INNOVATION CONFIGURATION

Universal Design for Learning: Recommendations for Teacher Preparation and Professional Development

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Table of Contents

Innovation Configuration for Universal Design for Learning: Recommendations for Teacher Preparation and Professional Development

This paper features an innovation configuration (IC) matrix to guide educator preparation professionals in developing Universal Design for Learning (UDL). This matrix appears in Appendix A.

Implementing any innovation comes with a continuum of configurations of implementation from non-use to the ideal. ICs are organized around two dimensions: essential components and degree of implementation (Hall & Hord, 1987; Roy & Hord, 2004). Essential components of the IC—along with descriptors and examples to guide applying the criteria to coursework, standards, and classroom practices—are in the rows of the far-left column of the matrix. Essential components come from the research. For more information, see this guide describing CEEDAR's standards for selecting essential components. Several levels of implementation are in the top row of the matrix. For example, no mention of the essential component is the lowest level of implementation and would receive a score of zero. Increasing levels of implementation receive progressively higher scores.

ICs have been used in the development and implementation of educational innovations for at least 30 years (Hall & Hord, 2001; Hall et al., 1975; Hord et al., 1987; Roy & Hord, 2004). Experts studying educational change in a national research center developed these tools, which are used for professional development (PD) in the Concerns-Based Adoption Model (CBAM). The tools have also been used for program evaluation (Hall & Hord, 2001; Roy & Hord, 2004).

This tool provides data on the strengths and needs of educator preparation programs (EPPs) that can assist leaders in ensuring that teachers and leader candidates have the necessary knowledge, skills, and practice. The IC in Appendix A of this paper is for EPPs, although it can be modified for PD purposes. Appendix B summarizes evidence-based practices (EBPs) for designing instruction with the UDL framework.

Introduction

UDL is an educational framework based on research from the learning sciences. The framework guides the development of flexible learning environments that account for individual learning differences. It provides a blueprint for creating instructional goals, methods, materials, and assessments. UDL is not a single, one-size-fits-all solution. Rather, it is a multidimensional, proactive design framework for planning, teaching, and assessment. UDL instruction design methodology is customized and adjusted based on individual student needs. Its principles involve the use of multiple means of representation, action, expression, and engagement.

The role of UDL has been amplified since the outbreak of COVID-19, when most schools moved to online instruction (Basham, Blackorby, et al., 2020). Post-pandemic schools utilize a diverse array of modalities, including face-to-face, synchronous, and asynchronous online instruction, along with hybrid and HyFlex models (Detyna et al., 2022). The purpose of IC was to synthesize the research on UDL and provide recommendations for embedding UDL in general and special education pre-service teacher preparation programs. In addition, the IC is designed to improve PD for in-service teachers.

The Neurocognitive Basis for Universal Design for Learning

Neuroscience and developmental psychology research provide a foundation for UDL (Rao et al., 2023). The research suggests that teachers can effectively design instruction by integrating three principles based on the following interrelated networks in the brain: (a) recognition, (b) strategic, and (c) affective (Al-Azawei et al., 2016). These neuro-cognitive networks provide a framework for planning instruction for diverse learners. The UDL framework is based on the following three broad principles:

1. **Multiple Means of Engagement to Support Affective Learning (i.e., Why We Learn)**

Guidelines within this principle include recruiting interest, sustaining effort, and supporting self-regulation. Educators provide options to engage students by building relevance and a sense of community through activities such as collaborative learning, instructional games and simulations, and real or virtual tours of locations such as National Parks.

2. **Multiple Means of Representation to Support the Ways in Which We Assign Meaning to What We See and Recognize (i.e., What We Learn)**

Guidelines within this principle include perception, language and symbols, and comprehension. Educators provide flexible options for content delivery and acquiring background knowledge using multiple sensory options such as discussion, readings, digital texts, and multimedia presentations.

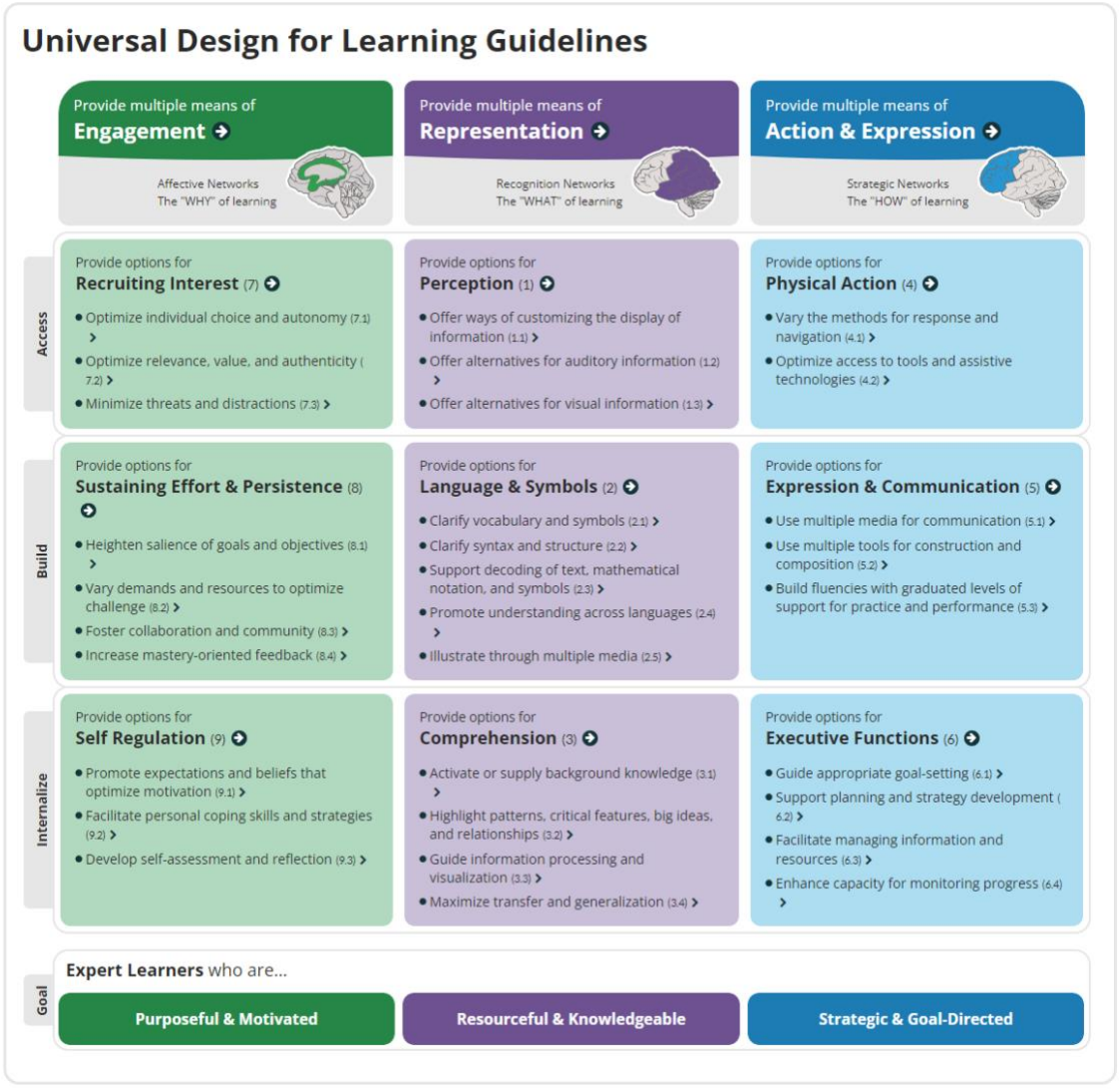
3. **Multiple Means of Action and Expression to Support the Ways of Learning (i.e., How We Learn)**

Guidelines for this principle include physical action, expression and communication, and executive functions. Educators consider providing opportunities for students to demonstrate their understanding in multiple ways beyond traditional tests or papers, such as through art, multimedia presentations, and digital recordings.

These three principles expand into more detailed guidelines and checkpoints that teacher educators and professional developers can explicitly introduce, explain, and practice within teacher preparation programs and during PD. New and continuing general and special education teachers can effectively integrate each principle into their teaching practices (see Figure 1; CAST, 2018).

Figure 1.

Universal Design for Learning Graphic Organizer of Principles and Checkpoints



Note. Used with permission. (CAST, 2018).

The impact of UDL can be associated with its use in general education classrooms, even though it was conceptualized in special education (Edyburn, 2010). Both general and special education teachers should have a strong foundation in UDL. We provide a process for integrating the three principles, guidelines, and accompanying checkpoints into teacher preparation programs and PD to prepare all teachers to work with diverse learners.

Research on Universal Design for Learning

Studies have evaluated the impact of UDL across the K-12 grade span, from early childhood, elementary, middle, and high school and into transition programs (e.g., Coogle et al., 2022; Mackey, 2019; Scott & Bruno, 2018; Snodgrass et al., 2016). Researchers have investigated how UDL supports learning across content areas, including writing, math, music, chemistry, computer science, and social studies (e.g., Armstrong, 2022; Blackburn & McGrath, 2021; Hansen et al., 2016; Hashey et al., 2020; King-Sears & Johnson, 2020; Mackey, 2019; Scalise et al., 2018). The research on UDL has specifically focused on a range of disabilities, including autism, intellectual disabilities, learning disabilities, and severe support needs (e.g., Carrington et al., 2020; Hartmann, 2015; King-Sears & Johnson, 2020; Smith & Lowery, 2017; Rao et al., 2017; Root et al., 2022). Implementing UDL can also reduce discipline events (Sasson et al., 2022).

Research suggests that the UDL framework is an effective approach to improving student outcomes in the classroom (Smith et al., 2019). Craig and colleagues (2022a) identified a positive correlation between teachers with high UDL implementation scores and students with high standardized test scores when compared to teachers with lower UDL implementation scores. Previous studies examined the impact of implementing one or more of the principles. For example, Marino et al. (2014) found that UDL-aligned video games promoted vocabulary knowledge and conceptual understanding using multiple means of representation. In another study, Gravel (2018) found that elementary English language arts teachers applied specific UDL guidelines and checkpoints to their content area with a high degree of sophistication.

