Accessibility Strategies for Mathematics

> "Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students."
>
> -- *Principles and Standards for School Mathematics* (NCTM, 2000, p.12)

This document provides an organized list of strategies that teachers can use to make mathematics more accessible to students with disabilities. The goal is to enable teachers to provide support so students with learning disabilities can succeed, while maintaining high standards and the integrity of the mathematics.

The *Addressing Accessibility in Mathematics* (AAM) group examined current research on student difficulties in mathematics, and analyzed the kinds of tasks students are asked to use in various middle school mathematics curricula. Based on this, AAM identified six areas in which students' strengths and needs strongly affect mathematics learning. The lists that follow detail the types of tasks commonly required in the six areas, along with examples of student difficulties and corresponding accessibility strategies. Note that some problems, such as multi-step problems, involve tasks from multiple areas.

Many of the strategies provide *scaffolding* so that students can focus on the main mathematical content. For example, a strategy might take over a mechanical aspect of a task, such as drawing a table, so students can focus on higher-order thinking and demonstrate their grasp of concepts. Over time, the scaffolding is often removed—therefore, part of planning accessibility strategies is considering how and when to remove the scaffolding. It's akin to learning to ride a bicycle: at first, training wheels help a child focus on riding without having to worry about falling over.

Some students may always need certain supports; others may leave the supports behind. In either case, the students can expand their own repertoires of strategies, building on their strengths to help bypass their weaknesses.

The six areas addressed in this document[1]:

While the strategies in this document are targeted at improving the learning experience for students with disabilities, many are also common teaching strategies that you may already use in your classroom. The AAM team is very interested in hearing from teachers who have additions to this list—if you have a strategy that you don't see on these lists and would like to add, please email us at aam@edc.org.

[1] This list is not all-inclusive. Some other areas (such as psycho social issues) also affect students' learning of mathematics

Conceptual Processing

Standards-based mathematics emphasizes the need to build a deep understanding of concepts. This involves making connections among mathematical ideas, facts, and skills, and reflecting upon and refining one's own understanding. In middle school, students begin to work with abstract concepts such as variables and linear functions, and make greater use of symbolic representations. Students who tend to think concretely may need additional support in order to move from concrete to abstract representations.

Conceptual		
Type of Task	**Examples of Student Difficulties**	**Accessibility Strategies to Consider**
Use or manipulate symbols	• Does not always connect symbols with what they represent • Does not remember the meaning of symbols	• Use manipulatives to connect symbols to concrete objects • Post wall charts or provide resource sheets with symbols and meanings
Solve abstract problems	• Does not understand abstract problems easily • Tends to think concretely	• Set up the investigation so that students move from the concrete to the abstract • Make connections to familiar contexts
Visualize and extend patterns	• Has difficulty visualizing and identifying patterns	• Use manipulatives to build and extend patterns • Provide simpler patterns
Make generalizations	• Finds it difficult to make generalizations and to write rules • Tends to think concretely	• Provide generalizations for students to test • Have students use multiple representations of situation and then make a generalization
Understand mathematical relationships and make connections	• Thinks of mathematics as disparate parts and doesn't see the connections	• Make explicit connections between current and prior lessons or units • Use concept maps
Learn, represent, and explain new concepts	• Tends to think concretely • Focuses on small parts and does not see big picture • Does not identify key points	• Use hands-on investigations to build understanding • Contrast examples and non-examples of a concept • Provide resource sheets with summary information on complex concepts • Use frequent assessments to identify gaps in the students' understanding of concepts • Use multiple representations of concepts • Make concept maps • Provide organizers for students to complete • Use concept map software like Inspiration
Apply concepts to new situations	• Sees new problems as unfamiliar • Does not see a connection between new problems and those he or she has already solved	• Help students to see the connections between new problems and prior work
Self monitor understanding and ask clarifying questions	• Lacks a metacognitive awareness of what he/she doesn't understand	• Have students to reflect on their own learning using questions from KWL strategy: "What do I **K**now? What do I **W**ant to learn? What have I **L**earned?"

Language

In mathematics, students need to describe strategies, explain their reasoning, justify solutions, and make persuasive arguments, both orally and in writing. They need to learn mathematical vocabulary and use it to express ideas with precision and clarity. In class and small group discussions, they need to build on the thinking of their classmates and to ask questions to help them understand another person's strategies.

