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Do Different Learning Style Inventories Report Similar Findings Among Pilots?

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This study investigated the gender and generational learning preferences of pilots and non-pilots and the gender and generational differences among the pilots surveyed. The Felder and Soloman Index of Learning Styles questionnaire measured 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 scales, and males scored higher on the Visual aspect of that scale. Generation variation occurred between Generation X and Y, where Generation Y favored the Sensing learning style more than Generation X. Among pilots, males scored higher than females on the Visual preference, and Generation Y and Z preferred the Sensing learning style. Generation Z favored the Sequential learning style more than Generation X. Curriculum design, instructional methodologies, 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.

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Introduction

Mandatory age-related pilot retirements and industry growth have resulted in air carriers recruiting younger, less experienced pilots when compared to past industry hiring cycles. Researchers have looked to understand the most effective approaches to educating student pilots. Efforts over the last 25 years have yielded some insight into the learning styles or preferences by using a variety of learning style inventories (Brady et al., 2001; Chui et al., 2020; Fanjoy & Gao, 2011; Fussell et al., 2018; Gao et al., 2013; Kanske & Brewster, 2001). Using existing measurement tools, aviation scholars have sought to determine if student pilots displayed learning preferences unique to the aviation industry. Measurement tools used have been the Visual, Auditory, Read/Write, and Kinesthetic (VARK) or VAK, which is a form of the VARK, the Kolb Learning Style Inventory (KLSI), the Five Factor Model (FFM), and the Myers-Briggs Type Indicator (MBTI). The FFM and MBTI are personality inventories but have been used to see if learning preferences could be associated with personality types. This study used a learning style inventory yet to be identified in the literature for pilots; the Felder and Soloman Index of Learning Styles (ILS). The findings from this research will be compared with previous research for consistency and to note any differences in the emerging pilot workforce, Generations Y (or Millennials) and Z, who have been labeled as digital natives (Prensky, 2001), as well as any gender variations.

Review of Learning Style Inventories in Aviation

VARK/VAK

Chui et al. (2020) used the VARK model, developed by Fleming, to understand how visual and auditory systems contribute to the learning process. 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). Their study sampled 18 Generation Z college students (Mean age = 21.89 years).

Significant learning occurs after a flight when a thorough event debrief is conducted. This feedback can have a meaningful impact on the learning process but is often neglected. Chui et al. (2020) cite others who mention four attributes of feedback: 1. the nature of the feedback (i.e., content – “what”); 2. the temporal dimension of the feedback (i.e., frequency and timeliness – “when”); 3. the 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 an important aspect of aviation training for debriefing a maneuver or flight.

Chui et al. (2020) focused on the relationship between feedback type, visual or auditory, and the pilot's preference for learning, visual or auditory, based on 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 were observed (i.e., crossover interaction), and these differences were most notable for auditory learners. Specifically, when auditory learners were presented with 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 with 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, the auditory learner is at a disadvantage if they only receive visual feedback. Chui et al. (2020) note that only focusing on two of the four VARK learning dimensions was a limitation of this study. It remains unknown if the read/write and kinesthetic styles would have been affected similarly.

Karp (2000) noted a difference in the learning style preferences of 117 pilots and the type of classroom instruction they received. He used visual, auditory, and hands-on (kinesthetic) (VAK) to determine the pilot's predominant learning style. 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 suggesting that course designers were unaware of the student learning styles or that matching the teaching style to the learning style provided the best educational experience.

KLSI

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 they want to do it themselves instead of someone showing them how to do it. Kanske identified *assimilator* as 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) concluded that the current demonstration/performance mode of teaching works well for both styles.

Kanske and Brewster (2001) researched the learning style preferences of college aviation students. They found that the predominant college aviation student learning style was *assimilator*, followed by *converger*, then *accommodator*, and lastly, *diverger*. The first two learning styles comprised nearly two-thirds of this study's college students. The first two styles are consistent with Kanske's research with Air Force pilots.

The data from the Fussell et al. (2018) study, which sampled 41 university flight students, revealed that the Concrete-Experiential (CE), where the learner encounters a new or reinterpreted experience, scores of 19 Generation Z aviation students were in the 80th percentile or higher when compared to population norms. Those who begin the learning cycle at the CE stage prefer to learn by being involved in an experience and working with feelings instead of theories. The scores of 16 aviation students were in the 80th percentile or higher of the Reflective-Observation (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 CE and RO orientation scores within the study align 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).

