Differentiation in Mathematics Classrooms

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Cluster 4 of the new professional development materials that are housed on the [Minnesota STEM Teacher Center website] focuses on differentiating instruction. This month's *MathBits* article summarizes that material. It is critical that a common understanding of and how differentiation is implemented be established. It is a term that has been abused over the years. A common understanding allows for a consistent implementation approach among classrooms and building sites.

Differentiation in the mathematics classroom is about allowing and planning for multiple access points for students to engage in and to discuss the rich mathematical ideas under consideration. It is about the maximum growth and success of all students (Tomlinson & Allan, 2000). It is about supporting student autonomy, allowing for varied pacing, for editing one's work, and allowance for multiple solution strategies. It includes the ways in which students are allowed to work and where to work within the learning space (Brickwedde, 2022). Differentiation is frequently thought of as being what happens at the Tier 2 or 3 levels of intervention. Differentiation is not a synonym for *intervention* nor *ability grouping.* Research has shown that ability grouping harms more than helps students. Instead, as teachers plan for Tier 1 learning, they plan for how all learners in the classroom will engage with the learning objective.

How and why to differentiate at the whole class level occurs in the planning process by reviewing what is already known about how one's students think, including the range of partial to advanced levels of thinking. Where one would take students next includes considering how to facilitate a meaningful

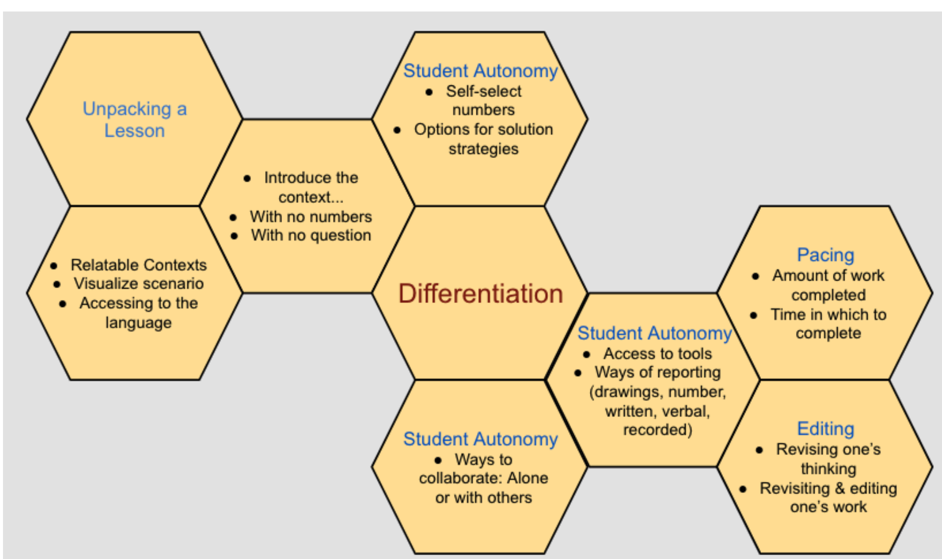

Figure 1

From *Instructional Practices: Differentiation,* Brickwedde, Project for Elementary Mathematics, 2022 mathematics discourse around the range of mathematical solution strategies generated by students that can lead to conversations around commonalities and efficiencies among the progression of the strategies. Understanding the students' thinking assists in anticipating what would students say and do that would constitute the developmental progressions towards comprehending the mathematical objectives. Knowing the range of students allows the instructional tasks to be refined and the access points to be identified. (Brickwedde, 2022; NCTM Position Statement: Differentiated Learning; Boaler 2005, Griesinger, 2023)

Consider this fraction task.

