Top 10 Ways to Improve Science Achievement: Actions for School Principals, Assistant Principals, Department Chairs and School Improvement Consultants

- Education leaders have a responsibility to promote “scientific literacy” — defined by the National Research Council as the use of scientific principles and processes in making personal decisions and participating in discussions of scientific issues that affect society. Science education increases students’ critical thinking and problem-solving skills and provides explanations of “why things work the way they do.”

- When visiting a classroom where students are actively engaged in learning science, a principal or other school leader who knows about good science instruction will observe, ask students to explain the activity and check for data collection and safety procedures. A savvy instructional leader will seek evidence of well-planned science lessons that engage students and ensure the mastery of science content.

- Science achievement scores for the more than 75,000 students who participated in the 2006 High Schools That Work Assessment and the 2006 Middle Grades Assessment revealed that 47 percent of eighth-graders and 57 percent of 12th-graders scored below Basic in science. Clearly, there is a need to improve science education in the middle grades and high school.

- This “tip sheet” is designed to help principals and other school leaders and teachers identify rigorous instruction and successful strategies in science classrooms. This document contains ideas to help instructional leaders gain confidence in recognizing what works and what does not work in teaching science. It can be used as a checklist to enable leaders and teachers to work together to establish priorities and make needed changes in raising science.

1. Get to know the science faculty and the science department.

- Work with the department chair and observe every classroom, laboratory and storage room. Learn the strengths and weaknesses of the teachers and the space.

- Schedule time (with an agenda) to meet with science teachers. Promote the use of hands-on learning activities and ask teachers to assign at least one hands-on activity per week. Convince teachers of the importance of scheduling regular meetings to share ideas and information and to build enthusiasm for raising science achievement.

- Share new information, publications, activities, Web sites and other resources with science teachers. Make available multiple copies of materials for distribution in the department. Avoid creating an extra step for teachers to get materials.

- Encourage teachers to attend and to make presentations at professional conferences. Make it easy and convenient for teachers to register for these events by ensuring that information reaches them far enough in advance.
- Invite teachers to join panels, forums and other science activities.
- Schedule time for teachers to take inventory of science equipment and materials.
- Encourage lab fees, if possible, and develop other sources of funding for science needs.
- Stay in touch via regular e-mails and phone calls. Monthly conference calls are helpful. Ask teachers to share ideas with you and with others.
- If the department chair is unresponsive, decide to work with a teacher who is effective and enthusiastic.

2. **Make it clear to everyone what “quality science teaching” looks like.**

- Science rooms should show solid evidence of active student engagement. They should “look like” science rooms.
- Model how to use the scientific method to solve problems:
  - Design a scientific investigation.
  - Conduct a scientific investigation.
  - Analyze the findings.
  - Communicate and defend the findings.
  - Evaluate other scientific investigations and apply the results.
- Science classrooms should show evidence of active, inquiry-based investigation that goes from concrete to theoretical. For example, students can create microscopic slides of cells before discussing the cell theory.
- Align laboratory activities vertically and horizontally to state and district standards. All activities should be standards-based and increase in rigor each year. Have students at each grade level complete a variety of product-, performance- and problem-based assessments. For example, students should not be expected to construct a cell model every year.
- Good teachers connect science activities to real life. They constantly link science concepts to content in other subject areas. Students understand and can discuss the reason for assignments and the relationship of activities to real life.
- Ask science teachers to take the following actions to increase student engagement and achievement:
  - Utilize technology, science materials and equipment as integral parts of instruction. For example, students can use mathematics and graphing calculators to integrate data from field, Internet and tabular sources; create maps, charts, tables and other graphic displays; use software packages to import photos, graphs and tables into documents; and use appropriate equipment to measure volume, mass, weight, length, width and temperature.
  - Integrate literacy (reading, writing, speaking and listening) into all lessons. Emphasize science vocabulary in context. NEW words must be used multiple times before they are an integral part of a student’s vocabulary.
  - Collect current sources of information such as newspapers, magazines and science journals to supplement the science textbook.
  - Increase the level of assignments and assessments until most students (60 to 70 percent) are at or above the Proficient and Advanced levels. Teachers can develop a tuning protocol that they agree to use to peer-review student work.
Increase wait-time for students’ answers and include higher-order thinking questions in teacher-to-student discussions. Incorporate higher-order thinking questions, including open-response questions, into assignments and assessments.

Create classroom questions to help students link science to their world.

Include a variety of activities in lesson plans: labs, research papers, and short- and long-term assignments that reflect students’ interests.

Arrange desks and tables to make the room student-friendly and conducive to investigative, hands-on activities.

3. Focus on engaging, student-centered, standards-based units and lessons.

- Lead science teachers in developing a planning instrument that they agree to use. The principal has final approval.
- Make the change from a daily, standards-based lesson to biweekly, standards-based units and lessons.
- Make changes in planning voluntary in the first semester after development and mandatory in the next semester.
- Suggest and schedule time for teachers to plan integrated lessons to help students connect science to the real world.
- Administer a learning styles inventory and disseminate the findings to students and teachers. Monitor lesson plans to determine how different learning styles are being addressed.
- Train administrators, but not department heads (who usually prefer not to be evaluators) in the process of reviewing lesson plans for evaluation and instructional improvement. Use a rubric and provide immediate feedback.
- Observe classes with lesson plans in hand. Determine if teachers need help in writing better plans, delivering better instruction or both.
- Encourage teachers to develop an integrated planning approach that uses natural (not forced) correlations to other subject areas. Expand the integration as teachers become more experienced in doing standards-based unit planning across several content areas.
- Ensure each science course contains a minimum number of labs that students are expected to complete. The labs should increase in rigor from grade six through grade 12. Ask for a list of labs required of every student in each course.