FFM

The FFM inventory comprises *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 focus on their external environment and thrive on the stimulation they receive. 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 of human nature and will get along with others. The *conscientiousness* trait exemplifies the desire to do well and usually indicates a high level of organization and efficiency. Low *neuroticism* shows that these student pilots were less anxious or worried and could cope with high levels of stress (Gao & Kong, 2016).

MBTI

The personality assessment tool appearing most in the literature 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) (Kutz et al., 2004). An individual's test result will indicate the strongest characteristic of each pair. There are 16 different personality types, or combinations, possible. Brownfield (1993) identified 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 instead 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 & Woodruff, 1992). *Sensing* students are fact and detail-oriented, while *intuitive* students prefer the larger picture and the ability to examine the relationships between concepts (Brownfield, 1993). Lawrence (1993) suggests *thinking* students are often impersonal and use a logical decision-making process 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 and 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 integral part of the educational process, and the *judging-perceiving* scale addresses this aspect. *Judging* students prefer a more structured learning environment and concrete assignments while *perceiving* students prefer 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 who fall into the Generation Y group. They found that most aviation management students were ESTJ, while the professional pilot students were ESTP. Both liked group work, talking, trial and error, as well as dealing with facts in a logical and structured manner. The only real difference between the two was that professional pilot students preferred a less structured, more flexible learning environment. Robertson and Putnam (2008) found that the most common personality types in the population of student pilots surveyed in their study were the ENFP, ISTP, ISTJ, ENTP, and INFP personality types which do not correspond to the Kutz et al. (2004) findings. Fussell et al. (2018) observed that the predominant student pilot MBTI personality type was ISJT. 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.

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. They rely on their observations, 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 and alternative solutions and should ensure 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 that when designing a course or learning experience for aviation students, an instructor should incorporate information on systems and procedures, encourage discussion of past experiences so students may learn from their peers, and engage students in practical exercises to strengthen skills. However, it must be pointed out 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 by the KLSI. In addition, Brownfield (1993) suggested that a perfect correlation between personality type and learning style is not possible because of the many variables involved; however, the MBTI can identify various 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).

Study Introduction

The research efforts previously discussed were either done nearly two decades ago or chose a different learning style inventory. One learning style tool that seems to be absent in the literature for pilots is the Felder and Solomon Index of Learning Styles© (ILS) (Felder & Soloman, n.d.-a). This research effort used the ILS to answer the following research questions (RQs):

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?

Assumptions

The following assumptions were made before 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 are 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.

Research Method

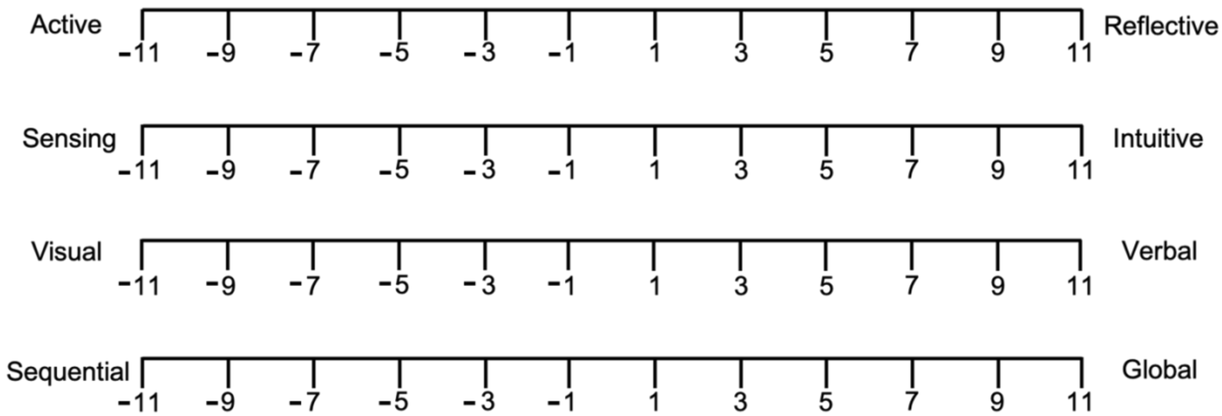
The survey design was used for this study. It was administered to a population sample of non-pilots and pilots in various career fields and fields of study. The survey sought to obtain data that might identify unique learning preferences for a non-pilot and a pilot. In addition, in the pilot category, this survey would reveal learning styles or preferences that may vary by gender and generation.