> *A carpenter is placing molding around new kitchen cabinets at a work site. The lengths of molding are cut from one long single piece of wood. Two pieces are needed first. One measures ___ inches in length. The other measures ___ inches in length. What is the total length of molding that the carpenter will use for these first two cuts?*

Notice that the problem is initially presented to students without any numbers. The benefit is to be able to help students visualize the context, clarify and academic language (What's 'molding' and how is it different from mold?), and to contemplate what strategies might be used (draw a picture, use a number line, use addition…). Keeping the numbers absent also prevents those students who want to solve the problem while the focus is on understanding the context itself. Not initially showing the last sentence, the question, at first focuses students attention even more strongly on visualizing and mathematicizing the context. Having students predict what they think the question might be, narrows their attention further to what the task is specifically about. Differentiation is occurring by providing that important space and time to make sure the context is understood by all *before* solving the task begins.

Once the problem is unpacked, consider how the following number choices, now shown for the first time, provide multiple access points for the range of students in the class. Everyone will be working on the same task. Everyone will have a *just right or challenging* access point. When public sharing occurs, common strategies can be explored across the number range and how working with more complex number combinations can be demonstrated by one's peers.

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$$(12\,\tfrac{1}{2},\ 8\,\tfrac{1}{4}) \quad (12\,\tfrac{3}{4},\ 8\,\tfrac{3}{8}) \quad (12\,\tfrac{3}{4},\ 8\,\tfrac{3}{16})$$

(NOTE: The first number in a set goes on the first blank space, the second number on the second blank space)

Giving students a choice of numbers builds autonomy and allows everyone to successfully engage with the core mathematical objective of adding mixed numbers with unlike denominators. Some students can be successful as long as the denominators are in a comfort range of halves and fourths, where others are ready to tackle fourths and sixteenths. Those who are ready for more complex number combinations can proceed at a pace that challenges their intellect. Everyone has to deal with equivalent fractions. It's just not the same combination of denominators. The focus of the public sharing is then on the underlying algebraic properties of equivalency. Above all else, differentiated learning positions students to continue to grow vertically with mathematical ideas.

Allowing for and respecting the use of multiple strategies to solve a problem is also a form of differentiating. The classic instructional approach that has the teacher demonstrate a specific strategy first which the students then copy and replicate (I do, we do, you do) limits students to being passive learners. It denies alternative thinking that oftentimes is equally, if not more efficient, than the strategy the teacher is presenting. Allowing for multiple strategies means different mathematical ideas are drawn into the larger conversation thus helping students to develop and connect a range of mathematical ideas.

Are students expected to only work alone or are they able to work in pairs? Is the pairing random or pre-set? These are instructional decisions that are options to differentiate access to the lesson. The flexible grouping strategy is best used to form purposeful small groups of either 2 to 3 based on the task, language needs, and social dynamics of the class. This includes the use of public, randomly assigned groups (Liljedahl, 2021). Another model, called Mixed Strength Strong Groups, (Kobett and Karp, 2020) very strategically looks at student social skills brought to a group as much as the mathematical needs of the group's members. Each of these models are most effective when used to strategically place emergent learners with more capable peers. It is important to ensure individual accountability as well as shared responsibility within the groups. Create explicit guidelines, norms and roles for group members to ensure equal participation occurs.

Differentiation includes the use of tools/manipulatives and drawings to create physical and/or visual models in addition to tables, equations and graphs. Each representation is a form of mathematical modeling (Standards for Mathematical Practice MP4). A key aspect of facilitating a meaningful mathematical discourse is how ideas are connected across the different representations. Are the tools readily accessed by students, or is teacher permission required? Always starting public sharing with a drawn or manipulative based strategy may inadvertently convey that such strategies are only for the entry level students. Starting with an equation-based strategy first and then asking how the equation emerges from a drawing makes the "equation student" think harder. (Maldonado Rodriguez, et al., 2022)

Both while students are in the midst of solving a task or even after an initial solution is determined, allowing students to edit their work, revise their thinking, helps all students to use mistakes as points of learning and growth rather than one of shame and embarrassment. Helping students to distinguish between the strategy used – which may be fully appropriate – from the calculation – that needs double checking – allows the student to know what to trust and what to revisit. Processing errors constructively and in full has a positive effect on student achievement (Kazemi & Stipek, 2001; Webb, et al., 2014, Bishop, 2021). For those students who finish quickly, having them solve the task using a different strategy or to try a more challenging set of numbers pushes that range of students to keep broadening their thinking to being more flexible and to transfer strategies to more complex number combinations. Differentiation is equally important for those students moving above grade level standards. Access for them to understand the vertical connections to what's coming next, what's possible down the road, keeps them engaged and motivated to learn more.

