Chapter 1

Helping All Students Learn Science and Math

Science and math are just about the only subjects where well-educated and intelligent adults freely admit ignorance. Social forces, including family ties, underpin attitudes towards science and math learning. We think of learning as something that happens in school. But what happens in the home environment enables students to learn in school. For many adults, a certain lack of scientific and mathematical interest goes with the territory. So, it's little wonder that so many students show a lack of interest (Cathcart, *et al.*, 2005).

How we teach is as important as *what* we teach. This is especially true when it comes to teaching students who are not interested in science and math (Stigler & Hiebert, 2004). When it comes to these subjects, asking disaffected learners to reason, solve problems, and maintain a positive disposition is a tall order. Of course, no one method of teaching science and math has been found to meet the needs of these youngsters all of the time. But various kinds of active and collaborative learning experiences certainly help. The basic idea is to encourage such students, without slowing down those who are already motivated and successful.

The ideas and activities presented here are all designed to maximize the potential of students as they work with others in mixed-ability groups. Effective teachers of science and math use various interactive learning group strategies and adapt techniques from a wide repertoire of methods. In addition, they design their lessons in a way that connect to students with multiple needs and learning styles.

Science, Math, and Reluctant Learners

Some students tend to avoid challenge, some don't complete tasks, and some simply are satisfied to just get by. These students often have the potential to do well but don't care about achieving in school. Identifying the reasons behind their reluctance to learn is essential if we are going to engage their interest and help them succeed. The challenge is finding something that will spark a student's interest and turn that spark into a flame.

Even the most reluctant learners are naturally curious and able to learn. Most want to get their hands and minds around objects of interest as much as anybody. Students are capable of learning, but have trouble making math and science instruction work for them (Loveless & Coughlan, 2004). It's never too early to get started. The seeds of academic success are planted in early childhood and cultivated through elementary school. Middle school builds on that base and moves students on to deeper mathematical, statistical, and scientific understandings. The students who reach secondary school without enough literacy and numeracy skills to do the work are the ones most likely to drop out. Competency in science and math is important for high school graduation, college entry, the workplace, and thoughtful citizenship (National Research Council, 2001).

Since a learner's mental, emotional and physical needs have a direct impact on their schoolwork, exploring individual student needs should be near the top of the teaching agenda (Van De Walle & Lovin, 2006). Curriculum reform is often geared more to academically oriented children and young adults, and not to students who have different interests. Fortunately, most kindergarten through ninth grade teachers (our focus) try to teach science and math concepts and skills in a way that helps students (along with everyone else) understand and remember what's being taught. Teachers often pay special attention to motivating students who aren't too fond of these subjects (Clarke, 2006).

Students often become motivated to learn about science and math as a result of influences outside of school. The better organized and directed these influences, the better the chance of success for the student.

Students all have different needs and these needs have a tremendous influence on their achievement. What can teachers do to insure academic success? To begin with, they can assess each individual's ability. The next step is choosing teaching strategies that best match students' learning strengths and difficulties. Questions teachers have such as, "How does this child learn best?" or "What kind of learning environment can best bring out a student's natural learning abilities?" are part of this diagnostic process. The focus should be on understanding the child as a learner, and making choices about structuring the learning environment through innovative teaching strategies and methods.

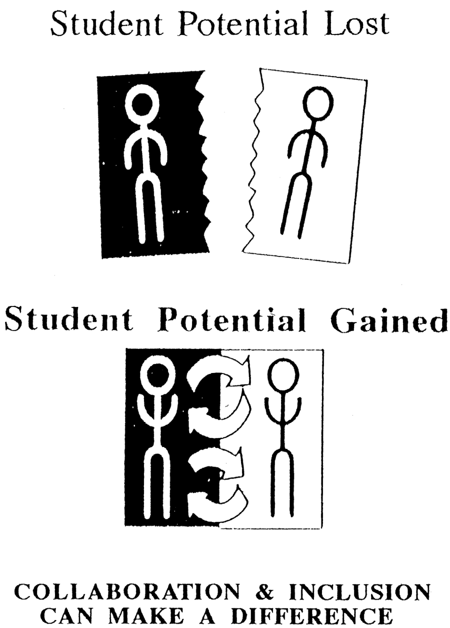
Effective teachers internalize responsibility for students' learning and examine their practices critically if they aren't reaching some students. They realize that most students want to succeed, but many do not find success when taught from the traditional teaching model. Students who have difficulties with science and math often need alternative approaches and remedial strategies that are designed to promote academic success.