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. 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. The birth year was used to determine which generational category the participants were placed in. The generations were categorized as Silent Generation (1928-1945), Baby Boomers (1946-1964), Generation X (1965-1980), Generation Y (1981-1996), and Generation Z (1997-2012) (Dimock, 2019)

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). Graf et al. (2007) indicated that each learner has a personal preference for each of the four dimensions. Each scale is expressed similarly, -11 to +11 in increments of ±2 (i.e., -11, -9, -7, -5, -3, -1, +1, +3, +5, +7, +9, +11) as demonstrated in Figure 1. This range configuration is the result of the 11 questions that are posed for each dimension. This range configuration is the result of the 11 questions that are posed for each dimension totaling 44 questions contained on the ILS. There are only two possible answers for each question, “a” or “b.” Each question is scored either with a value of -1 (answer *a*) or +1 (answer *b*). Answer *a* corresponds to the preference for the first pole (left side) of each dimension (active, sensing, visual, or sequential), and answer *b* to the second pole (right side) of each dimension (reflective, intuitive, verbal, or global) (Graf et al., 2007). As an example, reference the *active-reflective* scale in Figure 1. An individual who answered “a” for four of the 11 questions related to that scale would have a minus four on the *active* side of the scale. By default, that person would have answered “b” for the other seven of the 11 questions related to that scale giving a score of positive seven on the *reflective* side of the scale. When you add the two scores together, the resulting score would be a positive seven on the *reflective* side of the scale. The larger number indicates which of the two options for that scale is the learner’s preference. When the two values are added together (-4 plus 7), the strength of preference that would be displayed for that person would be a three on the *reflective* scale and indicate a moderate preference for *reflective* 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 learn better in an environment with 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 1

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. This document is provided by the authors, along with permission to use the ILS, to those wishing to use this instrument in research. It is not published for individual access.

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

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. In contrast, *intuitive* learners are more comfortable with abstractions and are more likely to be rapid and innovative problem solvers (Felder & Brent, 2005). 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 (Felder & Brent, 2005). 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 are more likely to understand and remember information best by doing something active with it – discussing, applying, or explaining it to others. By contrast, *reflective* learners prefer to think about it quietly first (Felder & Brent, 2005). Lastly, responses to specific ILS questions focusing on the final scale will determine whether they are *sequential* or *global*. Sequential learners tend to think in a linear manner and can function with only a partial understanding of the material they have been taught. *Global* learners, on the other hand, 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 & Brent, 2005).

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

Sampling

The three variables of interest for this study included individuals represented in the FAA pilot status (i.e., yes or no), gender (i.e., male or female), and generations (Silent Generation, Baby Boomer, Generation X, Generation Y or Millennial, and Generation Z) categories. They were all found in the research sample group.

Among those sampled were students from three different Aviation Accreditation Board International (AABI) universities with FAA Part 141 flight programs and participants from aviation-related LinkedIn and Facebook pages.

ILS Internal Consistency and Reliability

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 concluded that if the ILS was used as 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 paper 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 the timing of retesting 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. (2003) 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. (2002) 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 1 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. (2000), 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 validated 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 1
Test-Retest Correlation Coefficients

Δ*t*	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 2), the expectation that all items measure a certain variable is necessary. If each part is consistent and points to what is to be measured, then it will be reliable. Cronbach's *alpha* is a test used to estimate a set of test items' 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 minimum acceptable *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, exceed Tuckman's acceptable standards 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 2
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.

In this study, using IBM SPSS V27, a Reliability Analysis procedure was used to measure the scale reliability of the Felder and Soloman Index of Learning Styles questionnaire. Table 3 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 3
Cronbach Alpha Coefficients

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

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 the 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. They 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.

Demographics of Participants

Survey invitations were extended to three higher education institutions 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 unknown, but each outreach option consisted of non-aviation and aviation individuals, male and female participants, and five generations of followers.

