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Active Participation in Reasoning and Sense-Making

What is active participation in mathematics learning?

When students reason, conjecture, problem solve, and justify their thinking in mathematics, they are actively participating in mathematics learning. Providing daily, varied opportunities for students to explain their thinking, orally and in writing, is essential for students to become mathematically proficient. When students participate in making sense of mathematical concepts and procedures by connecting new information to what they already know, they are able to connect and transfer their learning to various contexts without applying rules with little or no understanding.

Active participation in reasoning and sense-making occurs when students are intellectually engaged in mathematics learning. They understand the question, the success criteria, and are invested in finding a solution. Students who participate actively in reasoning and sense-making ask questions, make connections to prior learning, make predictions and generalizations, use visualization and models, and reflect on their progress and learning. Teachers support students in becoming competent mathematicians by providing daily opportunities for them to make sense of the mathematical ideas being studied.

What role does reasoning and sense-making play in problem solving?

In mathematics, problems are questions where the solution or solution path is unknown – they require students to determine a way to get from what is known to what is sought. If students have already been given ways to solve the problem, it is not a problem, but practice (Alberta Mathematics Programs of Study, 2016). Students need opportunities to solve all types of mathematical tasks, however it is essential that they engage in high-level tasks to develop their reasoning, problem solving, and sense making abilities.

The teacher's role in selecting tasks goes well beyond choosing good individual tasks, one after another. Teachers need to select sequences of tasks so that, over time, students' experiences add up to something important. Teachers need to consider the residue left behind by sets of tasks, not just individual tasks. (Hiebert et al. 1997, p.31)

Some characteristics of high-level mathematical tasks are:

- The problem requires students to understand the nature of mathematical concepts, processes, or relationships
- The problem connects procedural fluency and conceptual understanding
- The problem can be approached in multiple ways or representations, and/or has different solutions that can be justified or defended

- The problem encourages mathematical discourse and sharing of strategies
- The problem requires students to self-monitor their own cognitive processes

How do teachers encourage active participation in classrooms?

It is important to establish discourse-rich learning environments in order to support active participation by students. Students need to feel safe and supported in math classrooms to engage in risk-taking, sharing strategies, and justifying their solutions. When students are given opportunities to engage in sharing, appreciating, representing, comparing, and defending mathematical solutions through problem solving, significant learning gains are made in both conceptual and procedural understanding.

Implementing mathematical tasks that promote reasoning and sense-making is necessary for students to participate actively in mathematics. Some sample problems for Grades 6 and 9 with success criteria are available here. It is important for teachers to think about how they might support students during the productive struggle that might ensue during a challenging math task without giving away answers or over-simplifying the task.

In order to maintain the cognitive demand of the task during instruction, teachers can consider the following factors:

- Scaffolding
- Student self-monitoring of progress
- Teacher or students modeling high-level performance
- Sustained demand for justifications, explanations, meaning
- Tasks that build on students' prior knowledge
- Frequent conceptual connections
- Sufficient time to explore

References:

Alberta Mathematics Programs of Study, 2016.

Smith, Margaret Schwan, Steel, Michel D., Raith, Mary Lynn. (2017).*Taking Action: Implementing Effective Mathematics Teaching Practices in Grade 6-8*. National Council of Teachers of Mathematics, 2017.

Hiebert, James, Thomas P. Carpenter, Elizabeth Fennema, Karen C. Fuson, Diana Wearne, Hanlie Murray, Alwyn Olivier, and Piet Human. *Making Sense: Teaching and Learning Mathematics with Understanding.* Washington, D.C.: U.S. Department of Education, National Center for Education Statistics, 2003.