Everyone Needs to Understand Science and Math

The need to understand and use science and math in everyday life has never been greater. Personal satisfaction and confidence come with making wise quantitative decisions, whether it's buying a house, solving problems on the job, choosing health insurance, or voting intelligently. Our careers, our workplace, and our community all require a foundation of scientific and mathematical knowledge. Although it may not be readily apparent, proficiency in these subjects can open doors to future achievements and sound citizenship.

Everyone needs to understand science and mathematics to make decisions about important societal issues in our democracy. The media doesn't always help. Take the example of global warming. For a long time, the story was reported in a way that suggested some scientists took it seriously and some didn't. And this was after a large number of scientists had recognized the reality of the problem (Kolbert, 2006). Advances in medicine have sometimes been reported in another problematic way. Exciting breakthroughs are reported when only small advancing steps have been taken. Whatever the scientific issue, a better understanding of the mathematical significance of results would help everyone understand the situation, whatever their age.

When we asked some of the more reluctant learners in a sixth grade class why they weren't interested in science and math, many replied either that it was "not interesting," "too difficult," or "never made much sense." These explanations and other reasons might be classified as students' personal or environmental situations. No matter what gets



in the way of learning, teachers have to know what to teach and how to teach it. Four or five years of college and continuous professional development help. So do the suggestions and recommendations that can be found in the science and math standards and state and school district guidelines. Even many textbooks are helpful. But wherever teachers get them, activities may have to be adapted for students. Like everyone else, they have to be involved in building knowledge by asking relevant questions, reasoning, making connections, and solving problems.

The Characteristics of Students

All students of science and math have individual strengths and weaknesses and most of the time, they often have similar learning problems (Miller & Mercer, 2001). Being able to identify individual problems and knowing some helpful teaching strategies certainly help.

Students may be passive learners, who have little motivation or interest in becoming active participants in math and science learning (Levine, 2000). Some students who struggle may think that math and science achievement is a matter of luck. They may think it's too easy, too difficult, or too boring. They may also believe that achievement in these subjects is beyond their control. "I'm just not good at math." "Science is boring." Students with such feelings about these subjects may prefer not to acknowledge the fact that their lack of success may have something to do with personal discipline, hard work, and persistence. They may mistakenly believe that students succeed in science and math through some combination of luck and level of intelligence. The home and school environments also matter a great deal; if poor achievement is expected, then that is the most likely result. Whatever the reason, when students are discouraged or disinterested, their ability to move forward is limited.

Teachers can learn to do a good job with students without simplifying problems or always telling them exactly what to do. It's important to get learners actively involved in interesting and relevant situations.

So, the teacher has to encourage reluctant learners to construct ideas and communicate their thoughts. Visual displays such as graphic wall charts can help individual students see how they are doing and track their achievement. Such displays give students, teachers, and parents very powerful ways to see the progress of a student's learning (Kame'enui *et al.*, 2002).

Some students have difficulty remembering basic science facts. Remembering simple math combinations, even basic facts such as addition, subtraction, multiplication, and division are difficult for many. Not to be alarmed, strategies to improve remembering skills can be taught. Repetition games such as having the teacher call out a fact combination problem like, "$4 \times 3 =$" and have a students solve it, and repeat with a new combination "$2 \times 7 =$" is one example. The game continues as each player calls out a new fact and each student responds with an answer. Students' ability to organize their thinking and use it to recall basic combinations will affect their success (Malone & Lepper, 1987).

In science, young students often classify plants, animals and other living things into groups. This process of sorting things based on their similar characteristics helps students group and organize objects. Students act just like scientists when they use classification to learn more about what they study, because when discovering something new, they see if and where the object, substance or organism fits into their classification system. An activity for students to help them remember classification is have them develop a flow chart to group and organize different organisms.

Classification is also used for older students in chemistry. Chemists need to know about the different atoms that make up living and nonliving things on earth. Just as biologists classify animals into groups, chemists place atoms that have similar characteristics into groups. These groups are organized on a chart called the periodic table. The periodic table can be made into a fun game. The task is to try and find two or more elements that are next to each other on the periodic table and come up with a product that uses the elements. For example silver and gold are next to each other and copper is above silver. Jewelry is the connection that students may make (American Chemical Society, 2001).

Quite often, students also have attention problems (Miller & Mercer, 2001). They have trouble sustaining attention, avoiding distractions, and controlling their impulses. They may be easily distracted and have difficulty focusing on complex problems. These students are helped by a structured, consistent classroom where clear expectations are spelled out. This does not mean that the teacher must tell students how to do a task; instead, the teacher should give all students opportunities to understand what is expected and ways to monitor their progress. Effective use of visuals, manipulatives, and learning aids could help overcome these problems. Working in pairs also assists a typical learner.