Nine hundred forty-seven individuals 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 was fairly evenly split across the other four generations: Baby Boomers – 24.4%, Generation X – 21.5%, Generation Y – 26.3%, and Generation Z – 25.8%. 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 comprised 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. Over half of the sample comprised 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 4. Descriptives for the study population learning styles broken down by pilot status are presented in Table 5, gender in Table 6, and by generation in Table 7. Tables 8 and 9 present Descriptives of Pilot Certificate and Pilot Generation by Gender, respectively.

Table 4

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 5
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 6
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 7
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 8
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 9
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%

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 unknown 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 the distribution of the survey to the potential participant pool.

Pilot status refers to whether an individual is a FAA certificated pilot or not. 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 military or internationally certificated pilots to be identified in the pilot group if they did not 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 was 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 non-aviation students enrolled at a Southeastern university. This assumption was solely based on the major selected and may not be entirely accurate. All social media sites used were connected to the aviation industry in some way. The LinkedIn and Facebook pages targeted for inviting participants were all pilot or pilot-group oriented. The newsletters, websites, and blogs were those of prominent influencers directing 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) and 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 initially 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, suggesting 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 variables 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.

Findings

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

A MANOVA was conducted on the entire participant population with all four ILS subscales (ACTREF, SENINT, VISVER, and SEQGLO) as the dependent variables (DVs) and Pilot status, Gender, and Generation as the independent variables. All assumptions were met except for the 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 robustness to the 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).

There was a statistically significant difference between pilots and non-pilots on learning styles ($F_{4, 696}$ = 7.222, p < .001; Wilks' Λ = .960; partial η^2 = .040). There was also a significant difference between males and females ($F_{4, 696}$ = 4.582, p = .001; Wilks' Λ = .974; partial η^2 = .026) and between generations ($F_{16, 2126.953}$ = 2.029, p = .009; Wilks' Λ = .955; partial η^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 10).

Table 10

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 the heterogeneity of variances.

Pilot Status

Two Mann-Whitney U tests examined potential differences between pilots and non-pilots in SENINT and VISVER. In both cases, the distributions between pilots and non-pilots were not similar. 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) than non-pilots (mean rank = 287.37; $U = 34550.000$, $z = -4.954$, $p < .001$). In both cases (SENINT and VISVER), the higher scores for pilots over non-pilots indicate that pilots preferred a more sensing and visual learning style than non-pilots.

The primary focus of research question one was on the 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 sub-group.

Gender

A Mann-Whitney U test examined potential differences between males and females in VISVER. The distributions between males and females were not similar. Males had significantly higher VISVER scores (mean rank = 373.75) compared to females (mean rank = 297.30; $U = 38017.500$, $z = -4.453$, $p < .001$), indicating that males preferred a more visual learning style than females.

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.

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?

Research questions two and three were answered using a single MANOVA only on the pilot participants. All four ILS subscales (ACTREF, SENINT, VISVER, and SEQGLO) were the dependent variables and Gender and Generation were the independent variables. All assumptions were met except homogeneity of the covariance-variance matrix and homogeneity of variances. The assumption of homogeneity of the covariance-variance matrix 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). 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).

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). 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 11).

Table 11
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 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 the heterogeneity of variances.

Gender

A Mann-Whitney U test examined potential differences between male and female pilots in VISVER. The distributions between males and females were not similar. Male pilots had significantly higher VISVER scores (mean rank = 279.01) compared to female pilots (mean rank = 223.64; $U = 18607.500$, $z = -3.420$, $p < .001$), indicating that males preferred a more visual learning style than females.

Generation

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

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 preferred 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 visuals; 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.