Several recent meta-analyses address early limitations, such as lacking a validated UDL implementation protocol. For example, Al-Azawei et al. (2016) conducted a meta-analysis of

empirically based UDL research. The authors analyzed articles (N = 12) from multiple databases, such as RIC, Google Scholar, ACM, Science Direct, IEEE Xplore, and IRROLD. The selected manuscripts selected were peer-reviewed, provided empirical results, implemented UDL as a framework, and were published between 2012 and 2015. According to the authors, results suggested that both teachers and learners in all educational contexts were beneficiaries of UDL due to the positive effects on both perceptions of instruction and academic performance.

Similarly, Capp (2017) retrieved articles across multiple databases, selecting 18 peer-reviewed articles published between 2013 to 2016. The articles provided pre- and post-test data. Collating the articles into three sub-groups (i.e., target population, UDL principle employed, and research methodology), effect sizes were used as the primary outcome measure of UDL's impact on learner performance. Results from the analysis supported the assertion that UDL improves the learning process.

Baybayon (2021) examined seven empirically based articles about explicitly implementing UDL published in peer-reviewed journals between 2012 and 2018. The purpose of the study was to examine UDL's effect on learner engagement, perception, and performance. Results from the meta-analysis indicated a positive effect on these three areas. The author noted both teachers and students as beneficiaries of UDL, echoing the conclusions of Al-Azawei et al. (2016). As a result, the author highly recommended adopting the UDL framework to reduce barriers and improve learner outcomes.

A recent comprehensive meta-analysis by King-Sears et al. (2023) examined 20 studies from 2014 to 2021 utilizing the validated UDL reporting criteria espoused by Rao et al. (2020). Inclusion criteria included an experimental or quasi-experimental design, measures of student learning, UDL being proactively and intentionally applied, and enough data to calculate an effect

size. The studies ranged from kindergarten through postsecondary settings in courses ranging from reading at the primary level to computer science at the postsecondary level. Articles included both peer-reviewed and gray literature to avoid publication bias. Findings from this seminal work indicated that UDL-based instruction leads to enhanced student performance for all students, most notably when UDL is implemented in small groups of six students or fewer. Additionally, UDL was found to have a greater effect size for students with disabilities than those without.

UDL provides a framework where EBPs are embedded and implemented with fidelity. When teachers design instruction using the UDL framework, they make proactive choices regarding how to deliver EBPs within their instruction in a manner consistent with UDL, which appears differently in each setting and results in a diverse array of pragmatic implementation models. For example, one teacher may present materials on cell organelles using text, Kahn Academy videos, and annotated PowerPoint slides, while another might use pre-recorded Zoom lectures, CORGI graphic organizers, and video games to reinforce vocabulary and conceptual understanding.

Although the content in each medium is overlapping and redundant, the student has the choice to decide which mode(s) of representation to access to maximize their engagement and learning. The UDL principles, guidelines, and checkpoints result from a wealth of research accessible through the CAST (2018) website, which provides citations directly tied to each of the principles, guidelines, and checkpoints addressed in this IC.

Policy Foundations of Universal Design for Learning

Consider the foundational elements of UDL, including relevant policy and legislative initiatives. Ronald Mace, an architect and disability rights advocate, originally coined the term

universal design in 1988 (Mace, 1988). The term subsequently emerged in federal disability policy with the Assistive Technology Act of 1998 (U.S.C.§ 3002). The Center for Universal Design at North Carolina State University and the Center for Applied Special Technology, now known as CAST, later adapted the principles for education to promote accessibility for all learners.

The term *Universal Design for Learning* appeared in the 2004 reauthorization of the Individuals with Disabilities Education Act (IDEA, 2004); the Common Core State Standards (CCSS, 2010); and The Higher Education Opportunity Act (HEOA, 2008), Every Student Succeeds Act (ESSA, 2015), and Strengthening Career and Technical Education for the 21st Century Act (2018) calling for the implementation of UDL based on the HEOA definition:

> a scientifically valid framework for guiding educational practices that (a) provide flexibility in the ways information is presented, in the ways learners respond or demonstrate knowledge and skills, and in the ways learners are engaged and (b) reduce barriers in instruction; provides appropriate accommodations, supports, and challenges; and maintains high achievement expectations for all learners, including students with disabilities and students who are limited English proficient (20 U.S.C. § 1022d).

ESSA (2015) called on states to develop quality assessments based on the UDL principles, ensuring accessibility to all students. Additionally, ESSA highlighted the role of UDL in the provision of comprehensive literacy instruction.

Both the No Child Left Behind Act (NCLB; 2001) and the 2004 IDEA reauthorization emphasized increased accountability and access to the general education curriculum for all students. Students with disabilities have increasingly received their education in inclusive settings during the past 20 years. Consequently, both general and special education teacher

educators must have the skills to provide UDL-designed instruction and assessments. Beyond legislation, the 2016 National Education Technology Plan (NETP) reaffirmed that implementing the three UDL principles can lead to improved outcomes for diverse learners (U.S. Department of Education, 2024). The NETP identified additional evidence supporting a proactive role in preparing pre- and in-service teachers to implement UDL in an effective manner.

Independent educational organizations have incorporated UDL into their policies and resources. The Council for Exceptional Children (CEC, 2022) promoted UDL as a means to design effective learning environments. The American Speech-Language-Hearing Association (ASHA, 2022) explained that speech-language pathologists (SLPs) require knowledge of UDL as part of their role in conducting assessments and providing interventions. The American Occupational Therapy Association (AOTA, 2015) defined the role of occupational therapists in UDL as critical to supporting classroom teachers in UDL implementation. The National Association for the Education of Young Children (NAECY, 2020) embedded UDL into its teacher preparation competencies. Meanwhile, organizations focused on content areas, such as the American Chemical Society (ACS, 2018), provide guidance to their members on the importance of UDL. The National Science Teaching Association (NSTA, 2020) provided UDL resources to its members. In the field of computer science education, CSforAll (2024) expressed concern for equity, noting that the lack of inclusion prevents students from accessing the general education curriculum and also excludes them from becoming computationally literate citizens (Israel et al., 2022).

UDL and Equity in Education

The COVID-19 pandemic prompted discussions of issues with equity across education contexts (Basham, Blackorby, et al., 2020; Takemae et al., 2022). CAST (2018) invited the

community to partner in a revision of the UDL guidelines with the intent to better respond to the needs of all learners. Chardin and Novak (2020) expressed concern with one-size-fits-all education, stating, "one curriculum, without embedded flexible options using the principles of UDL, cannot possibly build equity within the classroom" (p. 10). In its Education 2030 declaration, UNESCO (2020) called for inclusive and equitable education, specifically changing the traditional one-size-fits-all approach to education. The Global Education Monitoring Report posits UDL as an effective means to include all learners.

The UDL framework can foster equity, inclusion, and social justice when combined with culturally responsive instructional practices. Waitoller and King Thorius (2016), Alim and colleagues (2017), and Fornauf and colleagues (2023) advocated for UDL to expand with culturally responsive teaching (CRT) to address systemic inequities in education. Both the UDL and CRT frameworks emphasize the uniqueness of every learner. UDL embraces learner variability, while CRT acknowledges the role of culture and experience in shaping students' learning preferences (Ladson-Billings, 2021). Ralabate and Lord Nelson (2017) provided a crosswalk integrating UDL and CRT, emphasizing the focus on learner assets rather than a deficit-based model of instruction.

UDL and CRT have similar goals for equity and inclusion, with UDL removing barriers to ensure that every student has access to education. At the same time, CRT supports a more equitable learning environment by recognizing the strength of students' diverse cultural backgrounds (Hammond, 2014). UDL and CRT prioritize supportive learning communities. UDL addresses community and collaboration through its guidelines, while CRT emphasizes the importance of strong teacher-student relationships. CRT advocates for including diverse cultural content, supported by UDL's multiple means and options for learning resources.

While UDL focuses on removing barriers to classroom instruction, the UDL 2.0 guidelines do not explicitly address barriers caused by implicit bias or organizational-level practices. As UDL moves into its third decade, CAST has begun the UDL Rising to Equity initiative to "… re-envision the UDL Guidelines through an equity lens" (Rao et al., 2023, p. 715). By adopting UDL and CRT, educators can identify and address disparities in access to education and learning resources, working toward dismantling systemic barriers and promoting social justice in education.

Recommendations for Teacher Preparation and Professional Developers

Providing a general introduction to the UDL framework will not result in a significant change in practice (Waitoller & King Thorius, 2016). Teacher educators and professional developers must develop purposeful experiences for teacher candidates and in-service educators. Coy et al. (2014) found that teachers in an online environment often struggled to implement UDL across an entire unit even when they had a basic understanding of the framework, illustrating the importance of knowing the framework and having an explicit plan to integrate it into the classroom. Barrio and Hollingshead (2017) identified needs assessments as a critical early implementation tool to provide relevance and ensure professional learning about UDL for educators.

What are the subsequent steps once a needs assessment is complete? Tobin (2021) advocated for teachers to learn one guideline and checkpoint at a time to promote expert learning amongst the teachers. Intentional experiences may involve having pre- and in-service teachers use the framework to manipulate content, revise instruction, and address barriers in the general and special education environments. Designing lessons with partners or a grade-level team may support novices in designing with UDL (Lowery et al., 2019). Walker and colleagues (2022)

used UDL principles to bring relevance and scaffolds to teacher preparation, including case studies, role playing, modeling, feedback, and mentoring. Moore et al. (2017) identified challenges with implicit modeling in teacher education, encouraging teacher preparation programs to explicitly model UDL paired with student reflection and connection to theory, which could include pointing out intentional incorporation of UDL principles in course design, having students reflect on how the options provided worked for them, and then connecting back to the principles. For example, a professor could provide options for demonstrating learning on an accessible materials module and then have a discussion in which students reflect on barriers and successes.