Students with attention difficulties often have trouble with time management and changes between subjects and classes. They often benefit from opportunities to be physically engaged in learning. Giving students many chances to move and interact with peers in structured situations is one of the keys to their success (Vaughn, Bos, & Schuum, 2003).

Language problems can result in a bad attitude towards math and science. Even students whose first language is English are often confused by the vocabulary of these subjects. Words that have special meanings such as equals, divisor, sum, cycle, or properties, often slow down students' ability to focus and understand the terms being used. When students fail to see the connections among concepts, science and math become a rote exercise and understanding is limited. As experienced teachers will tell you, simply memorizing terms without knowing what they mean is not useful. Comprehension is the goal. Language understanding is helped by discussing important vocabulary, using creative writing strategies, and asking pertinent questions (White, 2004).

Learning is also assisted by reviewing previous concepts and demonstrating connections in problem-solving situations.

Metacognition is the ability to think about thinking. Students need to reflect on their own thinking in order to be aware of what they need to know (self-knowledge) and how they can go about acquiring information (procedural knowledge). As students become better at figuring out their own reasoning, they can also observe their own learning. The process includes evaluating whether or not they are learning, using helpful strategies when needed, and making changes when necessary. As children grow and develop, they become better at thinking about their own thinking and how they think. This helps them move beyond their own personal perspective and better understand how others might think about a topic. These are critical skills for a science and math problem-solving situation.

Many students do not understand that being successful in science and math involves employing problem-solving strategies. Teachers have to teach them how to be metacognitive learners and help them recognize the thinking strategies they are using. Along the way, metacognition strategies can amplify self-reliance and creativity for learners. Teachers who model thoughtfulness and encourage students to share problem-solving strategies with each other can go a long way towards fully engaging students (Swanson, 1999).

Students with a vast array of special needs are now found in the regular classroom (inclusion). In addition, the levels of language and cultural differences represented in schools continue to grow. The result is that today's classrooms include students with a broad range of learning problems, abilities, and dispositions (Tucker, Singleton, & Weaver, 2006). The suggestions here would apply to even the most diverse student body.

Whatever the reason for how well they perform, youngsters need opportunities to learn about their individual strengths and weaknesses. The successful teaching of students is most likely when teachers utilize

culturally relevant materials, use collaborative instructional activities, and recognize that learning can take many forms through many modalities (Tucker, Singleton, & Weaver, 2006). Of course, there are many ways to go about using collaborative activities in ways that build on the natural learning dispositions of a wide variety of cultural groups. Engaging in problem-solving strategies that are similar to those used in real-life situations certainly helps. And, yes, celebrating individuality and working together to build successful learning communities certainly complement each other.

Collaborative Inquiry in Science and Math

All students can flourish when good teaching is combined with collaborative inquiry and an engaging curriculum (Tomlinson, 2001).

Collaborative inquiry is a form of reasoning and peer cooperation that begins with a problem and ends with a solution. It generally involves asking questions, observing, examining information, investigating, arriving at answers, and communicating the results. A collaborative inquiry approach to the teaching of science and math has been found to work well with learners (Brodesky, Gross & Tierney, 2004). Among other things, it helps these students experience the excitement of science and math activities in learning groups. Knowledge has always been constructed in association with others. At all levels, scientific and mathematical inquiry are much more than an individual endeavor. So, it's best if students employ procedures similar to the collaborative procedures that scientists and mathematicians actually use (White, 2004). Structure helps, but too much can stifle the imagination.

Don't tell people how to do something.
Tell them what to do and let them surprise you with their ingenuity.
— Anonymous

The collaborative inquiry approach is a student-centered process of cooperative discovery. The teacher often gives the students directions and materials — but does not tell the small group exactly how to go about doing their work. The teacher encourages conversation and provides activities that help students understand how science and math are applied in the world outside of school. The teacher might also give a brief whole class presentation and then, go from small group to small group, encouraging questions and guiding student observations. As students interact with materials and their peers, they can interact with science-math problems and jointly recognize the results of their investigation. The next step is applying what's been learned and recognizing the fact that the knowledge acquired through inquiry is subject to change.

Students certainly have different talents and interests, but they should all have access to high-quality science and math instruction. All students can be motivated with concrete materials, differentiated instruction, and cooperative experiences. But it is especially important for students who are challenged by basic science and math concepts and skills (Stigler & Hiebert, 2004). Since motivation is a major concern, it is important go beyond rote skill building to challenge reluctant learners. This means helping them deal with interesting, difficult, and ambiguous problems where they are expected to discuss, question, and resolve problems themselves.