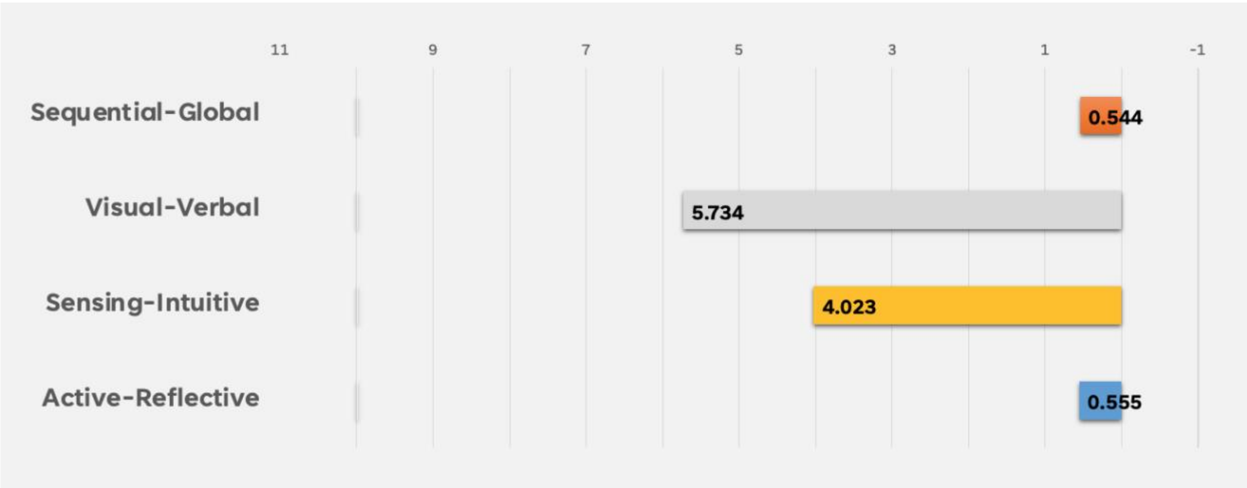
Pilot Population

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. However, each still preferred the visual side of that scale, consistent with the total sample population. Results for generations were different from the total sample population. The data indicate that Generation X had lower SENINT scores than Generations Y and Z and 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.

Data Visualization

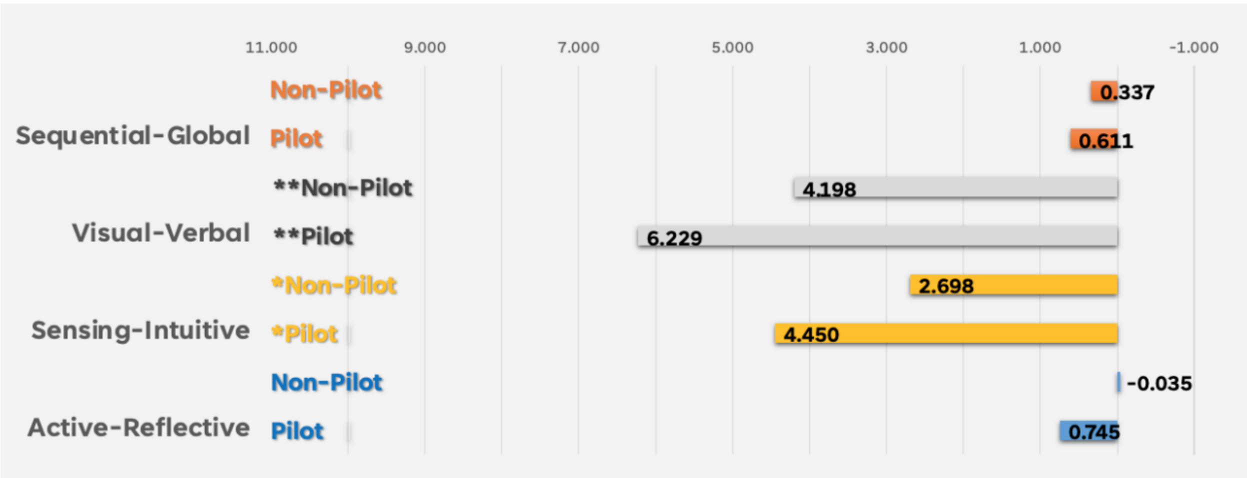
An interesting trend is noted when data for each research question is plotted on the four ILS scales of the ILS. Figure 2 indicates the learning preferences for the total study population. Figures 3, 4, and 5 indicate the learning preferences of the pilot status, gender, and generation, respectively, for the total study population. Figures 6 and 7 indicate the learning preferences for gender and generation, respectively, within the pilot group.

