivariate normality - Multicollinearity - Linear relationship - Homogeneity of variance-covariance matrices - Homogeneity of variance - Estimates of effect size - MANOVA - Post Hoc

Chapter 4

Findings

Introduction

The challenges of educators have not become easier over time but instead have become more difficult with the shifting sands of student demographics, teaching methodologies, technology advances, and much more (Felder, 1998; Knowles, 1980; OCED, 2021; Schaffernak et al., 2020). The commercial aviation industry has been challenged with four generations of pilots that are becoming more diverse while operating technologically advanced aircraft in airspace that is more complex than ever (Federal Aviation Administration [FAA], 2020b; AA, 2020c; United Airlines, 2021). This study hoped to increase understanding on how to best teach the student to a level where critical thinking skills need to be highest. This chapter presents the findings of the online Qualtrics survey. Data regarding the research questions are presented and were analyzed using the IBM SPSS® statistical system (V27) for computing the numerical values indicated.

Purpose of the Study

The purpose of this quantitative correlational study was to examine the learning styles of pilots versus non-pilots, generational similarities and differences, and gender differences in learning styles among the pilot group. This study addressed the development of commercial pilot training curriculum and instructional styles. An understanding of learning styles that are thought to be unique to pilots will guide how curriculum is developed. It identified the best approach, pedagogical or andragogical or a combination of the two, when designing training curriculum, as well as training the instructors who will deliver the training. The findings also identified the best use of current technology in the learning process and highlighted the possible advantages and

disadvantages for the given generational differences that currently exist in the commercial aviation industry pilot population. The goal was to build training programs that best suit how pilots learn. Despite the severe negative impact COVID-19 has had on the commercial aviation industry, this period of reduced airline activity and pilot hiring may provide researchers an unexpected opportunity to identify ways to ensure the impeccable safety record enjoyed by the commercial aviation industry is not impacted. The end of the pandemic is hopefully in sight and the airlines are preparing to resume normal operations in this new paradigm of commercial aviation operations.

Research Questions

This study was guided by the following research questions:

1. What is the relationship of pilot status, gender, and generation on learning styles?
2. What is the relationship of gender on learning styles for pilots?
3. What is the relationship of generation on learning styles for pilots?

Organization of Data Analysis

This study utilized an online Qualtrics survey to collect the necessary demographic and learning style data to answer the research questions for this research effort. Specific demographic data included pilot status, pilot gender, and pilot generation affiliation which were the independent variables in this study. Learning style preference data on each of four scales were determined from the results of the Felder and Soloman Index of Learning Styles questionnaire responses. Each of the four learning style scales were dependent variables. Descriptive statistics for the study population are presented first followed by testing assumptions, MANOVA findings, and post hoc analysis for each of the research questions.

Demographic Data

The invitations were extended to three institutions of higher education and published on three LinkedIn pages, one widely circulated aviation newsletter, one well-known aviation blog, and four Facebook pages. The total number of possible participants was not known, but each outreach option consisted of non-aviation and aviation individuals, male and female participants, and five generations of followers.

Nine hundred forty-seven began the survey; however, only 706 completed the survey for a total survey completion rate of 74.6%. Almost three quarters of the sample were males (*N* = 519, 73.5%). Two percent (*N* = 14) of the sample were classified as belonging to the Silent Generation, while the rest of the sample were fairly evenly split across the other four generations (see Table 12). Three-quarters of the sample were pilots (*N* = 534, 75.6%). Most participants were not Hispanic (*N* = 660, 93.5%), and described their race as White (*N* = 624, 88.4%). A little over three quarters of the sample had a bachelor's degree or higher (*N* = 537, 76.1%). Most of the participants were not university students at the time of the survey (*N* = 503, 71.2%).

Males made up 79.25% of pilots, while only 20.8% of pilots were females. 81.5% of all male participants were pilots, while only 59.4% of all female participants were pilots (see Table 14). Over half of the sample was comprised of male pilots (59.9%). The mean age for the entire sample was 42 years (*SD* = 17.75). Means, standard deviations, skewness, and kurtosis of the continuous study variables for all participants are presented in Table 15. Descriptives for learning styles broken down by pilot status are presented in Table 16, gender in Table 17, and by generation in Table 18. Tables 19 and 20 present Descriptives of Pilot Certificate and Pilot Generation by Gender respectively.

Table 12

Frequencies of Categorical Study Variables

Variable		Total	
		N	%
Gender	Male	519	73.5
	Female	187	26.5
Generation	Silent	14	2.0
	Baby Boomer	172	24.4
	Generation X	152	21.5
	Generation Y	186	26.3
	Generation Z	182	25.8
Pilot	Yes	534	75.6
	No	172	24.4
Instructor	Yes	250	35.4
	No	283	40.1
Ethnicity	Hispanic/Latino	31	4.4
	Not Hispanic	660	93.5
	Prefer not to answer	15	2.1
Race	White	624	88.4
	Black	18	2.5
	American Indian	2	0.3
	Asian	24	3.4
	Native Hawaiian	2	0.3
	Other	222	3.1
	Prefer not to answer	14	2.0
Education	High school	26	3.7
	Some college	114	16.1
	Associate's	29	4.1
	Bachelor's	288	40.8
	Master's	191	27.1
	Doctoral	41	5.8
	Professional	17	2.4
University Student	Yes	203	28.8
	No	503	71.2

Table 13

Frequency of Pilot and Instructor Certificate Types

Variable		Total	
		N	%
Pilot Certificates			
Student	Yes	39	5.5
	No	667	94.5
Private	Yes	190	26.9
	No	516	73.1
Instrument	Yes	255	36.1
	No	451	63.9
Commercial	Yes	252	35.7
	No	454	64.3
ATP	Yes	254	36.0
	No	452	64.0
Other	Yes	83	11.8
	No	623	88.2
Instructor Certificates			
CFI	Yes	216	30.6
	No	490	69.4
CFII	Yes	211	29.9
	No	495	70.1
MEI	Yes	141	20.0
	No	565	80.0
AGI	Yes	87	12.3
	No	619	87.7
IGI	Yes	61	8.6
	No	645	91.4
Other	Yes	14	2.0
	No	692	98.0

Note. ATP = Airline Transport Pilot, CFI = Certificated Flight Instructor, CFII = Certificated Flight Instructor – Instrument, MEI = Certificated Flight Instructor – Multiengine, AGI = Advanced Ground Instructor, IGI = Instrument Ground Instructor.

Table 14

Pilot by Gender Breakdown

			Gender		
			Male	Female	Total
Pilot	Yes	Count	423	111	534
		% w/in Pilot - Yes	79.20%	20.80%	100.00%
		% w/in Gender	81.50%	59.40%	75.60%
		% of Total Participants	59.90%	15.70%	75.60%
	No	Count	96	76	172
		% w/in Pilot - No	55.80%	44.20%	100.00%
		% w/in Gender	18.50%	40.60%	24.40%
		% of Total Participants	13.60%	10.80%	24.40%
Total Participants		Count	519	187	706
		% w/in Pilot	73.50%	26.50%	100.00%
		% w/in Gender	100.00%	100.00%	100.00%
		% of Total	73.50%	26.50%	100.00%

Table 15

Descriptives for Continuous Study Variables for Entire Sample

Variable	*N*	Min	Max	*M*	*SD*	Skew		Kurtosis	
						Stat	SE	Stat	SE
Total									
Age	706	18	86	41.996	17.748	0.332	0.092	-1.149	0.184
ACTREF	706	-11	11	0.555	4.791	-0.091	0.092	-0.525	0.184
SENINT	706	-11	11	4.023	5.371	-0.746	0.092	-0.103	0.184
VISVER	706	-9	11	5.734	4.379	-0.866	0.092	0.188	0.184
SEQGLO	706	-11	11	0.544	4.416	-0.189	0.092	-0.406	0.184

Note. ACTREF = ILS questionnaire Active-Reflective scale, SENINT = ILS questionnaire Sensing-Intuitive scale, VISVER = ILS questionnaire Visual-Verbal scale, and SEQGLO = ILS questionnaire Sequential-Global scale.

Table 16

Descriptives of Learning Styles by Pilot Status

Scales	Gender	*N*	Min	Max	*M*	*SD*	Skew		Kurtosis	
							Stat	SE	Stat	SE
ACTREF	P	534	-11	11	0.745	4.813	-0.133	0.106	-0.482	0.211
	NP	172	-9	11	-0.035	4.687	0.031	0.185	-0.590	0.368
	Total	706	-11	11	0.555	4.791	-0.091	0.092	-0.525	0.184
SENINT	P	534	-11	11	4.450	5.273	-0.868	0.106	0.217	0.211
	NP	172	-11	11	2.698	5.472	-0.432	0.185	-0.645	0.368
	Total	706	-11	11	4.023	5.371	-0.746	0.092	-0.103	0.184
VISVER	P	534	-9	11	6.229	4.104	-0.998	0.106	0.606	0.211
	NP	172	-9	11	4.198	4.840	-0.460	0.185	-0.530	0.368
	Total	706	-9	11	5.734	4.379	-0.866	0.092	0.188	0.184
SEQGLO	P	534	-11	11	0.611	4.451	-0.204	0.106	-0.357	0.211
	NP	172	-11	9	0.337	4.310	-0.152	0.185	-0.554	0.368
	Total	706	-11	11	0.544	4.416	-0.189	0.092	-0.406	0.184

Note. ACTREF = ILS questionnaire Active-Reflective scale, SENINT = ILS questionnaire Sensing-Intuitive scale, VISVER = ILS questionnaire Visual-Verbal scale, SEQGLO = ILS questionnaire Sequential-Global scale. P = Pilot and NP = Non-pilot.

Table 17

Descriptives of Learning Styles by Gender

Scales	Gender	*N*	Min	Max	*M*	*SD*	Skew		Kurtosis	
							Stat	SE	Stat	SE
ACTREF	M	519	-11	11	0.680	4.829	-0.093	0.107	-0.487	0.214
	F	187	-9	11	0.209	4.681	-0.099	0.178	-0.640	0.354
	Total	706	-11	11	0.555	4.791	-0.091	0.092	-0.525	0.184
SENINT	M	519	-11	11	4.233	5.314	-0.819	0.107	0.061	0.214
	F	187	-11	11	3.439	5.499	-0.563	0.178	-0.416	0.354
	Total	706	-11	11	4.023	5.371	-0.746	0.092	-0.103	0.184
VISVER	M	519	-9	11	6.214	4.084	-0.917	0.107	0.310	0.214
	F	187	-9	11	4.401	4.880	-0.621	0.178	-0.303	0.354
	Total	706	-9	11	5.734	4.379	-0.866	0.092	0.188	0.184
SEQGLO	M	519	-11	11	0.561	4.442	-0.134	0.107	-0.452	0.214
	F	187	-11	11	0.497	4.353	-0.356	0.178	-0.253	0.354
	Total	706	-11	11	0.544	4.416	-0.189	0.092	-0.406	0.184

Note. ACTREF = ILS questionnaire Active-Reflective scale, SENINT = ILS questionnaire Sensing-Intuitive scale, VISVER = ILS questionnaire Visual-Verbal scale, and SEQGLO = ILS questionnaire Sequential-Global scale. M = Male and F = Female.