Preparation programs may look to the work by Fornauf and colleagues (2021), who revised their teacher preparation/residency program using a UDL lens. Through a barrier analysis process, they identified barriers within coursework, as well as in program design, which they addressed through syllabus redesign and scaffolded persistence. Lowery and colleagues (2017) identified a misconception of UDL as "good teaching," emphasizing the need to clarify the proactive and preventative nature of UDL. Williams and colleagues (2022) personalized professional learning about UDL to individual educators' UDL observational recordings and their perceived needs for improvement. Support and training during implementation led to more inclusive instruction in elementary settings. Additionally, in a study on UDL implementation, educators who received UDL coaching reported value and changes in professional practice (Craig et al., 2022b). Using case study research, Eun Lee and colleagues (2020) found that educators required ongoing professional learning rather than a one-and-done approach to PD. Ample evidence supports the notion that UDL must be explicitly taught, modeled, and implemented throughout pre-service teacher education programs.

Components of the Innovation Configuration

This section features the components of the IC matrix, as well as recommendations for integrating them within teacher preparation programs and continuing PD within schools. We acknowledge that teacher preparation programs and K-12 instructional settings differ. Any single recommendation may not be appropriate for all settings. Therefore, we provide general descriptions of effective UDL implementation methods along with suggestions for how teacher educators can adapt UDL based on their programs and needs.

1.0 Foundations of Universal Design for Learning

1.1 Develop Expert Learners Who Are Purposeful, Motivated, Resourceful, Knowledgeable, Strategic, and Goal-Directed.

The goal of UDL is to develop expert learners who are purposeful, motivated, resourceful, knowledgeable, strategic, and goal-directed (CAST, 2018; Ertmer & Newby, 1996). Every student can benefit from UDL, which increases meaningful access and reduces barriers in the environment for students across a wide range of learner variability. UDL supports students with diverse learning needs, including, but not limited to, students with disabilities, English language learners, and those from diverse cultural and socioeconomic backgrounds. Educational researchers, policymakers, and practitioners have embraced this instructional framework to meet the needs of an increasingly heterogeneous student population.

Navaitienė and Stasiūnaitienė (2021) described expert learning in the context of inclusion in which every student can experience optimal learning conditions. Students develop as expert learners in conjunction with their instructors (McDowell, 2019). According to Lohmann (2023), becoming an expert learner begins in early childhood. Expert learners depend on well-prepared educators who understand the connection between expert learning and learner variability and

how it relates to UDL. The key is to teach students to self-identify what types of representation (e.g., interactive video games) lead to maximizing their learning experience. The time invested should directly correlate to the level of knowledge gained (CAST, 2017). Expert learning is not limited to students without disabilities; every student can become an expert learner (Lowery et al., 2019). UDL-designed instruction meets the needs of a wide range of learners while still acknowledging that some students will require individualization, such as explicit strategy instruction, assistive technologies (AT), accommodations, and modifications to the curriculum. However, when teachers use the UDL framework to plan for learner variability proactively, the need for individualization decreases.

1.2 Recognize Learner Variability and Jagged Learning Profiles Across Students With and Without Disabilities

Research from the learning sciences supports learner variability as the natural differences occurring across students (Taub et al., 2018, 2022), which includes strengths and challenges across cognitive, social-emotional, and prior learning experiences (Bray et al., 2023). An average individual does not exist, according to Rose et al. (2018), who posited that all learners have their own jagged learner profile. Learner variability is the norm, with students differing in how they approach learning tasks (Chardin & Novak, 2020). Students may differ across independent variables such as attention, motivation, interests, sensory needs, reasoning, memory, background knowledge, and vocabulary. Rao and Meo (2016) noted that the perception of UDL is often viewed as specific to students with disabilities. However, variability is not contained within any specific group of students. Preparation programs can support pre- and in-service teachers by having them complete their own learning profiles and reflect on what learning experiences have worked for or provided barriers to their profile.

An asset-based approach to curriculum development, based on learner variability, can improve outcomes for all students, including those who are culturally and linguistically diverse (Eichhorn et al., 2019). Asset-based approaches identify individual and community strengths related to prior knowledge, skills, and reciprocal communication (Scott et al., 2020). An asset map is then developed and used to guide instruction, which enables students to share successful attributes and promotes expert learning of complex concepts such as conceptual understanding of fractions (Hunt et al., 2023).

1.3 Set High Expectations for Learning to Meet Established Standards Without Reducing Rigor

Teacher educators and professional developers can use the UDL framework to facilitate inclusion by enabling teachers to reduce learning barriers while maintaining high expectations for all learners. UDL allows teachers to consider learner differences, preferences, and needs at the onset of planning and instruction rather than after lessons have been developed for "typical learners" and modified to address individual students' needs (Edyburn, 2010). Traditional planning and curriculum development assume that learners can access and engage in learning through a single pathway (e.g., by reading the textbook or listening to a teacher explain a concept). Flexibility is not built into this instruction, and lessons must be altered whenever a learner experiences challenges. An alternative, proactive approach calls for teachers to use the UDL framework to structure their lessons, which makes them accessible and engaging for every learner at the outset. In addition, students can meet established standards without reducing rigor by providing alternative pathways for students to learn and demonstrate mastery in diverse ways.

As students progress through the learning experience, UDL provides a step-by-step process for students to access the materials, build knowledge, and internalize learning. For

example, if students were learning conceptual understanding of fractions, the teacher would minimize distractions in the environment (i.e., increase access to the content), which could be followed with an opportunity for collaborative learning in which students discuss symbols and mathematic notation that were explained using multimedia (i.e., build knowledge). Finally, students could develop an advanced organizer highlighting key concepts from their new knowledge, which could be transferred and generalized to other contexts (i.e., internalize).

1.4 Understand Learning Barriers Are External to the Student; They Occur as Students Interact With Instructional Environments

A broader view of learner variability requires a mindset shift from the often-used deficit model of disability (Gronseth & Dalton, 2020). Even students who require significant levels of support fall into the natural range of learner variability (Hartmann, 2015). Disabilities are exacerbated when challenges in physical, cognitive, or social/emotional domains combine with barriers in the learning environment. Educators learning about UDL should identify their personal biases about student learning and embrace the fundamental belief that every student can learn when presented with an appropriate learning pathway.

According to Toutain (2019), an impairment does not necessarily result in a learning deficit if the barrier can be removed. Wehmeyer (2020) described the person-environment fit as enabling people to succeed regardless of diagnosis or disability label. For instance, if students cannot hear, they will not benefit from content provided only in auditory formats. UDL allows the students to access the content, in this case, by providing text and other visual scaffolds. At the knowledge-building level, students should be able to communicate easily and effectively with peers, which could be aided by captions or AT, such as a hearing device. To facilitate

internalization, the students could develop a visual representation of strategies they used to manage the new information.

1.5 Proactively Identify Potential Barriers Across Cognitive, Social, Physical, and Cultural Domains in Instruction, Assessment, and the Learning Environment

A cornerstone of UDL is the amelioration of learning barriers through proactive instructional design (Hickey, 2021), achieved through engagement; flexible use of materials; and meaningful, accessible instruction. UDL focuses on barriers within the curriculum and learning context, not the learners themselves (Rose et al., 2018). Educators design inclusive education environments by removing physical, sensory, cognitive, social, and cultural barriers to learning (Navaitienė & Stasiūnaitienė, 2021; Vasquez & Marino, 2021). Technology provides another means for removing barriers within instruction and assessments (Rao et al., 2021). Removing barriers creates an environment where students can better build their learning through added support where they are challenged. Students possess enhanced abilities to meet learning goals when provided with the support, challenge, and metacognitive skills associated with the UDL framework (Grant & Perez, 2022).

1.6 Remove Barriers by Providing "Multiple Means" in Which Every Student Selects From Flexible Options in Instruction and Assessment

Each UDL principle begins with the term *multiple means*; each guideline begins with *provide options for* (CAST, 2018). Educators facilitate expert learning by providing choices and guiding students to identify what works best for their own learning. Educators should expect students to experiment as they identify learning methods that maximize their efficiency (Fornauf et al., 2021).

Educators should closely review learning standards to identify which options they can feasibly provide. A Common Core English/Language Arts standard (CCSS, 2010) requires Grade 6 students to "Describe how a particular story's or drama's plot unfolds in a series of episodes, as well as how the characters respond or change as the plot moves toward a resolution" (p. 36). Students may be provided with options for the choice of text, such as having small group literature circles. Students may also be provided options in how they demonstrate the content, whether through a video recording, drawing, or written response. Using rubrics ensures that the demonstrated skill directly correlates to the standard. At the build level, students can be provided with multiple tools, both technology-enhanced and traditional, allowing them to manipulate the information in their own ways. For example, some may choose to write in a notebook while others choose to produce an interactive graphic for their peers about the content. At the internalize level, they may highlight patterns and big ideas in the new information.

1.7 Understand How the UDL Framework Integrates EBPs and Differentiated Instruction

UDL provides a foundation to ground EBPs and high-leverage practices (HLPs). The integration of UDL and differentiated instruction may cause confusion for some learners. Misconceptions about UDL and differentiated instruction have resulted in the terms being used interchangeably in the past (Griful-Freixenet et al., 2020). Differentiated instruction is a responsive teaching approach in which the teacher modifies the content, process, and products to meet the needs of individual students in a classroom. In contrast, Basham, Gardner, et al. (2020) described UDL as a proactive framework offering multiple means of representation, action, expression, and engagement to provide students with diverse pathways when learning. Students select a pathway that meets their individual learning needs. UDL is based on the premise that all

students can learn, regardless of their abilities or disabilities, and all students deserve access to the same educational opportunities.

