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V. Descriptive Studies of Specific Instructional Applications



Using Universal Design for Learning to Personalize an Evidence-Based Practice for Students With Disabilities

Sara Cothren Cook, Kavita Rao, and Bryan G. Cook

Personalized learning lies at the heart of special education. From the foundational work of Itard (Lane, 1976) and Farrell (1908–1909) to the Individualized Education Programs (IEPs) mandated by the Individuals with Disabilities Education Act, prominent elements of personalized education have been and continue to be guiding principles of special education. Personalized learning requires practitioners to use multiple modes of instruction in order to scaffold learning and enhance student motivation with the aim of improving educational outcomes (see Redding’s chapter elsewhere in this volume) and includes (a) variation in time, pace, and place; (b) technological aids; (c) individualized and varied instruction with student engagement in design; (d) teacher–student–family relationships; and (e) personal competencies (i.e., cognitive, metacognitive, motivational, social/emotional). Consistent with special education, these core tenets of personalized learning focus on individualized and differentiated instruction that take into account student needs, preferences, and interests (Twyman, 2014).

Two contemporary educational initiatives, evidence-based practices and Universal Design for Learning (UDL), hold considerable promise for improving the educational experiences and outcomes of students. We propose that evidence-based practices and UDL can be applied to promote personalization of effective instruction for students with disabilities. In this chapter, we provide a brief overview and definition of evidence-based practices and UDL and describe how one teacher implements an evidence-based practice in her inclusive classroom, applying principles of UDL and personalized learning in order to support students with disabilities.

Spencer, Detrich, and Slocum (2012) defined evidence-based practice as “a decision-making process in which empirical evidence is one of several important influences” (p. 130). That is, instructional practices are implemented when they align with the best available research evidence, teachers’ professional judgment, and clients’ (e.g., learners and their families) values and contexts. Replacing generally ineffective practices that are sometimes used in special education (e.g., Burns & Ysseldyke, 2009) with

“evidence-based practices” shown to be generally effective by bodies of high-quality, experimental research should result in generally improved learner outcomes (Cook, Smith, & Tankersley, 2012). Scholars have emphasized the importance of implementing evidence-based practices as they were designed, that is, with fidelity (Dulak & DuPre, 2008). If core elements of an evidence-based practice are not implemented as designed, then the practice may lose its effectiveness. However, emphasizing strict adherence to core elements of evidence-based practices in a way that does not account for unique learner characteristics, experiences, and preferences may be counterproductive and ineffective (Johnson & McMaster, 2013). To optimize learner outcomes, we recommend that special educators strike a balance between evidence-based practice and fidelity on one hand and personalization and adaptation on the other. UDL provides a means for balancing fidelity and personalization when engaging in evidence-based practice.

UDL is a framework for designing flexible instructional environments that reduces barriers to learning in the curriculum and increases cognitive access to instruction with the goal of developing expert learners (Meyer, Rose, & Gordon, 2013). Teachers can use the UDL framework during the lesson planning process to consider and proactively design instruction that addresses learner variability and personalizes learning. The three main principles of UDL are to provide multiple means of (a) representation, (b) action and expression, and (c) engagement. These three foundational principles are further defined by nine guidelines and 31 specific “checkpoints” that provide detailed guidance about how to apply UDL to instruction (National Center on Universal Design for Learning, 2014). Teachers can apply these guidelines to instructional goals, materials, methods, and assessments. By definition, UDL-based lessons provide multiple access points that can support a range of learners in a classroom while concurrently providing personalized choices and options for individual students.

Redding (2014) identified four personal competencies that are integral to personalized learning: (a) cognitive competency, (b) metacognitive competency, (c) motivational competency, and (d) social/emotional competency. Redding defined the term competency as “a general and evolving accumulation of related capabilities that facilitate learning and other forms of goal attainment” (p. 4). The intention of developing these competencies within the personalized learning framework is consistent with UDL’s goal of developing expert learners. Both UDL and personalized learning ultimately focus on instructional strategies and the provision of supports that develop learner agency and mastery learning.