Table 18

Descriptives of Learning Styles by Generation

Scales	Gen	*N*	Min	Max	*M*	*SD*	Skew		Kurtosis	
							Stat	SE	Stat	SE
ACTREF	SG	14	-9	7	1.143	5.172	-1.213	0.597	0.382	1.154
	BB	172	-11	11	0.395	4.975	-0.120	0.185	-0.576	0.368
	GX	152	-11	11	0.671	4.923	-0.275	0.197	-0.282	0.391
	GY	186	-11	11	0.667	4.607	-0.049	0.178	-0.538	0.355
	GZ	182	-9	11	0.451	4.702	0.172	0.180	-0.640	0.358
	Total	706	-11	11	0.555	4.791	-0.091	0.092	-0.525	0.184
SENINT	SG	14	-11	9	1.429	6.186	-0.780	0.597	-0.119	1.154
	BB	172	-11	11	4.023	5.592	-0.780	0.185	-0.108	0.368
	GX	152	-11	11	3.158	5.641	-0.634	0.197	-0.423	0.391
	GY	186	-11	11	4.785	5.119	-0.792	0.178	-0.004	0.355
	GZ	182	-11	11	4.165	4.998	-0.725	0.180	0.055	0.358
	Total	706	-9	11	5.734	4.379	-0.866	0.092	0.188	0.184
VISVER	SG	14	-5	7	3.429	3.694	-1.220	0.597	1.059	1.154
	BB	172	-9	11	5.767	4.002	-0.966	0.185	0.618	0.368
	GX	152	-7	11	5.947	4.318	-0.938	0.197	0.322	0.391
	GY	186	-9	11	6.161	4.559	-1.038	0.178	0.691	0.355
	GZ	182	-7	11	5.264	4.574	-0.643	0.180	-0.460	0.358
	Total	706	-9	11	5.734	4.379	-0.866	0.092	0.188	0.184
SEQGLO	SG	14	-3	9	1.857	4.130	0.241	0.597	-1.149	1.154
	BB	172	-9	9	0.233	4.487	-0.334	0.185	-0.538	0.368
	GX	152	-11	11	-0.237	4.947	0.043	0.197	-0.831	0.391
	GY	186	-11	11	0.817	4.209	-0.128	0.178	-0.101	0.355
	GZ	182	-11	11	1.110	4.004	-0.189	0.180	-0.041	0.358
	Total	706	-11	11	0.544	4.416	-0.189	0.092	-0.406	0.184

Note: SG indicates Silent Generation, BB indicates Baby Boomer, GX indicates Generation X, GY indicates Generation Y, and GZ indicates Generation Z. ACTREF = ILS questionnaire Active-Reflective scale, SENINT = ILS questionnaire Sensing-Intuitive scale, VISVER = ILS questionnaire Visual-Verbal scale, and SEQGLO = ILS questionnaire Sequential-Global scale.

Table 19

Descriptives of Pilot Certificate by Gender

		Gender		
		Male	Female	Total
Student	Count	24	15	39
	% w/in Pilot	61.5%	38.5%	100.00%
Private	Count	143	47	190
	% w/in Pilot	75.3%	24.7%	100.00%
Instrument	Count	205	50	255
	% w/in Pilot	80.4%	19.6%	100.00%
Commercial	Count	204	48	252
	% w/in Pilot	81.0%	19.0%	100.00%
ATP	Count	211	43	254
	% w/in Pilot	83.1%	16.9%	100.00%
Other	Count	65	18	83
	% w/in Pilot	78.3%	21.7%	100.00%

Table 20

Descriptives of Pilot Generation by Gender

		Gender		
		Male	Female	Total
Silent Generation	Count	10	0	10
	% w/in Generation	100.00%	0.00%	100.00%
	% w/in Gender	2.40%	0.00%	1.90%
	% of Total	1.90%	0.00%	1.90%
Baby Boomers	Count	125	23	148
	% w/in Generation	84.50%	15.50%	100.00%
	% w/in Gender	29.60%	20.70%	27.70%
	% of Total	23.40%	4.30%	27.70%
Generation X	Count	90	29	119
	% w/in Generation	75.60%	24.40%	100.00%
	% w/in Gender	21.30%	26.10%	22.30%
	% of Total	16.90%	5.40%	22.30%
Generation Y	Count	113	32	145
	% w/in Generation	77.90%	22.10%	100.00%
	% w/in Gender	26.70%	28.80%	27.20%
	% of Total	21.20%	6.00%	27.20%
Generation Z	Count	85	27	112
	% w/in Generation	75.90%	24.10%	100.00%
	% w/in Gender	20.10%	24.30%	21.00%
	% of Total	15.90%	5.10%	21.00%
Total	Count	423	111	534
	% w/in Generation	79.20%	20.80%	100.00%
	% w/in Gender	100.00%	100.00%	100.00%
	% of Total	79.20%	20.80%	100.00%

ILS Internal Consistency Reliability

Using IBM SPSS V27, a Reliability Analysis procedure was used to the scale reliability of the Felder and Soloman Index of Learning Styles questionnaire. Table 21 indicates that all alpha values fell within the range reported from previous studies and were above the suggested 0.5 cutoff specified by Tuckman who noted that while an alpha of 0.75 or greater was acceptable

for instruments that measured achievement, an alpha of 0.50 or greater is permissible for attitude assessments (Felder & Spurlin, 2005). The highest value was SENINT and the lowest value was SEQGLO, with ACTREF and VISVER falling in the middle.

Table 21

Cronbach Alpha Coefficients

N	Active-Reflective	Sensing-Intuitive	Visual-Verbal	Sequential-Global
706	0.640	0.754	0.682	0.557

Research Question Findings

Research Question 1

RQ 1: What is the relationship of pilot status, gender, and generation on learning styles?

Testing Assumptions

Multivariate normality.

This was tested by examining normality of each of the four ILS scales for each level of all three IVs (pilot status, gender, generation). All skewness values fell within the acceptable +/- 2 cutoff range. Similarly, all kurtosis values fell withing the +/- 2 cutoff range (George & Mallery, 2009). Because all values were within range for each ILS scale at each level of the three independent variables, the assumption of multivariate normality was met.

Multicollinearity.

Pearson correlations between all four ILS scales were used to examine the degree of relatedness between the scales. The highest correlation between two scales was between SEQGLO and SENINT ($r_{706} = .52$, $p < .001$). Because no correlations were above the accepted 0.7 cutoff range, the assumption of no multicollinearity between the dependent variables was met (see Table 22).

Table 22

Correlations for Testing Multicollinearity for RQ 1

	ACTREF	SENINT	VISVER	SEQGLO
ACTREF	-			
SENINT	.049	-		
VISVER	.277***	.130***	-	
SEQGLO	-.011	.520***	-.009	-

Note. *** indicates $p < .001$; $N = 706$ for all correlations.

Linear relationship.

Scatterplots were produced to determine if a linear relationship existed between the dependent variables for each group of the IV. All scatterplots were visually examined for each pair of DV's for each level of all three independent variables. The strongest evidence for a linear relationship was between SENINT and SEQGLO. Additionally, there was evidence for a linear relationship between ACTREF and VISVER in all demographic subsets. Because of the small number of participants, evidence of a linear relationship was more difficult in the Silent Generation subgroup.

Homogeneity of the covariance-variance matrix.

This assumption was tested using Box's Test of Equality of Covariance Matrices, or Box's M. The test revealed homogeneity of the variances between all pairs of DV's for all levels of all three independent variables ($p = .181$).

Homogeneity of variances.

Levene's test of equality of error variances was used to test whether the variance structure was the same for each DV between each level of each independent variable. Although this assumption was met for ACTREF ($p = .943$) and SEQGLO ($p = .189$), Levene's test showed significant heterogeneity in the variances for SENINT ($p = .033$) and VISVER ($p = .001$). Historically, the ANOVA has demonstrated a robustness to heterogeneity of variance when

sample sizes are equal and demonstrate smaller effects when sample sizes are larger (Boneau, 1960; Box, 1954; Glass & Hopkins, 1995; Lindquist, 1956).

Analysis

A MANOVA was conducted on the entire participant population with all four ILS subscales (ACTREF, SENINT, VISVER, and SEQGLO) as the dependent variables, and Pilot status, Gender, and Generation as the independent variables. There was a statistically significant difference between pilots and non-pilots on learning styles ($F_{4, 696} = 7.222$, $p < .001$; Wilks' $\Lambda = .960$; partial $\eta^2 = .040$). There was also a significant difference between males and females ($F_{4, 696} = 4.582$, $p = .001$; Wilks' $\Lambda = .974$; partial $\eta^2 = .026$), and between generations ($F_{16, 2126.953} = 2.029$, $p = .009$; Wilks' $\Lambda = .955$; partial $\eta^2 = .012$). To decompose each main effect, a separate post hoc analysis was conducted. These post hoc analyses were guided by the results of the between-subjects effects to determine which dependent variables to test for effects (see Table 23).

Table 23

Between-Subjects Effects for RQ 1

Source	DV	Type III SS	*df*	*MS*	*F*	*p*	Partial η^2
Corrected Model	ACTREF	112.344	6	18.724	0.814	0.559	0.007
	SENINT	798.229	6	133.038	4.759	0.000	0.039
	VISVER	958.363	6	159.727	8.888	0.000	0.071
	SEQGLO	234.576	6	39.096	2.023	0.061	0.017
Intercept	ACTREF	30.860	1	30.860	1.342	0.247	0.002
	SENINT	1775.513	1	1775.513	63.517	0.000	0.083
	VISVER	4185.166	1	4185.166	232.887	0.000	0.250
	SEQGLO	79.455	1	79.455	4.111	0.043	0.006
Pilot Status	ACTREF	65.788	1	65.788	2.861	0.091	0.004
	SENINT	352.193	1	352.193	12.599	0.000	0.018
	VISVER	331.361	1	331.361	18.439	0.000	0.026
	SEQGLO	23.849	1	23.849	1.234	0.267	0.002
Gender	ACTREF	14.633	1	14.633	0.636	0.425	0.001
	SENINT	52.536	1	52.536	1.879	0.171	0.003
	VISVER	310.269	1	310.269	17.265	0.000	0.024
	SEQGLO	1.498	1	1.498	0.078	0.781	0
Generation	ACTREF	20.206	4	5.051	0.220	0.927	0.001
	SENINT	375.023	4	93.756	3.354	0.010	0.019
	VISVER	152.453	4	38.113	2.121	0.077	0.012
	SEQGLO	224.859	4	56.215	2.908	0.021	0.016
Error	ACTREF	16072.002	699	22.993			
	SENINT	19539.408	699	27.953			
	VISVER	12561.575	699	17.971			
	SEQGLO	13510.562	699	19.328			

Note. ACTREF = ILS questionnaire Active-Reflective scale, SENINT = ILS questionnaire Sensing-Intuitive scale, VISVER = ILS questionnaire Visual-Verbal scale, and SEQGLO = ILS questionnaire Sequential-Global scale.

Post-Hoc Analysis

The specific type of post hoc test used for each main effect was determined based on the number of levels of the specific independent variable (e.g., Mann-Whitney U tests for binary variables pilot status and gender; and a Games-Howell post hoc test for Generation). All post hoc analyses were selected for their ability to handle heterogeneity of variances.

Pilot Status.

Two Mann-Whitney U tests were conducted to examine potential differences between pilots and non-pilots in SENINT and VISVER. In both cases, the distributions between pilots and non-pilots were not similar (see Figures 6 & 7). SENINT scores for pilots were significantly higher for pilots (mean rank = 370.21) compared to non-pilots (mean rank = 301.61; U = 36999.500, z = -3.866, $p < .001$). Pilots also had significantly higher scores on VISVER (mean rank = 374.800 compared to non-pilots (mean rank = 287.37; U = 34550.000, z = -4.954, $p <$ .001).