Collaboration, Inquiry, and Motivating All Learners

Inquiry is sometimes thought of as the way people study the world and propose explanations based on the evidence they've accumulated. It involves actively seeking information, truth, and knowledge. When collaboration is added to the process, it helps build the positive relationships that are at the heart of a learning community. Collaborative inquiry may be thought of as a range of concepts and techniques for enhancing interactive questioning, investigation, and learning. When questions that connect to student experiences are raised collectively, ideas and strengths are shared in a manner that supports the students' search for understanding (Snow, 2005).

Teachers have found that using a collaborative approach to connect science and math instruction is a way to involve disinterested students in active small group learning (Karp & Howell, 2004). When students work together as a team, they tend to motivate each other. Accomplishing shared goals benefits all of the individuals in a group and makes it more likely that collaboration will become a natural part of the fabric of instruction. The teacher provides a high degree of structure in forming groups and defining procedure, but students control the interactions within their groups. Building team-based organizational structures in the classroom makes it easier for teachers to reach out to students who have problems and ensure that all students are successful.

A shift in values and attitudes may be required for a collaborative learning environment to reach its full potential. Some traditional school environments have conditioned students to rely on the teacher to validate their thinking and direct learning. So, getting over years of learned helplessness takes time. As they share and cooperate rather than compete for recognition, many children find more time for reflection and assessment. Although collaborative learning helps teachers achieve a number of motivational and social objectives, it also aims to improve student performance on academic tasks.

By tapping into students' social nature and natural curiosity, collaborative inquiry can go a long way towards helping schools achieve academic and social goals. It's a disciplined and imaginative way of exploring and coming together in community with others. As they work in pairs or in small mixed-ability groups, students can take more responsibility for helping themselves and others learn. As teachers learn when and how to structure group lessons, collaboration can become a regular part of the day-to-day instructional program.

The activities presented here are based on national science and math standards. They have been field tested and designed for students. Effective science and math teachers are usually those who have built up their knowledge base, can connect to other subjects, and know how to look for real-life connections. Just as important, most experienced teachers have also developed a large repertoire of current teaching techniques. They know how to take field-tested ideas and insert them into the science and math curriculum of their district.

Making Instructional Decisions With Differentiated Learning

Because we know that students learn in different ways and at different rates, it's important to consider differentiating instruction. The basic idea is to provide individual students with different avenues for learning content. Differentiated learning is an organized approach where teachers and students work together in planning, setting goals, and monitoring progress. In such classrooms, the teacher draws on the cultural knowledge of students by using culturally and personally relevant examples. They show respect for learners by valuing their similarities and differences, not by treating everybody the same. Teachers are the main organizers, but students often help with the design. It is the teacher's job to know what is important and to analyze and offer the best approach to learning. Students can let teachers know when materials or assignments are too hard or too easy and when learning is interesting (or when it's not). As a collaborative effort in shaping all parts of the learning experience, students will assume ownership of their learning.

Understanding how students adapt to learning environments and classroom structure is crucial. When teachers focus on students' strengths, then, students become more interested and work to achieve. Learners who struggle are frequently rebellious and out of sorts in a learning environment that does not adequately address different teaching strategies and learning styles. This can result in failure for these students, starting with inaccurate diagnosis and remedial, or sometimes, even withdrawal from school.

The most useful teaching approach for all learners is often well-organized differentiated instruction (Tomlinson & Cunningham Edison, 2003). A teacher who is organized examines the conditions surrounding the student, such as curriculum content, the classroom environment, and the students' academic and social behaviors. The ways students react to information and respond to feedback are also important. Planning for manageable units of classroom time and including as many teaching and behavioral approaches as possible certainly helps. But teachers know that no approach is effective in every situation, so it's important to be flexible. They also know that when they depend too much on rote memorization (devoid of meaningful applications), many students have trouble recognizing and retaining science/math facts. And they have trouble drawing conclusions.

In general, today's standards-driven curriculum provides many opportunities for students to develop a real understanding of science and mathematics content. As learners become more skillful and experienced, science and math ideas can be built upon and related to previous learning. Disaffected students, too often, are assigned uninteresting drill work each year to help them learn "basic skills." Yet, we know that students who did not understand the concept the first time are not likely to "catch on" the next time. Limiting their chances for science and math reasoning and problem solving puts many students at a serious disadvantage (Karp, K., & Howell, P., 2004). It doesn't take long for students to get the message that teachers have low expectations when it comes to their academic achievement.