UDL also focuses on providing students with a variety of ways to access, process, and demonstrate an understanding of content. Where the educator drives differentiated instruction, UDL focuses on students as the experts in their own learning. Novak (2016) provided a dinner party analogy, describing differentiated instruction as creating individualized meals for guests based on their dietary needs compared to UDL as offering a buffet for guests to make choices. UDL and differentiated instruction work symbiotically in the classroom, with the UDL design proactively removing barriers to learning and differentiated instruction providing specific supports as necessary.

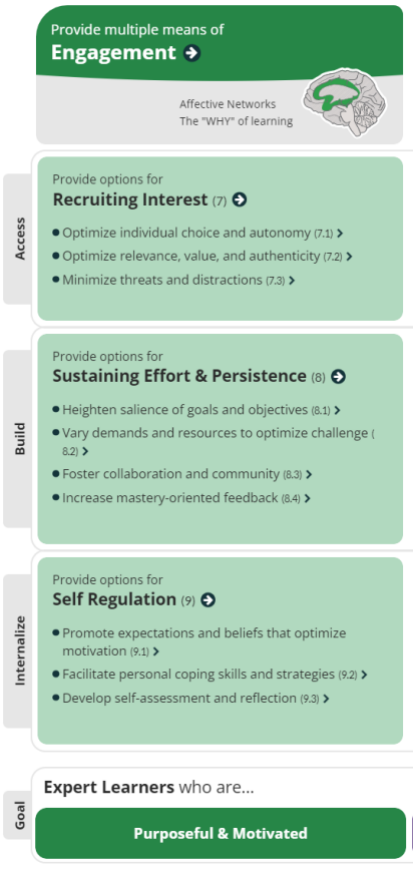
2.0. Principles of the UDL Framework

2.1 Understand How the Nine UDL Guidelines Gradually Shift Learner Responsibility From Teacher-Directed to Student-Directed as Students Become Expert Learners

As Figure 2 illustrates, the guidelines offer depth to the three principles and a roadmap to reduce barriers and strategically plan lessons/units of study or curricula for all learners.

Figure 2.

Levels of Learner Responsibility in the Guidelines



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Teachers do not need to include every checkpoint in each lesson, as the checkpoints are not a checklist (Novak, 2016). Viewing a unit rather than individual lessons when mapping individual checkpoints is far more practical.

Figure 2 displays gray subheadings on the left side of the UDL graphic organizer, with the first row labeled Access, the second Build, and the third, Internalize. The Access row, consisting of one guideline from each principle, focuses on teacher-directed efforts to ensure that every student can access and demonstrate the content. For example, under Multiple Means of Engagement, an educator may design a lesson around a local problem to address Checkpoint 7.2, "Optimize relevance, value, and authenticity" (CAST, 2018). In the second row of Figure 2, a shift occurs with more responsibility transitioning to students. For instance, an educator may support students with Checkpoint 8.2, "Heighten salience of goals and objectives," by having them restate a goal they have accomplished. As the students grow as expert learners, the educator shifts to the third row, Internalize, in which students may engage in Checkpoint 9.3, "Develop self-assessment and reflection."

2.2 Understand the Three Principles of the UDL Framework and How They Apply to Instructional Planning, Instruction, Assessment, and the Learning Environment

Experts in the field indicate that a general understanding of the UDL framework is necessary for successfully implementing UDL (Edyburn, 2010; Spooner et al., 2007). This understanding is especially important as students with disabilities and other learners needing support spend more time in inclusive classrooms due to policy and best-practice initiatives.

Teachers should be familiar with the three core principles of the UDL framework (i.e., providing multiple means of engagement, multiple means of representation, and multiple means of action and expression) to maximize the effectiveness of implementing UDL (Pfund & Smith, 2019). By understanding and addressing these three principles in instructional planning and assessment, teachers can create an environment of equitable learning to meet a wide range of learner needs.

The first UDL principle emphasizes providing multiple means of engagement, which refers to the way in which students can be actively involved in the learning process. Examples include minimizing distractions; creating activities requiring collaboration, critical thinking, or creativity; and fostering learners' self-regulation. For example, in a mathematics class, the teacher could provide opportunities for problem-solving activities to build relevance and interest, or in a social studies classroom, the teacher could use group projects or simulations to allow students to explore concepts in more depth (Hepler et al., 2016; Thomas et al., 2015). By providing multiple forms of engagement, teachers can ensure that all students are actively involved in the learning process.

The second principle of UDL emphasizes providing multiple means of representation, which refers to the ways information, concepts, and topics are presented to students. Accessibility of the content, including alternative languages, is critical to this principle. Multiple means of representation could include providing graphics, videos, audio recordings, task lists, text, and other forms of multimedia. The types of representation will vary based on the content area and the individual needs of learners. For example, a science classroom might emphasize visuals such as graphic organizers, diagrams, graphs, and illustrations (Love et al., 2020). An English class might utilize a variety of texts, audio files, videos, and writing assignments for students to access the same concepts in different ways. These multiple means should support decoding text and provide enhanced conceptualization for students learning English. In addition, they should activate or supply relevant background knowledge while highlighting patterns and relationships. Providing multiple forms of representation ensures that all students, regardless of their differences, can successfully access and make sense of the material.

The third principle emphasizes providing multiple means of action and expression, which refers to the ways in which students can demonstrate their understanding of the material, which could include written assessments, oral presentations, drawings or diagrams, performances, or other forms of communication. For example, in a geography class, students could be asked to create a physical topographic model or a PowerPoint presentation to demonstrate their understanding of the physical geography of a location to ensure that students can demonstrate their understanding of the material in ways that best fit their individual strengths while also offering an opportunity for teachers to have a more holistic perspective of students' knowledge. In addition, the Internalize level of this principle calls for enhancing students' executive functions to challenge learners to set appropriate goals, map strategies for achieving the goals, manage information and resources, and monitor progress systematically.

Teacher educators and professional developers can use several methods to integrate UDL into their programs. The first method is through reflection on their own learning process. Which learning barriers did they personally experience? Which instructional supports were most effective? How did they differ from their peers? Next, introduce learners to the UDL framework and have them use tools and resources online. Examples are as follows:

- CAST
- CEEDAR Course Enhancement Module
- Learning Designed
- TIES Center Module: Design for Each and Every Learner UDL Modules
- The IRIS Center UDL Module—Universal Design for Learning: Creating a Learning Environment that Challenges and Engages All Students
- UDL for Teachers

These web resources can be assigned as independent work and discussed as a group. Instructors can facilitate conversations about whether the pre- or in-service teachers have seen and/or participated in instruction aligned with the UDL framework.

2.3 Understand the UDL Checkpoints, Provide Specific Suggestions to Support Learning, and Support Educators to Address Identified Problems of Practice Within the Classroom

Educators can become overwhelmed when attempting to concurrently master each of the UDL checkpoints. Instead, using Teitel's (2020) work on instructional rounds, educators can define a problem of practice in their classroom, identify related barriers, and select a specific checkpoint to address the POP to provide educators with relevant application of UDL to authentic instructional challenges and provides a scaffold on which to build a UDL skillset. The educator can then incorporate the selected checkpoint into other lessons and content areas until ready to repeat the cycle.

2.4 Understand How the Four Curricular Pillars of UDL Implementation (i.e., Goals, Methods, Materials, and Assessments) Are Applied in Different Instructional Contexts

Traditional classroom practices can inhibit students' performance. For example, classroom instruction is often based on learning goals established by national and state standards, which are not typically explicitly shared with students. Instructional materials may or may not be accessible to all students. For example, written information presented using grade-level textbooks will exclude students with disabilities or limited language proficiency. Singular assessment practices can also limit performance. For example, paper-and-pencil quizzes or tests assess students' reading and writing abilities without necessarily capturing a conceptual understanding of the content. The four curricular pillars of UDL should be considered to proactively address these challenges: (1) instructional goals, (2) instructional delivery methods,

(3) instructional materials, and (4) student assessments. Applying these four pillars ensures that instruction has the flexibility to meet the needs of diverse learners (Meyer & Rose, 2014).

The UDL framework addresses goals, methods, materials, and assessments in a flexible manner, which makes instructional content both physically and intellectually more accessible (Garrad & Nolan, 2022). Rose and Meyer (2002) provided the following guidelines:

- Instructional goals address learning outcomes for all learners. For example, teachers clearly define goals, maintaining high expectations for every learner.
- A variety of methods and materials are used in instruction, providing flexibility to address the needs of all learners. For example, teachers use multimedia materials, e-text, and other resources to support learning within their instruction.
- The assessments used to evaluate student learning are flexible enough to allow students to demonstrate their learning in an accurate manner, not hindered by their abilities. For instance, if a student has difficulty with written expression, a paper-and-pencil assessment requiring written expression may not accurately assess conceptual understanding of the content.

Although these curricular processes may be taught within teacher preparation programs, they are not often taught in a manner focused on flexibility and student diversity. Consequently, teacher educators and professional developers should embed these curricular pillars in their instruction. In addition, they should provide examples across grade levels and content areas because UDL-based instruction will look different across instructional contexts (e.g., face-to-face vs. asynchronous online) because each content area and modality presents a unique progression of concepts along with a distinct structure for discourse. For example, Curry et al. (2006) explained how the UDL framework was applied to scientific inquiry and described how

teachers used tools, such as visual content mapping and accessible laboratory and field equipment, to ensure that standards-based inquiry learning was planned and implemented in a flexible and accessible manner. In another study, Bouck et al. (2009) described how UDL was integrated into social studies through a web-based curriculum called the Virtual History Museum (VHM) with multiple means of accessing and interacting with historical, geographical, and cultural materials.

Just as Marino and colleagues (2022) and Bouck and colleagues (2009) described how UDL uniquely applies within the context of science inquiry-based and social studies learning, teachers must apply the four curricular pillars of UDL differently across content areas. Therefore, teacher educators and professional developers must provide a range of examples of UDL implementation so teachers can begin to understand broad ways of understanding instructional goals, methods, materials, and assessments within a UDL framework (Lambert et al., 2021).