Figure 6

Distributions for Pilots and Non-Pilots on SENINT for RQ 1 Post hoc Analyses

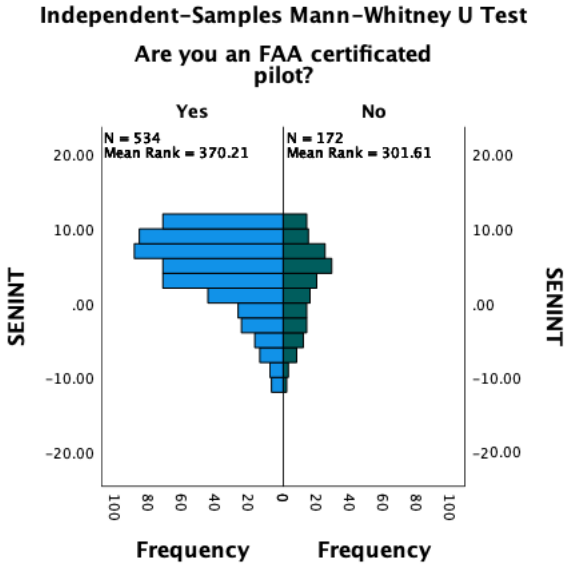
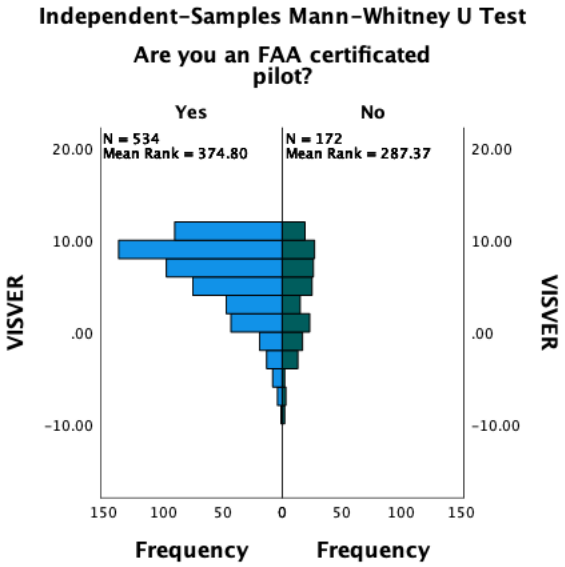


Figure 7

Distributions for Pilots and Non-Pilots on VISVER for RQ 1 Post hoc Analyses



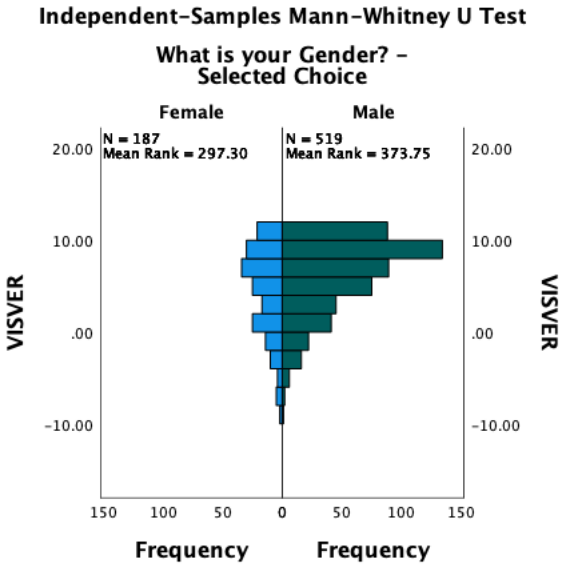
The primary focus of research question 1 was on pilot status and learning style preference of the entire participant sample. Both gender and generation were also examined to determine if differences existed in either of these sub-groups.

Gender.

A Mann-Whitney U test was conducted to examine potential differences between males and females in VISVER. The distributions between males and females were not similar (see Figure 8). Males had significantly higher VISVER scores (mean rank = 373.75) compared to females (mean rank = 297.30; U = 38017.500, z = -4.453, p < .001).

Figure 8

Distributions for Males and Females on VISVER for RQ 1 Post hoc Analyses



Generation.

When using a Games-Howell post hoc test, the only difference between generations for either learning type was between Generation X and Y on SENINT (p = .049) where Generation Y was more sensing.

Research Questions 2 and 3

RQ 2: What is the relationship of gender on learning styles for pilots?

RQ 3: What is the relationship of generation on learning styles for pilots?

Data for RQ 2 and RQ 3 are presented together because a single MANOVA was conducted which included both gender and generation when examining learning styles for each. Where appropriate findings for gender and generation will be highlighted individually.

Testing Assumptions

Multivariate normality.

This was tested by selecting only pilots, and then examining normality of each of the 4 ILS scales for each level of both IVs (gender and generation). All skewness values fell within the acceptable +/-2 cutoff range (see Tables 24 & 25). Similarly, all kurtosis values fell withing the +/- 2 cutoff range (George & Mallery, 2010). Because all values were within range for each ILS scale at each level of the two independent variables, the assumption of multivariate normality was met.

Table 24

Descriptives of Learning Styles by Gender for Pilots

Scales	Gender	*N*	Min	Max	*M*	*SD*	Skew		Kurtosis	
							Stat	SE	Stat	SE
ACTREF	M	423	-11	11	0.773	4.849	-0.106	0.119	-0.477	0.237
	F	111	-9	9	0.640	4.696	-0.256	0.229	-0.496	0.455
SENINT	M	423	-11	11	4.504	5.321	-0.930	0.119	0.300	0.237
	F	111	-11	11	4.243	5.103	-0.620	0.229	-0.049	0.455
VISVER	M	423	-7	11	6.575	3.856	-0.971	0.119	0.450	0.237
	F	111	-9	11	4.910	4.728	-0.858	0.229	0.233	0.455
SEQGLO	M	423	-11	11	0.612	4.451	-0.168	0.119	-0.384	0.237
	F	111	-9	11	0.604	4.471	-0.343	0.229	-0.214	0.455

Note. M = Male and F = Female

Table 25

Descriptives of Learning Styles by Generation for Pilots

Scales	Gen	*N*	Min	Max	*M*	*SD*	Skew		Kurtosis	
							Stat	SE	Stat	SE
ACTREF	SG	10	-9	5	1.000	4.619	-1.421	0.687	1.461	1.334
	BB	148	-11	11	0.405	5.097	-0.139	0.199	-0.64	0.396
	GX	119	-11	11	0.966	4.871	-0.374	0.222	-0.114	0.440
	GY	145	-11	11	0.766	4.687	-0.047	0.201	-0.480	0.400
	GZ	112	-7	11	0.911	4.598	0.191	0.228	-0.714	0.453
	Total	706	-11	11	0.555	4.791	-0.091	0.092	-0.525	0.184
SENINT	SG	10	-11	9	1.600	6.328	-0.659	0.687	0.170	1.334
	BB	148	-11	11	4.189	5.390	-0.854	0.199	0.206	0.396
	GX	119	-11	11	3.319	5.645	-0.637	0.222	-0.420	0.440
	GY	145	-11	11	5.179	5.115	-0.965	0.201	0.461	0.400
	GZ	112	-11	11	5.304	4.510	-0.994	0.228	1.095	0.453
	Total	706	-9	11	5.734	4.379	-0.866	0.092	0.188	0.184
VISVER	SG	10	-5	7	3.400	3.502	-1.620	0.687	3.446	1.334
	BB	148	-5	11	6.216	3.781	-1.031	0.199	0.548	0.396
	GX	119	-7	11	6.059	4.356	-1.079	0.222	0.706	0.440
	GY	145	-9	11	6.559	4.213	-1.060	0.201	0.947	0.400
	GZ	112	-7	11	6.250	4.108	-0.891	0.228	0.239	0.453
	Total	706	-9	11	5.734	4.379	-0.866	0.092	0.188	0.184
SEQGLO	SG	10	-3	7	2.000	3.682	0	0.687	-1.173	1.334
	BB	148	-9	9	0.203	4.437	-0.356	0.199	-0.445	0.396
	GX	119	-11	11	-0.092	5.020	0.011	0.222	-0.833	0.440
	GY	145	-11	11	0.862	4.433	-0.125	0.201	-0.162	0.400
	GZ	182	-11	11	1.110	4.004	-0.189	0.180	-0.041	0.358
	Total	112	-9	11	1.446	3.736	-0.070	0.228	0.081	0.453

Note: SG indicates Silent Generation, BB indicates Baby Boomer, GX indicates Generation X, GY indicates Generation Y, GZ indicates Generation Z. ACTREF = ILS questionnaire Active-Reflective scale, SENINT = ILS questionnaire Sensing-Intuitive scale, VISVER = ILS questionnaire Visual-Verbal scale, SEQGLO = ILS questionnaire Sequential-Global scale.

Multicollinearity.

Pearson correlations between all four ILS scales were used to examine the degree of relatedness between the scales for pilots. The highest correlation between two scales was

between SEQGLO and SENINT (r_{534} = .517, p < .001). Because no correlations were above the accepted 0.7 cutoff range, the assumption of no multicollinearity between the dependent variables was met (see Table 26).

Table 26

Correlations for Testing Multicollinearity for RQ 2 & RQ 3

	ACTREF	SENINT	VISVER	SEQGLO
ACTREF	-			
SENINT	.047	-		
VISVER	.259***	.106*	-	
SEQGLO	-.022	.517***	.007	-

Note: * indicates p < .01; *** indicates p < .001; N = 534 for all correlations.

Linear relationship.

Scatterplots were produced to determine if a linear relationship existed between the dependent variables for each group of the IV. All scatterplots were visually examined for each pair of DV's for each level of both independent variables. Similar to the first set of scatterplots, the strongest evidence for a linear relationship was between SENINT and SEQGLO. Additionally, there was evidence for a linear relationship between ACTREF and VISVER in all demographic subsets. Because of the small number of participants, evidence of a linear relationship was more difficult in the Silent Generation subgroup.

Homogeneity of the covariance-variance matrix.

This assumption was tested using Box's Test of Equality of Covariance Matrices, or Box's M. The test revealed heterogeneity of the variances between pairs of DV's for levels of the two independent variables (p = .010).

Homogeneity of variances.

Levene's test of equality of variances was used to test whether the variance structure was the same for each DV between each level of each independent variable. Although this assumption was met for ACTREF (p = .695), Levene's test showed marginal heterogeneity in the variances for SENINT (p = .076), and SEQGLO (p = .093), and significant heterogeneity for VISVER (p = .022). The ANOVA has been shown to be robust against heterogeneity of variance when sample sizes are equal and demonstrate smaller effects when sample sizes are larger (Boneau, 1960; Box, 1954; Glass & Hopkins, 1995; Lindquist, 1956).

Analysis

Research questions 2 and 3 were answered using a single MANOVA only on the pilot participants with all four ILS subscales (ACTREF, SENINT, VISVER, and SEQGLO) as the dependent variables, and Gender and Generation as the independent variables. There was a significant difference between males and females ($F_{4, 525}$ = 4.239, p = .002; Wilks' Λ = .969; partial η^2 = .031), and between generations ($F_{16, 1604.539}$ = 1.911, p = .016; Wilks' Λ = .944; partial η^2 = .014). In order to decompose each main effect, a separate post hoc analysis was conducted. These post hoc analyses were guided by the results of the between-subjects effects to determine which dependent variables to test for effects (see Table 27).

Table 27

Between-Subjects Effects for RQ 2 & RQ 3

Source	DV	Type III SS	*df*	*MS*	*F*	*p*	Partial η^2
Corrected Model	ACTREF	29.433	5	5.887	0.252	0.939	0.002
	SENINT	412.901	5	82.58	3.027	0.011	0.028
	VISVER	366.588	5	73.318	4.495	0.001	0.041
	SEQGLO	190.189	5	38.038	1.937	0.087	0.018
Intercept	ACTREF	87.137	1	87.137	3.734	0.054	0.007
	SENINT	2232.575	1	2232.575	81.831	0.000	0.134
	VISVER	4049.099	1	4049.099	248.263	0.000	0.32
	SEQGLO	118.905	1	118.905	6.055	0.014	0.011
Gender	ACTREF	2.745	1	2.745	0.118	0.732	0
	SENINT	10.751	1	10.751	0.394	0.530	0.001
	VISVER	267.282	1	267.282	16.388	0.000	0.03
	SEQGLO	0.03	1	0.03	0.002	0.969	0
Generation	ACTREF	27.868	4	6.967	0.299	0.879	0.002
	SENINT	406.944	4	101.736	3.729	0.005	0.027
	VISVER	122.964	4	30.741	1.885	0.112	0.014
	SEQGLO	190.183	4	47.546	2.421	0.047	0.018
Error	ACTREF	12319.931	528	23.333			
	SENINT	14405.234	528	27.283			
	VISVER	8611.539	528	16.31			
	SEQGLO	10368.792	528	19.638			

Note. ACTREF = ILS questionnaire Active-Reflective scale, SENINT = ILS questionnaire Sensing-Intuitive scale, VISVER = ILS questionnaire Visual-Verbal scale, and SEQGLO = ILS questionnaire Sequential-Global scale.

Post-Hoc Analysis

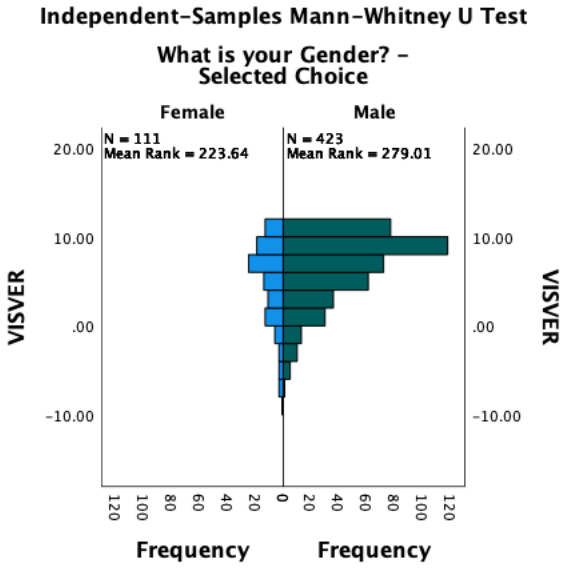
The specific type of post hoc test used for each main effect was determined based on the number of levels of the specific independent variable (e.g., Mann-Whitney U test for binary variable gender; and a Games-Howell post hoc test for Generation). All post hoc analyses were selected for their ability to handle heterogeneity of variances.

