Differentiation Through Choice

Using a Think-Tac-Toe for Science Content

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Differentiation is primarily a philosophy, not a strategy or recipe (Tomlinson 2000). By definition, *differentiation* recognizes that students' readiness levels, interests, and motivations differ, even within the same grade level. These differences impact what students learn and the pace they need to experience instruction. Differentiation develops more equitable learning environments for all students. It creates a classroom community in which all students develop a sense of belonging and acceptance. Making students active stakeholders when learning helps eliminate the notion that fairness means all

students doing the same thing at the same time. It improves students' motivation and involvement: Students incorporate their interests with the teacher's goal of meeting the standards via the curriculum. We differentiate because we believe that all students can learn and should have a say in how they learn.

Choice provides students opportunities to try different modalities for experiencing an idea or expressing what they know. When teachers solely direct learning, students may not generate imaginative questions that form the foundation of an inquiry project. Because we don't usually give students a chance to guide their own learning, we should not be surprised that when we do, they become more chaotic, noisy, or lost. Students must learn how to make appropriate choices, just as they learn to perform based on other teacher expectations. When students are regularly and routinely given choices, making choices about learning feels natural for the teacher and students.

What does it mean to differentiate?

Differentiation establishes a set of student tasks that align to specified goals for what students should know, understand, and be able to do at the end of a unit, se-

FIGURE 1 Alignment of standards, goals, and outcomes

Standards	Goals	Outcomes
• Students should develop an appreciation of how we know what we know about science.	• Students generate claims about how levers work and support these claims with evidence.	• Students' claims address the change in the effort force needed to lift a load as the length of the effort arm changes.
• Students should develop the dispositions to use the skills, abilities, and attitudes associated with science.	• Students design investigations to determine how a lever works and persist in gathering data until they have sufficient evidence to support their ideas. Students communicate their process and their findings to their classmates.	• Investigations control for variables. Data are collected over several trials. • Students use science notebooks to record questions, predictions, plans, data, claims, and evidence and communicate ideas to classmates.
• Changes in systems can be quantified. Evidence for interactions and subsequent change and the formulation of scientific explanations are often clarified through quantitative distinctions (measurement).	• Students use a variety of measuring tools to explore the way levers work and compose an explanation of how these measurements help them understand how systems change.	• Students use metric rulers, force meters, spring scales, and balances. Students write letters explaining how the tools and measurements helped them understand the changing effort forces in levers.
• If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.	• Students use force explanations when describing how to balance a lever and how a load is lifted. Students describe the lifting of the load in terms of its speed and direction.	• Students balance a first-class lever and incorporate forces in their explanations. • They describe forces to lift the load in terms of the effort force and the lengths of the effort and load arms. • Students compare the speed and direction of the effort's motion to the speed and direction of the load's motion.

mester, or year and are aligned with district and state curricula. For example, students, with teacher input, can set personal learning goals for units, semesters, and the year that build from their prior knowledge. Teachers can make information about topics to be learned available in an array of formats: books at varied reading levels, video clips, audio files, models, pictures, or access to experts. Teachers can differentiate the modalities students' use to demonstrate their learning: journals, podcasts, skits, demonstrations, or multimedia presentations (Tomlinson 2003).

MI Theory

We use multiple intelligence (MI) theory to guide this strategy. Howard Gardner proposed the concept of multiple intelligences in his 1983 book *Frames of Mind*. In this work, he proposed seven intelligences: linguistic, spatial, logical/mathematical, interpersonal, intrapersonal, bodily/kinesthetic, and musical. He later added naturalistic intelligence to his framework. Some of the proposed intelligences are related to aspects of "general" intelligence, while others are less so (Visser, Ashton, and Vernon 2006) and continue to be subjected to various tests to determine their validity.