Achievement gaps often result when science and math content is not connected to students' ability levels and experiences. What conditions will foster improved achievement? Research has not provided many clear-cut answers. Some suggest student absences or movement between schools may account for some of the problems (Barton, 2004). Other factors include the student's developmental environment and the home and school learning conditions. Gaps exist not only in the curriculum, but also between the student and some of the challenging content of science and math.

What works for all learners? Among other things, working with peers can help disaffected students focus and feel good about themselves. Opportunities to communicate with others, as part of interesting science and math activities, can make also these subjects more attractive. Such a team-based approach is particularly powerful when student efforts are rewarded by peers and the teacher (Garmston, R. I., & Wellman, B.M., 1999).

Discovering Ways To Differentiate Instruction

In a differentiated classroom, the teacher accepts students as they are and helps them succeed considering their unique circumstances.

Differentiated classrooms are places where the teacher carefully designs instruction around the important concepts, principles, and skills of each subject. The helpful teacher makes sure that learners focus on essential understandings and important skills. The subject is introduced in a way that each student finds meaningful and interesting. Although the teacher intends to have all students attain these skills, he or she knows that many won't achieve all there is to know (Tomlinson, 1999).

Recognizing individual learning styles and adapting a differentiated teaching style can make learning easier. With differentiated learning, the teacher provides specific ways for each student to learn deeply, working energetically to ensure that all students work harder than they imagined, and achieve more than they thought possible (Tomlinson, 2001).

What is clear is that many students seem to have a hard time with the traditional classroom setting (straight desks, teacher lectures, textbooks, worksheets, lots of listening, waiting, following directions, reading, and writing). In other environments, students who struggle have much less difficulty, for example in an art classroom, a wood shop, a dance floor, or the outdoors. In these differentiated classroom settings where students have opportunities to engage in movement, hands-on learning, arts education, project-based learning, and other new learning approaches, their interest and desire to learn have been shown to be at or above average (Gardner, 1993).

There are ways that teachers can differentiate or modify instruction to guarantee that each student will learn as much and as competently as possible. Teachers can modify the content of what is taught and the ways they give students information. They can also help students understand the process of how they learn important knowledge and skills. Did they use manipulatives to aid in their understanding? Did they ask others? Teachers want to know what the student understands and is able to do. Did the student show his or her work? The teacher is also interested in discovering students' thoughts and feelings in the classroom. How did students react to the learning environment or the way the class atmosphere worked?

There are several student characteristics that teachers respond to as they design differentiated lessons. They include readiness — what a student knows, understands, and is able to do today; a student's interest — what a student enjoys learning about; and the student's learning profile — their preferred learning style.

Several Sample Strategies for Differentiating Instruction

Readiness:

— Provide books at different reading levels, use activities at various levels of difficulty but focused on the same learning goal.

Interest:

— Encourage students to use a variety of media arrangements such as video, music, film, and computers to express their ideas.
— Use collaborative group work to explore topics of interest.

Learning profile:

— Present a project in a visual, auditory, or movement style.
— Develop activities that use many viewpoints on interesting topics and issues.

Today's classrooms are challenging environments for teachers. Designing lessons that are responsive to the individual needs of all students is not an easy task. Teaching science and math in a differentiated classroom can be challenging, especially when teachers are trying to increase the emphasis on science inquiry process skills and mathematical problem solving. Skills such as communicating, observing, reasoning, measuring, making connections, and experimenting are all part of the mix.

Meeting the Principles and Standards for All Students

The six principles discussed below describe important issues of the science and math curriculum standards. Used together, the principles will come alive as teachers develop comprehensive school science and math programs:

***Equity.** High-quality science and mathematics require raising expectations for students' learning. All students must have opportunities to study these subjects deeply. This does not mean that every student should receive identical instruction; instead it demands that appropriate accommodations be made for all students. Resources and classroom support are also a large part of equity.