Gender

A Mann-Whitney U test was conducted to examine potential differences between male and female pilots in VISVER. The distributions between males and females were not similar (see Figure 63). Male pilots had significantly higher VISVER scores (mean rank = 279.01) compared to female pilots (mean rank = 223.64; U = 18607.500, z = -3.420, p < .001).

Figure 9

Distributions for Males and Females on VISVER for RQ 2 Post hoc Analyses



Generation

When using a Games-Howell post hoc test, Generation X had significantly lower SENINT scores (less sensing) compared to Generations Y (p = .046) and Z (p = .028). Generation X also had significantly lower SEQGLO scores (more global) compared to Generation Z (p = .065).

Summary

Participant Population

Survey data indicated that within the total participant population, there was a statistically significant difference in learning styles between pilots and non-pilots, males and females, and generations. Further examination of the pilot status participants revealed that pilot scores were higher than non-pilots on the SENINT and VISVER scales. Both groups indicated a preference for sensing and visual; however, pilots scored significantly higher than non-pilots. When gender was analyzed more closely the data indicated that males had higher scores than females on the VISVER scale. Again, both groups indicated a preference for visual however males scored significantly higher than females. An inspection of the data for generation indicated a mild difference between Generations X and Y on the SENINT scale with both generations favoring the sensing preference.

Pilot Population

Consistent with the entire population findings, data for the pilot population indicated that there was a difference between male pilots and female pilots, as well as pilot generations. Gender differences showed that male pilots had higher VISVER scores than female pilots, but each still preferred the visual side of that scale which were consistent with the total sample population. Results for generations were different than the total sample population. The data indicated Generation X had lower SENINT scores than Generations Y and Z, as well as lower SEQGLO scores than Generation Z. Generations X, Y, and Z on the SENINT scales all preferred the sensing side of the scale but Generation X did not score as high as the other two generations. On the SEQGLO scale, Generation X indicated a mild preference for the global side while Generation Z demonstrated a mild to moderate preference for the sequential side of the scale.

Interpretation of the Data

The next chapter puts these results in context for today's pilot population and any training implications that follow. Additionally, a comparison to previous research findings was made to verify those outcomes or note differences which could be a result of time or measurement instrument. And lastly, recommendations for future research are suggested.

Chapter 5

Summary, Conclusions, Implications, And Recommendations

Introduction

Training organizations strive to build and implement training programs that are both efficient and effective. Efficiency relates to time and money. A well-designed training program can save employees time away from home and companies training costs that can be spent on other programs or passed on to other parties. Effectiveness is much more difficult to achieve unless there is an understanding of the educational process, the training of the instructor, and the learning characteristics of the students.

Purpose of the Study

The purpose of this quantitative correlational study was to examine the learning styles of pilots versus non-pilots, generational similarities and differences, and gender differences in learning styles among the pilot group. This study addressed the development of commercial pilot training curriculum and instructional styles. An understanding of learning styles that are thought to be unique to pilots will guide how curriculum is developed. It identified the best approach, pedagogical or andragogical or a combination of the two, when designing training curriculum, as well as training the instructors who will deliver the training. The findings also identified the best use of current technology in the learning process and highlighted the possible advantages and disadvantages for the given generational differences that currently exist in the commercial aviation industry pilot population. The goal was to build training programs that best suit how pilots learn. Despite the severe negative impact COVID-19 has had on the commercial aviation industry, this period of reduced airline activity and pilot hiring may provide researchers an unexpected opportunity to identify ways to ensure the impeccable safety record enjoyed by the

commercial aviation industry is not impacted. The end of the pandemic is hopefully in sight and the airlines are preparing to resume normal operations in this new paradigm of commercial aviation operations.

Research Questions

1. What is the relationship of pilot status, gender, and generation on learning styles?
2. What is the relationship of gender on learning styles for pilots?
3. What is the relationship of generation on learning styles for pilots?

Summary

All pilots in this study and the commercial aviation industry can be classified as adults as defined by age and therefore should be taught from an adult education, or andragogy perspective. Knowles (2015) preferred to define adulthood as an individual's self-directed behavior which is more difficult to identify because it can occur an any age. For purposes of this study, age was used to define adulthood. As previously mentioned, Knowles identified six assumptions of adult learners that should be considered in the curriculum design process (Merriam & Baumgartner, 2020). The focus of this study was on the learning styles of pilots but cannot exclude what these adult learners bring to the training experience.

Felder and Soloman (n.d.-b) explain that *active* learners understand and remember information by actively engaging with the material while *reflective* learners will muse over the data before acting. They continue to clarify that *sensing* learners are interested in facts, relationships, and problem-solving as opposed to *intuitive* learners who think more abstractly and like to discover relationships and possibilities. Next, they note, that the *visual* learner remembers best by what they see, and a *verbal* learner relies on the written and spoken word to enhance the learning experience. Finally, Felder and Soloman (n.d.-b) describe a *sequential* learner as one

who learns best when the material is presented in a step-by-step process, which differs from a *global* learner who "may be able to solve complex problems quickly or put things together in novel ways once they have grasped the big picture, but they may have difficulty explaining how they did it" (p. 3).

Before looking specifically at the pilot sample, an examination of the total sample of participants is in order. Research question one asked, "What is the effect of pilot status, gender, and generation on learning styles?" These data indicate pilots prefer learning environments that are *sensing* and *visual* more than non-pilots. Dissecting the total participant population along gender and generation lines, these data reveal that males would choose a learning environment that used a *visual* teaching modality more readily than females and the only generational differences were between Generations X and Y on the *sensing-intuitive* scale. Both generations preferred a *sensing* learning environment, however Generation Y had a stronger preference toward *sensing*.

A look specifically at the pilot participants was needed to answer research questions two and three. These data were consistent with the total participant population which indicated that male pilots preferred a *visual* learning environment more than females. Pertaining to gender, these data suggest that males and females shared an *active*, *sensing*, and *sequential* learning style environment preference. Both genders had a mild preference, which indicated a balanced learning style preference on that scale, for an *active* and *sequential* learning style environment. Even though they preferred *active* and *sequential* they can learn equally well in a *reflective* or *global* learning situation. When the other two scales were examined, these data suggest that males and females demonstrated a moderate preference for a *sensing* and *visual* learning

atmosphere. As was previously noted, males would edge out the females for the *visual* learning scenario.

These data are not so neatly organized when generational preferences are examined. Because the sample size for the Silent Generation was so small and contained only males it will not be reported in the findings. Baby Boomer, Generation X, Generation Y, and Generation Z generations all have a mild preference for the *active* learning style. This finding indicated that all generations would adapt equally well in a *reflective* learning setting. When the *sequential-global* scale was examined, data revealed that the Baby Boomer, Generation Y, and Generation Z generations had a mild preference for the *sequential* learning style while Generation X had a mild preference for the *global* learning style. The results for the *sensing-intuitive* scale showed that the Baby Boomer, Generation Y, and Generation Z generations had a moderate preference for the *sensing* learning style, while Generation X had a mild to moderate preference for the *sensing* learning preference. Finally, these data show that the Baby Boomer, Generation X, Generation Y, and Generation Z generations had a moderate preference for the Visual learning style.

A mild preference indicates a well-balanced learning style on that scale and learning would occur if the teaching style favored either end of that continuum. A moderate preference suggests that an individual will learn more easily in a teaching environment that favors that modality but can learn in the opposite style. Lastly, a strong preference for one dimension of a scale indicates that someone may have a difficult time learning in an environment where the instructor does not teach in that style.

It is important to note how these research data relate to previous research on the pilot population. Studies that used the VARK/VAK, MBTI, and Kolb LSI were examined and

compared. Chui et al. (2000) used the VARK learning style tool and identified the importance of feedback type for *visual* and *auditory* learners. They noted that auditory learners who received *visual* feedback were adversely affected in performance. In the present study the *visual* learning preference would not be adversely affected by either type of feedback. In 2000, Karp found that of 117 pilots, the predominant preference for learning was that almost one-half were hands-on, or *active* learners and nearly two-thirds were a combination of hands-on (*active*) and *visual* learners. These findings are consistent with the present study. The MBTI is used primarily as a personality inventory but is sometimes used to predict an individual's learning style. Kutz et al. (2004) found that professional pilot students identified at ESTP (Extrovert, Sensing, Thinking and Perceiving). These students learned best in an environment that was *active, sensing,* and *sequential*. Fussell et al. (2018) identified the ISTJ (Introvert, Sensing, Thinking, and Judging) personality type as the most prevalent for their population. These students learned best in an environment that was *reflective, sensing,* and *sequential*. Robertson and Putnam (2008) found a greater variety of student personality types in their study; ENFP, ISTP, ISTJ, ENTP, and INFP.

Fussell et al. (2018) used the MBTI to assess an aviation student's personality type and the Kolb LSI to assess the student's learning preference to see if a relationship existed between the two tools. Fussell et al (2018) and others (Brownfield, 1993; Niemczyk, 2020) found no significant relationship to indicate that an individual's personality preference predicted a specific learning style which may explain the varied findings of previous research on this topic.

Kanske (2001) used the Kolb LSI to identify the learning styles of 233 U.S. Air Force pilots. He found that the *convergent* or *active* learning style was the most prominent and the *assimilative* or *intuitive* learning style was next and many preferred using both styles.

Conclusions

The findings of each of the previously mentioned aviation studies broadly align with the findings from this study, however differences do exist. A parallel can be drawn with observations about generations. While generations may be identified with a certain characteristic, not everyone in that generation necessarily fits that stereotype. The same may be said about pilots and learning styles. These data indicate that pilots are primarily *active*, *sensing*, *visual*, and *sequential*; however, not every pilot shared these same learning preferences.

The ILS questionnaire not only revealed an individual's learning style preference but also their non-preference. It may benefit both teachers and students to understand their preferences and non-preferences. Teachers armed with this information can strengthen the learning experience by favoring the predominant learning style while also helping students understand how to learn in a non-preferred way. Teachers must understand that their primary teaching modality is aligned with their individual learning preferences, as well as teaching styles they found successful in previous educational experiences (Marshall, 1991; Stitt-Gohdes, Summer 2001). Brown (2003) claimed that instructors who lack an understanding of adult learning theory, or andragogy, will continue to teach with a teacher-centered rather than student-centered approach (Stitt-Gohdes et al., Spring 1999). An andragogical teaching approach (Brady et al., 2001) with an understanding of individual learning styles will help teachers broaden their ability to reinforce learning in multiple educational settings. An awareness of what was preferred and not preferred allowed individuals to work on the weaker or underdeveloped learning preferences to strengthen learning in a greater number of learning environments. Felder and Spurlin (2005) insist that:

> To function effectively as professionals, students will need skills associated with both categories of each learning style dimension; if they are never given practice in their less preferred categories, they will not develop the skills that correspond to those categories. The optimal teaching style is a balanced one in which all students are sometimes taught in a manner that matches their learning style preferences, so they are not too uncomfortable to learn effectively, and sometimes in the opposite manner, so they are forced to stretch and grow in directions they might be inclined to avoid if given the option. (p. 105)

Implications

Based on data from this study, aviation training curriculum and program implementation should focus on *active*, *sensing*, *visual*, and *sequential* learning styles but not at the expense of the other styles. While these unique styles were identified for both gender and generations for pilots, the strength was moderate at most but more typically mild. The more important focus should be on balance, which will not only reach each student but will also teach by example how to strengthen the non-preferred learning styles and make them better learners overall.

Recommendations for Further Studies

This study focused on students attending three higher education institutions and the followers of three LinkedIn pages, four Facebook pages, one popular Aviation Blog and book author, and one popular aviation newsletter publisher. Further research should:

1. Focus on students who are attending non-AABI institutions or not attending an institution of higher education to see if there is a difference in learning styles between non-pilots and pilots.