In this field report, we describe how one teacher uses an evidence-based practice in mathematics—the concrete–representational–abstract strategy (CRA)—and illustrate how she uses personal learning strategies and UDL guidelines to provide supports for learners with disabilities in the classroom. We highlight ways in which she uses strategies that vary the pace of learning, individualize curriculum, provide instructional choices that foster student engagement, make use of appropriate technology tools, and develop personal competencies in alignment with UDL guidelines and the personalized learning framework.

Concrete–Representational–Abstract: Instructional Strategies for an Inclusive Setting

Ms. B. is a math teacher at a public middle school in an urban school district. In the second quarter of the academic year, the seventh-grade math curriculum adopted by her district focuses on solving algebraic equations. Ms. B.’s fourth period inclusive math

class is composed of 25 students, including six students receiving special education services. Three students have learning disabilities, two students have emotional/behavioral disabilities, and one student has been diagnosed with autism. To meet the needs of all the students in this inclusion setting, Ms. B. understands the importance of using evidence-based practices that are likely to improve academic outcomes and of applying UDL principles to her instruction to provide flexible options and choices for her students with and without disabilities.

Ms. B. has read the research on the CRA strategy and believes that it is an effective practice to use for her diverse students (see Witzel, 2005; Witzel, Mercer, & Miller, 2003; Witzel, Riccomini, & Schneider, 2008). The CRA strategy involves a sequence of three steps (Flores, 2010) that scaffolds support to achieve student mastery of abstract concepts.

In the first phase, the teacher demonstrates the math skill or process with **concrete**, manipulative objects. In the second phase, the teacher uses **representational** objects (e.g., pictures, drawings) to replace the concrete manipulatives.

In the final **abstract** phase, students use only numbers to complete mathematical tasks with a focus on developing fluency when problem solving. In all three phases, the teacher models strategies for the whole class followed by guided practice and then an opportunity for independent practice.

Ms. B. knows that although CRA is evidence based and already aligns with UDL guidelines in many ways, she can provide additional supports for the special education students in her classroom. She plans her lessons with the goals of maintaining the key elements of the CRA strategy and integrating additional personalized supports to meet the needs of the individual students in her class in accordance with UDL guidelines. Table 1 shows how the core elements of the CRA strategy in addition to related personalized supports that Ms. B implements align with UDL guidelines and elements of the personalized learning framework.

Table 1. CRA Strategies, Personalized Learning Supports, and Universal Design for Learning Guidelines

Core CRA Supports and Related Personalized Learning Supports Implemented by Teacher	Alignment With UDL Guidelines and Personalized Learning Elements
Concrete and representational phases support <ul style="list-style-type: none"> • decoding of mathematical notation and symbols • understanding of abstract concepts across languages by providing alternatives to linguistic representation Related personalized learning supports implemented by teacher: <ul style="list-style-type: none"> • Pre-teaching activity clarifies vocabulary and symbols related to mathematical notation and symbols 	UDL Guideline 2: Options for language, mathematical expressions, and symbols Personalized learning elements: individualized and varied instruction, cognitive and metacognitive personal competencies

The CRA strategy involves a sequence of three steps (Flores, 2010) that scaffolds support to achieve student mastery of abstract concepts.

