Journal of Aviation/Aerospace Education & Research

Volume 32 | Number 3 Article 3

2023

Universal Design for Learning (UDL): A Contemporary Approach to Professional Flight Instruction

Denise K. Whitford Ph.D., CFI/CFII
Purdue University, denisekwhitford@gmail.com

Bernard W. Wulle Ph.D., CFI/CFII/ATP
Purdue University, bwulle@purdue.edu

Nicoletta Fala Ph.D., CFI/CFII
Oklahoma State University - Main Campus, nfala@okstate.edu

Scholarly Commons Citation

Whitford, D. K., Wulle, B. W., & Fala, N. (2023). Universal Design for Learning (UDL): A Contemporary Approach to Professional Flight Instruction. *Journal of Aviation/Aerospace Education & Research, 32*(3). DOI: https://doi.org/10.58940/2329-258X.1983

Abstract

In the United States, an increasing number of aspiring professional pilots are teaching as Certificated Flight Instructors, presumably to reach the minimum required flight hours and move into airline flight operations. High-quality training is the foundation of a high–quality globalized aviation workforce, yet there has been a persistent lack of systemic in-depth guidance surrounding how instructors are taught how to teach aviation subject matter, justifying the need for incorporating the use of evidence-based and promising practices into flight instruction. In this article, we outline the integral components and the research basis of the universal design for learning (UDL) instructional framework. We then provide recommendations for utilizing universal design for learning during ground and flight instruction. The broader impact of teaching flight instructors how to use the UDL framework includes the potential to improve retention rates, reduce flight training hours, and lead to strong knowledge and skills for both instructors and students.

Keywords: universal design for learning, UDL, flight instruction, lesson planning, tools

According to the International Air Transport Association (IATA), the industry was approximately 27,000 pilots short at the end of 2021. The demand is projected to increase to upwards of 484,000 pilots (IATA, 2022), while Boeing's Pilot and Technician Outlook forecasts a need for 602,000 new pilots by 2041 (2022). Focusing on U.S.-based demand versus supply, it is estimated that the demand is about three times the supply (Schonland, 2016). In 2022, there were an estimated 756,928 active pilots in the United States, 166,738 of whom held airline transport pilot certificates (Federal Aviation Administration [FAA], 2022).

The last large-scale study about student pilot retention was made public in 2011 by the Aircraft Owners and Pilots Association (AOPA). At that time, and still widely cited, an estimated 70-80% of students dropped out of flight training before securing their student pilot certificate, and, of those students who remained, the AOPA estimated that 60% of student pilots never completed their private pilot certificates (AOPA, 2011). Furthermore, while there were 120,285 student pilots in 2013 and 280,582 student pilots in 2022 (a 133% increase over the last decade), the number of non-student certificated pilots has not changed significantly during that same timeframe (FAA, 2022). There were 185,276 private/sport/recreational pilots in 2013 and 171,126 private/sport/recreational pilots in 2022, an 8% decrease across the decade. This would indicate that, although interest in flight training has substantially increased over the last decade, completion of initial certifications, such as private, sport, and recreational pilot, is decreasing.

One of the challenges of building a pilot supply pipeline in the United States is that pilots seeking a first officer position (a common entry-level position at Part 121 air carriers) are generally required to possess an Airline Transport Pilot (ATP) Certificate with 1,500 hours of total flight time, with some exceptions. This requirement was placed in response to three high-profile accidents, with the hope that increased required flight hours would lead to increased

safety (Smith et al., 2016). As a result, most national and global conversations have been focused on *quantity* rather than *quality* of flight hours within the flight training environment.

With the increase in total flight hours required to advance into airline operations, many aspiring professional pilots will build flight time by becoming Certified Flight Instructors (CFI) (Lutte & Lovelace, 2016). To become a CFI an applicant must pass written, oral, and practical tests with an FAA designated pilot examiner. The oral and practical phases of testing are comprised of scenario-based assessments regarding content knowledge of flight operations and technical *stick and rudder* skills during flight (FAA, 2020). This practice evaluates knowledge and skills while decreasing risks and increasing safety throughout flight operations. As part of this formal assessment, CFI applicants demonstrate their teaching of both ground and flight lessons (FAA, 2020). However, very little is required to be taught to future instructors and evaluated by examiners regarding *how* instructors teach their students the knowledge and skills associated with the Airman Certification Standards (ACS). Studies have found that educators teach in the same way that they themselves have been taught (Oleson & Hora, 2013), while observations also indicate that new flight instructors tend to model the behavior of their former instructors, which may not necessarily be the best or most reliable method for learning how to instruct (Schroeder, 2022; Thompson, 2017).