2. Be conducted at CFR Part 61 and Part 141 (non-AABI higher education institutions) to see if students receiving flight training display learning styles that are different from the AABI affiliated higher education institutions.
3. Be conducted using regional airlines, major airlines, corporate flight departments, commercial aviation training organizations (i.e., Flight Safety, CAE, etc.), and international airlines to see if the findings from this study can be generalized across the pilot population or if they discover other differences that must be considered in curriculum design and teaching strategies.
4. Examine the training departments of commercial airlines to determine what level of expertise is responsible for curriculum development (e.g., do experienced pilots or trained instructional designers develop the curriculum).
5. Focus on other demographics such as cultural background, ethnicity, race, geographic region, socio-economic status, level of educational, college major, etc.
6. Repeat this study but use the Kolb Learning Style Inventory 4.0 as the learning style measurement tool.
7. Conduct a similar study but ask participants to complete both the Kolb Learning Style Inventory 4.0 and the Felder and Soloman Index of Learning Styles to discover how they compare to one another.
8. Focus on the use of technology with pilots to see if gender and generational groupings influence what type of technology (Virtual, Augmented, and Mixed Reality, Artificial Intelligence, Adaptive Learning, etc.) works best with each demographic.

9. Collaborate with scholars and researchers who find that there is no data that suggests a relationship between learning and teaching style on academic success to devise a study that will establish the relationship using a scientific method.

References

Airbus. (2019). *Airbus Global Market Forecast 2019-2038* [Report]. http://www.airbus.com/aircraft/market/global-market-forecast.html

Andres, H. P., & Akan, O. H. (2015). A test of the teaching-learning style mesh hypothesis in a Chinese MBA. *Journal of International Education in Business*, *8*(2), 145–163. https://doi.org/10.1108/jieb-12-2014-0021

Antepohl, W., & Herzig, S. (1999). Problem-based learning versus lecture-based learning in a course of basic pharmacology: A controlled, randomized study. *Medical Education*, *33*(2), 106–113. https://doi.org/10.1046/j.1365-2923.1999.00289.x

Armstrong, S. J., Peterson, E. R., & Rayner, S. G. (2012). Understanding and defining cognitive style and learning style: A delphi study in the context of educational psychology. *Educational Studies*, *38*(4), 449–455. https://doi.org/10.1080/03055698.2011.643110

Baeten, M., Dochy, F., & Struyven, K. (2013). The effects of different learning environments on students' motivation for learning and their achievement. *British Journal of Educational Psychology*, *83*(3), 484–501. https://doi.org/10.1111/j.2044-8279.2012.02076.x

Barbuto, J. E., Jr. (1997). A critique of the Myers-Briggs Type Indicator and its operationalization of Carl Jung's psychological types. *Psychological Reports*, *80*, 611–625.

Beder, H., & Carrea, N. (1988). The effects of andragogical teacher training on adults students' attendance and evaluation of their teachers. *Adult Education Quarterly*, *38*(2), 75–87.

Berge, Z. L., & Berge, M. B. (2019). The economic ABCs of educating and training generations x, y, and z. *Performance Improvement*, *58*(5), 44–53. https://doi.org/10.1002/pfi.21864

Boeing. (2019a). *Commercial Market Outlook 2019-2038* [Report]. https://www.boeing.com/commercial/market/commercial-market-outlook/

Boeing. (2019b). *Pilot and Technician Outlook (2019-2039) Executive Summary* [Report]. https://www.boeing.com/commercial/market/pilot-technician-outlook/ or https://www.boeing.com/resources/boeingdotcom/commercial/market/pilot-technician-services/assets/downloads/2019_pto_infographic.pdf

Boeing. (2020). *Pilot and Technician Outlook (2020-2039) Executive Summary* [Report]. https://www.boeing.com/commercial/market/pilot-technician-outlook/

Boneau, C. A. (1960). The effects of violations of assumptions underlying the t-test. *Psychological Bulletin*, *57*(1), 49–64. https://doi.org/10.1037/h0041412

Box, G. P. (1954). Some theorems on quadratic forms applied in the study of analysis of variance problems, I: Effect of inequality of variance in the one-way classification. *The Annals of Mathematical Statistics*, *25*(2), 290–302. https://doi.org/10.1214/aoms/1177728786

Brady, T., Stolzer, A., Muller, B., & Schaum, D. (2001). A comparison of the learning styles of aviation and non-aviation college students. *Journal of Aviation/Aerospace Education & Research*, *11*(1), 33–44. https://doi.org/10.15394/jaaer.2001.1286

Brown, B. L. (2003). Teaching style vs. learning style. *Clearinghouse on adult, career, and vocational education*, *26*, 1–2.

Brownfield, K. M. (1993). *The relationship between the Myers-Briggs personality types and learning styles*.

CAE. (2019). *Airline Pilot Demand Outlook 10-year view*.

CAE. (2020). *Airline and Business Jet Pilot Demand Outlook 10-year review 2020 Update* [Report]. https://www.cae.com/cae-pilot-demand-outlook-2020/index.html

Cambridge University Press. (2021). Pedagogy. In *Cambridge Dictionary*. Retrieved February 27, 2021, from https://dictionary.cambridge.org/us/dictionary/english/pedagogy

Campbell, W. E. (1997). Introduction. In *New paradigms for college teaching* (pp. V–XIII, 281). Interaction Book Company.

Carlson, E. (2009). *20th-Century U. S. generations* (Population Bulletin 64, n. 1). Population Reference Bureau.

Chaparro, M. E., Carroll, M., & Malmquist, S. (2020). Personality trends in the pilot population. *Collegiate Aviation Review International*, *38*(2). https://doi.org/10.22488/okstate.20.100219

Chicca, J., & Shellenbarger, T. (2018). Connecting with generation z: Approaches in nursing education. *Teaching and Learning in Nursing*, *13*(3), 180–184. https://doi.org/10.1016/j.teln.2018.03.008

Chui, T. S., Molesworth, B. C., & Bromfield, M. A. (2020). Feedback and student learning: Matching learning and teaching style to improve student pilot performance. *The International Journal of Aerospace Psychology*, *31*(2), 71–86. https://doi.org/10.1080/24721840.2020.1847650

Clark, J. F. (2001). Teaching the pilots of the new millennium: Adult cooperative education in aviation education. *Collegiate Aviation Review International*, *19*(1), 29–40. https://doi.org/10.22488/okstate.18.100295

Conti, G. J. (2009). Development of a user-friendly instrument for identifying the learning strategy preferences of adults. *Teaching and Teacher Education*, *25*(6), 887–896. https://doi.org/10.1016/j.tate.2009.02.024

Cook, D. A. (2005, October Supplement). Reliability and validity of scores from the index of learning styles. *Academic Medicine*, *80*(10), S97–S101. https://doi.org/10.1097/00001888-200510001-00026

Cuevas, J. (2015). Is learning styles-based instruction effective? a comprehensive analysis of recent research on learning styles. *Theory and Research in Education*, *13*(3), 308–333. https://doi.org/10.1177/1477878515606621

Dantas, L., & Cunha, A. (2020). An integrative debate on learning styles and the learning process. *Social Sciences & Humanities Open*, *2*(1), 1–5. https://doi.org/10.1016/j.ssaho.2020.100017

Davenport, J., & Davenport, J. A. (1985). A chronology and analysis of the andragogy debate. *Adult Education Quarterly*, *35*(3), 152–159. https://doi.org/10.1177/0001848185035003004

Dewey, R. A. (2018). *Traits and types*. Psychology: An introduction. Retrieved July 26, 2021, from https://www.psywww.com/intropsych/index.html

Dimock, M. (2019, January 17). *Defining generations: Where millennials end and generation z begins*. Pew Research Center. Retrieved July 24, 2021, from https://www.pewresearch.org/fact-tank/2019/01/17/where-millennials-end-and-generation-z-begins/

Dolliver, R. H. (1994). Classifying the personality theories and personalities of Adler, Freud, and Jung with introversion/extraversion. *Individual Psychology: Journal of Adlerian Theory, Research & Practice*, *50*(2), 192–202. http://web.b.ebscohost.com.spot.lib.auburn.edu/ehost/pdfviewer/pdfviewer?vid=1&sid=2c1a16c6-329e-47f6-9afe-cc1dfab26da2%40sessionmgr103

Dunn, R., Beaudry, J. S., & Klavas, A. (1989). Survey of Research on Learning Styles. *Educational Leadership*, *46*(6), 50–58. http://www.ascd.org/ASCD/pdf/journals/ed_lead/el_198903_dunn.pdf

Eligibility Requirements: General, 14 C.F.R. § 61.153 (2021).

Emanuel, R. C., & Potter, W. J. (1992). Do students' style preferences differ by grade level, orientation toward college, and academic major? *Research in Higher Education*, *33*(3), 395–414. https://doi.org/10.1007/bf00992267

Fanjoy, R. O. (2002). Collegiate flight training programs: In search of cognitive growth. *Journal of Aviation/Aerospace Education & Research*, *11*(2), 39–45. https://doi.org/10.15394/jaaer.2002.1296

Fanjoy, R. O., & Gao, Y. (2011). Learning styles of Chinese aviation students. *International Journal of Applied Aviation Studies*, *11*(1), 57–65.

Federal Aviation Administration, 14 C.F.R. § 121.383 (d) (e) (2009).

Federal Aviation Administration. (2020a). *Aerospace Forecast Fiscal Years 2020-2040*. https://www.faa.gov/data_research/aviation/aerospace_forecasts/ or https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2020-40_FAA_Aerospace_Forecast.pdf

Federal Aviation Administration. (2020b). *NextGen annual report: A report on the history, current status, and future of national airspace system modernization* [Report]. FAA.

Federal Aviation Administration. (2020c). *2020 U.S. Civil Airmen Statistics* [Excel Table]. https://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

Felder, R. M. (1996). Matters of Style. *ASEE Prism*, *6*(4), 18–23.

Felder, R. M. (1998). *Learning Styles and Teaching Styles* (Proceedings of the 1998 Annual conference of the American Society for Engineering Education). N.C. State College of Engineering, STEM Education Resources, Education-Related Papers. https://www.engr.ncsu.edu/wp-content/uploads/drive/1vRjpenyeO5BbV6VLWBx4ebL8u2C_wUry/1998-ASEE-LS.pdf

Felder, R. M. (2010). *Are Learning Styles Invalid? (Hint: No!)* [On-Course Newsletter]. https://www.engr.ncsu.edu/wp-content/uploads/drive/10S5mLkGElsN8NTsYgOe_f0taEdlSpbJD/2010-LS_Validity(On-Course).pdf

Felder, R. M. (2020). Opinion: Uses, misuses, and validity of learning styles. *Advances in Engineering Education*, *8*(1), 1–14.

Felder, R. M., & Brent, R. (n.d.). *Richard Felder's Responses to Frequently Asked Questions about the ILS*. Resources for Teaching and Learning STEM. Retrieved February 27, 2021, from https://educationdesignsinc.com/index-of-learning-styles/ils-faq/#origin

Felder, R. M., & Brent, R. (2005). Understanding student differences. *Journal of Engineering Education*, *94*(1), 57–72. https://doi.org/10.1002/j.2168-9830.2005.tb00829.x

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education*, *78*(7), 674–681.

Felder, R. M., & Soloman, B. A. (n.d.-a). *Index of Learning Styles*. https://www.webtools.ncsu.edu/learningstyles/

Felder, R. M., & Soloman, B. A. (n.d.-b). *Learning styles and strategies. A four-page handout that briefly explains the learning style preferences defined by the Felder-Silverman*

model. https://doi.org/https://www.engr.ncsu.edu/wp-content/uploads/drive/1WPAfj3j5o5OuJMiHorJ-lv6fON1C8kCN/styles.pdf

Felder, R. M., & Spurlin, J. (2005). Applications, reliability, and validity of the Index of Learning Styles. *International journal of engineering education*, *21*(1), 103–112.

Fussell, S., Dattel, A., & Mullins, K. (2018). Personality types and learning styles of collegiate aviation students. *International Journal of Aviation, Aeronautics, and Aerospace*, *5*(3), 1–17. https://doi.org/10.15394/ijaaa.2018.1223

Gao, Y., Au, K., Kwon, H., & Leong, E. (2013). Learning styles of Australian aviation students: An assessment of the impact of culture. *Collegiate Aviation Review International*, *31*(1), 17–26. https://doi.org/10.22488/okstate.18.100435

Gao, Y., & Kong, S. (2016). Personality types of pilot students: A study of an Australian collegiate aviation program. *International Journal of Aviation, Aeronautics, and Aerospace*, *3*(3), 1–16. https://doi.org/10.15394/ijaaa.2016.1130

George, D., & Mallery, P. (2009). *Spss for windows step by step: A simple study guide and reference, 17.0 update (10th edition)* (10th ed.). Allyn & Bacon.