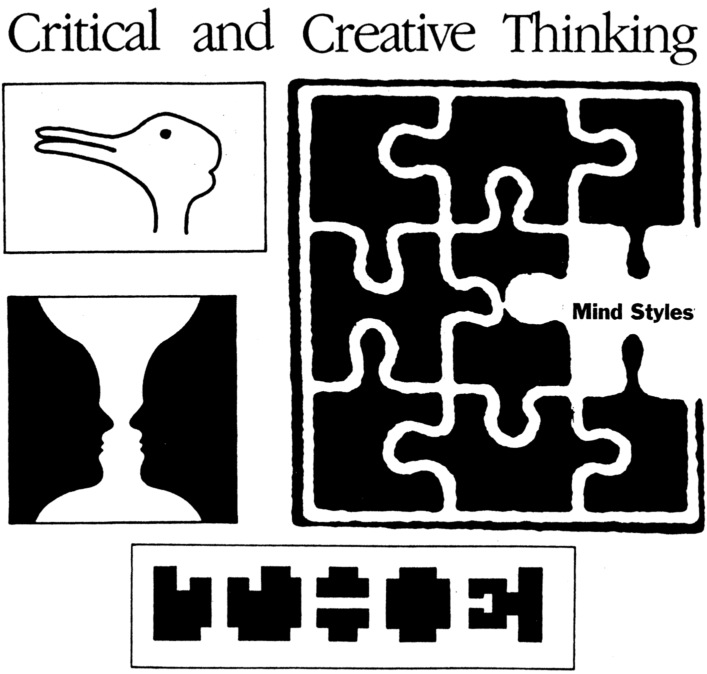
***Curriculum.** A curriculum must be coherent, focused on science and math, and articulated across grade levels. Interconnected strands effectively organize and integrate mathematical and scientific ideas so that students can understand how one idea builds on and connects with other ideas. Building deeper understandings provides a map for guiding teachers through the different levels of learning.

***Technology.** Technology today is an essential part of learning and understanding science and math. Effective science and mathematics teaching are dramatically increased with technological tools. Tools such as calculators and computers provide visual images of science and math ideas. They facilitate learning by organizing and analyzing data, and they compute accurately. Technology resources from the Internet, the World Wide Web, to computer programs like Logo, provide useful tools for science and mathematics learning.

***Assessment.** Assessment should support the learning of science and math and provide useful information to students and teachers. This enhances students' learning while providing a valuable aid for making instructional teaching decisions.

***Teaching.** Effective teachers understand what underachieving students know and need to learn, and challenge and support them through learning experiences. Teachers need several kinds of knowledge: Knowledge of the subject, pedagogical knowledge, and an understanding of how children learn. Different techniques and instructional materials also affect how well their students learn science and mathematics. Some students are often inundated with only practice materials trying to help them master the "basic skills." This leads to them lacking the conceptual foundations that are so important for real understanding. For lessons to be most successful, the learner has to be the focus, rather than making uninteresting basic skill drill the center of attention.

***Learning.** Science and math must be learned with understanding. Students actively build new knowledge from prior experience. Students should have the ability to use knowledge in a flexible manner, applying what is learned, and melding factual knowledge with conceptual understandings — thus, making learning easier. The learning principle is used when all students are involved in authentic and challenging work.



Helping All Learners meet Science and Math Standards

In science and mathematics, new knowledge and new ways of learning and communicating continue to evolve. Today, inexpensive calculators are everywhere. Powerful media outlets widely disseminate information as science and mathematics continue to filter into our lives.

If students can't learn the way we teach, we must teach them the way they learn.

— Carol Ann Tominson

It is best if all students are involved in high-quality engaging science and mathematics instruction. High expectations should be set for everyone, with accommodations for those who need them. As students become confident about engaging in science and math tasks, they learn to observe, explore evidence, and provide reasoning and proof to support their conclusions. As they become active and resourceful problem solvers, students learn to be flexible as they participate in learning groups (with access to technology).

Students do better in science and math if they have the chance to work productively and reflectively — communicating their ideas orally and in writing (NCTM, 2000; NRC, 1996). Here, we reference some of the principles behind the new standards and offer suggestions for effective teaching.

The *National Science Foundation* and the *National Council of Teachers of Mathematics* have developed standards that serve as guides for focused and enduring efforts to improve students' school science and mathematics education. These content standards provide a comprehensive set of standards for teaching science and mathematics from kindergarten through grade twelve.

An Overview of the National Science Education Standards

Principles that guide the standards:

1. Science is for all students.
2. Learning is an active process.

3. School science reflects the intellectual and cultural traditions that characterize the practice of contemporary science.
4. Improving science education is part of a systemic educational reform.

The science standards highlight what students should know, understand, and be able to do. Examples include:

* Becoming aware of physical, life, earth, and space sciences through activity-based learning.
* Connecting the concepts and processes in science.
* Using science as inquiry.
* Understanding the relationship between science and technology.
* Using science understandings to design solutions to problems.
* Identifying with the history and nature of science through readings, discussions, observations, and written communications.
* Viewing and practising science using personal and social perspectives. (National Academy Press, 1996)

An Overview of The Principles and Standards for School Mathematics

All students should:

* Understand numbers and operations, estimate and use computational tools effectively.
* Understand and use various patterns and relationships.
* Use problem solving to explore and understand mathematical content.
* Analyze geometric characteristics, use visualization and spatial reasoning to solve problems within and outside mathematics.
* Pose questions, collect, organize, represent, and interpret data to evaluate arguments.
* Apply basic notions of chance and probability.