Figure 2
Total Population Learning Preference



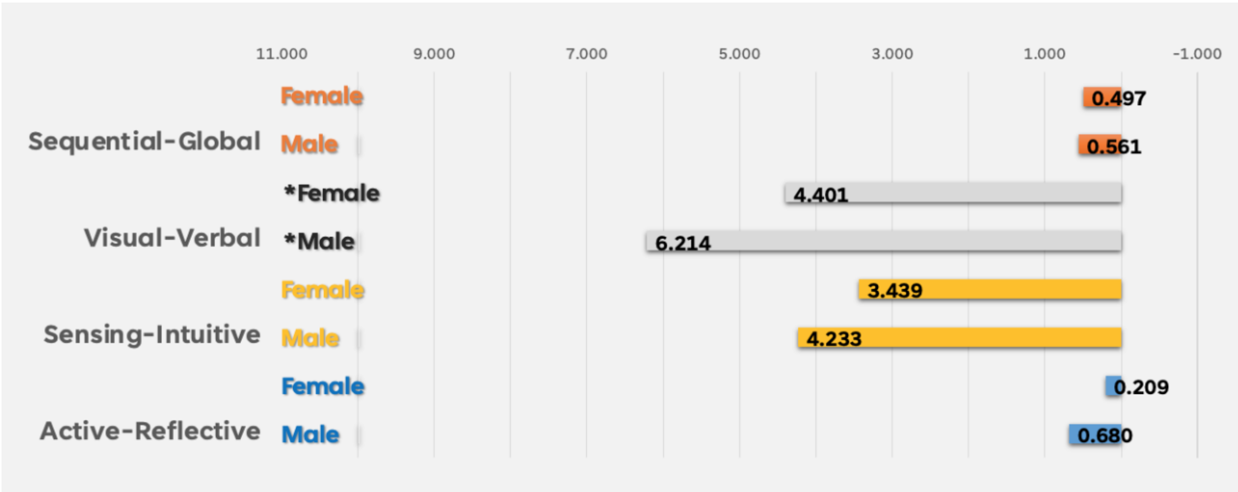
Note. Since all means favored the left side of each scale (i.e., sequential, visual, sensing, and active), only that side is displayed.

Figure 3
Total Population Learning Preference by Pilot Status



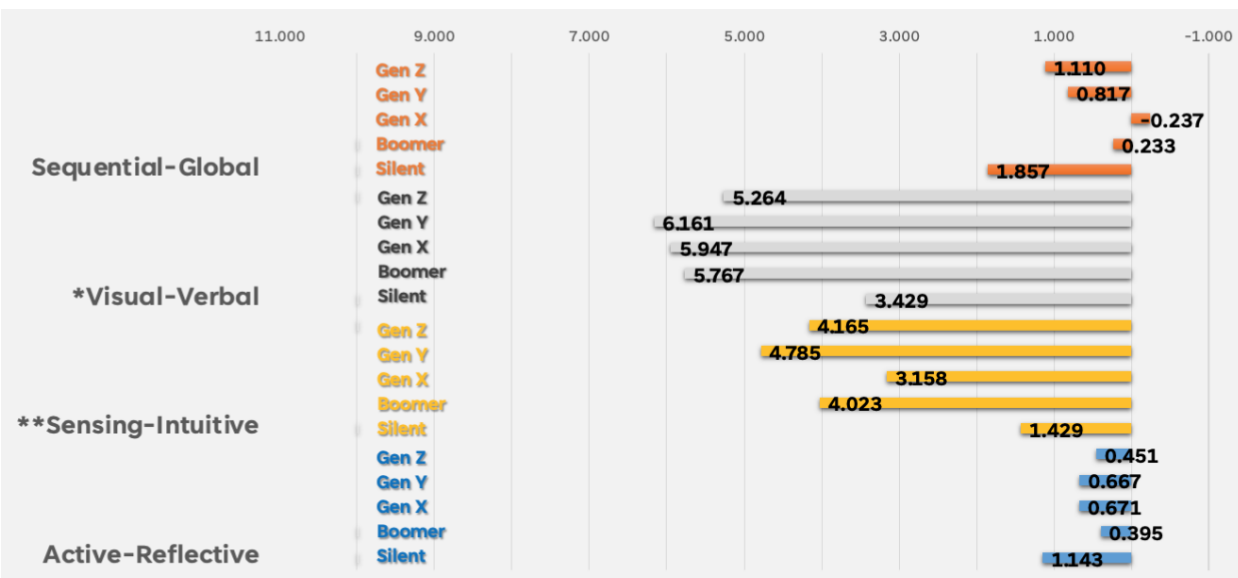
Note. Since all means favored the left side of each scale (i.e., sequential, visual, sensing, and active), only that side is displayed.