<p>Core CRA Supports and Related Personalized Learning Supports Implemented by Teacher</p>	<p>Alignment With UDL Guidelines and Personalized Learning Elements</p>
<p>All three CRA phases</p> <ul style="list-style-type: none"> • guide information processing by providing alternative means to comprehend abstract information • provide progressive scaffolds that maximize transfer and generalization of knowledge and skills <p>Related personalized learning supports implemented by teacher:</p> <ul style="list-style-type: none"> • Flashcard activity provides reinforcement to all students while specifically supporting students with disabilities • Charts and mnemonics activate background knowledge and support transfer and generalization 	<p>UDL Guideline 1: Options for perception</p> <p>UDL Guideline 3: Options for comprehension</p> <p>Personalized learning elements: varied instructional strategies, cognitive and metacognitive personal competencies</p>
<p>CRA instructional process builds fluency by providing graduated levels of support for practicing problem solving in repeated and varied ways</p> <p>Related personalized learning supports implemented by teacher:</p> <ul style="list-style-type: none"> • Teacher provides access to tools and assistive technology as appropriate (e.g., iPad apps, calculator); use of iPad apps helps minimize threats and distractions for student with autism • Resources such as organizational chart and mnemonics facilitate information management • Students are given options at various points (e.g., to work individually or in pairs, to use physical or digital tools) • Students can make choices about which CRA strategy to use when completing individual work in the abstract phase 	<p>UDL Guideline 4: Options for physical action</p> <p>UDL Guideline 5: Options for expression and communication</p> <p>UDL Guideline 6: Options for executive functions</p> <p>UDL Guideline 7: Options for recruiting interest</p> <p>Personalized learning elements: varied pace of instruction; instructional choice based on learning preferences and interest; cognitive, metacognitive, and motivational personal competencies</p>
<p>Working in pairs fosters collaboration between students, providing peer support for learning process</p> <p>Related personalized learning supports implemented by teacher:</p> <ul style="list-style-type: none"> • Teacher determines how to pair students to optimally support students with disabilities • Process places emphasis on student mastery of concepts; students have opportunities to practice and get teacher feedback in independent phase 	<p>UDL Guideline 8: Options for sustaining effort and persistence</p> <p>UDL Guideline 9: Options for self-regulation</p> <p>Personalized learning elements: individualized and varied instruction, varied pacing, motivational and social/emotional personal competencies</p>

Note: UDL Guidelines v 2.0 can be downloaded at <http://www.udlcenter.org/aboutudl/udlguidelines>
 CRA = concrete–representational–abstract; UDL = Universal Design for Learning.

Personalized Learning: Preteaching Vocabulary

Ms. B. starts by implementing a learning support that students can benefit from before she employs specific CRA strategies. Realizing that many students, including those with learning disabilities, will benefit from revisiting key vocabulary related to this unit on solving algebraic equations, she preteaches vocabulary words (e.g., variable, equation, equal) using student-friendly language and symbols to help support understanding. To give students an opportunity to practice the vocabulary, she asks them to create flashcards and gives them the choice of practicing with a partner or individually. These practices are consistent with UDL guidelines on providing options for language and comprehension (UDL Guidelines 2 and 3) and providing students with choices (UDL Guideline 7). For the student with autism, who uses apps on a tablet device as part of his IEP, Ms. B. provides the option to create and use flashcards on an iPad. In this way, she addresses this student's needs by providing access to tools and assistive technologies (UDL Guideline 4) and minimizing threats and distractions (UDL Guideline 7). These personalized learning practices provide individualized supports, integrate instructional choices, utilize appropriate technology tools, and support the development of cognitive and metacognitive personal competencies.

Phase One: Concrete

For the first stage of the CRA process, Ms. B. uses algebra tiles as the concrete manipulative. She explicitly teaches all students (a) the values of each of the different tiles (e.g., square tiles represent 1, rectangular tiles represent the variable) and (b) what the colors of tiles represent (e.g., blue tiles represent adding, red tiles represent subtracting). She posts a visual chart on the board to provide students a guide for what each tile represents.

Whole-Class Modeling

To teach students how to solve algebraic problems using the algebra tiles, Ms. B. demonstrates the process and steps of solving the problems for the class. She creates a chart that has space to (a) write the algebraic equation, (b) place tiles on each side of the equal sign, and (c) write in the answer to the equation. She will use this chart in all three phases of the CRA strategy. Ms. B. also posts the steps to solving algebraic problems on the board as she visually demonstrates how to use the manipulatives to solve the equation. Using these resources, Ms. B. models the problem-solving process with several examples.