We find MI useful because we believe students need several options to show themselves, their peers, and their teachers what they know and are able to do. MI provides teachers a framework to broaden the learning experiences that they provide students. It broadens the conception of what it means to demonstrate understanding and be a contributing member of the classroom. We note that MI theory can often be misused as another way to label students as particular types of learners or thinkers—minimizing the rugged landscape of their interest to one singular peak of ability. This is a use of MI we work to avoid.

Rather than use MI theory as a way to pigeonhole learners into a single method of teaching, we prefer to use MI as a way to consider the presentation of information and demonstration of knowledge across several modalities. This can scaffold learning for students with choices that permit them some control and input into their own learning process. We conceive this as a way to provide access to curricula and agency for students, particularly in a content area where traditionally marginalized students often struggle.

Teachers can also differentiate during direct instruction to the whole class and small groups. Using a variety of graphic organizers or note-taking methods can help students make sense of information. Teachers can use heterogeneous groups to review prior knowledge or new learning. Heterogeneous grouping is a method of differentiation that involves creating groups of students whose levels of readiness for a task differ and assigning students jobs in the group to either take advantage of one of their strengths or to work on an area for improvement. These groups can be used daily. Teachers can also differentiate by asking students questions that vary from the concrete to the abstract in each lesson. These questions can be asked in class discussion, in assignments, or on worksheets. Students can be invited to choose from a series of questions. Additionally, teachers can vary homework by producing a menu of options. The differentiation technique described in this article provides an example of how to vary questions and assignments for students.

Differentiation can begin with a single lesson, expand to a unit, and finally grow to be a natural part of a teacher's daily practice. The Think-Tac-Toe, described below, can evaluate students' learning during and at the conclusion of a unit. Prior to its creation, teachers should preassess students to be certain that the content of the Think-Tac-Toe will capture the array of readiness and skills present in the classroom. As with any new teaching skill, we believe that implementation is best achieved when teachers tackle a differentiation project of manageable size.

How to differentiate?

To differentiate well, teachers need a full understanding of their desired learning outcomes for the lesson or unit. Tasks should allow students to represent their learning in several ways and align with clear outcomes. Activities should be designed so that students learn meaningful material that has worth beyond just performing the activity. For example, students can be given the option of creating a photo essay of an ecosystem. In order for a teacher to be sure that the essay aligns with meaningful learning goals, specific requirements should be included in the assignment description so that the assignment becomes more than "go outside and take pictures of nature." Varied activities, such as a written essay, a photo essay, a letter to an expert, or an oral presentation should do more than introduce fun into the classroom. They should be enjoyable because they are engaging opportunities for meaningful learning that allow student choice.

FIGURE 2 Think-Tac-Toe

Logical/Mathematical • Construct a graph or design a chart that explains how a lever works. • Describe the relationships among lever components using ratios and proportion. • What is mathematical about levers? How do you know?	**Verbal/Linguisitic** • Create a bumper sticker about levers. It should be clever and catchy and summarize today's lesson.	**Bodily/Kinesthetic** • Act out each class of lever with your bodies. • There are at least five levers in your body; demonstrate them and explain why they are levers.
Visual/Spatial • Draw a cartoon, such as a comic strip, that describes how a very large lever could be used to help someone. Correctly use at least four vocabulary words to describe levers. • Create a flipbook that demonstrates the action of a lever.	**Interpersonal** • Find a partner. Interview your partner to discover what he or she already knows about levers. Together, create a quiz to test other's knowledge of levers. Include at least three examples of levers in the quiz.	**Intrapersonal** • Write a journal entry describing your favorite lever and explaining how it works. Brainstorm ways you might use this lever at home. • Read about the historical use of levers. Are they a new invention or have they been used for a long time? Add some of your new ideas to your journal.
Musical • Demonstrate with sound what happens to load and the effort when the length of the lever arm doubles.	**Bodily/Kinesthetic** • Given a tongue depressor and a small piece of dowel rod, design a lever that can lift the most weight. • Demonstrate your lever to three other classmates.	**Naturalistic** • Create a photo essay of levers in use in everyday life. Label the parts of the levers and explain why they are levers. Describe the patterns you see in the different types of levers.

