

Best Practices of Effective Mathematics and Science Classrooms

An effective mathematics and science program must provide appropriate instruction, high expectations, and the same standards for all students. The content should be challenging and stimulating for everyone and based on the assumption that all students can achieve these standards if given adequate opportunities to learn. The mathematics and science programs must be responsive to the demands of a technological society and the needs of an increasingly diverse population. Innovative, active learning experiences for the students are desired over the more traditional, passive learning. The mathematics and science program should foster conceptual convergence of the sciences, mathematics, and technology with other disciplines. Current research delineates several specific instructional strategies that ought to be present for exemplary mathematics and science programs.

Mathematics and Science Essential Components Appropriate for All Grade Levels

Preparing Students for Learning and Prior Knowledge Assessment

Teachers should inquire about students' understanding of concepts before sharing their own understanding about the topic. The technique of "frontloading" to elicit prior knowledge related to real-life experiences and applications can create a direct connection to the content for students.

Strategies: Using graphic organizers (Concept Mapping, KWL), showing a video clip, providing a demonstration, or using literature.

Developing Active Learners

Students can become active learners by providing opportunities for them to construct their own understanding. These situations should require students to organize, classify, interpret, and draw conclusions about real-life mathematical and scientific problems. Students must communicate their ability to problem-solve through oral, written, and physical demonstrations.

Strategies: Using open-ended questions, real-life scenarios to solve, and paradoxes.

Teaching to Diversity

Teachers, as the facilitators of the learning, should provide a variety of activities that address learning, language, and cultural differences. Activities within the classroom should include a variety of cultures, learning styles, and multiple intelligence. This will help students become aware that there are different ways of knowing and learning.

Strategies: Using graphic organizers such as concept mapping or KWL; incorporating verbal/linguistic, logical/mathematical, body/kinesthetic, visual/spatial, and musical/

rhythmic activities; providing opportunities to work individually as well as in small and large groups.

Orchestrating Collaborative Discourse

There should be encouragement of student discourse within the classroom through students engaging in dialogue, both with the teacher and especially with one another. Teachers should encourage and accept student autonomy and initiative by allowing student responses to drive lessons, shift instructional strategies, and alter the lesson plans. The ways of representing, thinking, discussing, agreeing, and disagreeing are central to what students learn about mathematics and science.

Strategies: *Posing questions and tasks that elicit, engage, and challenge thinking; asking students to clarify and justify issues; providing teacher elaboration during discussions.*

Vary the Instructional Format

A variety of instructional formats should be used in classrooms to make sense of the content and to construct meanings from new situations. Mathematics classrooms should foster the use of manipulatives whenever possible to teach concepts, while science classrooms should provide the opportunity for inquiry-based instruction. Instead of traditional lecture-type instruction, opportunities should be provided for small-group work, individual exploration, peer instruction, and whole-class discussion.

Strategies: *Using manipulatives, hands-on activities, and technology-based activities.*

Use of the Learning-Cycle Instructional Model

Teachers need to develop techniques that move their students from concrete to abstract concepts through frequent use of the learning-cycle model. First, the teacher provides an opportunity for students to generate questions and hypotheses through an open-ended discovery activity. This is followed by the concept introduction lesson(s) provided by the teacher. Finally, students must be provided with opportunities to demonstrate their understanding of the learned concept by transferring it successfully to other situations through solving a scenario or by doing a demonstration or project.

Strategies: *Posing scenarios to be solved.*

Integrated Teaching

Multi- and interdisciplinary activities that provide connections for students should be included within the classroom. Students must recognize the various roles mathematics and science play in real life. The connection and application of mathematics and science will motivate, give meaning to, and reinforce student learning. These activities should involve students in critical thinking, process skills, and product development.

Strategies: *Posing authentic problems to be solved, bridging.*

Best Practices (continued)

Critical Thinking and Higher-Order Questioning

Use effective, open-ended questioning techniques that encourage student inquiry. Encourage students to pose their own questions, evaluate the information presented, and make informed decisions about the information. Examples would include "How would you solve a similar situation?" or "What criteria would you use to . . . ?"

Strategies: *Elaborating, analyzing, hypothesizing, and evaluating.*

Continuous Assessment of the Learning

Assessment should reflect how and what is being taught. It should be embedded at various points in the lesson to guide the instructional planning and pacing. There is a clear alignment between curriculum, instruction, and how students are assessed.

Strategies: *Assigning performance tasks and essays, maintaining portfolios, using video presentations and demonstrations.*

Promotion of Collegiality

Teacher collaboration is essential for effective teaching practices. Teachers should collaborate to establish long-range plans, prioritize curriculum, share best practices, mentor, and model lessons for each other.

Strategies: *Incorporating team, departmental, and grade-level planning; participating in study groups, peer coaching, and mentoring.*