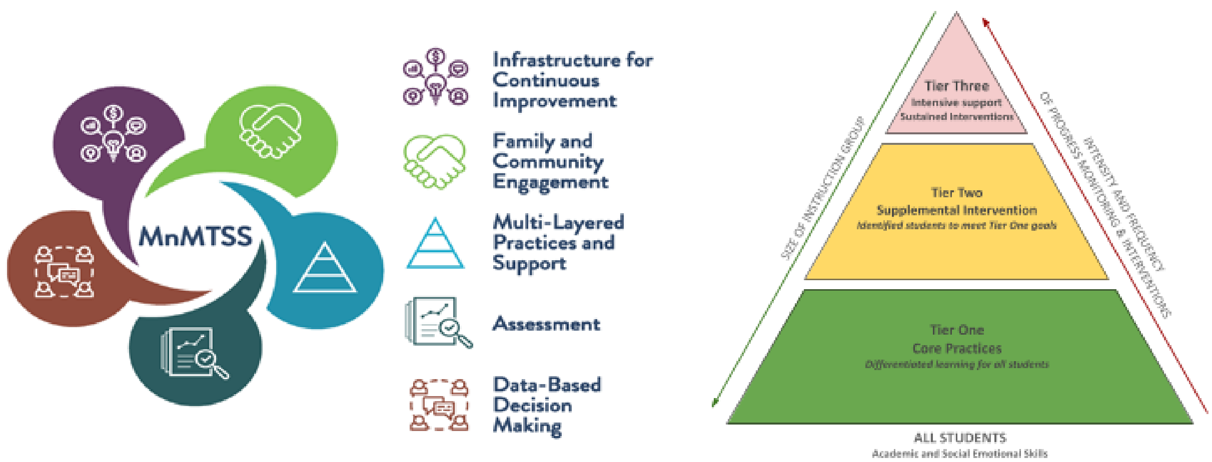

Figure Two

Left Image: Five Fundamental Components of MnMTSS, Minnesota Department of Education, Right Image: Multi-tiered Systems of Support

Differentiation within Tier 1 is what we have outlined thus far. This signifies the importance of enacting differentiation practices at this level before considering any additional support services. Knowing what a student knows, even if only a level of partial understanding, is critical to know what assets exist and therefore how best to support them with additional services. Tier 2 and 3 represent levels of intervention that range from small groups to intensive one-on-one support. The Minnesota Department of Education has significant background materials outlining what such support looks like (MDE: MTSS Frameworks, 2022). Effective intervention programs, such as Math Recovery, are built on research as to how students progress mathematically. While there is a role for explicit instruction practices in such settings, such approaches need to regularly check in to see if the student is truly comprehending rather than passively mimicking. The same approach of having students work with pictures, drawings, manipulatives that bridge to the numeric and graphical representations are key to having procedural fluency arise in tandem with conceptual understanding. You can bring the student to water, but make sure they can swim (conceptual understanding) before letting them get in (procedural skills alone without understanding).

Another article will look more closely at Tier 2 instructional options. So, too, special education. Special education is getting some new looks at how to work with students on individual education plans (Lambert, R. 2024) and how they can fully engage in mathematical ideas. The [Minnesota STEM Teacher Center website](https://stemtc.scimathmn.org) has further explanations and links to these areas for you to begin to explore.

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