Guided Practice

Ms. B. provides guided practice with the manipulatives in two ways. First, she gives each student the organizational chart as described earlier and a set of his or her own algebra tiles and asks them to copy a problem from the board. She then calls on individual students to help her place the appropriate tiles on each side of the equation and use additional tiles to solve the equation. She provides several examples to the whole class to allow students to use the manipulatives with her guidance. Next, she places students into pairs and has them work together using the chart and manipulatives to solve additional problems. She monitors the classroom to check for understanding among the pairs of students.

Individual Practice

To ensure that each student understands how to solve algebraic equations individually, Ms. B. provides students with three additional problems to solve independently. She allows students a choice to use either the algebra tiles or a digital manipulatives app on the classroom iPads. Ms. B. provides each student with the organizational chart to support their problem solving. She uses this independent practice as a formative assessment to determine whether students are able to individually solve algebraic equations using concrete manipulatives and are ready to move on to the next phase.

Personalized Learning

Ms. B. integrates several UDL-related supports to personalize learning in the concrete phase. First, Ms. B. provides both visual and organizational charts as guides to help students remember the values of each of the algebra tiles and stay organized when solving each problem (UDL Guidelines 3 and 6). In addition, Ms. B. pairs students intentionally to ensure that the students with disabilities are with peers who will collaborate effectively and provide peer-learning supports (UDL Guideline 8). Providing a choice of using algebra tiles or the digital manipulatives app in the independent practice phase also provides a personalized learning support for specific students. The digital manipulatives provide access to tools and technologies (UDL Guideline 4), and the provision of choice helps to recruit student interest and foster motivation (UDL Guideline 7). These personalized learning practices provide students with choices that align with their interests and motivation, utilize technological tools as needed, and contribute to the development of cognitive, motivational, and social/emotional personal competencies.

These personalized learning practices provide students with choices that align with their interests and motivation...

Phase 2: Representational

The representational phase of the CRA strategy provides a transitional step between the concrete and abstract levels (Flores, 2010). For the representational phase, Ms. B. replaces the concrete tiles with picture representations.

Whole-Class Modeling

Ms. B. begins by modeling how to solve algebraic equations with pictures, which act as a substitute for the manipulatives of the concrete phase. Ms. B. uses the organizational chart and colored pencils to solve problems using pictures of the algebra tiles. As part of modeling this process, Ms. B. explicitly describes how her pictures represent the concrete tiles that were used in the previous lesson.

Guided Practice

Ms. B. gives each student an organizational chart and colored pencils. Ms. B. writes a problem on the board and calls on individual students to help her draw the appropriate pictures on each side of the equation. To support some of the students with disabilities, who often struggle with keeping up with class notes, Ms. B. provides premade pictures for them to glue on their organizational chart during this guided practice. As they work through the problems, Ms. B. poses questions regarding the picture and color students are using when drawing and solving their equation; she monitors the students using premade

pictures to make sure they are choosing the appropriate pictures to place on either side of the equation. She provides several examples to the whole class to reinforce the concepts. Next, she places students into pairs and has them work together using the chart and pictures to solve several more problems. She monitors the students to check for understanding.

Independent Practice

Ms. B. provides several problems for the students to solve on their own. She offers all students a choice to draw their pictures using either colored pencils or a program on computers. For students with learning disabilities, who tend to struggle with basic math computations, and for students with emotional/behavioral disabilities, who become frustrated working on multistep problems, Ms. B. provides the option of using a calculator to check their work while practicing independently. She uses this independent practice as a formative assessment to determine whether students are ready to move on to the abstract phase.

Transition to the Abstract Phase

Because transitioning students from the representational to the abstract phase can be challenging, Ms. B. decides to introduce students to the “CAP” mnemonic (Mercer, Jordan, & Miller, 1996). She shows students how the steps they have used to solve algebraic equations align with the CAP mnemonic and asks students to practice using it.