Erickson (2009) claims that passing the Fundamentals of Instruction (FOI) knowledge test requires very little study. Most candidates rely on rote memorization, which does little to prepare the instructor candidate for actual teaching. Becoming a good instructor is often a form of apprenticeship, with CFIs becoming better instructors as they observe and learn from their peers and with practice. This on-the-job training negatively impacts student pilot training (Byrnes, 2017) but is currently necessary in developing teaching skills. The high turnover among

instructors, with instructors moving on to better-paying full-time positions at the airlines, may also result in a loss of the body of knowledge and experience overall. Wofford et al. (2013) explored the informal learning process of flight instruction using novice flight instructors as research participants and recommended using a collaborative learning culture with mechanisms to capture and share instructing experience through open communication and opportunities to engage in reflective practice. Byrnes (2017) evaluated the impact of a simulated classroom environment with instructors playing the role of the student on CFI applicants' understanding of the FOI and identified that the extra practice helped applicants retain information and perform better on their tests regarding specific topics.

Within K-12 teacher preparation programs, future educators are trained to use evidence-based teaching methods, including a framework known as universal design for learning (UDL), which combines knowledge from multiple learning theories and knowledge of developmental learning milestones for maximum student performance (Center for Applied Special Technology [CAST], 2022). Studies in education demonstrate the efficacy of UDL (Levicky-Townley et al., 2021), while the completion of two meta-analyses indicated that UDL is an effective method for improving student learning (Capp, 2017), particularly when used in small-group settings (King-Sears et al., 2023), as would be experienced in the typical flight instruction setting.

To address the need for systemic evidence-based instructional strategies within the flight training environment, this article seeks to provide CFIs and their instructors with several tools to help prepare them for working with the diverse training needs of their students. In this conceptual article, we provide: (a) an introductory knowledge base of the UDL framework, including integral components of UDL, (b) a description of the research base surrounding UDL,

and (c) recommendations for promoting and monitoring the planning and use of UDL techniques and practices throughout all phases of flight instruction.

Universal Design for Learning (UDL)

Definition of UDL

UDL is an instructional framework that supports educators as they work to proactively design high-quality instruction that meets the needs of different types of learners and learning styles, as opposed to changing learners to meet the needs of one method of instruction (CAST, 2022). In essence, the purpose of UDL is to design curriculum and accompanying lessons to simultaneously reach the greatest variety of learners possible (Edyburn, 2021).

UDL links cognitive research regarding learning and suggests that diversified instruction carries the potential of reaching an increasing number of learners (Armstrong, 2018). It is based on the premise that individuals can vary widely in their response to given instruction (Edyburn & Edyburn, 2021). Instructors who use the UDL framework understand that multiple complementary instructional methods delivered simultaneously can be the most effective approach to meeting the needs of most, if not all, learners in a single group (Cumming & Rose, 2021). UDL instructional planning includes multiple entry and exit points to aid in the differentiation of learning and work to meet students at their current level of knowledge and understanding in any given topic within a well-planned subject area (Edyburn & Edyburn, 2021).

Theoretical Framework

The underpinnings of the UDL framework come from the longstanding educational and psychological research originating with the seminal works of Bloom, Piaget, and Vygotsky, among others (CAST, 2022). Extensive research over the decades has determined that most individuals learn best with the scaffolding of information and instruction, from lower-level

knowledge and skills to a gradual progression of higher-level thinking and skills (Cumming & Rose, 2021). Scaffolding has made the integration of Bloom's Taxonomy into many aspects of teaching and assessment of student learning across professional fields, including aviation, very popular (see FAA, 2020).