Teacher educators and professional developers must be thoughtful and purposeful in their instruction of the three principles of the UDL framework. Although teachers must be able to define the three principles, teacher educators and professional developers must ensure that teachers can apply and generalize the principles to content, planning for instruction, and the environment in which growth and development are expected. Considering the general nature of the three principles, one would expect these conceptual ideas to be taught in teacher preparation programs (Smith et al., 2019). However, knowing the definition is one thing; recognizing how it applies to instruction, understanding the steps for implementation, and appreciating why and when to apply the framework requires a deeper understanding (Kelly et al., 2022). Therefore, teacher educators and professional developers must embed these principles into their instruction.

Teacher education coursework and/or PD experiences should require experiences, activities, and assignments across a diverse range of contexts. UDL knowledge and implementation are enhanced by expecting pre and in-service teachers to consider how these principles are integrated during classroom instruction (Lowery et al., 2017). For example, the three principles can be embedded within content development dependent on pre- and in-service teachers' areas of expertise (e.g., reading instruction, mathematics, social skills, science). Preparation for the elementary, middle, or secondary instructional environments could then be used to identify potential barriers for struggling learners.

Grillo (2022) explained how the UDL principles are applied to the planning, content identification, and instructional process so teachers and administrators can identify barriers and use tools to ensure instruction is flexible and accessible. Consider the potential challenges in science instruction through the following three principles:

- Engagement: Students may not automatically see the connection between science content and their everyday lives. Lectures and structured group experiments often present barriers to promoting student engagement, self-discovery, and empowering students during the learning process.
- Representation: Foundational reading requires skills in reading for vocabulary, reading fluency, and reading comprehension. By using print, students often struggle to identify critical information and the main idea and structure the foundational knowledge for subsequent learning. The initial barrier is the printed text and the expectation of a specific reading ability. Subsequent instruction will be negatively impacted as a result.

- Action/Expression: Science reports present challenges in accessibility and flexibility regarding students' ability to express understanding. Writing (e.g., mechanics, grammar, organization) can quickly become a barrier in this example.

Pre- and in-service teachers must identify barriers associated with content, planning for and delivery of instruction, and the environmental constraints of the classroom. The UDL principles foster the identification of these barriers, as well as the purposeful planning for accessible and flexible content and instruction. Likewise, embedding the three principles into content planning and instruction affords teachers an understanding of applying the UDL framework. Consider, in a science classroom, the following:

- Engagement: Methods to promote engagement and interaction with the learning experience and the instruction process, such as interactive games and active learning, allow for learner self-determination and activities that enable students to develop social skills.
- Representation: A variety of materials and modes of information develop foundational knowledge, such as visual scaffolds, audio, embedded supports, video, illustrations, animations, interactive webs, or similar components, are used to contextualize the content for the learner.
- Action and Expression: Opportunities like illustrations, storyboards, presentations, multimedia, and similar elements demonstrate understanding in an appropriate manner.

A mature understanding of the UDL principles enables teachers to appreciate the complexity of the UDL framework while accounting for significant barriers associated with content, instruction, and environmental constraints in the K-12 classroom. Standards-based

content often assumes a typical student as the primary audience, thus presenting learning barriers throughout the curriculum. These barriers can be eliminated by embedding the UDL principles into teacher education coursework.

Before teachers can begin to learn about UDL implementation, they must first understand how the three UDL principles use the guidelines and checkpoints to provide flexible implementation options. Rao and Meo (2016) describe a process for developing standards-based lessons in the context of UDL. The process offers a practical four-step procedure for collaboratively implementing UDL: (1) setting goals, (2) analyzing the status of the curriculum and classroom, (3) applying the UDL framework to lesson and unit development, and (4) teaching these UDL-aligned lessons and units. This process is intended to be collaborative, with members of the instructional team relying on each other to gain the information and expertise necessary to effectively implement UDL. The Universal Design for Learning-Implementation and Research Network (UDL-IRN, 2021) offers another framework, which provides teachers with a five-step procedure based on critical elements of UDL instruction and a backwards-designed instructional process that includes five steps: (1) establish clear goals, (2) anticipate learner variability, (3) establish measurable outcomes and an assessment plan, (4) establish an instructional sequence of events, and (5) reflect on the instructional process.

Pre- and in-service teachers are often overwhelmed when introduced to a UDL planning framework because unlike rigid curricula and benchmarks, the UDL framework is broad and offers many instructional choices. Offering concrete strategies for implementation, such as the following, can support pre- and in-service teachers.

- Evaluate from a UDL perspective the instruction that pre- or in-service teachers see in their field experiences/instructional settings or in specific curricula they may

encounter (e.g., social studies, language arts, mathematics, science). Teachers can reflect on

- aspects of instruction consistent with the UDL framework,
- aspects of instruction inconsistent with the UDL framework, and
- recommendations for how they would redesign and implement the instruction from a UDL perspective.

- Design group-based instruction in which different teachers focus on alternative principles, guidelines, and checkpoints. Teachers can then
  - share their lesson ideas and evaluate the different instructional choices within these lesson ideas to reinforce multiple ways to deliver instruction using the UDL framework and
  - discuss whether the lesson implementation, when examined as a whole, would meet the needs of specific student case examples so students can reflect on how the designed lessons would meet the needs of diverse learners.

3.0. Planning Instruction and Assessment using the UDL Framework

3.1 Identify Standards and Learning Goal(s)

Designing instruction with UDL begins with a clear understanding of the learning goal. National or state standards often set the foundation for these goals. Novak (2016) suggests educators categorize the standards as either content-based, in which information is internalized, or process/method, characterized by an expected end product. Educators can often determine the category by the verb. For example, a content standard in a social studies classroom may ask a student to describe historical events or discuss the causes leading to an event. Understanding the standard type will guide the educator to determine which options can be provided. A student

could be given options for demonstration, such as a choice to write, create an infographic, or record a presentation, for those standards. However, a process standard may require a student to decode words, write, or solve a problem. As these require a specific product, students may be given options around the problem they choose to solve or the writing topic (Hashey et al., 2020).

3.2 Identify Potential Barriers to Learning

Educators designing with UDL consider potential barriers to learning the identified goals. Marino and colleagues (2021) provide a process for educators to identify and address potential barriers that students with disabilities may experience in science, technology, engineering, and mathematics (STEM) laboratories; teachers can generalize this example to other content areas. Cognitive barriers in the STEM classroom may relate to domain-specific vocabulary, conceptual understanding, and procedural knowledge. For instance, transient students may lack background knowledge in concepts or have missed necessary mathematic skills. Students may experience barriers while working collaboratively with peers in a shared lab space or may have difficulty persevering with challenging lab directions. Bias in assessment templates and rubrics may present a cultural barrier for students. Barriers in the physical learning environment may result from accessibility, a lack of materials or technologies, or furnishings allowing for only one use (Marino et al., 2022). By considering potential barriers from the start, educators can reduce frustration and ensure that students expend their cognitive energy on learning rather than on obstacles. Educators may address the previously identified barriers by providing resources such as word walls, video demonstrations, and project-based learning. Rather than offering these options only to students with disabilities, the educator makes these supports available to all students.

A critical understanding between UDL-designed support and accommodation exists. A teacher may make graphic organizers available to all students. However, a student with a learning disability may require this graphic organizer, and, in turn, it may be included on the student's IEP. This graphic organizer is both a UDL resource for the class and an accommodation for the individual student.

3.3 Design Flexible Options for Assessment Using UDL Principles

Developing assessment options before designing instruction helps ensure alignment with the learning goal. Providing only one way to demonstrate learning often results in barriers for students. Traditional assessments often amplify students' challenges and can create an emotional barrier to learning (Rose et al., 2018). Large-scale assessments can create insurmountable barriers for a variety of learners, including students with disabilities and those who are English language learners (Hickey, 2015). UDL assessments are different in how they focus on alternative ways for students to demonstrate what they know (Rose et al., 2018). UDL also creates an environment in which the student's emotions are more conducive to learning. Assessments allow students to show their knowledge in a more equitable way, regardless of any physical or language barriers.

Spooner et al. (2007), in a study of 72 graduate and undergraduate students in four education courses, examined the students' abilities to modify lesson plans for students with severe and mild disabilities using the UDL framework. He advocated for the use of a rubric to assess the level at which students achieved the objectives of the lesson. This approach allowed learners to demonstrate their understanding of a concept using multiple formats. For example, if the objective of the lesson is to demonstrate three pathways for students to obtain information during an online lesson module, some students may choose to record a Zoom session where they

explore the module, another may choose to write a paper about how the module was constructed, and another might provide the pathway materials accompanied by an audio overlay describing how they meet the objectives of the lesson. These three different responses could each receive full credit on the assignment. Andersen (2022), along with Andersen and Nash (2016), reaffirmed the notion that students with cognitive disabilities benefit from choice during assessment activities.

Starting with a standard and goals before directly mapping them to any assessment is critically important (Rao & Meo, 2016). Instruction should allow students to choose their pathway and, in turn, their assessment. Daley et al. (2016) found beneficial the practice of guiding students through an analytic process for the assessment before completion, which increased their help-seeking and clarification behaviors. Zhang et al. (2022) noted that ongoing curriculum-based assessment aided teachers who were co-designing a learning environment with their students.

To ensure that assessments are designed with UDL principles in mind, teachers should use a variety of assessment types (e.g., exams, quizzes, portfolios, writing tasks, multiple choice questions, performance tasks; Meyer et al., 2014). This variety of assessment types can provide a comprehensive evaluation of student learning while also allowing teachers to assess mastery and address individual needs. Additionally, teachers should consider testing a student's development and skills within an assessment by allowing the student to demonstrate learning by responding to open-ended questions and providing multiple strategies to answer the questions (e.g., oral/visual/text-based response options).