Glass, G. V., & Hopkins, K. D. (1995). *Satistical methods in educaiton and psychology* (3rd ed.). Allyn & Bacon.

Goldberg, L. R. (1992). The development of markers for the big-five factor structure. *Psychological Assessment*, *4*(1), 26–42. https://doi.org/10.1037/1040-3590.4.1.26

Gordon, H. R. (1993, December). *Houle's typology: time for reconsideration*. https://files.eric.ed.gov/fulltext/ED363785.pdf

Graf, S., Viola, S., Leo, T., & Kinshuk. (2007). In-depth analysis of the Felder-Silverman learning style dimensions. *Journal of Research on Technology in Education*, *40*(1), 79–93. https://doi.org/10.1080/15391523.2007.10782498

H.R. Res. 4343, 110th Cong., 153 Cong. Rec. 1450 (2007) (enacted). https://www.congress.gov/110/plaws/publ135/PLAW-110publ135.pdf

Hampton, D., Welsh, D., & Wiggins, A. T. (2019). Learning preferences and engagement level of generation z nursing students. *Nurse Educator*, *45*(3), 160–164. https://doi.org/10.1097/nne.0000000000000710

Hawkins, R. F., & Kapelis, L. (1993). Teaching hypnosis: The andragogy and direct-teaching models. *Australian Journal of Clinical & Experimental Hypnosis*, *21*(2), 37–43.

Hopkins, G. E. (2001, February). *A short history of pilot shortages*. Air Line Pilots Association, Int'l. http://public.alpa.org/portals/alpa/magazine/2001/Feb2001_ShortHistory.htm

Houle, C. O. (1961). *The Inquiring Mind*. The University of Wisconsin Press.

Howe, N., & Strauss, W. (1991). *Generations: The history of America's future, 1584 to 2069* (1st ed.). Harper Perennial.

Ibrahimoglu, N., Unaldi, I., Samancioglu, M., & Baglibel, M. (2013). The relationship between personality traits and learning styles: a cluster analysis. *Asian Journal of Management Sciences and Education*, *2*(3), 93–108.

James, W. B., & Blank, W. E. (1993). Review and critique of available learning-style instruments for adults. *New Directions for Adult and Continuing Education*, *59*, 47–57.

Kanske, C. A. (2001). Learning styles of pilots currently qualified in United States Air Force aircraft. *Journal of Air Transportation World Wide*, *6*(2), 33–46.

Kanske, C. A., & Brewster, L. (2001). The learning styles of college aviation students. *Collegiate Aviation Review International*, *19*(1), 62–70. https://doi.org/10.22488/okstate.18.100298

Kanske, C. A., Brewster, L. T., & Fanjoy, R. O. (2003). A longitudinal study of the learning styles of college aviation students. *International Journal of Applied Aviaton Studies*, *3*(2), 79–89.

Karp, M. R. (2000). University aviation education: An integrated model. *Collegiate Aviation Review International*, *18*(1), 1–11. https://doi.org/10.22488/okstate.18.100286

Karp, M. R., Turney, M., Niemczyk, M., Green, M. F., Sitler, R. L., & Bishop, J. (2001). Retaining women in collegiate aviation by implementing learning style considerations. *Collegiate Aviation Review International*, *19*(1), 92–101. https://doi.org/10.22488/okstate.18.100300

Kirschner, P. A. (2017). Stop propagating the learning styles myth. *Computers & Education*, *106*, 166–171. https://doi.org/10.1016/j.compedu.2016.12.006

Knoll, A. R., Otani, H., Skeel, R. L., & Van Horn, K. (2016). Learning style, judgements of learning, and learning of verbal and visual information. *British Journal of Psychology*, *108*(3), 544–563. https://doi.org/10.1111/bjop.12214

Knowles, M. (1973). *The adult learner: A neglected species*. Gulf Publishing Company.

Knowles, M. S. (1980). *The modern practice of adult education: From pedagogy to andragogy* (Rev. and Updated ed.). Follett Pub. Co.

Knowles, M. S., Holton, E. F., III, & Swanson, R. A. (2015). *The adult learner: The definitive classic in adult education and human resource development* (8th ed.). Routledge.

Kolb, D. A., & Kolb, A. Y. (2013). *The Kolb Learning Style Inventory 4.0: Guide to Theory, Psychometrics, Research & Applications*. Experience Based Learning Systems. https://www.researchgate.net/publication/303446688_The_Kolb_Learning_Style_Inventory_40_Guide_to_Theory_Psychometrics_Research_Applications

Kutz, M. N., Brown, D. M., Carmichael, D. B., & Shandiz, M. (2004). Preliminary implications for academic professionals of aviation student Myers-Briggs Type Indicator (MBTI) preferences. *International Journal of Applied Aviation Studies*, *4*(2), 221–228.

Lai, K.-W., & Hong, K.-S. (2014). Technology use and learning characteristics of students in higher education: Do generational differences exist? *British Journal of Educational Technology*, *46*(4), 725–738. https://doi.org/10.1111/bjet.12161

Lawrence, G. (1993). *People types and tiger stripes* (3rd ed.). Center for Applications of Psychological Type, Inc.

Lester, S. W., Standifer, R. L., Schultz, N. J., & Windsor, J. M. (2012). Actual versus perceived generational differences at work. *Journal of Leadership & Organizational Studies*, *19*(3), 341–354. https://doi.org/10.1177/1548051812442747

Lindquist, E. F. (1956). *Design and analysis of experiments in psychology and education* (1st ed.). Houghton Mifflin Co.

Lissitsa, S., & Laor, T. (2021). Baby boomers, generation x and generation y: Identifying generational differences in effects of personality traits in on-demand radio use. *Technology in Society*, *64*, 1–10. https://doi.org/10.1016/j.techsoc.2021.101526

Litzinger, T. A., Lee, S., Wise, J. C., & Felder, R. M. (2007). A psychometric study of the index of learning styles©. *Journal of Engineering Education*, *96*(4), 309–319. https://doi.org/10.1002/j.2168-9830.2007.tb00941.x

Macky, K., Gardner, D., & Forsyth, S. (2008). Generational differences at work: Introduction and overview. *Journal of Managerial Psychology*, *23*(8), 857–861. https://doi.org/10.1108/02683940810904358

Marshall, C. (1991). Teachers' learning styles: How they affect student learning. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *64*(4), 225–227. https://doi.org/10.1080/00098655.1991.9955852

Mašić, A., Polz, E., & Bećirović, S. (2020). The relationship between learning styles, GPA, school level and gender. *European Researcher*, *11*(1), 51–60. https://doi.org/10.13187/er.2020.1.51

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality*, *60*(2), 175–215. https://doi.org/10.1111/j.1467-6494.1992.tb00970.x

McGlynn, A. P. (2005). Teaching millenials, our newest cultural cohort. *The Education Digest*, *71*(4), 12–16.

Merriam, S. B. (2001). Andragogy and self-directed learning: Pillars of adult learning theory. *New Directions for Adult and Continuing Education*, *2001*(89), 3–13. https://doi.org/10.1002/ace.3

Merriam, S. B., & Baumgartner, L. M. (2020). *Learning in adulthood: A comprehensive guide* (4th ed.). Jossey-Bass.

Mezirow, J. (1997). Transformative learning: theory to practice. *New Directions for Adult and Continuing Education*, *74*, 5–12.

Newton, P. M., & Miah, M. (2017). Evidence-based higher education – is the learning styles 'myth' important? *Frontiers in Psychology*, *8*, 1–9. https://doi.org/10.3389/fpsyg.2017.00444

Niemczyk, M. (2020). Ensuring success by using the 4 As of learning. In S. K. Kearns, T. J. Mavin, & S. Hodge (Eds.), *Engaging the next generation of aviation professionals* (pp. 119–132). Routledge.

Niemczyk, M., & Ulrich, J. W. (2009). Workplace preferences of millennials in the aviation industry. *International Journal of Applied Aviation Studies*, *9*(2), 207–219.

OCED. (2021). *Education at a glance 2021: OCED indicators*. https://doi.org/10.1787/b35a14e5-en

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest*, *9*(3), 103–119.

Philbin, M., Meier, E., Huffman, S., & Boverie, P. (1995). A survey of gender and learning styles. *Sex Roles*, *32*(7-8), 485–494. https://doi.org/10.1007/bf01544184

Rachal, J. (1983). The andragogy-pedagogy debate: Another voice in the fray. *Lifelong Learning: The Adult Years*, *6*(9), 14–15.

Revilla, M., & Ochoa, C. (2017). Ideal and maximum length for a web survey. *International Journal of Market Research*, *59*(5), 557–565. https://doi.org/10.2501/IJMR-2017-039

Richardson, D., & Birge, B. (1995). Teaching physiology by combined passive (pedagogical) and active (andragogical) methods. *Advances in Physiology Education*, *13*(1), S66–S74.

Richmond, A. S., & Cummings, R. (2005). Implementing Kolb's learning styles into online distance education. *International Journal of Technology in Teaching and Learning*, *1*(1), 45–54.

Richmond, A. S., & Liu, L. (2005). Student learning styles of traditional courses versus online distance courses. In C. Crawford, R. Carlsen, I. Gibson, K. McFerrin, J. Price, R. Weber, & D. A. Willis (Eds.), *Technology & teacher education annual* (pp. 576–578). AACE.

Roberts, B. W., & Mroczek, D. (2008). Personality trait change in adulthood. *Current Directions in Psychological Science*, *17*(1), 31–35. https://doi.org/doi:10.1111/j.1467-8721.2008.00543.x

Robertson, M. F., & Putnam, A. (2008). Personality types of student pilots admitted to the aviation flight program at Southern Illinois University Carbondale. *Collegiate Aviation Review International*, *26*(1), 111–124. https://doi.org/10.22488/okstate.18.100370

Robinson, J.-A., Scollan-Koliopoulos, M., Kamienski, M., & Burke, K. (2012). Generational differences and learning style preferences in nurses from a large metropolitan medical center. *Journal for Nurses in Staff Development*, *28*(4), 166–172. https://doi.org/10.1097/nnd.0b013e31825dfae5

Sakamoto, K. K., & Woodruff, R. (1992). Learning styles of medical school students in a problem-based learning model. *Journal of College Reading and Learning*, *24*(2), 1–10. https://doi.org/10.1080/10790195.1992.10849984

Schaffernak, H., Moesl, B., Vorraber, W., & Koglbauer, I. (2020). Potential augmented reality application areas for pilot education: An exploratory study. *Education Sciences*, *10*(4), 86–104. https://doi.org/10.3390/educsci10040086

Seemiller, C., Grace, M., Dal Bo Campagnolo, P., Mara Da Rosa Alves, I., & Severo De Borba, G. (2019). How generation z college students prefer to learn: A comparison of u.s. and brazil students. *Journal of Educational Research and Practice*, *9*(1), 349–368. https://doi.org/10.5590/jerap.2019.09.1.25

Shannon, D. M., & Davenport, M. A. (2001). *Using SPSS to solve statistical problems: A self-instruction guide*. Merrill Prentice Hall.

Stitt-Gohdes, W. L., Crews, T. B., & McCannon, M. (Spring 1999). Business teachers' learning and instructional styles. *Delta Pi Epsilon Journal*, *41*(2), 71–88.

Stitt-Gohdes, W. L. (Summer 2001). Business education students' preferred learning styles and their teachers' preferred instructional styles: Do they match? *Delta Pi Epsilon Journal*, *43*(3), 137–151.