Further, Piaget's work regarding conventional stages of cognitive development, although beginning in infancy, can explicate the stages of learning development well into adulthood (Piaget, 1952). Based on Vygotsky's work, there is also a need to consider the Zone of Proximal Development and educators' increased emphasis on moving learners to the highest boundaries of their personal zones of proximal development during the instruction and learning processes (Vygotsky, 1978). Vygotsky (1978) also acknowledged the importance of modeling expectations for learners and providing for extensive social interaction throughout the learning process. Lastly, in addition to the work of Piaget and Vygotsky, the UDL framework integrates work within neuroscience surrounding intersecting recognition, strategic, and affective networks within the human brain (CAST, 2022).

Integral Components of the UDL Framework

An extensive guide to the UDL framework can be found within the UDL Guidelines (CAST, 2022), including downloadable graphic organizers and other tools to support educators as they design their curriculum and plan instruction. There are several primary components of the UDL framework: four pillars (goals, instruction, materials, and assessment), three principles (multiple means of representation, action and expression, and engagement), and nine guidelines (provide options for recruiting interest, sustaining effort and persistence, self-regulation, perception, language and symbols, comprehension, physical action, expression and communication, and executive functioning) (Armstrong, 2018). The overarching goal of the

UDL framework is to mold expert learners who are purposeful and motivated, resourceful and knowledgeable, and strategic and goal directed (Cumming & Rose, 2021).

The UDL framework guides those who teach to consider multiple aspects of the material they present to learners and meaningfully evaluate how to present it for maximum impact. In the first segment, educators consider all three principles of UDL. Educators provide multiple means of engagement (consideration of affective networks in the brain; the *why* of learning), provide multiple means of representation (consideration of recognition networks of the brain; the *what* of learning), and provide multiple means of action and expression (consideration of strategic networks of the brain; the *how* of learning). Within each of the three principles of UDL, educators then consider recommendations for (a) increasing access to the learning goal via providing options for recruiting interest, perception, and physical action; (b) methods to building options for sustaining effort and persistence, language and symbol usage, and expression and communication; and (c) methods for empowering learners, via options for self-regulation, comprehension, and executive functioning (CAST, 2022). When combined, these areas within the UDL guidelines lead to the goal of producing learners who are (a) purposeful and motivated, (b) resourceful and knowledgeable, and (c) strategic and goal-directed (Flanagan & Morgan, 2021).

UDL Research

Today's CFI will continue to confront a more diverse group of learners with a broad spectrum of interests and abilities. UDL provides guidance for designing curriculum and instruction centered on diverse student learning needs. It is an important element in meeting that niche by providing critical insight for improving design, instruction, and assessment methodology. UDL, originally designed in the 1980s as a method for meeting the diverse needs

of students who received special education services, continues today as a method for teaching in both general education and special education classrooms (Flanagan & Morgan, 2021). It has also transitioned into use within post-secondary educational settings, workplace training, and online learning environments (CAST, 2022; see also, Flanagan & Morgan, 2021; Gronseth & Hutchins, 2020; Lee & Griffin, 2021; Levicky-Townley et al., 2021).

In a study conducted by Kang et al. (2018) the authors mapped the concept of learning styles to the UDL framework and used their findings to improve the efficacy of training air traffic control (ATC) trainees. A secondary outcome of the study indicated that through direct classroom observation, the authors found that collegiate instructors were using various pieces of the UDL framework. Furthermore, Kang et al. (2018) recommended "a checklist to systematically identify the gaps and address those gaps given the limited time and resources," of instructors (p. 42). We believe that information regarding UDL also has the potential to affect how flight instructors approach the learning environment. Just as with K-12 teachers, flight instructors with a better understanding of UDL and its applications to instruction can presumably employ the UDL framework for better design and style of instructional delivery for more effective learning, increasing the potential for training completion.

Utilizing the UDL Framework in Professional Flight Instruction

In addition to the theoretical and practical issues that concern any instructional endeavor, efficient flight instruction cannot be dissociated from basic adult learning principles. The seminal work of Knowles (1990) and Lindeman (2013) suggest that adult learners have additional needs in the learning environment, each of which can be met through the UDL framework. These needs include clearly defined learning goals and objectives, as well as autonomy in the learning and evaluation processes (Knowles, 1990; Lindeman, 2013). Additionally, adult learners are more

likely to be interested in learning information that is most relevant to attaining their goals, rather than learning for learning's sake; and they prefer active involvement in instruction and instructors who facilitate learning, as opposed to instructors that regurgitate information that can be readily located without the instructor (Knowles, 1990; Lindeman, 2013).