To demonstrate the process of differentiating through choice, we use the concept of levers as a model. Knowing that instruction should be organized by key concepts, guiding principles, and essential questions rather than topics or vocabulary words, we studied the National Science Education Standards for process and content goals (NRC 1996). For this unit, we determined that there were relevant goals in the science as inquiry standards and the motion and forces content (NRC 1996, p. 154) (see Figure 1). Although the study of levers is not specified by the standards, levers provide a way to explore the themes highlighted in Figure 1. For example, the levers unit is well suited to exploring two themes: an appreciation of how we know what we know in science and the dispositions to use the skills, abilities, and attitudes associated with science. With these content, conceptual, and inquiry standards in mind, we were ready to determine the goals and outcomes for student learning to build a Think-Tac-Toe. Think-Tac-Toe is a useful strategy for differentiating based on a variety of modalities that students can use to demonstrate what they learned during the unit. While we use multiple intelligence (MI) theory (see Sidebar) to guide the construction of the Think-Tac-Toe, we are not interested in identifying students' modalities as a permanent label of their interests. Instead, we choose MI structure as a way to consider potential preferences for learning and to help us plan for an array of student interests. Although we are aware that MI theory has its critics and that there are other descriptions of learning preferences, we chose MI because it challenges us to think broadly about potential ways students can represent what they know.

Constructing a Think-Tac-Toe

The first step is to determine the learning outcomes by studying the standards and determining the broad goals for a unit. The alignment of the standards, goals, and learning outcomes is shown in Figure 1.

Once learning outcomes were determined, we built the Think-Tac-Toe. The Think-Tac-Toe is arranged like a tic-tac-toe board with each space used to specify a task or product aligning with an intelligence described in multiple intelligence theory. Although there are more spaces than intelligences, each space on the board can still be occupied by coming up with two different tasks that align to the same category. An example is included in Figure 2.

Implementing the Think-Tac-Toe

Each box differentiates via modalities, but differentiation need not stop there. We copy the Think-Tac-Toe for every student and students use one of several directions for the handout. We vary the directions so that the Think-Tac-Toe is not used the same way every time. Occasionally, we suggest that students partner with someone else to complete the tasks. Other times, we want students to work individually. For example:

1. Choose three activities that demonstrate what you know and are able to do with levers. Complete these activities by the end of the week.
2. Choose a partner and play tic-tac-toe on the board. You will do the activities selected by your mark. (In this case, two students would get a copy of the Think-Tac-Toe. The student who uses Xs for playing tic-tac-toe would complete the tasks marked with an X, the other student would complete the tasks marked with an O. With this strategy, students balance their desire to win tic-tac-toe against their desire for a particular assignment.)
3. Choose one activity that matches your favorite way of representing your learning and choose a second that matches the area you'd like to work on most.

There are additional options. Students who need more time to process and complete a task can complete one task. Students who work quickly and need more challenge can complete one task from each square. We prefer to allow students to determine which modality works for them. We do not give students an assessment to identify their "best" modality, but we do work with them to reflect on the appropriateness of the modality they choose. If we notice that students need growth in a specific area (e.g., mathematics), we encourage them to select this area to expand their skills.

Is differentiation fair?

We're often asked this question when we work with teachers on differentiation. The answer depends on your definition of fairness. If fair means that all students do the same amount of things at the same time, our proposed strategy and framework for differentiation will not fit this meaning. However, we believe differentiation is fundamentally fair because we have shifted our definition of fairness to mean that all students get what they need. With guidance from an adult, students can propose ideas for what will work for them when they learn. While teachers initially think of the choices offered in a Think-Tac-Toe, students can later suggest ideas. Ultimately, the teacher must decide if these ideas align with the goals and objectives of the lesson or unit. When students are allowed to express what they need to learn and we meet that need with our instruction, we see more motivated, interested students who are eager to share their ideas with classmates—even when those ideas are different from the mainstream line of thinking. If students choose a task that isn't the best for them, they work with their teacher to determine a suitable remedy. For example, after completing a task, students could discuss how it could be improved. They can also choose another task or select a partner to finish the task with them. The key is to help students determine the reason for the difficulty and discuss ways it can be overcome in the future.