The Myers & Briggs Foundation. (2021a). *The Myers & Briggs Foundation*. Extraversion or Introversion. Retrieved March 6, 2021, from https://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/extraversion-or-introversion.htm

The Myers & Briggs Foundation. (2021b). *The Myers & Briggs Foundation*. https://www.myersbriggs.org

The Myers & Briggs Foundation. (2021c). *The Myers & Briggs Foundation*. Judging or Perceiving. Retrieved March 6, 2021, from https://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/judging-or-perceiving.htm

The Myers & Briggs Foundation. (2021d). *The Myers & Briggs Foundation*. Sensing or Intuition. Retrieved March 6, 2021, from https://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/sensing-or-intuition.htm

The Myers & Briggs Foundation. (2021e). *The Myers & Briggs Foundation*. Thinking or Feeling. Retrieved March 6, 2021, from https://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/thinking-or-feeling.htm

Thiele, J. E. (2003). Learning patterns of online students. *Journal of Nursing Education*, *42*(8), 364–366. https://doi.org/10.3928/0148-4834-20030801-08

Thompson, P. (2013). How digital native learners describe themselves. *Education and Information Technologies, 20*(3), 467–484. https://doi.org/10.1007/s10639-013-9295-3

Tolbize, A. (2008). *Generational differences in the workplace* [Manuscript]. http://dwashingtonllc.com/pdf/generational_differences_workplace.pdf

Troester, K. (2018, July 25). How will we train Generation Z? *Training Industry*. Retrieved March 10, 2021, from https://trainingindustry.com/blog/strategy-alignment-and-planning/how-will-we-train-generation-z/

Turney, M. (1994, October 7). *Women's Learning and Leadership Styles: Impact on Crew Resource Management* [Paper Presentation]. University Aviation Association, New Orleans, LA, United States.

U.S. Bureau of Labor Statistics. (2020, September 1). *Occupational Outlook Handbook, Airline and Commercial Pilots, Job Outlook*. U.S. Bureau of Labor Statistics Occupational Outlook Handbook. Retrieved February 20, 2021, from https://www.bls.gov/ooh/transportation-and-material-moving/airline-and-commercial-pilots.htm#tab-6

United Airlines. (2021, December 3). *United takes pilot development to greater heights: United Aviate Academy's first class to start Dec. 6 at new training facility in Phoenix* [Press release]. https://www.united.com/en/us/newsroom/announcements/united-takes-pilot-development-to-greater-heights-united-aviate-academy

Urick, M. (2016). Adapting training to meet the preferred learning styles of different generations. *International Journal of Training and Development, 21*(1), 53–59. https://doi.org/10.1111/ijtd.12093

Van Zwanenberg, N., Wilkinson, L. J., & Anderson, A. (2000). Felder and silverman's index of learning styles and honey and mumford's learning styles questionnaire: How do they compare and do they predict academic performance? *Educational Psychology*, *20*(3), 365–380. https://doi.org/10.1080/713663743

Westbrook, R. B. (1993). John Dewey. *Prospects*, *23*(1-2), 277–291.

Williams, C. J., Matt, J. J., & O'Reilly, F. L. (2014). Generational perspective of higher education online student learning styles. *Journal of Education and Learning*, *3*(2), 33–51. https://doi.org/10.5539/jel.v3n2p33

Willingham, D. T., Hughes, E. M., & Dobolyi, D. G. (2015). The scientific status of learning styles theories. *Teaching of Psychology*, *42*(3), 266–271. https://doi.org/10.1177/0098628315589505

Wilson, M., & Gerber, L. E. (2008). How generational theory can improve teaching: Strategies for working with the "millennials". *Currents in teaching and learning*, *1*(1), 29–44.

Wininger, S. R., Redifer, J. L., Norman, A. D., & Ryle, M. K. (2019). Prevalence of learning styles in educational psychology and introduction to education textbooks: A content analysis. *Psychology Learning & Teaching*, *18*(3), 221–243. https://doi.org/10.1177/1475725719830301

Zywno, M. S. (2003, June). *A contribution to validation of score meaning for Felder-Soloman's Index of Learning Styles* [In Proceedings of the 2003 American Society for Engineering Education annual conference & exposition (Vol. 119, No. 1-5)]. American Society for Engineering Education, Washington, DC, United States.

Appendix A

Pilot Learning Style Survey - Dissertation

Start of Block: Survey Description

This survey is designed to determine if there is a relationship in individual learning styles among pilots and non-pilots, among Baby Boomer, Generation X, Generation Y, and Generation Z generations of pilots, and between different genders among pilots.

End of Block: Survey Description

Start of Block: Informed Consent

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

INFORMATION LETTER
for a Research Study entitled
"Training the Emerging Pilot Workforce:
Does Generation and Gender Influence Curriculum Development?"

You are invited to participate in a research study to determine if there is a relationship in individual learning styles among pilots and non-pilots, among Baby Boomer, Generation X, Generation Y, and Generation Z generations of pilots, and between different genders among pilots. The study is being conducted by Kurt Reesman, Ph.D. candidate, under the direction of Dr. James Witte, Chair in the Auburn University Department of Aviation. You were selected as a possible participant because you are identified as someone who falls into one of the four generational categories and is age 18 or older.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to complete an online survey that consists of demographic information and the Felder-Soloman Index of Learning Styles questionnaire. The Felder-Soloman Index of Learning Styles questionnaire consists of 44 multiple-choice questions which have only two possible answers. Your total time commitment will be approximately 5-10 minutes.
Are there any risks or discomforts? The risk, loss of confidentiality, associated with participating in this study is minimal to none. You may stop and exit at any time during the survey, or you may choose not to answer any question.

Are there any benefits to yourself or others? Participants will not directly benefit from this study. Findings from this study will be used to inform curriculum development and instructional techniques for learners in aviation training programs.

Will you receive compensation for participating? Because participants are not identifiable, compensation for participation is not possible.

Are there any costs? There will be no costs to you if you choose to participate in this research effort other than your time.

If you change your mind about participating, you can withdraw at any time during the study by closing your browser window. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. This study is designed so that a person's identity will not be identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the Department of Aviation, or the Department of Adult Education.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by not asking for identifiable information, nor will your IP or email address be recorded as you complete this survey online. Information obtained through your participation may be used in a Ph.D. dissertation and possibly published in a professional journal or presented at a professional meeting.

If you have questions about this study, please contact Kurt Reesman at klr0051@auburn.edu or James Witte at witteje@auburn.edu.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

The Auburn University Institutional Review Board has approved this document for use from September 13, 2021 to --------- Protocol #21-432 EX 2109, Reesman

HAVING READ THE INFORMATION ABOVE, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, PLEASE SELECT "YES, I GIVE MY CONSENT" BELOW.

- ○ Yes, I give my consent
- ○ No, I do not give my consent

Skip To: End of Survey If HAVING READ THE INFORMATION ABOVE, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PR... = No, I do not give my consent

End of Block: Informed Consent

Start of Block: Demographics

What is your Gender?

- ○ Male
- ○ Female
- ○ Other or Non-Binary (please specify)

_____

- ○ Prefer not to answer

What is your Ethnicity?

- ○ Hispanic or Latino
- ○ Not Hispanic or Latino
- ○ Prefer not to answer

What is your Race?

- ○ White
- ○ Black or African American
- ○ American Indian or Alaska Native
- ○ Asian
- ○ Native Hawaiian or Pacific Islander
- ○ Other (please specify)

_____

- ○ Prefer not to answer

What **year** were you **born**?

_____

What is your **highest** Education Level completed?

- ○ High school or equivalent (for example: GED)
- ○ Some college credit, no degree
- ○ Associate's Degree
- ○ Bachelor's Degree
- ○ Master's Degree
- ○ Doctoral Degree
- ○ Professional Degree (please specify)

_____

End of Block: Demographics

Start of Block: StudentInfo

Are you **currently** a college/university student?

- ○ Yes
- ○ No

Skip To: End of Block If Are you currently a college/university student? = No

What college/university are you **currently** attending?

_____

What is your College Major or Area of Study?

- ○ Art
- ○ Aviation/Aeronautics
- ○ Communication/Journalism
- ○ Economics
- ○ English
- ○ History
- ○ Music
- ○ Philosophy
- ○ Political Science
- ○ Psychology
- ○ Sociology, Anthropology, & Social Work
- ○ Speech, Language, and Hearing Sciences
- ○ Theater and Dance
- ○ World Languages, Literatures, and Cultures
- ○ Other (please specify)

_____

End of Block: StudentInfo

Start of Block: Pilot_InstructorInfo

Are you an FAA certificated pilot?

- ○ Yes
- ○ No

Skip To: End of Block If Are you an FAA certificated pilot? = No

What FAA pilot certificate(s) do you currently hold? (select all that apply)

- ☐ Student Pilot Certificate
- ☐ Private Pilot Certificate
- ☐ Instrument Rating
- ☐ Commercial Pilot Certificate
- ☐ Airline Transport Pilot Certificate
- ☐ Other (please specify) _____

What are your Total Flight Hours (approximately)

_____

Are you an FAA certificated instructor pilot?

- ○ Yes
- ○ No

Skip To: End of Block If Are you an FAA certificated instructor pilot? = No

What FAA instructor certificate(s) do you currently hold? (select all that apply)

- [ ] Flight Instructor (CFI)
- [ ] Flight Instructor - Instrument (CFII)
- [ ] Flight Instructor - Multi-Engine (MEI)
- [ ] Advanced Ground Instructor (AGI)
- [ ] Instrument Ground Instructor (IGI)
- [ ] Other (please specify)

_____

What are your Total Instructor Hours (approximately)

_____

End of Block: Pilot_InstructorInfo

Start of Block: OccupationInfo

From the options below, choose which best describes your current occupation (if employed).

- ○ Employed, non-aviation related (please specify Job Title or brief description)

_____

- ○ Employed, aviation related, non-flying (please specify Job Title or brief description

_____

- ○ Employed, aviation related, pilot or flying
- ○ Not employed

Skip To: End of Block If From the options below, choose which best describes your current occupation (if employed). = Not employed

What company do you work for?

- ○ American Airlines
- ○ Delta Air Lines
- ○ Southwest Airlines
- ○ United Airlines
- ○ Auburn University
- ○ Middle Tennessee State University
- ○ Other _____

End of Block: OccupationInfo

Start of Block: Directions

INDEX OF LEARNING STYLES (ILS) SURVEY

This survey has 44 questions, each with only 2 possible answers. Please, select an answer to every question on the ILS survey so it can be scored correctly. Please **choose only one answer for each question**. If both answers seem to apply to you, **choose the one that applies more frequently**.

End of Block: Directions

Start of Block: SurveyQuestions

Q1 I understand something better after I

- ○ try it out
- ○ think it through

Q2 I would rather be considered

- realistic
- innovative

Q3 When I think about what I did yesterday, I am most likely to get

- a picture
- words

Q4 I tend to

- understand details of a subject but may be fuzzy about its overall structure
- understand the overall structure but may be fuzzy about details

Q5 When I am learning something new, it helps me to

- talk about it
- think about it

Q6 If I were a teacher, I would rather teach a course

- that deals with facts and real life situations
- that deals with ideas and theories

Q7 I prefer to get new information in

- pictures, diagrams, graphs, or maps
- written directions or verbal information

Q8 Once I understand

- all the parts, I understand the whole thing
- the whole thing, I see how the parts fit

Q9 In a study group working on difficult material, I am more likely to

- ○ jump in and contribute ideas
- ○ sit back and listen

Q10 I find it easier

- ○ to learn facts
- ○ to learn concepts

Q11 In a book with lots of pictures and charts, I am likely to

- ○ look over the pictures and charts carefully
- ○ focus on the written text

Q12 When I solve math problems

- ○ I usually work my way to the solutions one step at a time
- ○ I often just see the solutions but then have to struggle to figure out the steps to get to them

Q13 In classes I have taken

- ○ I have usually gotten to know many of the students
- ○ I have rarely gotten to know many of the students

Q14 In reading nonfiction, I prefer

- ○ something that teaches me new facts or tells me how to do something
- ○ something that gives me new ideas to think about

Q15 I like teachers

- ○ who put a lot of diagrams on the board
- ○ who spend a lot of time explaining

Q16 When I'm analyzing a story or a novel

- ○ I think of the incidents and try to put them together to figure out the themes
- ○ I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them

Q17 When I start a homework problem, I am more likely to

- ○ start working on the solution immediately
- ○ try to fully understand the problem first

Q18 I prefer the idea of

- ○ certainty
- ○ theory

Q19 I remember best

- ○ what I see
- ○ what I hear

Q20 It is more important to me that an instructor

- ○ lay out the material in clear sequential steps
- ○ give me an overall picture and relate the material to other subjects

Q21 I prefer to study

- ○ in a study group
- ○ alone

Q22 I am more likely to be considered

- ○ careful about the details of my work
- ○ creative about how to do my work

Q23 When I get directions to a new place, I prefer

- a map
- written directions

Q24 I learn

- at a fairly regular pace. If I study hard, I'll "get it"
- in fits and starts. I'll be totally confused and then suddenly it all "clicks"