Considering that the minimum age for certification is 17 years old, we can conclude that the majority of flight students fall within the adult learner classification. Increased opportunities for meaningful learning can occur with this population when they are provided efficient autonomous learning opportunities throughout their flight instruction. This autonomy can ostensibly be accomplished while using the UDL framework throughout all phases of flight instruction.

Initial UDL lesson planning can be a time-consuming endeavor. There is a considerable cost, effort, and time commitment to implement UDL well, most notably due to the use of multiple forms of instruction materials needed and the extensive planning for interactive learning (Kang et al., 2018). However, once a robust UDL curriculum is designed, implementation should theoretically be consistent each time the lesson is taught, because lesson plans will be designed to meet the needs of all learners and provide multiple entry and exit points. A well-planned UDL curriculum means that instructors may not need to modify their lesson plans until a new ACS is published.

Edyburn and Edyburn (2021) highlight the need for teachers, in this situation flight instructors, to have a readily available tool kit of resources on various topics. Although much of the information flight instructors will need can be found online, it will be much more beneficial to have a database of tried-and-true materials and information that covers a range of UDL guidelines. Although we recognize the need for a freely available database for professional flight

instructors, the curation of such a database is outside the scope of the current conceptual article. Instead, in the following sections, we outline the use of three tools that will comprise the first step toward using the UDL framework in flight and ground instruction. Professional flight instructors can use these two tools, which have been adapted from educational research (Professional Flight Instruction UDL Lesson Plan Template and Checklist), to plan the integration of UDL into their ground and flight lessons, while those who train CFIs can use the CFI Training Observation Tool to assess and evaluate UDL integration into instruction.

Professional Flight Instruction UDL Lesson Plan Template

In the newest version of the *Aviation Instructor's Handbook* (2020), the FAA emphasizes the increased importance of the instructor being more than a person teaching basic flying methods and techniques, by acting as an advisor, mentor, and guide for aviation students. Although the handbook calls attention to the increased need for new methods to accompany the new standards, due to advances in technology and innovation across fields within aviation, most new methodology discussion is placed on scenario-based training (FAA, 2020). This focus is undoubtedly due to its valid purpose of training aviators for real life situations. The handbook also highlights the extensive planning that is required to fulfill the roles and responsibilities of a professional flight instructor, including integrating aeronautical decision-making, risk management, and scenario-based training into each lesson (FAA, 2020). Scenario-based training complements the UDL framework, so it is a natural progression to identify methods to incorporate all the standard components of an aviation lesson plan into a UDL format, to which instructors can build their lesson plans accordingly.

The FAA does not have a standard or required template for instructional lesson planning but specifies that lesson plans "should include an objective, content, and completion standards"

(FAA, 2020, p. 7-9). High quality lesson plans should also include additional information, such as a list of necessary materials, procedures, and methods for assessment and evaluation of learning. The Professional Flight Instruction UDL Lesson Plan Template (see Figure 1 in Appendix) simplifies the requirements of a basic lesson plan and integrates them into the UDL framework. At the top of the lesson plan instructors list general information about the lesson: topic, agenda, objectives, required materials, location of instruction, relevant airman certification standards, and the methods that will be used for progress monitoring. The bulk of the lesson plan template allows instructors to outline the content and structure of their lessons using an evidence-based, systematic method, entitled Explicit Instruction (Archer & Hughes, 2011). To help with organization of the lesson in a meaningful progression from start to finish, subtitles are listed for the anticipatory set, direct instruction, guided practice, independent practice, and closure.

Anticipatory Set

The anticipatory set starts the lesson by soliciting the attention of the student. In the case of flight instructors, the anticipatory set may be an explanation of the value of the given lesson for the students' training and ultimate end goals for flight training. The anticipatory set is also an area of the lesson that should be used to queue any prior knowledge the students have of the subject matter. In flight instruction, an anticipatory set may include a scenario that students could experience in flight and ask them to engage in critical thought and brainstorm solutions to the scenario.