* Understand and use attributes, units, and systems of measurement and apply a variety of techniques and tools for determining measurements.
* Recognize reasoning and proof as essential to mathematics.
* Use mathematical thinking to communicate ideas clearly.
* Create and use representations to model, organize, record, and interpret mathematical ideas. (These are brief selections. For a full description see National Council of Teachers of Mathematics, 2000).

Going Beyond Skill Mastery

Students who complete their science and math lessons with little understanding quickly forget or confuse the procedures (Miller & Mercer, 2001). For example: In doing a long division problem, suppose that students cannot recall if they are supposed to divide the numerator into the denominator or the reverse, to find the correct decimal. They can do the problem either way, but may not understand what they are doing nor explain their reasoning.

In science, step-by-step directions for an experiment often are quickly given and extra time not provided for explanation. Understanding and skill mastery go together when students build upon ideas they already know in a discovery process (Bruner, 1986). Again, the goal should be understanding what's going on well enough to know how it can be applied in the world outside of school.

Understanding important ideas and accurately completing problems are some of the first steps in becoming scientifically and mathematically skillful. Science and mathematics learning contains five strands of thought:

1) Understanding ideas and being able to comprehend important content.
2) Being flexible and using accurate procedures.
3) Posing and solving problems.

4) Reflecting and evaluating knowledge
5) Reasoning and making sense and value out of what is learned.

Success with science and math lessons can be expected and achieved as adaptations are made to the students' curriculum. One good way to make this happen is involving students in collaborative work and relating problems to real-life interests.

Organizing Successful Lessons

Students reach higher rates of proficiency when they are involved in organized lessons that pay special attention to their individual learning needs (Karp & Howell, 2004).

Stage 1: Review

Students connect new science and math concepts to old ideas they are familiar with when they are actively engaged at a concrete level of understanding. Science and math manipulatives such as counters, eye droppers, rulers, and blocks are used to answer questions that represent real-life interesting problems. For example, students are asked to show how many more cupcakes need to be made for a class picnic if seven are already made for the class of 16 students (each student gets one cupcake). Connections are made to former lessons, such as relating subtraction to the mathematical idea of how many more. Questions are asked and students discuss their understanding of the mathematical ideas.

Stage 2: Demonstrate Knowledge or Skill (Using a Math Example)

Next, students show their thinking by drawing a picture of the problem. For example, the set of cupcakes might be shown like this: I have 7 cupcakes. How many more do we need to get 16? Have students draw a picture to show their results.

Table 1.1. Organized Strategies to Support Students with Learning Problems

1) Review important concepts — make connections between familiar and new information.
2) Demonstrate knowledge or skill — increase student engagement and promote independent student activities.
3) Guided practice — reinforce language skills, partner, and share. Have students do a variety of problems.
4) Check for understanding and provide feedback — summarize strategies and evaluate. Provide continuous reinforcement at each stage so errors can be found and corrected.

Stage 3: Guided Practice

Students form a number sentence to match their drawings. $7 + \_\_\_ = 16$. $\_\_\_ = 9$. We needed 9 more than 7 to get 16. Students fill in numerals and complete number sentences.

Stage 4: Check for Understanding

In the last part of the lesson, students practise skills and problems through a range of activities and supporting lessons. The teacher provides ongoing feedback at each step so that procedural errors can be corrected (see Table 1.1).

Assessing Students' Strengths

Science and math content knowledge, student learning styles, behaviors, and reinforcement that affect learning are all considered in assessment. Assessment data is gathered from teacher observations, performance on daily assignments, science and math quizzes, homework, and in-class work. This information is recorded on a student data sheet. The value of assessment is that it leads to an overall analysis of a student's strengths and weaknesses (see Table 1.2).

Summary and Conclusion

Recognizing the learning characteristics of students and finding instructional methods that motivate them are important steps in science

Table 1.2. Student Data Sheet

Learning setting — indicates the physical environment in which the student works.
Content — includes the subject matter in which the child is engaged.
Process — involves strategies, methods, and tools that students are engaged in (e.g., listening and speaking)
Behavior — refers to academic and social behaviors that students participate in.
Reinforcement — looks at responses from the learning environment that cause behaviors to occur.

