Making the Most of

Universal Design for Learning

More than just accommodation, this framework is designed to help teachers reach all students—no matter their level of ability.

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Inclusion in middle school classrooms is not new. Since 1974, legislation such as the Individuals with Disabilities Act (IDEA) has mandated that all students, including those with disabilities, should be engaged in rigorous content in the least restrictive educational environment. In 2001, students with disabilities, English language learners (ELLs), and gifted students were required to meet annual benchmarks mandated by the reauthorization of the Elementary and Secondary Education Act (formerly known as the No Child Left Behind Act). Thus, all students were required to meet academic demands on par with their peers, and teachers in inclusive environments were charged with delivering instruction that resulted in equal performance for all students.

Mathematics teachers in inclusive classrooms are expected to possess not only the necessary knowledge and training to facilitate the learning of mathematical content but also the pedagogical skills to support the learning needs of all students. Although most teachers are familiar with the concept of accommodating for varying student needs, the realities of providing such accommodations present a unique challenge to educators with respect to time, resources, and knowledge of what accommodations to provide to which students and

to what degree. *Principles and Standards for School Mathematics* (2000) emphasizes a shift in instruction from the practice of procedures and memorization of definitions toward mathematical inquiry and conceptual understanding.

Implementing Universal Design for Learning (UDL) principles can provide solutions for general educators in inclusive mathematics environments. Any lesson can be planned to provide learning experiences appropriate for meeting diverse learning needs. An example of both how to approach a topic in middle school mathematics and include essential UDL specifications using relevant technology will be explored. First, UDL will be defined, and specific characteristics of the methodology will be described. Next, we will look at an Illuminations lesson and illustrate how UDL principles and technology can be infused into rich mathematical lesson plans to heighten learning experiences for all students.

WHAT IS UNIVERSAL DESIGN FOR LEARNING?

Universal design is not a new idea; it is rooted in concepts used in architecture and product development. Universal Design for Learning is a process that maximizes learning for all students, minimizes the need for individual accommodations, and eventually benefits every learner by considering different ways that students' minds are activated. It is somewhat comparable to Differentiated Instruction, which involves a framework for modifying or adapting curriculum in response to learner needs or preferences as identified during instruction. However, UDL differs from these approaches in that its use—

- addresses learner diversity at the beginning of curriculum and lesson design;
- builds the tools and methods of differentiation directly into the curriculum; and
- provides students with mechanisms so as to become more self-aware of how to take charge of their learning rather than rely on the teacher to make modifications.

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The Center for Applied Special Technology (CAST) *Universal Design for Learning Guidelines Version 1.0* (2008, p. 2) states the following:

> The burden of adaptation should be first placed on the curriculum, not the learner. . . . Because most curricula are unable to adapt to individual learning differences, we have come to recognize that curricula, rather than our students, are disabled.

Therefore, when the curriculum is created in such as way that it is accessible to as many students as possible, it eliminates the need to fix areas or aspects of instruction that are troublesome for students with disabilities, English language learners (ELLs), and gifted students, to name a few. The advent of new technology allows the learner to access information using multiple means. Curricula delivered using UDL principles can be even more versatile and can eliminate the need to retrofit lessons and assessment. Research suggests that using UDL in lesson planning and assessment can increase student achievement (Dolan et al. 2005) and decrease behavior issues (Kern, Bambara, and Fogt 2002) among diverse populations. UDL is based on three essential principles: using multiple means of (1) representation, (2) expression, and (3) engagement. In so doing, UDL eliminates the one-size-fits-all mentality in lesson planning. The UDL principles are described below.

Representation

Planning lessons using a UDL framework ensures that students gain access to instruction through multiple means of *representation*, giving learners various ways of acquiring information and knowledge. In standards-driven mathematics classrooms, the notion of alternate representations is incorporated in the Process Standards, particularly Representation and Communication. Students come to classrooms with varying recognition networks, or ways the brain works to gather facts. How we identify and categorize what we see, hear, and read can affect learning if instruction is not delivered in such a way that is accessible to how we recognize information. For instance, when classroom discussions are delivered completely using words, students with an auditory processing issue or students whose first language is not English may not be able to comprehend important points in the discussion. Providing multiple means of representation will work to ensure that all students are able to make sense of the information (e.g., the "what" of learning) that we want them to acquire in the classroom.

Expression

Too often, teachers and policymakers expect the end result or product of learning to occur in the form of writ-

ten tests or other traditional measures. Multiple means of action and *expression* can be used to provide alternatives for demonstrating what learners' know. Assessments in mathematics and other academic subject areas activate students' strategic brain networks. This network involves the planning and performing of academic or other tasks and deals with how we organize and express our ideas. Using strategic tasks, then, can be anything from writing a report to solving a math problem. However, not every student will be able to access the same strategies to show what they understand.

For students with disabilities, traditional means of showing knowledge could be inhibiting. For instance, Geary (2010) describes the following mathematical areas of difficulty for students with disabilities:

1. Verbally designating mathematical terms and relations
2. Manipulating real objects in accordance with the conventions of mathematics
3. Reading mathematical symbols
4. Manipulating mathematical symbols in writing
5. Understanding mathematical concepts and ideas

If assessments are geared toward an area of deficiency, some students will be less able to show what they understand about the mathematics, or the "how" of learning.