Implementation of Think-Tac-Toe works best when it follows class discussion about this shift in the definition of fairness. Team-building activities that help students establish commonalities and learn to appreciate the differences among them can further support its use. We suggest *Joyful Learning: Active and Collaborative Learning in Inclusive Classrooms* as a great resource (Udvari-Solner and Kluth 2007).

Making rubrics with students that link the modality options in the Think-Tac-Toe to the desired learning outcomes can also support its implementation. We like to work with students to construct the rubrics because we believe it increases their ownership of the task and helps them understand more deeply what is required of them during the unit. To construct the rubric, we

ask students to think of qualities that would make an excellent oral presentation. We list these qualities on the board and then ask students how many of the qualities would need to be present in an assignment for it to get an A, B, C, etc. Initially, this discussion can take 30 to 45 minutes, but you'll need less time with practice. Regardless, hearing students discuss the merits of good work is time well spent.

What about materials and safety?

One way to implement differentiation is to assign tasks to students that assist you with management. For example, ask students to serve as materials managers who monitor how materials are being consumed, checked out, turned off, and so on. Other students can help groups plan the centers they will visit so that students are evenly spaced. Some students can volunteer to be activity experts to learn the purpose of a station well enough to explain to others who might need review or clarification. These tasks can rotate from one unit to another so that every student gets an opportunity at each job. The process of students learning to perform these tasks helps create community in the classroom that supports differentiation.

Young adolescents need adult guidance regarding safety issues. For differentiation, this means that students need to get their ideas for a task approved by their teacher. Teachers should anticipate the safety issues with all activities and have a discussion with students when they get approval to make sure safety procedures are followed. Teachers are responsible for students' safety and need to monitor classroom activities. For example, if students want to create a photo essay and need to leave the classroom or complete the assignment outside or at home, it is important that they have the supervision of an adult. Safety concerns can also be minimized by the selection of materials a teacher provides. In the bodily/kinesthetic option, students are only given a tongue depressor and a dowel rod so that the weight they are able to lift is limited by the capacity of the materials. This reduces the chance that students will get hurt constructing their lever.

What about inquiry?

There may be a perception among some teachers who value inquiry that this teaching method cannot be differentiated, particularly for learners with low levels of readiness. This perception may be grounded in the assumption that the level of thinking needed for inquiry is beyond some students' capabilities. In quality inquiry lessons, students can be heterogeneously grouped and assigned, or they can select a role that takes advantage of their strengths. For example, drawing and labeling, writing, presenting findings, or sharing data with peers are parts of the inquiry process that go beyond design or data collection. These portions of the inquiry process provide natural ways for students with differing strengths and interests to be actively engaged.

Concluding thoughts

Meeting the needs of all learners is a top priority for science teachers. As teachers' see their classes' diversity, they recognize the necessity of varying their instructional practices. Differentiation is a philosophy, and the Think-Tac-Toe provides us with a strategy for enacting this philosophy in instruction. By designing a unit grounded in choice, we allow students to become agents in their own learning and increase their motivation for learning in the science classroom. ■

References

Gardner, H. 1983. *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academies Press.

Tomlinson, C.A. 2000. Reconcilable differences? Standards-based teaching and differentiation. *Educational Leadership* 58 (1): 6–11.

Tomlinson, C.A. 2003. Deciding to teach them all. *Educational Leadership* 61 (2): 6–11.

Udvari-Solner, A., and P. Kluth. 2007. *Joyful learning: Active and collaborative learning in inclusive classrooms*. Thousand Oaks, CA: Corwin Press.

Visser, B.A., M.C. Ashton, and P.A. Vernon. 2006. Beyond "g": Putting multiple intelligences theory to the test. *Intelligence* 34 (5): 487–502.

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