Educators must design assessment tasks to provide multiple options for engaging with information. Performance-based assessments (PBAs) meet this requirement. PBAs assess student

learning in contexts requiring students to authentically demonstrate knowledge, understanding, and skill. Unlike traditional assessments, which focus on factual recall, PBAs allow for complex tasks such as research activities or presentations, which allow students to apply the knowledge and skills they have acquired (Gottlieb, 2020). PBAs provide teachers with more accurate information about a student's knowledge and skills, as well as a better indication of the student's future success.

The Multi-Stage Abilities Test (MSAT) provides teachers with guidelines for assessing performance in line with UDL principles. This assessment requires students to demonstrate a range of skills and abilities to be successful. According to the MSAT framework, the assessment should include multiple activities and processes to assess a student's growth and development. Furthermore, this assessment should give students the option to complete a variety of tasks, either in a single task or through multiple smaller tasks, to display their diverse skill sets. Additionally, the MSAT requires teachers to provide multiple supports for students of all learning levels regardless of disability, language, or learning preference by providing students with high-quality instructional materials, alternative item formats, and feedback tailored to individual learners and their unique manner of demonstrating competency (Vaughn, 2019).

Portfolio-based assessments provide students with choices throughout the evaluation process, allowing students to select work they consider to be their most successful or most reflective of their abilities. Portfolios are in line with UDL's multiple means of engagement, which provides the student with a critical role in deciding what and how students will engage with their education (McElligott, 2014). In addition, the criteria used to evaluate portfolios can be customized by the students, promoting the choice of expression subscribed by UDL. For example, Flynn et al. (2019) implemented an embedded portfolio-based assessment with 190

undergraduate students in an anatomy and physiology course. The authors reported that students chose materials and criteria for evaluation, which allowed them to customize the portfolio to best reflect their abilities and interests.

PBAs also encourage the development of skills in a variety of areas aligned with UDL's goal of creating flexible learning opportunities promoting skills, knowledge, and attitudes (McElligott, 2014). Students may choose to develop a portfolio focused on different areas they find personally meaningful, such as their creativity, problem-solving skills, communication skills, or conceptual understanding. For example, students in an art history class may choose to focus on their ability to interpret and explain a work of art. They may present this ability in the portfolio using written text, as well as images, videos, or audio clips of the artwork. This combination encourages students to develop and demonstrate skills in both written and oral communication, as well as visual interpretation. Data gathered during portfolios should be transparent, continual, and actionable, focusing on the learner's voice and multiple ways to represent understanding (Basham et al., 2016). Therefore, PBAs provide students with the opportunity to develop and exercise a multitude of skills in meaningful and personally relevant ways.

Finally, portfolios offer tasks to scaffold learning and enhance student's cognitive development (Flynn et al., 2019). This task can be used as a method of assessing students while they are in the process of learning new material. The student-driven development of a portfolio can be used as a continual measurement of student progress. Portfolios can also be used as aids during the transition process for students with disabilities (Scott & Bruno, 2018), aligning with the UDL concept of multiple means of assessment, which focuses on using a variety of assessments to inform instruction and provide feedback on learning (McElligott, 2014). This type

of assessment provides both educators and students with a comprehensive view of the learning process and promotes continual student reflection and self-evaluation.

Technology offers an additional form of individualized assessment (Basham, Blackorby, et al., 2020). For example, students at a primary school in rural Cyprus were taken to a play space located within the school and were exposed to alternative reality and augmented reality environments and given assessments. Bilingual students, students with disabilities, and students who would otherwise be disengaged were more engaged in the assessment when given an alternative reality or augmented reality environment (Stylianidou et al., 2020). Marino et al. (2014) utilized video game play analytics to determine students' comprehension of scientific vocabulary and conceptual understanding of cell organelle functions. Both teachers and students reported that video games were a more accurate representation of their knowledge and skills than the paper-and-pencil tests used in the study (Marino et al., 2014).

In another published example, a case study was conducted with four secondary students using digital media to assess writing. Digital media was used to allow students to contribute various literacy talents to a digital media product. Data mining from a video documenting the project was used to assess students. The author concluded that learning was accurately measured by the data collected during the video (Leach, 2017). Finally, PutraPacer, an online assessment tool developed with UDL elements, taught students higher-level thinking skills. The tool was tested with pre-service teachers from a university in Malaysia. The pre-service teachers found the tool easy to use and most highly intended to use it in their future classrooms (Majuddin et al., 2022).

3.4 Ensure That Instruction and Assessment Materials Provide Key Information Equally Perceptible to All Learners

Students with disabilities may require accessible educational materials (National Center for Accessible Educational Materials [AEM Center], 2022). By law, these materials must be provided in a timely manner (IDEA, 2004). The UDL first guideline grounds instructional design in accessibility by providing multiple means for perception. Educators need the skills to provide materials in different modalities, such as captioned video, slide presentations supported by alt-text for images, or audio formats for print-based materials. Additionally, educators should demonstrate proficiency in using technology to adjust instructional materials to meet student needs. Tools such as Immersive Reader allow students to adjust their own documents for font size, color, line spacing, and focus.

3.5 Create and Evaluate Learning Environments Aligned With the UDL Framework

These UDL guidelines further articulate the UDL framework and offer a path or strategy to reduce barriers and optimize levels of challenges and supports from the beginning (Rose et al., 2018). Teacher educators must infuse the UDL guidelines and connected checkpoints during teacher preparation experiences. Each of these nine guidelines further articulates the three principles of UDL, and the corresponding checkpoints clarify and illustrate the guideline and the respective principle. Using these guidelines, teachers can quickly identify barriers common to curricula (i.e., goals, methods, materials, and assessments).

Aligning the UDL principles and guidelines to the instructional content (e.g., reading, science, mathematics, visual arts, physical education) provides teachers with a framework to determine which content-specific standard is required by all students, which parts are applicable to most students, and which areas are relevant for enrichment for some students. If teachers

understand and appreciate what all students must know specific to a curriculum standard (e.g., CCSS), they are prepared to consider the UDL framework and its application to this content. If teachers cannot determine what is primary or critical for all learners within the content, they will likely struggle with prioritizing goals and levels of complexity, thus limiting the flexibility of instruction.

While introducing the checkpoints, teacher educators and professional developers should utilize the UDL Guidelines graphic organizer version 2.2 (see http://udlguidelines.cast.org/) provided by CAST (2018). This tool structures the guidelines and corresponding checkpoints under the three respective principles. The checkpoints are designed to operationalize the principles and guidelines beyond a definition to support the implementation of UDL. For example, CAST defines the checkpoints; explains the potential barriers and how the principles and guidelines address content and instructional limitations; and offers examples and links to resources, allowing teachers solutions/tools for subsequent implementation.

Instruction occurs across many learning environments. Teacher preparation and PD related to UDL must address the role of the learning environments (e.g., the classrooms and other instructional areas in which learning takes place). These learning environments contain the technologies, resources, and supports with which students and teachers interact during learning. Teachers should receive opportunities to evaluate the physical instructional spaces and the resources within the spaces from a UDL perspective. Can students physically access all the resources within the environment? Is the space conducive to the types of instructional delivery planned through the UDL framework (e.g., is the physical layout conducive to collaboration)? For example, in a mathematics lesson designed to provide multiple means of representing the concept of a number line, does the physical space have room for numerous manipulatives and

online materials accessible through computers or mobile devices? Does the space allow students to collaboratively solve problems?

Strategies for helping teachers create and assess learning environments from a UDL perspective are as follows:

- While teachers learn about environmental or ecological inventories, they can simultaneously evaluate environments from a UDL perspective.
- They can include a section in their lesson plans devoted to the learning environment.

3.6 Identify and Strategically Use Materials, Curricula, and Technologies to Align Instruction With the UDL Framework

Many students with disabilities have difficulty accessing instructional curricula for a wide variety of reasons (Evmenova, 2018). Teachers need opportunities to identify and use materials, curricula, and technologies that are accessible and meet the needs of diverse learners. UDL implementation research related to accessible materials and curricula focuses on how instructional materials can be used in a flexible manner and can be altered to meet the needs of individual learners (Bray et al., 2023). Discussions about UDL and technology often concurrently occur because technology can enhance teaching and learning through the UDL framework due to the power of technology to act as an equalizer, empower students, and encourage independence. Research on the use of technology to support teaching and learning through the UDL framework (e.g., Basham, Blackorby, et al., 2020; Cook & Rao, 2018) has pointed toward the adaptability and individualization afforded to learning by the flexibility inherent within technologies such as gaming, digital text, text-to-speech software, media-rich experiences, and flexible technology-based assessment systems.

Israel et al. (2013) discussed integrating technology into teaching and learning, including its use within the UDL framework. Several strategies to provide teachers with experiences to enhance their understanding and use of materials, curricula, and technologies aligned with the UDL framework follow:

- Compare and contrast technology and AT within the UDL framework and the role of AT and general instructional technologies within the UDL framework. Although UDL proactively addresses the needs of diverse learners, some students will require individualization from technology (i.e., AT) and instructional planning perspectives. The distinction between AT and technologies used within the UDL framework is that AT meets the individual needs of a learner with disabilities, while general instructional technologies are those designed to be used by any learner who may benefit from their use. Thus, AT use by individual students concurrently occurs alongside UDL-based materials and technologies for all learners. Readers interested in learning more about recommended AT practices for students with disabilities are referred to the Office of Special Education Programs' (OSEP) guidance document.
- Emphasize that materials and technologies used within the UDL framework should be considered tools (UDL-IRN, 2011) to enhance curricula and make it more engaging and accessible. Teacher educators should be aware that teachers think that by using technology, they are "doing UDL." For example, just because a teacher is using Clicker software (i.e., a reading- and writing-based technology tool) does not mean the teacher has fully considered the UDL framework. Teacher educators should, therefore, emphasize instruction and pedagogy and the way in which technologies support and

enhance teaching and learning rather than simply assuming the use of technology results in increased access, learning, and engagement.