Language		
Type of Task	**Examples of Student Difficulties**	**Accessibility Strategies to Consider**
Read directions and problems	• Has difficulty decoding words • Reads slowly	• Read aloud • Use a tape recorder (or use taped texts from *Recordings for Blind and Dyslexic*) • Digitize materials and use text-to-speech software, such as eReader and TexEdit
	• Finds comprehension challenging • Tends to misunderstand directions	• Have students highlight key points and identify unnecessary information • Use pre-reading questions to focus their attention
Follow verbal directions	• Has difficulty with the auditory processing of verbal information • Does not understand verbal directions well	• Provide written as well as oral directions • Make handouts of the overhead masters • Have students rephrase directions in their own words • Use an overhead
Write explanations of mathematical thinking	• Takes a long time to get started on writing tasks	• Reword the question as a statement for students to complete • Have students talk about ideas with a partner before writing them down
	• Does not know how to organize ideas	• Use graphic organizers and writing templates, such as paragraph templates • Use the same writing process as Language Arts • Teach organizational strategies • Use outlining software such as Inspiration
	• Gets distracted rather than focusing on the writing task	• Break writing tasks into smaller parts and provide frequent feedback
	• Does not have necessary fine-motor skills for extended writing	• Have the student dictate to a "scribe" • Use a computer or portable keyboard such as Alpha-smart • Have the student record ideas on a tape recorder
Participate in Class Discussions	• Does not express ideas orally with ease	• Prearrange when you will call on the student or use a nonverbal signal
	• Does not listen well to other students' explanations and gets distracted easily	• Reduce the time for whole group discussions. • Break class into small discussion groups and then have groups report back to the whole group
Give Oral Presentations	• Is not comfortable speaking in front of class • Speaks slowly	• Provide an organizer with questions for preparing the talk • Provide practice time

Visual-Spatial Processing

Representing mathematical ideas is key to understanding mathematics. Students use representations to solve problems, explore concepts, and communicate ideas. For example, students use different visual representations for percents, including number lines, fraction circles and bars, base ten blocks, and hundred-grids. In algebra, students use visual patterns to determine rules, analyze graphical representations of functions, and create mathematical models.

Some difficulties with such tasks are caused by a breakdown in the processing of visual information. Students may benefit from such strategies as color-coding systems to help them focus on key information, and from learning explicit strategies for interpreting visual representations.

Visual-Spatial Processing		
Types of Tasks	**Examples of Student Difficulties**	**Accessibility Strategies to Consider**
Create and interpret visual representations	• Has difficulty representing mathematics concepts visually • Does not connect graphics to the concepts they represent	• Provide handouts of the representations for students to draw on, highlight, measure, and cut out • Provide manipulatives
	• Finds it difficult to visualize and represent a three-dimensional model in two dimensions • Finds it difficult to interpret a two-dimensional representation of a three-dimensional model	• Provide examples of actual 3-D models for students to view or manipulate
Work with tables and graphs	• Has difficulty figuring out how to create tables or graphs or has difficulty physically creating them • Has difficulty reading or interpreting graphs	• Provide templates that address particular needs (for example, larger or partially filled-in tables) • Use scaffolding strategies to help students eventually develop their own templates for tables, charts, and graphs
Read text	• Cannot read standard-size text	• Use larger fonts • Provide oral versions (spoken, taped) of the instructions and text, where appropriate • Use text-to-speech software • Provide Braille version of the text
Read handouts and book pages	• Finds crowded pages distracting	• Reorganize the material into a handout • Make all of the handouts single-sided and provide ample white space
	• Has difficulty focusing on the important information • Finds extraneous material distracting	• Have students highlight the key information • Eliminate extraneous page features • Explicitly teach how to find information in a book, noting chapter structures, bold text, previews, and summary boxes • In preparing materials, consistently use methods such as bolding or underlining
Copy or read information displayed on a blackboard, chart, or overhead	• Does not see board well • Does not know where to focus	• Use large font sizes for overhead masters and give copies of the masters as handouts • Seat students close to the blackboard • Reduce glare from the windows • Use a consistent format for displaying information on the board • Color code

Organization

Problem solving is integral to mathematical learning. The NCTM Problem Solving standard states that "students should have frequent opportunities to formulate, grapple with and solve complex problems that require a significant amount of effort." (NCTM, 2000) Complex problems make many organizational demands—students must figure out how to get started; carry out a sequence of steps; keep track of the information from prior steps; monitor their own progress and adjust strategies accordingly; and present solutions in an organized manner. Further, they must organize their time to ensure that they neither rush through tasks and make careless errors, nor spend too much time and yet not complete the task.

