

MEETING THE NEEDS OF SPECIAL STUDENTS: FIVE WAYS TO “TAILOR” MATHEMATICS INSTRUCTION¹

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Today’s mathematics teachers are required to teach rigorous content and use appropriate research-based pedagogy in classrooms with an increasingly wider range of student abilities than previous generations. At first this may seem a daunting task; however, there are several easy strategies that allow the teacher to tailor instruction to the needs of all learners. The five strategies we will discuss here are useful when teaching all learners of mathematics; however, research has also found them particularly useful for facilitating special needs students’ understanding of mathematics. These strategies are to:

- know your student,
- differentiate teaching strategies (adapt instruction),
- establish a positive classroom culture,
- make mathematical connections, and
- utilize multiple representations.

KNOW YOUR STUDENT

In order to appropriately meet the needs of all students, the teacher will need to know information about their previous experiences learning mathematics, their content knowledge and their general academic strengths and weaknesses. Think of this as creating a type of learning profile. To gather this information, there are a variety of sources to use, such as previous mathematics teachers, parents, special education teachers, and the students themselves. With large class sizes, it can seem a difficult task to get to know all students in a meaningful manner, but this does not need to be overwhelming. Here are some suggestions about how this can be completed in an efficient manner.

Questionnaire: A short questionnaire may be sent out at the beginning of the year (or prior to school opening) to the student’s previous mathematics teacher, special education teacher, and parents. Some questions to ask are:

- What are the student’s relative strengths/weaknesses when learning mathematics?
- How do you think the student learns new concepts and skills best?
- How would you describe the student’s communication skills both verbally and in writing?
- Please describe the student’s mastery of [any specific content area that will be important in the new math class].

Observation of the student doing mathematics during class: From observation, note how the student interacts with other students, how they communicate in a large group or small group setting, and how they focus on mathematical tasks.

¹ Editor’s note: Much of this article is adapted from a book written by the author: *Teaching Inclusive Mathematics to Special Learners, K-6*. Corwin Press. 2003.

Student Interview: Interview the student after school or at a free time during the day. The teacher may want to ask the student about past experiences learning mathematics, give the student several types of problems to solve, and observe student approaches and question student thinking.

Reading through information gathered from questionnaires, observation, and interview will help the teacher begin to formulate ideas about where to begin with the student in terms of content and pedagogically affective strategies. With this information, the teacher will be ready to partner with others, such as the special education teacher and the parent (who often has insights into strategies that work as well) to be able to most effectively teach special needs students.

DIFFERENTIATE TEACHING STRATEGIES

Teachers differentiate teaching strategies based on the information gathered and synthesized in the process of “knowing your student.” To many people, that may sound like creating twenty different lesson plans for twenty different students. A few easy strategies can help meet the needs of many students.

Provide a structured environment. This includes a given place for materials and books, as well as structure for instruction.

Simplify verbal instructions, and supplement with written or visual clues. Instructions given both verbally and in written form address the needs of students who may have difficulties with auditory discrimination (as they will also be able to see the assignment in writing), who have weaknesses visually (as they may have relative auditory strengths) and who have difficulty with organizational issues (as they are reminded in two different ways).

Present new concepts using concrete, semi-concrete, and abstract models for instruction. This research-based sequence of instruction engages learners in a new concept at a concrete level, and then progresses to a more abstract level. For example, when teaching the concept of slope, a staircase of blocks might be used to demonstrate different representations of a positive slope (concrete representation), followed by students copying the block structure onto their paper or making a graph (semi-concrete), and lastly representing slope with numbers and variables (abstract). Without this sequence, many special learners may not connect the abstract idea of slope with the concept. This sequence differentiates instruction because it captures learners at an appropriate level of understanding and moves towards engagement at a higher level of mathematical understanding (Harris, Miller, & Mercer, 1995; Mercer & Miller, 1992; Witzel, Smith, and Brownell, 2001).

Use a “think-aloud” strategy that enables you (the teacher) to model appropriate behaviors. A teacher who models his/her thinking and strategies for solving a problem out loud is using the “think-aloud” strategy.

Example of a “Think-Aloud” Strategy

Consider this problem: “Eric has 14 baseballs which cost \$2 each and 3 bats which cost \$25 dollars each. How much money will he have if he sells all of his bats and balls?” The teacher may state the following aloud to her class: “Ok, first I need to read the problem (she then reads the problem aloud). Now I need to make sure I understand what the problem is asking me to solve. It seems to me that the problem is asking me to solve for how much money Eric will have if he sells all of his bats and balls. (The teacher may also state out loud at this time to the students that if they do not understand the problem they should ask for clarification from the teacher or another student.) Now, I need to figure out how to solve it. I think I need to find out how much all the balls cost and how much all the bats cost, then add those totals together. (The teacher may also be writing notes on the board to show what she is thinking such as cost of balls + cost of bats = total cost). To find out how much the balls cost, I multiply $2 \times 14 = 28$. To find out how much the bats cost, I multiply $25 \times 3 = 75$. Together the bats and balls are $28 + 75 = 103$. The problem asks for the amount of money so the amount is \$103. Now I need to write the answer in a complete sentence. If Eric sells all of his bats and balls he will have \$103.”

Create a template to isolate information. To remove distractions, create window templates to isolate certain problems, paragraphs, or sentences on a page. The templates may be created on a computer, and students can keep templates in their notebooks for repeated use when needed.

Allow students to communicate their knowledge with manipulatives, with pictorial representations, or verbally. Many students with learning difficulties face challenges with communicating clearly what they know using traditional paper and pencil methods. Allowing them to use alternative methods to express their thinking is useful for obtaining information about their mathematical understandings. Students may use manipulatives or pictorial representations to express their thinking in large or small groups or even as a one-on-one assessment. As well, there some students with verbal strengths who may express themselves better verbally than using paper and pencil. This is especially useful for students who may have visual processing or motor processing difficulties. As a teacher, it is important to be aware that these students may take longer to respond and may need more “wait time” in the classroom than the average student.