- Assess the degree to which materials and technologies enhance learning, meaningful access, and engagement. While considering these materials and technologies through the lens of UDL, teachers can evaluate whether the materials and technologies are appropriate for the desired learning tasks and outcomes. This practice should occur throughout instruction related to lesson planning, lesson evaluation, and general discussions of technology integration, as well as throughout instruction related to UDL.
- Extend technology consideration beyond access. Too often, access to content or instruction is deemed effective and aligned with the UDL framework. For example, text-to-speech through Microsoft Immersive Reader or speech-to-text through applications like Google Voice Typing or Windows Dictation are highlighted as effective UDL-aligned tools and are showcased as UDL in action. Teacher educators should emphasize that they do not offer the scaffolds and embedded supports needed for subsequent learning. Thus, access afforded by such technologies is a part of UDL but does not represent the entire framework. An analogy to present to teachers could be to keep in mind traditional classroom accessibility efforts via automatic doors, automatic classroom lights, and wider entryways to accommodate wheelchairs; these solutions offer entry into the classroom but do not alter the content or instruction once there.

3.7 Strategically Integrate EBPs With UDL Planning, Teaching, and Assessment

As teachers start to understand how the UDL framework meets the needs of diverse learners, helping them understand how to embed effective instruction is critical. As they learn

about different EBPs, teachers should have opportunities to see how these practices fit within the framework. Opportunities are as follows:

- While teaching about different EBPs, provide examples of how students would be taught within the UDL framework. For example, while teaching about mathematics practices, teacher educators provide opportunities for students to have concrete examples of mathematical concepts, illustrating how to provide multiple means of representation using manipulatives, virtual manipulatives, and opportunities to access information through online resources. While teaching about instructional strategies in writing or reading, teacher educators teach the use of modeling, guided practice, independent practice, and generalization, illustrating how students can integrate different means of expressing their understanding (beyond paper-and-pencil assessments); have access to technologies to support understanding; and monitor their progress.
- While teaching about implementing EBPs, discuss the EBPs by filtering them through the UDL framework, using the guidelines and checkpoints to identify additional tools to maximize the impact of the intervention and potentially extend its usefulness to a larger set of learners. For instance, Foxworth and colleagues (2022) explain how explicit instruction can integrate into UDL, providing a way to best meet the instructional needs of students with disabilities.

3.8 Use Progress Monitoring and Data-Based Decision-Making to Inform Instruction, Provide Mastery-Oriented Feedback, and Provide Opportunity for Student Reflection

Considering how to embed experiences related to progress monitoring, data-based decision-making, and mastery-oriented feedback within the UDL framework is important for

teacher educators. The UDL literature showcases a complex interaction between progress monitoring, understanding the interplay between student performance, and UDL-based instruction and environmental factors. In addition, teachers should consider how to effectively provide feedback to students.

Timely progress monitoring can be effectively combined with data-based decisions within the context of the UDL framework, which should be done with both student- and environmental-level data as part of the evaluation process. Although student-level progress monitoring data are typically gathered, students' learning environments are not often assessed to the same degree.

To support the implementation of UDL, teacher educators and professional developers should provide experiences for teachers to consider which elements of the learning environment support or impede learning. In this way, they will begin to see the relationship between assessment practices and students' goals, motivation, and performance (Van Boxtel & Sugita, 2022). Providing students with feedback on their learning and performance helps them persevere, makes them aware of how their effort translates to success, and improves their attitudes about themselves as learners (Singleton et al., 2019). When teachers focus on providing mastery learning feedback, students are more likely to invest in the learning process for the sake of learning and see increases in self-efficacy, persistence, and self-regulation (Hartmann & Blackorby, 2019).

3.9 Understand UDL Implementation Is an Iterative Process

UDL is an iterative instructional design framework (Sasson et al., 2022). Educators should be encouraged to reflect on their practice, revisit lessons, and incorporate additional checkpoints. The transition to a fully UDL-aligned unit seldom occurs on the first attempt.

Teachers should be encouraged to view the process as iterative, with continuous improvement cycles occurring each time the content is taught and assessed. Incorporating student voices and feedback can give educators an opportunity to co-design instruction with their students.

Conclusion

UDL is a proactive and purposeful curriculum design framework. It embraces learner variability by integrating multiple means of engagement, representation, action, and expression. The framework includes critical aspects of independent expert learning, such as self-regulation and the development of executive function skills. Students are taught to identify relevant goals in the curriculum and exhibit goal-driven behavior as their content knowledge and skills increase.

This UDL IC (see Appendix A) was created to offer practical recommendations intended to assist and guide special and general education teacher preparation programs as both special and general education teachers instruct students with diverse needs, including students with disabilities. This assistance and guidance will better prepare teachers to effectively instruct the range of learners in their classrooms.

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Appendix A
Innovation Configuration: Universal Design for Learning

Essential Components	Implementation Levels				
Instructions: Place an X under the implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1:** Instruction	**Level 2:** Observation	**Level 3:** Application	**Rating**
	No evidence the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, lecture/ presentation, discussion, modeling/ demonstration, or assessment.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/ activity, case study, or lesson plan study.	Must contain at least one item from Level 1 and at least one item from Level 2, plus at least one of the following: tutoring, small-group student teaching, or whole-group internship.	Rate each item as the number of the highest level receiving an "X."

Foundations of Universal Design for Learning					
1.1 Develop expert learners who are purposeful, motivated, resourceful, knowledgeable, strategic, and goal-directed.					
1.2 Recognize learner variability and jagged learning profiles across students with and without disabilities.					
1.3 Set high expectations for learning to meet established standards without reducing rigor.					
1.4 Understand that learning barriers are external to the student. They occur as students interact with instructional environments.					
1.5 Proactively identify potential barriers across cognitive, social, physical, and cultural domains in instruction, assessment, and the learning environment.					

1.6 Removes barriers by providing "multiple means" in which every student selects from flexible options in instruction and assessment.					
1.7 Understand how the Universal Design for Learning (UDL) framework integrates evidence-based practices (EBPs) and differentiated instruction.					
2.0 Principles of the Universal Design for Learning Framework					
2.1 Understand how the nine UDL guidelines gradually shift learner responsibility from teacher-directed to student-directed as students become expert learners.					
2.2 Understand the three principles of the UDL framework and how they apply to instructional planning, instruction, assessment, and the learning environment.					
2.3 Understand the UDL checkpoints, provide specific suggestions to support learning, and support educators to address identified problems of practice within the classroom.					

2.4 Understand how the four curricular pillars of UDL implementation (i.e., goals, methods, materials, and assessments) are applied in different instructional contexts.					
3.0 Planning Instruction and Assessment Using the UDL Framework					
3.1 Identify standards and learning goal(s).					
3.2 Identify potential barriers to learning.					
3.3 Design flexible options for assessment using UDL.					
3.4 Ensure that instruction and assessment materials provide key information equally perceptible to all learners.					
3.5 Create and evaluate learning environments aligned with the UDL framework.					
3.6 Identify and strategically use materials, curricula, and technologies to align instruction with the UDL framework.					
3.7 Strategically integrate EBPs with UDL planning, instruction, and assessment.					

3.8 Use progress monitoring and data-based decision-making to inform instruction, provide mastery-oriented feedback, and provide opportunity for student reflection.					
3.9 Understand that UDL implementation is an iterative process.					

Appendix B
Summary of Evidence-Based Practices for Designing Instruction With the Universal Design for Learning Framework

Evidence-based practices (EBPs) in this innovation configuration (IC) are defined as practices substantiated by individual research studies and ranked as emerging, limited, moderate, or strong based on alignment with https://ceedar.education.ufl.edu/wp-content/uploads/2014/08/Evidence-Based-Practices-guide.pdf rather than the traditional What Works Clearinghouse definition.

Practice	**Brief Description of Practice**	**Evidence/Citation(s)**
Provide Multiple Means of Engagement		**Strong Evidence-Based Practice**
Provide options for **Recruiting Interest:** • Optimize individual choice and autonomy. (7.1) • Optimize relevance, value, and authenticity. (7.2) • Minimize threats and distractions. (7.3)	Educators recognize the role of engagement on achievement and acknowledge the barrier that exists when students do not know the "why" for learning. Educators design the environment and instruction with options for students in how they engage. Educators empower their learners to share in the responsibility for their learning by creating meaningful learning opportunities and providing a safe space to take learning risks.	Bai, S., Hew, K. F., & Huang, B. (2020). Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review*, *30*(100322). https://doi.org/10.1016/j.edurev.2020.100322 Scott, L., Saddler, S., Thoma, C. A., Bartholomew, C., Virginia, N. A., & Tamura, R. (2011). Universal design for transition: A single subject research study on the impact of UDT on student achievement, engagement and interest. *Journal on Educational Psychology*, *4*(4), 21-32.