Engagement

Getting students excited about learning can be a challenge, especially in middle school. Planning lessons though a UDL framework means providing multiple means of *engagement* to tap into learners' interests, challenge them appropriately, and motivate them to learn. How teachers work to challenge, excite, or interest students in mathematics will ultimately affect success in the classroom.

A teacher who provides instruction in a real-life context that is interesting and relevant may better engage students in the mathematics behind the lesson. Further, teachers who use a variety of tasks that work to promote multiple learning styles and preferences will work toward stimulating motivation for today's middle school students. Just as multiple representations work to provide access to the "what" of learning, providing students with multiple means of engagement in mathematics will provide increased access to affective dimensions, or the "why" of learning, that is relevant and interesting to students.

HOW CAN I USE UDL TO IMPROVE MY MATH LESSONS?

To illustrate how UDL can be infused in mathematics lessons that are rich in content, depth, and sense making, consider the middle school lesson plan called Feeding Frenzy. This lesson, on NCTM's Illuminations website (http://illuminations.nctm.org/LessonDetail.aspx?id=L781), involves rational numbers, ratios, and proportions. The task involves a recipe for cookies, and determining quantities of each ingredient for different numbers of servings.

Suppose that Ms. Torres, a seventh-grade mathematics teacher, wishes to infuse UDL into this lesson plan. She would need to consider each of four main lesson components: learning goals, instructional materials, instructional methods, and assessment. Although all components are interconnected and interdependent, the learning goals drive the other three lesson components, as in all well-planned instruction.

Learning Goals

Teachers recognize learning goals that are clearly stated, observable, measurable, and that align with

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Potential Lesson Barriers

Being cognizant of materials, types, and issues will promote a working UDL framework.

PRINT-BASED MATERIALS

Require students to—

- see;
- decode written information;
- comprehend written information;
- read proficiently; and
- process information visually.

TACTILE MATERIALS

Require students to—

- be mobile;
- be able to fluently use their hands; and
- manipulate objects in accordance with mathematical ideas.

AUDITORY MATERIALS

Require students to—

- verbally designate mathematical terms and relations;
- hear;
- identify key points;
- process information orally; and
- take notes.

IMAGES AND GRAPHICS

Require students to—

- see; and
- be able to visually process information.

Table 1 Various situations can be enhanced over and above the UDL framework.

Instruction	Further Enhancements
Multiple means of representation highlight important information.	Allow students who may have difficulty to summarize others' solution strategies in multiple ways.
Multiple means of expression (a) provide practice opportunities with scaffolds and supports and (b) allow alternative ways for students to express their understanding	Provide a summation of strategies presented to students with disabilities. Multimedia may be used. Add technologies such as PowerPoint® presentations, digital story-telling software, or blogs.
Multiple means of engagement (a) offer choice to students (tools, etc.) and (b) allow flexible grouping.	Add computerized options. Allow student choice in groupings or assign groupings according to learning style or learning level.

grade-level standards. However, goals written in this manner may not adhere to the three UDL principles, and barriers may prevent all students in the class from achieving the goals. Teachers sometimes inadvertently limit the means by which the students can learn the content (e.g., read a textbook chapter) and demonstrate their knowledge (e.g., write a report or a problem solution). They also can unintentionally create learning goals that limit how their students can achieve the goal or can demonstrate their understanding of the mathematics.

The Feeding Frenzy learning goals require students to (1) use ratios and solve proportions and (2) combine mathematics with practical knowledge to analyze a problem. These goals do meet the principles of UDL because they do not stipulate *how* students will use ratios and solve proportions or solve problems (e.g., requiring students to use a certain method or algorithm). In other words, the goal is written so as not to limit the way in which students access information.

Learning Materials

The learning materials listed with the Feeding Frenzy lesson include measuring cups and spoons, sand, a large mixing bowl, and a Feeding Frenzy Activity Sheet and Answer Key. As Ms. Torres evaluates the use of these materials, she notices two important aspects of the materials that might not meet UDL principles. First, text and images or graphics are *fixed*. In other words, the media cannot be altered to meet the needs of all students. Many students might not find the materials engaging, whereas others might find them too challenging. Second, she notes that tactile learners may benefit from the use of sand and mixing bowls, but other students with behavior or mobility issues might find their usage challenging. (The **sidebar** on p. 169 outlines other potential barriers for various types of media often incorporated into lesson planning.)

Using UDL "encourages teachers to use materials that are more flexible and that therefore enable them to present concepts in a variety of ways to better meet the needs of a diverse group of learners" (CAST 2008). Teachers can continue to use some of their traditional materials but can also apply the three UDL principles to make the materials more accessible and engaging to a greater number of students. By using a combination of flexible materials and media and allowing students to choose the materials they work with, teachers can allow greater access for students to the mathematics. For instance, to combat the text issue, Ms. Torres uses a Wiki with text-reading options as a choice not only for six students who have difficulties with reading, processing, language, or visual perception but also for all students to access the mathematics problems through alternate means instead of through paper and pencil only. For the tactile items, she provides the choice of using virtual manipulatives.