Figure 4
Total Population Learning Preference by Gender



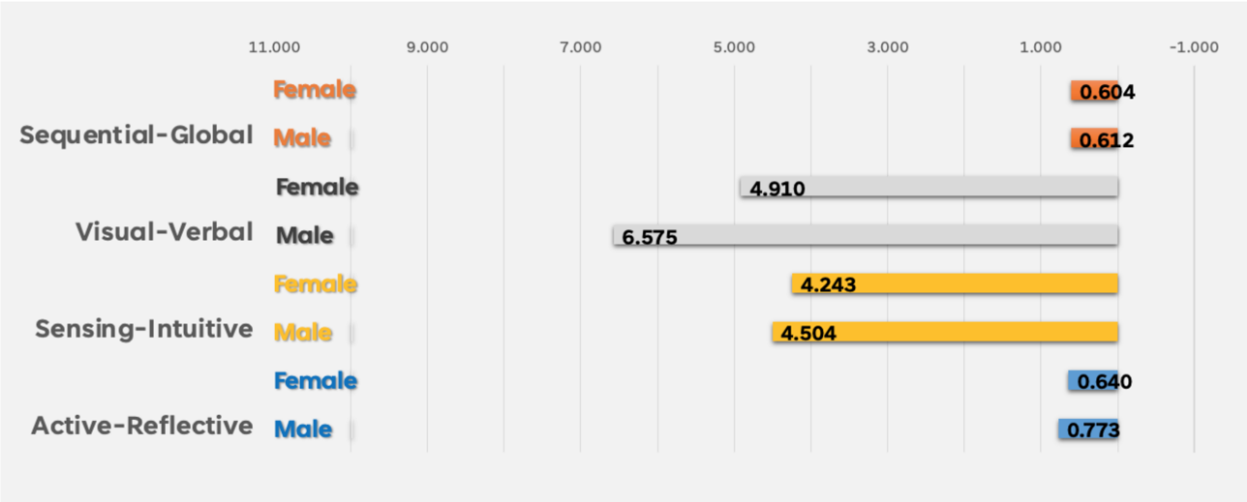
Note. Since all means favored the left side of each scale (i.e., sequential, visual, sensing, and active), only that side is displayed.

Figure 5
Total Population Learning Preference by Generation



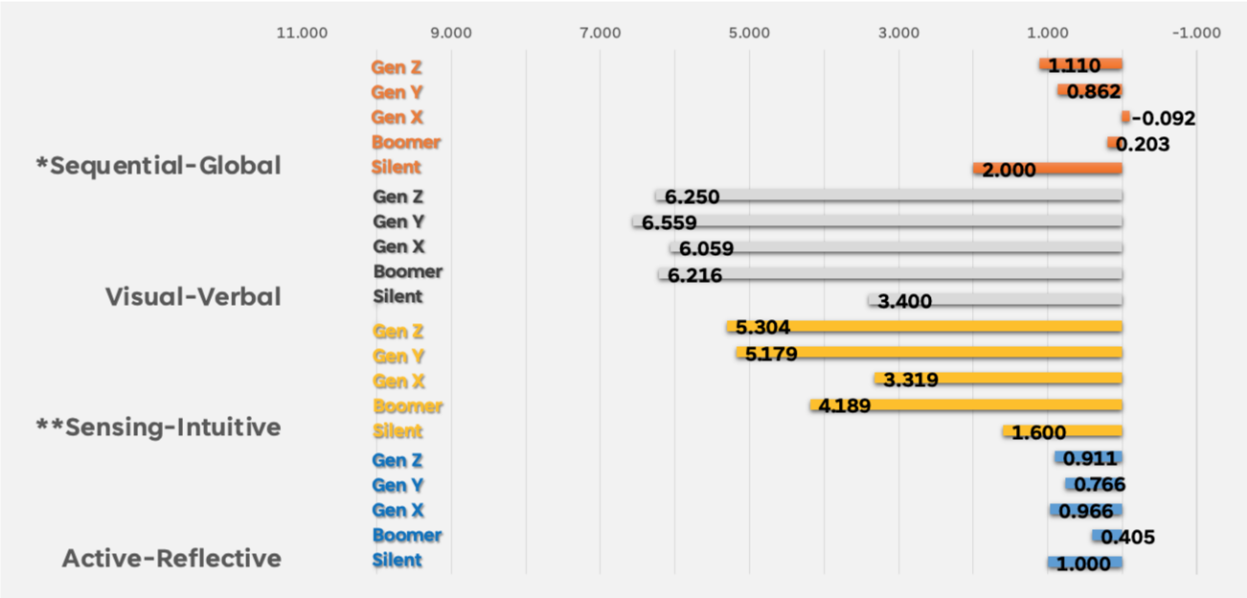
Note. Since all means favored the left side of each scale (i.e., sequential, visual, sensing, and active), only that side is displayed.