Direct Instruction, Guided Practice, and Independent Practice

Each of the three sections after the anticipatory set are broken down into steps for teaching students new material. First, instructors provide direct instruction, which may be in the form of a group or individual lecture about the material. The length of the direct instruction will

be dependent on the information that must be covered, and the pace at which students are learning the material. It is important to note that instructors should be asking questions of their students throughout the lesson, including during direct instruction. The purpose of these questions is to monitor their progress and determine if the instructor can move on from the topic or if they need to further explain the material, potentially in a different way.

During guided practice, instructors work closely with students, whether individually or in groups, and guide them through the material. For example, when students are learning to create navigation logs, it is important that instructors walk them through the process step-by-step the first time they do it, until the students demonstrate their understanding of the process. Independent practice is the portion of the lesson when the instructor leaves the students alone to work on the material individually or in small groups; during this time, instructors should answer questions as they arise. During both guided and independent practice, it is important that instructors have a plan for students who may be progressing more slowly or more quickly than others. In individual settings, this may mean taking longer to complete the lesson or moving on to the next lesson. However, for instructors who are teaching students in groups, it may mean having additional or higher-level requirements for those progressing quickly, while working with the remainder of the group.

Closure

The final portion of the intended lesson should wrap up student learning, include a final evaluation of progress and understanding, and then provide students with next steps in their training. For example, instructors may ask their students to reevaluate their decisions from the scenario provided at the beginning of the lesson, based on the information that they learned during the lesson.

To finalize the lesson plan and help instructors determine if they met the basic requirements of UDL, they should review their lesson plan and place indicators next to the locations where they met UDL guidelines: provided multiple means of representation (MMR), provided opportunities for action and expression (OAE), provided opportunities for engagement (OE), and monitored their students' progress (PM). The lesson criteria listed in Figure 2: Professional Flight Instruction UDL Lesson Plan Checklist provides examples of MMR, OAE, and OE (see Appendix).

Professional Flight Instruction UDL Lesson Plan Checklist

If instructors have a preferred lesson plan format already in use, they can use the Professional Flight Instruction UDL Lesson Plan Checklist (Figure 2) to determine whether their lesson plans meet the requirements of the UDL framework, and then adjust accordingly. Instructors can check off each item as they review their lesson plans. The checklist is separated into five sections: general information, environment, content knowledge, pedagogy, and professional growth and development. The checklist is designed to align with Figure 3: Professional Flight Instruction UDL Training Observation Tool (see Appendix).

Professional Flight Instruction UDL Training Observation Tool

Observation of instructor performance is an integral part of education and a means for working towards standardization and ensuring that each student is receiving high quality instruction. The Professional Flight Instruction UDL Training Observation Tool (Figure 3) was designed to allow those who train CFIs to systematically observe how the CFI performs concerning integration of the UDL framework into their lessons. Lesson observers use the observation tool by rating the flight instructors, or pre-flight instructors, according to the lesson criteria that aligns with the lesson plan template and the lesson-plan checklist. The rating scale,

shown at the bottom of the observation tool, can provide CFI trainers with quantitative data. If observers standardize observation with inter-observer agreement interrater reliability can also be obtained. CFI trainers should also provide comments and feedback at both the item level and overall, at the end of the observation, so that in addition to quantitative information students have a qualitative evaluation of their performance.

Conclusion

The critical pilot shortage and the rate at which students drop out of the pilot pipeline is alarming (see AOPA, 2011; FAA, 2022). The AOPA 2011 report clearly indicated that student perceptions of their training were among the major contributing factors for leaving flight training before completion of certification. With this knowledge in mind, it is important that flight instructors place a high value on the quality of the instruction that they are providing to their flight students. Contemporary, evidence-based methods for teaching may help stem part of that movement away from flight training and keep students actively engaged in aviation and prepared to meet the needs of the profession. UDL is an attractive solution to less-than-stellar flight training because it expands an instructors' teaching and learning tools, beyond the conventional lecture and rote memorization. As previously noted, UDL provides guidance to support the diverse learning needs of multiple students simultaneously, which is not only a benefit to students in group settings, but it can also minimize frustration among flight instructors who find themselves in a situation where not all students in a group are grasping the concepts at a rate on par with their peers, or who may be excelling at a much faster rate than their peers.