Q25 I would rather first

- try things out
- think about how I'm going to do it

Q26 When I am reading for enjoyment, I like writers to

- clearly say what they mean
- say things in creative, interesting ways

Q27 When I see a diagram or sketch in class, I am most likely to remember

- the picture
- what the instructor said about it

Q28 When considering a body of information, I am more likely to

- focus on details and miss the big picture
- try to understand the big picture before getting into the details

Q29 I more easily remember

- something I have done
- something I have thought a lot about

Q30 When I have to perform a task, I prefer to

- master one way of doing it
- come up with new ways of doing it

Q31 When someone is showing me data, I prefer

- charts or graphs
- text summarizing the results

Q32 When writing a paper, I am more likely to

- work on (think about or write) the beginning of the paper and progress forward
- work on (think about or write) different parts of the paper and then order them

Q33 When I have to work on a group project, I first want to

- have "group brainstorming" where everyone contributes ideas
- brainstorm individually and then come together as a group to compare ideas

Q34 I consider it higher praise to call someone

- sensible
- imaginative

Q35 When I meet people at a party, I am more likely to remember

- what they look like
- what they said about themselves

Q36 When I am learning a new subject, I prefer to

- stay focused on that subject, learning as much about it as I can
- try to make connections between that subject and related subjects

Q37 I am more likely to be considered

- outgoing
- reserved

Q38 I prefer courses that emphasize

- concrete material (facts, data)
- abstract material (concepts, theories)

Q39 For entertainment, I would rather

- watch television
- read a book

Q40 Some teachers start their lectures with an outline of what they will cover. Such outlines are

- somewhat helpful to me
- very helpful to me

Q41 The idea of doing homework in groups, with one grade for the entire group,

- appeals to me
- does not appeal to me

Q42 When I am doing long calculations,

- I tend to repeat all my steps and check my work carefully
- I find checking my work tiresome and have to force myself to do it

Q43 I tend to picture places I have been

- easily and fairly accurately
- with difficulty and without much detail

Q44 When solving problems in a group, I would be more likely to

- ○ think of the steps in the solution process
- ○ think of possible consequences or applications of the solution in a wide range of areas

End of Block: SurveyQuestions

Start of Block: ThankYou

Thank you for taking the time to complete this survey. Your participation will contribute to our efforts to improve the pilot training process.

End of Block: ThankYou

Appendix B

Index of Learning Styles*
Richard M. Felder
Barbara A. Soloman

Directions:

Enter your answers to every question on the ILS scoring sheet. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I
- **a)** try it out.
- **b)** think it through.

2. I would rather be considered
- **a)** realistic.
- **b)** innovative.

3. When I think about what I did yesterday, I am most likely to get
- **a)** a picture.
- **b)** words.

4. I tend to
- **a)** understand details of a subject but may be fuzzy about its overall structure.
- **b)** understand the overall structure but may be fuzzy about details.

5. When I am learning something new, it helps me to
- **a)** talk about it.
- **b)** think about it.

6. If I were a teacher, I would rather teach a course
- **a)** that deals with facts and real life situations.
- **b)** that deals with ideas and theories.

7. I prefer to get new information in
- **a)** pictures, diagrams, graphs, or maps.
- **b)** written directions or verbal information.

8. Once I understand
- **a)** all the parts, I understand the whole thing.
- **b)** the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to
- **a)** jump in and contribute ideas.
- **b)** sit back and listen.

10. I find it easier
- **a)** to learn facts.
- **b)** to learn concepts.

11. In a book with lots of pictures and charts, I am likely to
- **a)** look over the pictures and charts carefully.
- **b)** focus on the written text.

12. When I solve math problems
- **a)** I usually work my way to the solutions one step at a time.
- **b)** I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken
- **a)** I have usually gotten to know many of the students.
- **b)** I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer
- **a)** something that teaches me new facts or tells me how to do something.
- **b)** something that gives me new ideas to think about.

15. I like teachers
- **a)** who put a lot of diagrams on the board.
- **b)** who spend a lot of time explaining.

16. When I'm analyzing a story or a novel
- **a)** I think of the incidents and try to put them together to figure out the themes.
- **b)** I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to
- **a)** start working on the solution immediately.
- **b)** try to fully understand the problem first.

18. I prefer the idea of
- **a)** certainty.
- **b)** theory.

19. I remember best
- **a)** what I see.
- **b)** what I hear.

20. It is more important to me that an instructor
- **a)** lay out the material in clear sequential steps.
- **b)** give me an overall picture and relate the material to other subjects.

21. I prefer to study
- **a)** in a study group.
- **b)** alone.

22. I am more likely to be considered
- **a)** careful about the details of my work.
- **b)** creative about how to do my work.

23. When I get directions to a new place, I prefer
- **a)** a map.
- **b)** written instructions.

24. I learn
- **a)** at a fairly regular pace. If I study hard, I'll "get it."
- **b)** in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first
a) try things out.
b) think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to
a) clearly say what they mean.
b) say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember
a) the picture.
b) what the instructor said about it.

28. When considering a body of information, I am more likely to
a) focus on details and miss the big picture.
b) try to understand the big picture before getting into the details.

29. I more easily remember
a) something I have done.
b) something I have thought a lot about.

30. When I have to perform a task, I prefer to
a) master one way of doing it.
b) come up with new ways of doing it.

31. When someone is showing me data, I prefer
a) charts or graphs.
b) text summarizing the results.

32. When writing a paper, I am more likely to
a) work on (think about or write) the beginning of the paper and progress forward.
b) work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to
a) have "group brainstorming" where everyone contributes ideas.
b) brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone
a) sensible.
b) imaginative.

35. When I meet people at a party, I am more likely to remember
a) what they looked like.
b) what they said about themselves.

36. When I am learning a new subject, I prefer to
a) stay focused on that subject, learning as much about it as I can.
b) try to make connections between that subject and related subjects.

37. I am more likely to be considered
a) outgoing.
b) reserved.

38. I prefer courses that emphasize
a) concrete material (facts, data).
b) abstract material (concepts, theories).

39. For entertainment, I would rather
a) watch television.
b) read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
a) somewhat helpful to me.
b) very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,
a) appeals to me.
b) does not appeal to me.

42. When I am doing long calculations,
a) I tend to repeat all my steps and check my work carefully.
b) I find checking my work tiresome and have to force myself to do it.

43. I tend to picture places I have been
a) easily and fairly accurately.
b) with difficulty and without much detail.

44. When solving problems in a group, I would be more likely to
a) think of the steps in the solution process.
b) think of possible consequences or applications of the solution in a wide range of areas.

Index of Learning Styles – Report of Results

ACT												**REF**
	11a	9a	7a	5a	3a	1a	1b	3b	5b	7b	9b	11b
SEN												**INT**
	11a	9a	7a	5a	3a	1a	1b	3b	5b	7b	9b	11b
VIS												**VRB**
	11a	9a	7a	5a	3a	1a	1b	3b	5b	7b	9b	11b
SEQ												**GLO**
	11a	9a	7a	5a	3a	1a	1b	3b	5b	7b	9b	11b

- If your score on a scale is 1-3, you are fairly well balanced on the two dimensions of that scale.
- If your score on a scale is 5 or 7, you have a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favors that dimension.
- If your score on a scale is 9 or 11, you have a very strong preference for one dimension of the scale. You may have real difficulty learning in an environment which does not support that preference.

Appendix C

E-MAIL INVITATION FOR ON-LINE SURVEY

Dear _____,

I am a graduate student in the Department of Aviation at Auburn University. You are invited to participate in a research study entitled "Training the Emerging Pilot Workforce: Does Generation and Gender Influence Curriculum Development?" where I seek to answer the following three questions:

1. What is the relationship in the learning styles or preferences between non-pilots and pilots?
2. What is the relationship in the learning styles or preferences between Baby Boomer, Generation X, Generation Y (Millennials), and Generation Z generations in the pilot population?
3. What is the relationship in the learning styles or preferences between genders in the pilot population?

You may participate if you are 18 years or older.

Participants are asked to complete an anonymous, on-line survey which will only take approximately 5-10 minutes. You will experience minimal to no risks, loss of confidentiality, for participation in this study. **Because participants are not identifiable, compensation for participation is not possible.** There are no costs to the participant.

If you would like to know more information about this study, an information letter can be obtained by sending me an e-mail to Kurt Reesman at klr0051@auburn.edu. If you decide to participate after reading the letter, you can access the survey from the link below.

If you have any questions, please contact me at klr0051@auburn.edu or my advisor, Dr. James Witte at witteje@auburn.edu.

Thank you for your consideration,

Kurt Reesman
PhD Candidate
Auburn University

Survey Link: https://auburn.qualtrics.com/jfe/form/SV_88HSBAVREFUHLE1

Appendix D

SOCIAL MEDIA INVITATION FOR ON-LINE SURVEY

Calling All Pilots (and Non-Pilots)

My name is Kurt Reesman and I am an Adult Education Ph.D. candidate teaching in the Department of Aviation at Auburn University. I invite you to participate in my research study entitled *Training the Emerging Pilot Workforce: Does Generation and Gender Influence Curriculum Development?* With your help, I will learn more about the following three questions:

1. Do non-pilots and pilots have different learning styles or preferences?
2. Do pilots in the Baby Boomer, Generation X, Generation Y (Millennials), and Generation Z generations have learning styles or preferences that differ from each other?
3. Do male pilots and female pilots have different learning styles or preferences?

You may participate if you are 18 years or older.

I am asking that you take 5-10 minutes of your time to complete an anonymous, on-line survey that asks you to provide basic demographic information and then answer 44 questions that only have 2 possible answers each. These questions are from the Felder and Solomon Index of Learning Styles questionnaire. If you are interested and eligible to participate, click the link below to begin the survey.

If you would like to know more information, or have any questions about this study, you can send an email to Kurt Reesman at klr0051@auburn.edu or my advisor, Dr. James Witte at witteje@auburn.edu.

Thank you for your consideration,

Kurt Reesman, Lt Col, USAF (retired)
Ph.D. Candidate / Lecturer
Department of Aviation
Auburn University

Survey Link: https://auburn.qualtrics.com/jfe/form/SV_88HSBAVREFUHLE1

Appendix E

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

INFORMATION LETTER
for a Research Study entitled
"*Training the Emerging Pilot Workforce: Does Generation and Gender Influence Curriculum Development?*"

You are invited to participate in a research study to determine if there is a relationship in individual learning styles among pilots and non-pilots, among Baby Boomer, Generation X, Generation Y, and Generation Z generations of pilots, and between different genders among pilots. The study is being conducted by Kurt Reesman, Ph.D. candidate, under the direction of Dr. James Witte, Chair in the Auburn University Department of Aviation. You were selected as a possible participant because you are identified as someone who falls into one of the four generational categories and is age 18 or older.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to complete an online survey that consists of demographic information and the Felder-Soloman Index of Learning Styles questionnaire. The Felder-Soloman Index of Learning Styles questionnaire consists of 44 multiple-choice questions which have only two possible answers. Your total time commitment will be approximately 5-10 minutes.

Are there any risks or discomforts? The risk, loss of confidentiality, associated with participating in this study is minimal to none. You may stop and exit at any time during the survey, or you may choose not to answer any question.

Are there any benefits to yourself or others? Participants will not directly benefit from this study. Findings from this study will be used to inform curriculum development and instructional techniques for learners in aviation training programs.

Will you receive compensation for participating? Because participants are not identifiable, compensation for participation is not possible.

Are there any costs? There will be no costs to you if you choose to participate in this research effort other than your time.

If you change your mind about participating, you can withdraw at any time during the study by closing your browser window. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. This study is designed so that a person's identity will not be identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the Department of Aviation, or the Department of Adult Education.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by not asking for identifiable information, nor will your IP or email address be recorded as you complete this survey online. Information obtained through your participation may be used in a Ph.D. dissertation and possibly published in a professional journal or presented at a professional meeting.

If you have questions about this study, please contact Kurt Reesman at klr0051@auburn.edu or James Witte at witteje@auburn.edu.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION ABOVE, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, PLEASE CLICK ON THE LINK BELOW.
YOU MAY PRINT A COPY OF THIS LETTER TO KEEP.

_____

Investigator, Kurt Reesman Date

_____

Co-Investigator, Dr. James Witte Date

The Auburn University Institutional Review Board has approved this document for use from _____ to _____. Protocol #_____

Link to Survey:
https://auburn.qualtrics.com/jfe/form/SV_88HSBAVREFUHLE1