4. Begin with a solid core curriculum of rigorous science courses.

- Review the master schedule and discuss the science courses offered.
- Schedule Advanced Placement (AP) and dual-enrollment classes as quickly as possible.
- Use technology such as the Internet to offer online courses to supplement face-to-face, lab-based classes.
- Purge the schedule of low-level, introductory and applied science courses.
- Eliminate or phase out courses that have no direct connection to the needs of students and the community.
- Correlate the sequencing of science courses to the sequencing of mathematics and career/technical courses. For example, students need specific mathematics skills to take physical science.
5. **Align the curriculum and document the development of products such as curriculum maps and pacing guides.**

- Schedule at least one week during the summer for a group of science teachers to develop a curriculum that aligns vertically from the elementary grades to the middle grades to high school. Designate a curriculum specialist to facilitate the work. Schedule the work in a computer lab with appropriate computer and networking capabilities. Develop electronic and hard copies of documents (mark them “draft” until approved) to distribute to all participants. Formal documentation calls for:
  - specifying content standards for each grade level and course;
  - identifying process standards (including the skills for investigating and understanding science) as an integral part of teaching scientific content;
  - developing lists of teacher demonstrations and student lab activities required for each grade level and course;
  - identifying a variety of reading assignments and literacy strategies for each grade level and course;
  - emphasizing “habits for success” — the skills that all students need to develop;
  - using technology-based activities at each grade level and in each course; (For example, students use a wireless Internet connection to do research on global warming; use a graphing calculator to estimate the amount of plaque buildup in arteries and to predict when a heart attack might occur; and use Microsoft Word and Excel software to present and defend research.) and
  - scheduling time at the end of each nine-week grading period for teachers to review and revise curriculum documents and plan for the next grading period.

6. **Provide professional support for science teachers.**

- Meet with teachers to pinpoint whether science materials and equipment are sufficient for rigorous, quality instruction. Ask teachers to submit a prioritized “must-have list” and a “wish list.”
- Schedule time for teachers to observe teaching strategies and student work with carefully selected teachers on and off campus.
- Schedule consultant-led and teacher-led professional development specific to teachers’ needs.
- Provide travel time and funding for teachers to attend national and regional professional development activities conducted by organizations such as:
  - Southern Regional Education Board
  - National Science Teachers Association
  - National Biology Teachers Association
  - National Council of Teachers of Mathematics
  - National Center for Career and Technical Education
- Arrange for site licenses to pay for science-based periodicals.
- Require participation in professional development as part of each teacher’s personal development plan.
- Distribute information about best practices for engaging students in doing challenging work.
- Provide information on raising expectations, including a policy for revising work to meet standards.
- Review safety policies, plans, and emergency equipment and procedures.
7. Set high expectations based on a rigorous curriculum to accelerate the achievement of all students.

- Publicize to students, parents and the community that high expectations are required, not optional.
- Schedule students in challenging classes. Most students achieve at a higher level if their courses are rigorous and their teachers expect high performance.
- Devote a significant amount of time in the school schedule for science instruction. Don’t let other classes and activities “chip away” at science time.
- Require assignments, assessments and all student work to be at or above grade level.
- Hold students accountable for course work, high standards and demonstration of effort. Promote a policy change that prevents students from opting out and “taking a zero.” Incomplete grades, rather than zero grades, hold students accountable. Require students to redo work until it meets acceptable standards.
- Establish a grading policy that reflects higher expectations. Students need to understand what each lesson contains. Require standards, benchmarks and objectives, and an activity agenda to be posted daily in each classroom.

8. Coordinate a system of extra help and extra time for students who learn in different ways and at different rates.

- If the state and the district do not test students in science, or if science data are not available in a timely manner, encourage teachers to use data from mathematics or another content area to identify students’ needs.
- Provide extra help at different times in a variety of formats: before, during and after school; double doses of science; a summer bridge program; support classes; catch-up classes; and transition courses.
- Provide extra help in multiple ways: peer tutoring, teacher tutoring and study groups.
- Plan ways to overcome student deficiencies identified by data.
- Determine if ESL/ELL or special education students need additional support in science. Use enrichment and/or accommodation activities from the standards-based unit plans.
- Encourage students to participate in grade-level courses, even if they lack some skills. Provide extra help and extra time to build needed skills.
- Gear up and prepare students early in the middle grades. Use a standard, common assessment tool to determine strengths and weaknesses.
- Know and apply research-based strategies, such as moving from concrete to abstract and using representations.
- Change teaching strategies if students are unsuccessful.
9. Organize students and teachers into adviser/advisee groups. Assign each student to an adult advocate who takes an interest in the student’s successful learning, goal setting, educational planning and personal growth.

- Include science teachers as advisers.
- Emphasize that teachers can change students’ perceptions about science. Teachers play a major role in helping students believe that they can succeed.
- Stress that the middle grades — particularly the seventh grade — are a pivotal point for students in deciding whether to “like” or “dislike” specific content areas.
- Provide guidance and advisement curriculum materials that are student- and teacher-friendly and easy to use.

10. Recognize the specific needs of your school.

- Identify and prioritize the school’s needs related to science achievement.
- Develop action plans to encourage short- and long-term success.
- Help everyone understand that science achievement is a vital part of school improvement. As instructional leaders, principals can pull or push staff members to raise students’ science performance.
- Recognize the multiple types of data that are needed to identify student achievement and establish a timeline for examining the data and taking action.