As noted, UDL has been successfully used to improve the efficacy of ATC training (Kang et al., 2018), so providing flight students with lessons based on the UDL framework is not an unreasonable request. We propose that a single UDL flight instruction lesson can be designed

for each of the Airman Certification Standards. Using an Airplane Single Engine Land (ASEL) Private Pilot student as an example would require a flight instructor to have access to 44 UDL Flight Instruction Lesson Plans, as opposed to creating individual lessons for every student they encounter, or worse, creating one generic lesson plan to use with all students. We encourage researchers to use the three tools presented here in real-world training environments, and assess, evaluate, and improve upon them for future use and dissemination.

References

Aircraft Owners and Pilots Association. (2011). *The flight training experience: A survey of students, pilots, and instructors.* https://download.aopa.org/epilot/2011/AOPA_Research-The_Flight_Training_Experience.pdf

Archer, A. L., & Hughes, C. A. (2011). *Explicit instruction: Effective and efficient teaching.* Guilford Press.

Armstrong, T. (2018). *Multiple intelligences in the classroom* (4th ed.). Association for Supervision and Curriculum Development (ASCD).

Boeing. (2022). *Pilot and Technician Outlook 2022-2041*. https://www.boeing.com/commercial/market/pilot-technician-outlook/

Byrnes, K. P. (2017). Employing flight simulation in the classroom to improve the understanding of the fundamentals of instruction among flight instructor applicants. *Journal of Aviation/Aerospace Education & Research, 26*(1). https://doi.org/10.15394/jaaer.2017.1623

Capp, M. J. (2017). The effectiveness of universal design for learning: A meta-analysis of literature between 2013 and 2016. *International Journal of Inclusive Education, 21*(8), 791-807. https://doi.org/10.1080/13603116.2017.1325074

Center for Applied Special Technology. (2018). *Universal Design for Learning Guidelines version 2.2* [Graphic organizer]. https://udlguidelines.cast.org/binaries/content/assets/udlguidelines/udlg-v2-2/udlg_graphicorganizer_v2-2_numbers-yes.pdf

Center for Applied Special Technology. (2022). *The UDL Guidelines*. http://udlguidelines.cast.org

Cumming, T. M., & Rose, M. C. (2021). Exploring universal design for learning as an accessibility tool in higher education: A review of the current literature. *The Australian Educational Researcher, 49,* 1025-1043. https://doi.org/10.1007/s13384-021-00471-7

Edyburn, D. L. (2021). Column guest editor's introduction: A tactic for clarifying the teacher's role in universal design for learning. *Intervention in School and Clinic, 56*(4), 241-242. https://doi.org/10.1177/1053451220944382

Edyburn, K., & Edyburn, D. L. (2021). Classroom menus for supporting the academic success of diverse learners. *Intervention in School and Clinic, 56*(4), 243-249. https://doi.org/10.1177/1053451220944381

Erickson, D. (2009). What becoming pilot-in-command taught me about teaching adults [Perspectives on Teaching]. *New Horizons in Adult Education and Human Resource Development, 23*(4), 74-84. https://doi.org/10.1002/nha3.10361

Federal Aviation Administration. (2022). *U.S. Civil Airmen statistics.* https://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics

Federal Aviation Administration. (2020). *Aviation Instructor's Handbook* (FAA-H-8083-9B). U.S. Department of Transportation. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/aviation_instructors_handbook/media/aviation_instructors_handbook.pdf

Flanagan, S., & Morgan, J. J. (2021). Ensuring access to online learning for all students through universal design for learning. *Teaching Exceptional Children, 53*(6), 459-462. https://doi.org/10.1177/00400599211010174

Gronseth, S. L., & Hutchins, H. M. (2020). Flexibility in formal workplace learning: Technology applications for engagement through the lens of universal design for learning. *TechTrends, 64*, 211-218. https://doi.org/10.1007/s11528-019-00455-6

International Air Transport Association. (2022). *Celebrating pilots around the globe.* https://www.iata.org/en/training/pages/pilot-training/

Kang, Z., Dragoo, M. R., Yeagle, L., Shehab, R. L., Yuan, H., Ding, L., & West, S. G. (2018). Adaptive learning pedagogy of universal design for learning (UDL) for multimodal training. *Journal of Aviation/Aerospace Education & Research, 27*(1). https://doi.org/10.15394/jaaer.2018.1752

King-Sears, M. E., Stefanidis, A., Evmenova, A. S., Rao, K., Mergen, R. L., Owen, L. S., & Strimel, M. M. (2023). Achievement of learners receiving UDL instruction: A meta-analysis. *Teaching and Teacher Education, 122*, 1-15. https://doi.org/10.1016/j.tate.2022.103956

Knowles, M. S. (1990). *The adult learner: A neglected species.* Gulf Publishing Company.