Organization		
Type of Task	**Examples of Student Needs**	**Accessibility Strategies to Consider**
Solve multi-step or complex problems	• Has a hard time getting started	• Provide hints or prompts • Teach problem-solving strategies
	• Does not know how to figure out a sequence of steps for solving the problem	• Teach organizational strategies such as breaking the problem into smaller parts • Give frequent feedback
	• Rushes through tasks or spends excessive time	• Teach organizational strategies for using time wisely • Teach students to pause at specific points to check work • Set expectations for how much time students should spend on tasks • Remind students of how much time remains for completing the tasks
	• Does not answer all of the questions or all parts of the investigation	• Explicitly teach about the layout of the book and the question formats • Provide a handout of the questions that students can highlight or underline
Make a table, graph, chart, number-line, spinner, or map	• Gets confused by the multiple steps involved in making a table, graph, etc.	• Provide Resource Sheets that list the steps involved or provide examples or templates
Collect and record data	• Records data in a disorganized manner that is difficult to analyze • Has difficulty organizing data into tables	• Use table templates for data collection
Find information in prior student work	• Does not organize class notes well and thus has trouble finding the needed information	• Use a notebook organization system and reinforce it with notebook checks (if possible, use the same notebook organization system across subject areas)
Complete long-term assignments or projects	• Has difficulty organizing a large project • Works slowly or spends an excessive amount of time • Does not manage project resources well • Needs help breaking a large task into steps	• Provide a Project Organizer in which the project is broken into steps with due dates. Establish frequent check-in points.

Memory

Both long-term memory and short-term memory play essential roles in learning mathematics. For example, students use their memories to perform calculations and procedures, identify geometric figures, and create graphs that have all of the necessary parts.

Long-term memory. Students with long-term memory deficits may not easily store information (such as number facts or the steps of algorithms) in memory, or may have difficulty retrieving information. Long-term memory difficulties also affect their abilities to use mathematical vocabulary and to make connections among concepts that they have learned in prior months or years.

Short-term memory. Students with short-term memory deficits may have difficulty keeping track of several pieces of information for a brief time, such as keeping track of calculations in multi-step problems, or performing mental calculations. Short-term memory difficulties also affect their ability to remember directions, follow a presentation, or build on others' responses in a class discussion.

Memory

Type of Task	Examples of Student Difficulties	Accessibility Strategies to Consider
Use basic arithmetic facts	• Has difficulty memorizing or recalling basic facts • Retrieves incorrect facts	• Allow students to use a number line • Provide a multiplication chart • Ask students to find patterns in the facts • Allow the use of calculators
Carry out algorithms	• Does not remember sequence of steps in an algorithm	• Provide a model of worked-out calculations, highlighting the steps • Teach mnemonic devices • Provide practice problems and examples • Allow the use of calculators
Perform mental calculations	• Cannot keep the steps of a calculation in his or her working memory	• Allow students to use pencil and paper • Have students talk about which operations they would use instead of calculating • Allow the use of calculators
Solve multi-step problems	• Does not have needed information in his or her working memory to solve a problem	• Provide resource sheets • Provide templates or organizers for recording information • Break the problem into smaller chunks • Allow the use of calculators
Use previously-taught skills and concepts	• Does not remember skills and concepts that were taught earlier in the year or in previous years	• Use a notebook organization system to help students find information in their prior work • Review the needed skills at the beginning of the lesson or in the resource room • Provide resource sheets with cues to remembering the skills
Use math vocabulary	• Has difficulty remembering math vocabulary	• Preview the needed vocabulary prior to the lesson • Have students look up vocabulary words and write the definitions on a resource sheet • Provide resource sheets for needed vocabulary

Attention

In middle school, the increasingly complex math content and tasks lead to demands for longer attention spans from students. They need to complete multi-step investigations and long-term projects, pay attention to details, and complete tests and assessments, often within limited time. Students have to listen to directions and explanations, filter out extraneous information, participate in class discussions, and work effectively by themselves.

Attention		
Type of Task	**Examples of Student Difficulties**	**Accessibility Strategies to Consider**
Complete long-term projects	• Cannot maintain attention for the details needed to complete the project • Loses track of what needs to be completed	• Provide a project organizer • Schedule frequent check-in points for longer projects
Complete math work accurately	• Makes careless errors because of going too quickly or poor attention to detail	• Encourage or require that students check their own work
Focus on teacher presentations	• Gets distracted easily • Has difficulty listening for long periods of time	• Provide key questions to help students focus • Use visuals • Include student activities and participation
Work in pairs or small groups	• Distracts the group	• Set clear behavioral and academic expectations • Assign group roles, such as recorder
Participate in class discussions	• Distracts the group • Does not listen to other students • Makes irrelevant comments	• Use visuals • Reduce the time for whole class discussions • Break into small groups and have them report back to large group
Work with manipulatives	• Uses manipulatives for activities that are not task-oriented	• Set clear behavioral and academic expectations • Check-in frequently on manipulative use