Figure 6
Pilot Population Learning Preference by Gender



Note. Since all means favored the left side of each scale (i.e., sequential, visual, sensing, and active), only that side is displayed.

Figure 7
Pilot Population Learning Preference by Generation



Note. Since all means favored the left side of each scale (i.e., sequential, visual, sensing, and active), only that side is displayed.

The first observation is that each group in this study indicated that visual information was most effectively perceived. Second, these groups also revealed that the type of information they preferred to perceive was sensory in nature. Felder and Solomon (n.d.-b) explain that visual learners remember best by seeing and that sensing learners tend to be concrete, practical, methodical, and oriented toward facts and hands-on procedures. All groups had a mild preference toward active learning or learning by doing as a means of processing information. The same can be said for each group except for Generation X, where the progress toward understanding is preferred in a sequential manner. Generation X displayed a mild preference for the global, or big picture, approach toward understanding.

Summary

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 relationship of pilot status, gender, and generation on learning styles?” The data indicate that 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. 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 for *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, indicating 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 prefer *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 moderately preferred 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 Boomers, 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 examining the *sequential-global* scale, data revealed that the Baby Boomer, Generation Y, and Generation Z generations had a mild preference for the *sequential* learning style. In contrast, Generation X slightly preferred 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. In contrast, Generation X had a mild to moderate preference for *sensing* learning preference. Finally, these data show that the Baby Boomer, Generation X, Generation Y, and Generation Z generations moderately preferred the *visual* learning 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. (2020) 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. Chui et al. (2020) noted that *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. Some researchers have attempted to identify the "best" learning environment based on an individual's personality style using the aspects of one's personality to define the ideal educational situation (e.g., an extrovert is outgoing and would prefer an active environment). These assumptions are drawn based on matching the definition of the terms used in each tool or theory. A review of the literature, however, did not reveal any studies that matched personality style to a particular learning environment. 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 in 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 *visual, sensing, active*, and *sequential*; however, not every pilot shares these same learning preferences.

The ILS questionnaire revealed not only 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 (Fanjoy, 2002; 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 more 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

Aviation training curriculum and program implementation should focus on *visual* and *sensing* learning styles because data from this study indicate a moderate preference for these learning styles, but not at the expense of the other styles. *Active* and *sequential* learning styles were favored on their respective scale, but participant responses indicated a mild preference (balanced or normal), meaning the learner could learn equally well using *active* or *reflective* and *sequential* or *global* learning 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.

It should be noted that the pilot training process takes place in a variety of environments using varying techniques. Ground training can be done in a classroom setting or a one-on-one scenario. Each of these orientations will differ in what training method works best. Classroom settings are limited to lecture and PowerPoint (visual, auditory, and sensing) with some hands-on (active) activities but have limited flexibility for changing teaching methods, while one-on-one scenarios allow an instructor to switch between techniques to enhance the learning experience. Flight training, on the other hand, is solely done one-on-one for pre-flight, in-flight, and post-flight instruction. Flight instructors may possibly have additional resources at his or her disposal (e.g., flight training devices, apps that replay training flights, etc.) to ensure the training process achieves its maximum potential and is only limited by the available resources where instruction is given. These assets can engage more of an individual's senses which will enhance the learning experience.

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. Focus on other demographics such as cultural background, ethnicity, race, geographic region, socio-economic status, level of education, college major, etc.
5. 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.

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