ESTABLISH A POSITIVE CLASSROOM CULTURE

Creating a positive classroom culture supports the learning of mathematics for all students. The most important feature here is:

Believe that the student can and will be a successful mathematics student. Without this, the student is much less likely to succeed in learning mathematics. Research has found that the teacher is the single most important variable in the success of a student. It is very important that the teacher does not create a low ceiling of achievement for a student with learning disabilities due to what has been written in an IEP or from prior experiences this teacher has had with the student. Often these students have had learning experiences where they have been taught with an inferior curriculum, thereby not being given the same opportunities as their non-disabled peers. Lower expectations cheat these students of opportunities to learn. In the

opinion of this author, a strong belief that the student can and will learn mathematics is the single most important feature for teaching these students.

Other ways to create a positive classroom culture are to:

Expect high-level thinking from everyone. This feature is a component of the first one discussed. It is essential to have high expectations for all students; not just the ones that have done well in the past.

Select an appropriate standards-based curriculum for all students. Differentiate teaching strategies, not content! Research has demonstrated that special needs students can learn and succeed in mathematics, however, they must have the same access to a rich problem-solving standards-based curriculum as their peers to do so.

Expect participation from all students. Special needs students may participate in varying ways; this is expected. Group work, both small and large, one-on-one, and peer learning have been found to be successful when working with students with learning difficulties; and the teacher must be clear on the goal of instruction to determine which will work best. As well, a structure for how students will participate, which includes expectations for respect, responsibilities, and communication strategies within groups must also be established.

- Establish rules for engagement in the classroom to set the tone for a positive, respectful environment. These “rules” should include how to work in groups as well as how to speak appropriately in a respectful manner. For example, you may spend time role-playing. Ask a student to role-play as the teacher and to respond to you as if you were a student. In this role-playing experience, be sure to model correct student answers as well as partially correct and incorrect answers. Be sure to discuss the activity, specifically the responses of the “teacher” and how the students might like to be responded to if they were in that situation. This type of activity can naturally lead into a discussion about respect for each other and the teacher in the classroom.
- Make a special effort to include all students in class activities. For those students who may feel they have difficulties communicating verbally or in written form, allow the student to bring a partner to the board or the overhead to explain a problem. Be sure to allow peers without learning disabilities the same opportunity.
- Incorporate group work into classroom routines. Group work helps students participate more fully. Establishing group work roles and responsibilities keeps all members involved.

Expect all students to learn both concepts and skills. Do not limit a special needs student to just skill-based learning. Special needs students just learn at different paces and in different ways.

Create a culture which supports the belief that making mistakes is part of being on the road to success in learning mathematics. The most important thing to remember is that all students need to feel comfortable learning in their classroom; whatever you can do to make them feel as if they are capable of learning mathematics will support their success.

MAKE MATHEMATICAL CONNECTIONS

Cognitive research on teaching and learning emphasizes the importance of making connections. Hiebert and Carpenter (1992) state that the degree of a student's understanding is determined by the number, accuracy, and strength of connections. For example, it is useful for students to understand the inverse relationship between addition and subtraction as the concept is used when developing rules for integer operations, and for solving equations. Students with special needs often have trouble making connections themselves and need support in making them. Here are a few strategies:

Use concept maps. A concept map ties newly-learned concepts to other mathematical ideas. As students create a concept map, they visually illustrate mathematical connections and describe them in writing.

Use graphic organizers. A graphic organizer helps students see patterns within mathematical ideas and generalize them. Graphic organizers also reduce the demand on language.

Make connections to other curricular areas. When students interact with mathematics in other disciplines, it can help to strengthen and generalize their understanding of the mathematics.

UTILIZE MULTIPLE REPRESENTATIONS

The "fourfold way" refers to a collection of four ways to approach a mathematics problem. Each approach may lead to a valid solution. Collectively, they should lead to a complete and comprehensive solution, which is readily accessible to more learners, and which provides more insight. Using this method is particularly useful for special needs learners as it provides multiple ways for them to represent their thoughts in order to facilitate their understanding of mathematics. According to the fourfold approach, the ways a teacher can represent a mathematics problem are:

- Numbers (numerical approach, as by making a t-table)
- Pictures (visual approach, as with a picture or graph)
- Words (verbalizing a solution, orally or in writing)
- Symbols (approaching the problem using algebraic symbols to express a solution)

Figure 1: The Fourfold Way

<p>Numbers (example)</p> $\text{slope} = \frac{2}{1} = \frac{4}{2} = \frac{-6}{-3}$	<p>Symbols</p> $m = \frac{y_2 - y_1}{x_2 - x_1}$
<p>Words</p> <p>For each vertical change of 2, there is a horizontal change of 1.</p> $\text{slope} = \frac{\text{vertical change}}{\text{horizontal change}}$ <p>as we move from one point to another</p>	<p>Picture (graph)</p>

SUMMARY

From this discussion emerge three important questions every teacher should consider when planning a lesson:

- Am I taking into consideration what I know about how **my** students learn best?
- Am I demonstrating the concept using a concrete representation? using the fourfold way?
- Am I making connections within the content area of mathematics and to other discipline areas?

Teachers may begin to work on strategies to meet the needs of special learners by including just one new strategy each week. Answering “yes” with a detailed explanation of why to the planning of lessons puts a teacher well on the way to “tailoring” instruction to meet the needs of all learners, especially those with special needs.

RESOURCES

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