Lee, A., & Griffin, C. C. (2021). Exploring online learning modules for teaching universal design for learning (UDL): Preservice teachers' lesson plan development and implementation. *Journal of Education for Teaching: International Research and Pedagogy, 47*(3), 411-425. https://doi.org/10.1080/02607476.2021.1884494

Levicky-Townley, C., Garabedian Stork, M., Zhang, J., & Weatherford, E. (2021). Exploring the impact of universal design for learning supports in an online higher education course. *The Journal of Applied Instructional Design, 10*(1). https://doi.org/10.51869/101/clt

Lindeman, E. C. (2013). *The meaning of adult education.* Windham Press

Lutte, R., & Lovelace, K. (2016). Airline pilot supply in the US: Factors influencing the collegiate pilot pipeline. *Journal of Aviation Technology and Engineering, 6,* 53-63. https://doi.org/10.7771/2159-6670.1148

Oleson, A., & Hora, M. T. (2014). Teaching the way they were taught? Revisiting the sources of teaching knowledge and the role of prior experience in shaping faculty teaching practices. *Higher Education, 68,* 29-45. https://doi.org/10.1007/s10734-013-9678-9

Piaget, J. (1952). *The origins of intelligence in children* (M. Cook, Trans.). International Universities Press, Inc. https://doi.org/10.1037/11494-000

Schonland, A. (2016). *The pilot shortage part 2 – The supply of commercial pilots.* AirInsight Group. https://airinsight.com/pilot-shortage-part-2-supply-commercial-pilots/

Schroeder, R. (2022). *Faculty teaching the way they were taught.* Inside Higher Education. http:// https://www.insidehighered.com/digital-learning/blogs/online-trending-now/faculty-teaching-way-they-were-taught

Smith, G., Bjerke, E., Smith, M., Christensen, C., Carney, T. Q., Craig, P. & Niemczyk, M. (2016). Pilot source study 2015: An analysis of FAR Part 121 pilots hired after public law 111-216—Their backgrounds and subsequent successes in U.S. regional airline training and operating experience. *Journal of Aviation Technology and Engineering, 6*(1), 64-89. https://doi.org/10.7771/2159-6670.1140

Thompson, M. (2017). *Telling is not teaching: The flight instructor's handbook.* CreateSpace Independent Publishing.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wofford, M. G., Ellinger, A. D., & Watkins, K. E. (2013). Learning on the fly: Exploring the informal learning process of aviation instructors. *Journal of Workplace Learning, 25*(2), 79-97. https://doi.org/10.1108/13665621311299771

Appendix

Figure 1

Professional Flight Instruction UDL Lesson Plan Template

Professional Flight Instruction UDL Lesson Plan Template	
Instructor: _____	Materials: _____
Lesson Topic: _____	Location: _____
Agenda: _____	Objectives: _____
_____	_____
_____	_____
Airman Certification Standards: _____	Assessment and Evaluation Methods: _____
_____	_____
_____	_____
Content and Structure of the Lesson	
Anticipatory Set	
Direct Instruction	
Guided Practice *Differentiation for slower performing students:* *Differentiation for faster performing students:*	
Independent Practice *Differentiation for slower performing students:* *Differentiation for faster performing students:*	
Closure	

Note: Indicate where multiple means of representation are addressed throughout the lesson with (MMR); Indicate where action and expression are addressed throughout the lesson with (OAE); Indicate where engagement is addressed throughout the lesson with (OE); Indicate where progress monitoring is addressed throughout the lesson with (PM).