Instructional Methods

Lessons that promote inquiry, discussion, and varying solution strategies, such as the Feeding Frenzy lesson, go a long way toward promoting multiple ways of engaging students and helping them express themselves while learning mathematics. Allowing students to generate their own strategies to solve problems will encourage them to express their thought processes in varying ways and help them engage in the lesson through thinking that is meaningful to them. However, some aspects could be further enhanced with UDL principles to allow even greater expression, representation, and engagement, as shown in **table 1**.

To highlight important information, teachers may choose to incorporate UDL technologies, such as podcasts, into a lesson. A podcast can transmit the richness of the discussion

and strategies used in class to students who might need a review, who are homebound, or who have missed that day's lesson. Ms. Torres knows that some students have difficulty with verbal conversations, so she gives students the choice of showing a problem solution using digital software or digital concept maps. To increase engagement, she regularly changes student groupings based on learning styles or preferences.

Assessment

Assessment is the last component of the curriculum that needs to be examined for UDL alignment. Just as with other lesson components, it is good to use multiple tools to assess student learning. Typically, teachers rely on chapter tests, homework assignments, an occasional project, or discussion to gauge understanding of the content being taught. However, as with other lesson components, barriers exist in limiting student options for expression of knowledge, especially in mathematics. **Figure 1** shows the questions and assessment options that can be used with the Feeding Frenzy activity specifically.

Potential issues with the lesson's assessment included these:

- A reliance on printed text ignores the needs of students who have

Fig. 1 Questioning students can produce a windfall of assessment information.

Questions for Students

- Did you notice any shortcuts as you worked through the problems?

[Some students may have found that they could repeat their baking soda values for butter (and change the units) and repeat the egg values for vanilla extract. They may also have found that they could multiply their values for baking soda by two to get the values for eggs, and so on.]

- Do you think the calculations would have been easier if you gave your answers in decimals? Why do you think cooking measurements are made in fractions?

[Answers will vary, depending on students' comfort with fractions. There is no correct answer for why measurements are made this way—it is just a convention. In fact, in other areas of the world that use the metric system, decimals are used in recipes.]

- What practical knowledge do you need to bake cookies? Is it enough to calculate the quantities of the ingredients?

[Answers will vary, depending on students' knowledge of baking. Most students will easily understand why using 2/3 of an egg is undesirable, but they may not realize that using a whole egg instead makes little difference in the recipe. Regardless, it should be clear to all students by the end of the lesson that more than math skills are necessary to make a good batch of cookies.]

Assessment Options

1. Give students another recipe and ask them to find the amount of each ingredient needed for a different number of servings.

2. Allow students to bring in their own recipes for chocolate chip cookies. If possible, test the conversions by baking the cookies and comparing the results. Ask students to write a journal entry about the way math was applied in this lesson and other skills that they needed or learned.

Table 2 Although some barriers exist with the assessment used in the Feeding Frenzy activity, addressing them is possible.

Assessment Type	Barriers	UDL Solutions
Verbally discussing questions	Auditory processing Behavior Interest Ability to verbally articulate ideas	Allow students to create multimedia presentations of solutions, such as digital storytelling, blogs, podcasts, Blabberize.com for audio explanations. Offer text instead of speech (e.g., computerized modes of reading text) solutions.
Baking items and comparing tastes to judge correct proportion	Separation of learning and testing contexts (e.g., offered as an assessment but not as part of the learning activity itself)	Use alternate senses as a learning activity prior to assessment.

difficulty decoding and comprehending text and those who have visual impairments.
- A reliance on writing ignores the needs of students who have difficulty with fine-motor skills and in some cases those who have difficulty organizing their thoughts.
- A separation between the learning context and the testing context impedes a student's ability to demonstrate his or her knowledge (e.g., if a student learned the content through the tactile instructional methods, he or she should be allowed to demonstrate knowledge through tactile means).

Students who are ELLs, are visually impaired, have reading difficulties, or have difficulty writing would not be able to successfully interact with paper-and-pencil assessments. **Table 2** highlights solutions that could be used to enhance the current assessment options used with Feeding Frenzy.

When teachers assess using UDL, it should reflect the learning goals, allow for scaffolds or supports, and provide many flexible opportunities to demonstrate a skill, whether those assessments are formative or summative in nature. Grading of UDL-type assessments should be about students succeeding in the goal of the lesson, but it also needs to be accurate and fair. Because UDL gives students alternative ways to express what they know, teachers are not grading just one means of expression; therefore, assessment tools such as rubrics can be used to grade nontraditional assessments fairly.

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FINAL THOUGHTS

Students with disabilities as well as their classmates are required to meet the academic demands proposed in the NCTM Curriculum Focal Points (NCTM 2006). Teachers in inclusive environments are responsible for delivering instruction that can potentially result in equal treatment of all students, including those with special needs. UDL is a process that maximizes learning for all students and minimizes the need for individual accommodations. In fact, UDL benefits every learner by considering different ways that students' minds are activated and how these students learn.

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