- C: Combine like terms on both sides of the equation.
- A: Ask yourself how you can get the variable on one side of the equation (e.g., undo all addition, subtraction, multiplication, and division).
- P: Put the value of the variable into the original equation to check your answer.

Personalized Learning

In the representational phase, Ms. B. provides many of the same personalized learning supports as the concrete phase (i.e., visual chart, organizational chart, purposeful student pairing). In addition, Ms. B. minimizes students’ frustration by providing students the choice of using premade pictures during guided practice and the computer during independent practice. Both supports are consistent with UDL Guideline 4 to provide appropriate tools and assistive technologies. Using the calculator provides additional access to an assistive technology tool (UDL Guideline 4) and gives students the opportunity to gain fluency through practice (UDL Guideline 5) while reducing the frustration they may feel when checking problems manually. Ms. B. also introduces the mnemonic strategy to personalize learning and support students’ transition from the representational to the abstract phase, helping students activate background knowledge and supporting transfer and generalization (UDL Guideline 3). These personalized learning practices vary pace of instruction, utilize technological tools to support specific students, and support the development of cognitive and metacognitive personal competencies.

Phase 3: Abstract

After ensuring students are able to use the CAP mnemonic to solve algebraic equations using pictures, Ms. B. is ready to transition her students to the abstract phase of algebraic problem solving.

Whole-Class Modeling

During this phase, Ms. B. uses the organizational sheet described in previous steps and models several problems on the board for students. Ms. B. uses a think-aloud process to model the CAP mnemonic when solving algebraic equations. In the abstract phase, Ms. B. replaces the pictures with numbers and shows how the same steps students used in the earlier concrete and representational phases can be used with problems in the abstract form.

Guided Practice

Ms. B. provides all students with a modified version of the organizational chart that includes the steps of solving the algebraic equation using the CAP mnemonic. She calls on students individually to help her solve problems on the board, practicing the steps with the abstract (numerical) representation. Ms. B. checks for understanding and provides feedback to students during guided practice.

Independent Practice

Ms. B. provides five problems to practice independently. For the students with disabilities, Ms. B. adds in an element of choice. She allows these students to select any of the three methods for solving the problems (concrete, representational, or abstract) with the guideline that at least two problems have to be solved using the abstract method. Students complete five problems on their own.

Personalized Learning

In the abstract phase, Ms. B. again provides some personalized learning supports used in earlier phases (i.e., organizational chart, mnemonic). The organizational chart, as used in the abstract phase, incorporates the CAP mnemonic, alleviating the need for students to refer back to the board for each step and providing them with a scaffold when solving problems abstractly. In addition, Ms. B. allows the students with disabilities to choose how they will solve the problems during the independent practice, giving them an option to use concrete or representation strategies. Students are motivated by having the opportunity to choose how they want to complete the problems (UDL Guideline 7) and are given varied ways to practice and reach mastery in this independent practice phase (UDL Guideline 8). These personalized learning practices vary pace of instruction, provide instructional choice based on learning preferences and interest, and support the development of cognitive, metacognitive, and motivational personal competencies.

Considerations for Personalized Learning and Evidence-Based Practices

The vignette in this chapter focuses on how one evidence-based practice in mathematics, the CRA strategy, can be used to improve academic outcomes for all students in an inclusive classroom and how UDL strategies can be used to personalize learning for students with disabilities. The UDL guidelines provide a menu of options that teachers can use as the vehicle for adapting evidence-based practice to create a more personalized curriculum and can be applied to any instructional strategy, intervention, or evidence-based practice. Although we believe that UDL guidelines represent a promising approach for beginning to personalize evidence-based practice, we recognize that other strategies, as discussed in the other chapters in this book, can and should be used to maximize the personalization and effectiveness of instruction for learners with disabilities.

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