

Research Supporting Science Starters

The No Child Left Behind Act (NCLB, 2001) emphasizes the accountability of schools in achieving student success. Each state is charged with using current research to determine learning strategies used in the classroom (U.S. Dept. of Education, 1987). The web-based Science Starters program includes daily presentations that spiral through the tested objectives, vocabulary presentations, worksheets, and assessment tests. Modifications are provided for students requiring accommodations, and Spanish vocabulary is available to support English language learners. Optional online benchmark testing is available to provide the data necessary to drive instruction as it generates individualized and group intervention reports.

The Science Starters program is built on sound brain research, best instructional practice, and empirical data. Scientific Minds has collected data from 18 pilot high schools with student populations from 100 to over 3,000 and with demographic populations that vary from 65% African American to 98% Hispanic. Though scores in Texas gained an average 8 percentage points from 2007 to 2009, Scientific Minds' pilot schools saw an overall 16 point gain. Student subpopulations saw even greater gains as shown in the table below.

Increase in Percentage Points (% Met Standard) for TAKS 11 th Grade Science 2007-2009						
	All Students	At Risk	ELL/LEP	African American	Hispanic	Econ. Disadv.
State of Texas	+8	+13	+12	+12	+12	+12
Pilot Schools for Science Starters	+16	+26	+19	+31	+16	+23

Pilot schools are those reporting use of Science Starters as recommended by Scientific Minds.

5E Instructional Model

The Science Starters program was developed using the 5E Instructional Model. In the 1980s, the Biological Sciences Curriculum Study group (BSCS) developed the 5E Instructional Model based on earlier models proposed by 20th century educational leaders such as John Dewey and Johann Hebert. The BSCS took Dewey's 6-step concept along with the "explore, invent, discover" learning cycle proposed in the early 1960s by Atkin and Karplus to create the 5E model. The five phases for the BSCS model are engagement, exploration, explanation, elaboration, and evaluation. Research reports from institutions such as the National Research Center support the effectiveness of the 5E model in creating positive interest and attitudes about science, enhancing mastery of subject matter, and developing scientific reasoning abilities (Bybee, Garner, Landes, Powell, Scotter, Taylor, & Wetbrook, 2006).

Presentations

Science Starters are daily, 3-8 minute presentations that spiral through the tested science objectives throughout the year. A spiraling approach to information acquisition allows some students to master a concept immediately while providing others time and repeated opportunity to gain a thorough understanding. "Repeated exposure to information in specifically timed intervals provides the most powerful way to fix memory

into the brain. Learning occurs best when new information is incorporated gradually into the memory store rather than when it is jammed in all at once” (Medina, 2008). According to the work of Jensen (1998) and followed by Sprenger (1999), “information must be repeatedly processed for long-term memory to take place.” Research in effective learning and teaching even goes as far as stating that “any topic in science, mathematics, or technology that is taught only in a single lesson or unit is unlikely to leave a trace by the end of schooling” (Project 2061, 1990). The problem lies in the brain’s inability to pay attention for long periods of time; in fact, it is commonly cited that the brain can only focus on a single concept for about 10-15 minutes, depending on age. Students absorb information best in small yet thought-provoking chunks (Marzano, 2009). Science Starters provide visual stimulation as each presentation incorporates sharp, colorful pictures with minimal text to explain a specific concept. “Pictures are a more efficient delivery mechanism of information than text. If information is presented orally, people remember about 10 percent, tested 72 hours after exposure. That figure goes up to 65 percent if you add a picture” (Medina, 2008). Picture representation helps students to create mental images of new information, an encoding process that significantly improves learning (Marzano, Pickering, & Pollock, 2001). The auditory aspect of Science Starters also reinforces learning as information in the presentation is read aloud by the teacher or students. “If we ‘say’ to ourselves what is in the picture, we reinforce the visual memory with the auditory component” (Sprenger, 1999).

Vocabulary

Each Science Starter elaborates on key vocabulary within the presentation. This elaboration is essential to student achievement, which increases when vocabulary is focused on specific words important to what students are learning (Marzano & Pickering, 2005, Kinzer & Leu, 2003). Science Starters at all levels even offer Spanish vocabulary translations to aid English language learners.

Formative Assessment

Multiple choice and open-ended questions are built into each Science Starter presentation as a formative assessment tool. Black and William (2004) have done extensive research on formative assessment and have found that effective questioning is “an important aspect of the impromptu interventions teachers conduct once the students are engaged in an activity.” As a class views a Science Starter, question slides appear that open the presentation to collaborative discussion. Research indicates that collaborative input in classroom questioning benefits all students as they become more likely to challenge expressed ideas and are forced to explain their reasoning (Daniels, Hyde, & Zemelman, 2005). Teachers can then shape their own instruction according to perceived classroom needs.

Summative Assessment

Summative assessment is fundamental to education because to measure learning is to measure memory retrieval over time (Medina, 2008; Sousa, 2001; Sprenger, 1999). Science Starters programs at all levels offer summative assessment in the form of quizzes for each Science Starter presentation and online benchmark testing for each program. Quizzes and tests are aligned with state expectations as they are developed using

state assessments. Increasing student achievement on summative assessments is an important function of the Science Starters programs.