Figure 2

Professional Flight Instruction UDL Lesson Plan Checklist

Professional Flight Instruction UDL Lesson Plan Checklist Instructor: _____ Lesson: _____
Lesson Criteria
I. General
☐ Lesson Topic
☐ Lesson Agenda and Objective(s)
☐ Airman Certification Standard (ACS) Addressed
☐ Materials
☐ Methods for Assessment and Evaluation
II. Environment
☐ Selection of a location most conducive to learning the lesson (e.g., classroom, hanger, sim)
III. Content Knowledge
☐ Thorough explanation of the content
☐ Lesson organized in a meaningful progression from start to finish
☐ Appropriate pacing
☐ Plan for making abstract concepts concrete and meaningful
☐ Includes a plan for progress monitoring to assess learning and address misconceptions during the lesson
IV. Pedagogy
Multiple Means of Representation (MMR):
☐ Opportunities for recruiting student interest (e.g., addresses choice, relevance, value)
☐ Options for sustaining effort and persistence (e.g., provides optimized challenges)
☐ Opportunities for self-regulation (e.g., provides self-assessment and reflection)
Opportunities for Action and Expression (OAE):
☐ Alternative formats (e.g., auditory, visual, kinesthetic)
☐ Clarification of terms and symbols
☐ Addresses comprehension (e.g., provides background knowledge, highlight patterns/relationships, highlights critical ideas, maximizes generalization)
Opportunities for Engagement (OE):
☐ Opportunities for physical action (e.g., method of response varies, access to tools and technology)
☐ Options for expression and communication (e.g., multimedia, multiple tools, graduated levels of support for practice and performance)
☐ Addresses executive functions (e.g., appropriate goal setting, organization and management of resources, self-monitoring of progress)
V. Professional Growth and Development
☐ Prepared to address any common questions that might arise from the lesson

Figure 3

Professional Flight Instruction UDL Training Observation Tool

Professional Flight Instruction UDL Training Observation Tool Instructor: _____ Observer: _____ Lesson: _____ Date: _____		
Lesson Criteria	**Rating**	**Comments/Feedback**
VI. General		
Lesson Topic		
Lesson Agenda and Objective(s)		
Airman Certification Standard (ACS) Addressed		
Materials		
Methods for Assessment and Evaluation		
VII. Environment		
Creates a positive climate (e.g., encourages student curiosity, has flexibility and persistence)		
Demonstrates a positive attitude toward the subject matter		
Maintains clear expectations and promotes student efforts		
VIII. Content Knowledge		
Demonstrates a thorough knowledge of the content		
Organizes the lesson in a meaningful progression from start to finish		
Demonstrates appropriate pacing		
Explains content clearly; makes abstract concepts concrete and meaningful		
Demonstrates the use of progress monitoring to assess learning and address misconceptions during the lesson		
IX. Pedagogy		
Includes opportunities for recruiting student interest (e.g., addresses choice, relevance, value)		
Includes options for sustaining effort and persistence (e.g., provides optimized challenges)		
Includes opportunities for self-regulation (e.g., provides self-assessment and reflection)		
Includes alternative formats (e.g., auditory, visual, kinesthetic)		
Includes clarification of terms and symbols		
Addresses comprehension (e.g., provides background knowledge, highlights		

patterns/relationships, highlights critical ideas, maximizes generalization)		
Includes opportunities for physical action (e.g., method of response varies, access to tools and technology)		
Includes options for expression and communication (e.g., multimedia, multiple tools, graduated levels of support for practice and performance)		
Addresses executive functions (e.g., appropriate goal setting, organization and management of resources, self-monitoring of progress)		
X. Professional Growth and Development		
Professional (e.g., punctual, dependable, prepared, appropriate attitude and attire)		
Shows self-confidence and presence when working with people		
Accepts professional advice; considers constructive criticism		
Engages in professional development; shows desire to improve teaching effectiveness		
Overall Performance/Comments/Feedback:		

Rating Scale

1 – Unsatisfactory (application of criteria is not evident or is inconsistent with standard expectations)
2 – Minimum Standard (application of criteria is evident at a novice level)
3 – Proficient (application of criteria is evident at a competent level)
4 – Robust (application of criteria is evident at a fluent level)
5 – Exemplary (application of criteria is evident at a fluent level, even within challenging conditions)