Provide options for **Sustaining Effort and Persistence:** • Heighten salience of goals and objectives. (8.1) • Vary demands and resources to optimize challenge. (8.2) • Foster collaboration and community. (8.3) • Increase mastery-oriented feedback. (8.4)	Educators recognize that learners vary in their ability to initiate tasks and persist through learning challenges. Educators design the learning environment and instruction with options for students to support their ability to learn, even during productive struggle.	Daley, S. G., Hillaire, G., & Sutherland, L. M. (2016). Beyond performance data: Improving student help seeking by collecting and displaying influential data in an online middle-school science curriculum. *British Journal of Educational Technology*, *47*(1), 121-134. Dalton B., Proctor, C. P., Uccelli P., Mo E., & Snow C. E. (2011). Designing for diversity: The role of reading strategies and interactive vocabulary in a digital reading environment for fifth-grade monolingual English and bilingual students. *Journal of Literacy Research*, *43*, 68-100.
Provide options for **Self-Regulation:** • Promote expectations and beliefs that optimize motivation. (9.1) • Facilitate personal coping skills and strategies. (9.2)	Educators recognize that students vary in their ability to regulate their emotions and how they interact in the classroom environment. Educators explicitly provide options for students with a range of skills and experiences to successfully manage their engagement in the learning process.	Loman, S. L., Strickland-Cohen, M. K., & Walker, V. L. (2018). Promoting the accessibility of SWPBIS for students with severe disabilities. *Journal of Positive Behavior Interventions*, *20*(2), 113-123. Moore, J., Way, J., Casillas, A., Burrus, J., Allen, J., & Hanson, M. A. (2016). Effects of psychosocial

• Develop self-assessment and reflection. (9.3)		characteristics of middle school students on high school grades and on-time graduation. *European Journal of Psychological Assessment*, *32*(1), 75-83. https://doi.org/10.1027/1015-5759/a000334 Takacs, Z. K., & Kassai, R. (2019). The efficacy of different interventions to foster children's executive function skills: A series of meta-analyses. *Psychological Bulletin*, 145(7), 653-697. https://doi.org/10.1037/bul0000195
Provide options for **Perception:** • Offer ways of customizing the display of information. (1.1) • Offer alternatives for auditory information. • Offer alternatives for visual information.	Educators recognize that providing only one format of instructional materials (e.g., print only, audio only) can create barriers for students who may not easily perceive materials in the format provided (e.g., read at different grade levels). This barrier prevents students from having access to grade-level content. Educators address this barrier by providing learning materials, either in a range of formats or with the opportunity for	Donnelly, P. M., Larson, K., Matskewich, T., & Yeatman, J. D. (2020). Annotating digital text with phonemic cues to support decoding in struggling readers. *PLOS ONE*, *15*(12): e0243435. https://doi.org/10.1371/journal.pone.0243435 Liu, H., Cao, S., & Wu, S. (2019). An experimental comparison on reading comprehension effect of visual, audio and dual channels. *Proceedings of the ASIST Annual Meeting*, *56*(1), 716-718. https://doi.org/10.1002/pra2.148

	students to adjust (e.g., color contrast) so every learner can have access to instructional content.	Knutson, T. (2019). Exploring the influence of audiobooks on adolescent readers' motivation and reading comprehension. *Illinois Reading Council Journal*, *47*(4), 3-18. https://doi.org/10.33600/IRCJ.47.4.2019.3 Marino, M. T., Gotch, C., Israel, M., Vasquez, E. III, Basham, J. D., & Becht, K. M. (2014). UDL in the middle school science classroom: Can video games and alternative text heighten engagement and learning for students with learning disabilities? *Learning Disability Quarterly*, 37, 87-99. https://journals.sagepub.com/doi/abs/10.1177/0731948713503963?journalCode=ldqa McMahon, D., Wright, R., Cihak, D. F., Moore, T. C., & Lamb, R. (2016). Podcasts on mobile devices as a read-aloud testing accommodation in middle school science assessment. *Journal of Science Education and Technology*, *25*, 263-273.

Provide options for **Language and Symbols:** • Clarify vocabulary and symbols. (2.1) • Clarify syntax and structure. (2.2) • Support decoding of text, mathematical notation, and symbols. (2.3) • Illustrate through multiple media. (2.5)	Educators recognize that learners vary in how they best make sense of learning on a continuum from the concrete to abstract. Providing only one way to understand content creates a barrier to learning for students who could grasp the concept if taught in another way. Educators provide a range of options to ensure clarity and understanding of content and instruction.	Guo, D., Zhang, S., Wright, K. L., & McTigue, E. M. (2020). Do you get the picture? A meta-analysis of the effect of graphics on reading comprehension. *AERA Open*, *6*(1). Hetzroni, O. E., & Schanin, M. (2002). Emergent literacy in children with severe disabilities using interactive multimedia stories. *Journal of Developmental and Physical Disabilities.* 14, 173-190. https://doi.org/10.1023/A:1015271531459 Kennedy, M., Thomas, C. N., Meyer, J. P., Alves, K. D., & Lloyd, J. W. (2014). Using evidence-based multimedia to improve vocabulary performance of adolescents with LD: A UDL approach. *Learning Disability Quarterly*, *37*(2), 71-86. https://doi.org/10.1177/0731948713507262 Marino, M. T., Coyne, M. D., & Dunn, M. W. (2010). Technology-based curricula: How altered readability levels affect struggling readers' passage comprehension. *Journal of Computing*

		in Mathematics and Science Teaching, *29*(1), 31-49. https://eric.ed.gov/?id=EJ881592
Provide options for **Comprehension:** • Activate or supply background knowledge. (3.1) • Highlight patterns, critical features, big ideas, and relationships. (3.2) • Guide information processing and visualization. (3.3) • Maximize transfer and generalization. (3.4)	Educators recognize that each student comes to the learning environment with unique experiences and skills for sense-making. Some students may experience barriers if educators assume they have had the full range of experiences and instruction as their peers. Educators provide options for students to actively make connections to their learning.	Israel, M., Marino, M., Basham, J., & Spivak, W. (2013). 5th graders as app designers: How diverse learners conceptualize educational apps. *Journal of Research on Technology in Education*, *46*(1), 53-80. https://www.tandfonline.com/doi/abs/10.1080/15391523.2013.10782613 Marino, M. T., Black, A., Hayes, M., & Beecher, C. C. (2010). An analysis of factors that affect struggling readers' comprehension during a technology-enhanced STEM astronomy curriculum. *Journal of Special Education Technology*, *25*(3), 35-48. https://journals.sagepub.com/doi/abs/10.1177/016264341002500305 O'Reilly, T., Wang, Z., & Sabatini, J. (2019). How much knowledge is too little? When a lack of knowledge becomes a barrier to comprehension. *Psychological Science*, *30*(9), 1344-1351.

Provide options for **Physical Action:** • Vary the methods for response and navigation. (4.1) • Optimize access to tools and assistive technologies. (AT; 4.2)	Educators recognize that instructional materials (e.g., print materials, software, manipulatives) may pose barriers to interaction and navigation, and, in turn, consider and provide options so all students can fully engage.	Noakes, M. A., Schmitt, A. J., McCallum, E., & Schutte, K. (2019). Speech-to-text assistive technology for the written expression of students with traumatic brain injuries: A single case experimental study. *School Psychology*, *34*(6), 656-664. https://doi.org/10.1037/spq0000316 Ok, M. W., Rao, K., Pennington, J., & Ulloa, P. R. (2022). Speech recognition technology for writing: Usage patterns and perceptions of students with high incidence disabilities. *Journal of Special Education Technology*, *37*(2), 191-202. Perelmutter, B., McGregor, K. K., & Gordon, K. R. (2017). Assistive technology interventions for adolescents and adults with learning disabilities: An evidence-based systematic review and meta-analysis. *Computers & Education*, *114*, 139-163.

Provide options for **Expression and Communication:** • Use multiple media for communication. (5.1) • Use multiple tools for construction and composition. (5.2) • Build fluencies with graduated levels of support for practice and performance. (5.3)	Educators recognize that providing only one form of assessment presents barriers to students. Educators provide options for students to "show what they know" that allows them to demonstrate their success with standards and learning goals.	Hitchcock, C. H., Rao, K., Chang, C. C., & Yuen, J. W. (2016). TeenACE for science: Using multimedia tools and scaffolds to support writing. *Rural Special Education Quarterly*, *35*(2), 10-23. Leite, W., Cetin-Berber, D. D., Huggins-Manley, A. C., Collier, Z. K., & Beal, C. R. (2019). The relationship between Algebra Nation usage and high-stakes test performance for struggling students. *Journal of Computer Assisted Learning*, *35*(5), 569-581. https://doi.org/10.1111/jcal.12360
Provide options for **Executive Function:** • Guide appropriate goal-setting. (6.1) • Support planning and strategy. development (6.2) • Facilitate managing information and resources. (6.3)	Educators recognize that executive functioning (EF) skills, from setting goals, creating a plan to accomplish those goals, and self-monitoring their goal progress, vary across each student. Educators support students to build their EF skills by scaffolding their cognitive load and resources and incorporating strategies to support EF skills.	Daley, S. G., Hillaire, G., & Sutherland, L. M. (2016). Beyond performance data: Improving student help seeking by collecting and displaying influential data in an online middle-school science curriculum. *British Journal of Educational Technology*, *47*(1), 121-134. Desideri, L., Di Santantonio, A., Varrucciu, N., Bonsi, I., & Di Sarro, R. (2020). Assistive technology for

• Enhance capacity for monitoring progress. (6.4)		cognition to support executive functions in autism: A scoping review. *Advances in Neurodevelopmental Disorders 4*, 330-343. https://doi.org/10.1007/s41252-020-00163-w Guzman, G., Goldberg, T. S., & Swanson, H. L. (2018). A meta-analysis of self-monitoring on reading performance of K-12 students. *School Psychology Quarterly*, *33*(1), 160-168. https://doi.org/10.1037/spq0000199 Hall, T. E., Cohen, N., Vue, G., & Ganley, P. (2015). Addressing learning disabilities with UDL and technology: Strategic reader. *Learning Disability Quarterly*, *38*(2), 72-83. Lemberger, M. E., Selig, J. P., Bowers, H., & Rogers, J. E. (2015). Effects of the student success skills program on executive functioning skills, feelings of connectedness, and academic achievement in a predominantly Hispanic, low-income middle school district. *Journal of Counseling & Development, 93*, 25-37.

		https://doi.org/10.1002/j.1556-6676.2015.00178.x Martin, A. J., & Elliot, A. J. (2016). The role of personal best (PB) goal setting in students' academic achievement gains. *Learning and Individual Differences*, *45*, 222-227. Wright, R. E., McMahon, D. D., Cihak, D. F., & Hirschfelder, K. (2020). Smartwatch executive function supports for students with ID and ASD. *Journal of Special Education Technology*. https://doi.org/10.1177/0162643420950027 Xu, S., Wang, J., Lee, G. T., & Luke, N. (2016). Using self-monitoring with guided goal setting to increase academic engagement for a student with autism in an inclusive classroom in China. *The Journal of Special Education.* https://doi.org/10.1177/0022466916679980