Recording Behavior Patterns

Behaviors that are consistent are called likely behaviors. They might include the desire to play video games or use the computer. Unlikely behaviors describe behaviors that usually occur below an average rate or at a very minimal level. For example, a classroom environment that is conducive to student achievement could be rated with a "+" symbol. If a student is having problems in the classroom environment, the teacher would mark this category with a "−" symbol. Collecting and reviewing this information with students allows teachers to focus on recognizing which classroom activities foster positive behaviors.

Instruction in science and math now tends to be more research based and standards driven. In addition, it often involves constructing deeper content knowledge through collaborative inquiry. Science and math are more than a collection of isolated rules and procedures to memorize. Understanding and applying these subjects involves certain levels of reasoning, problem solving, and imagination. There are, after all, multiple ways to solve problems and chart the way forward. Creativity and originality are often a matter of perspective. Sometimes, you don't dig up new ground — you just work to see the old ground differently.

and math instruction. The basic idea is to use strategies that consider all aspects of the learners' instructional needs so that students can be successful. Of course, the instructional methods mobilized for reluctant learners must not get in the way of the students who are already doing well in science and math. The good news is that differentiated learning doesn't get in the way of providing meaningful opportunities for everyone in the class (Elmore, 2005).

Students who struggle with science and math are, by definition, not doing as well as their parents or their teachers think they can. All too many of them view school as boring and irrelevant. Worse, for some, it's a place that they associate with humiliation and failure. It's little wonder that the standards and the dropout rates often go up together. One way or another, everyone is involved in the education of children and young adults; so there is enough blame to go around. Educators need to be aware of social forces (including the family) that so strongly influence what's learned in school. This doesn't mean that someone has to teach students science and math outside of school, although that wouldn't hurt. It's just that the home environment is where students learn to relate to very complicated things.

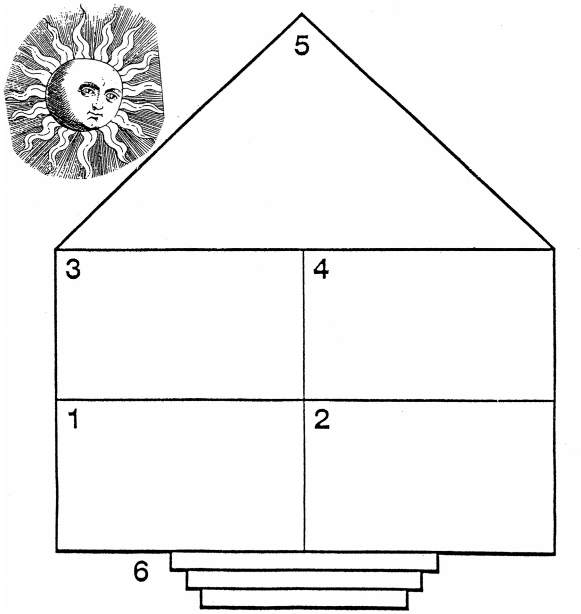
The self-esteem and spirit of individuals and groups are often expressed through culture. Students who struggle with science and math are helped when community resources, issues, events, and topics connect to what happens in the individual science and math classes (Van DeWalle & Lovan, 2006). Past and present experiences outside of school also serve as powerful resources for learning. In addition, purposeful classroom linkages with the home environment can be created and sustained by the science/math curricula and by the actions of the teacher.

As teachers use an organized approach to assess their students' science/math strengths (and error patterns), they can put into practice learning strategies that connect a student's predisposition to a positive classroom learning environment. One of the things that helps is having students explore the practical applications of science and math in their lives. This means connecting rules of these subjects to student understandings in a way that offers them an authentic invitation to interesting problems. This organized approach may well be the best way to get students to express their reasoning in ways that can lead to academic success (Barton, 2004).

Getting some young people to see science and math instruction as good thing can be a challenge, but educators know something about making the classroom a positive experience. What seems to matter most for disaffected students is working with others, extracurricular activities, and the particular attention paid by a teacher who takes time to help a student. Whatever the curriculum or methodology, it ultimately

HOUSE OF SELF

* In room # 1 draw a picture of the best thing that ever happened in your life.
* Room 2: your greatest success or achievement.
* Room 3: what you do well.
* Room 4: your greatest dilemma.
* Room 5: something big you would like to accomplish.
* Steps: special virtues or talents.



comes down to the teacher's energy, knowledge, character, sense of humor, and ability to relate to young people.

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Avoid being trapped under an avalanche of minutia