Accommodations for Students with Disabilities

The Americans with Disabilities Act (1990) together with the Individuals with Disabilities Education Improvement Act (2004) and NCLB (2001) hold schools accountable for the appropriate education of all children with disabilities and require schools to provide interventions and accommodations to improve learning. Scientific Minds has developed Science Starters with these students in mind: the visual and auditory components support a variety of learning styles; modified quizzes are provided; and modifications are available with online testing. Modification options include larger font, reduced answer choices, and formulas appearing as needed. The online testing generates targeted intervention assignments for individual students as well as individual and group intervention reports for educators.

English Language Learners

Scientific Minds has used research in dual language instruction to develop the Science Starters programs. This research shows that creating predictable routines and signals and presenting visual images related to content both reduce anxiety and provide language support for the English language learner (Herrell & Jordan, 2004). Use of Science Starters presentations creates a predictable, daily routine signaled by similar formatting in each presentation, especially in the opening and closing slides. Each slide in a presentation is pictorially representing a scientific concept that the student simultaneously sees, hears, and reads. Additionally, Science Starters at all levels offer Spanish vocabulary translations to aid English language learners. To support bilingual education, the elementary program offers the Science Starters presentations entirely in Spanish.

Instructional Alignment

Scientific Minds provides professional development in effective use of the Science Starters program to align science instruction. In preparation for state assessments, science teachers commonly need to review information outside of their familiar teaching assignments. “Exemplary teachers in both pedagogy and curriculum are more likely to make substantial errors in content when teaching out of field” (Troupe, 2008). The framework for Science Starters presentations is autonomous so that teachers can confidently review information outside of what they teach every day.

Development of each Science Starter is driven by state and national student expectations. All presentations are developed with collaborative input and feedback from hundreds of science teachers, elementary through high school, as well as administrators, post-secondary level advisors, and consulting PhDs.

Bibliography

Americans with Disabilities Act of 1990, 42 U.S.C. §12101 (1990).

- Atkin, J. M. and Karplus, R. (1962). Discovery of invention? *Science Teacher* 29(5): 45.
- Bender, W. (2002). *Differentiating Instruction for Students with Learning Disabilities*. Thousand Oaks, CA: Corwin Press, Inc.
- Black, P., Harrison, C., Lee, C., Marshall, B., and William, D. (2004). Working Inside the Black Box: Assessment for Learning in the Classroom. *Phi Delta Kappan*, Vol.86. No.1, 9-21.
- Bybee, R., Gardner, A., Landes, N., Powell, J., Scotter, P., Taylor, J., Westbrook, A. (2006). *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications*. Retrieved May 2010 from www.bsccs.org/pdf/bsccs5eexecsummary.pdf.
- Daniels, H., Hyde, A., Zemelman, S. (2005). *Best Practice: Today's Standards for Teaching and Learning in America's Schools* (3rd Ed.). Portsmouth, NH: Heinemann.
- Deiote, M., Howell, R., Patton, S. (2008). *Understanding Response to Intervention: A Practical Guide to Systemic Implementation*. Bloomington, IN: Solution Tree.
- Dewey, J. (1971). *How we think*. Chicago: Henry Regnery Company. Originally published in 1910.
- Duffy, H. (2007). Meeting the Needs of Significantly Struggling Learners in High School: A Look at Approaches to Tiered Intervention. Brief created at the American Institutes for Research, Washington, DC. Retrieved May 2010 from www.betterhighschools.org/docs/NHSC_RTIBrief_08-02-07.pdf.
- Gregory, G., Parry, T. (2003). *Designing Brain Compatible Learning* (2nd Ed.). Glenview, IL: Pearson Education, Inc.
- Herrell, A., Jordan, M. (2004). *Fifty Strategies for Teaching English Language Learners* (2nd Ed.). Upper Saddle River, NJ: Pearson Education, Inc.
- Individuals with Disabilities Education Improvement Act of 2004*, 20 U.S.C. §1400 (2004).
- Jensen, E. (1998). *Teaching with the Brain in Mind*. Alexandria, VA: ASCD.
- Kinzer, C., Leu, D. (2003). *Effective Literacy Instruction: Implementing Best Practice* (5th Ed.). Upper Saddle River, NJ: Pearson Education, Inc.
- Marzano, R. (2009, October). Helping Students Process Information. *Educational Leadership*, Vol. 67 No. 2, 86-87. Retrieved April 2010 from http://ascd.org/publications/educational_leadership/oct09/vol67/num02/Helping_Students_Process_Information.aspx.
- Marzano, R., Pickering, D. (2005). *Building Academic Vocabulary*. Alexandria, VA: ASCD.
- Marzano, R., Pickering, D., Pollock, J. (2001). *Classroom Instruction that Works*. Alexandria, VA: ASCD.

Medina, J. (2008). *Brain Rules: 12 Principles for Surviving and Thriving at Work, Home, and School*. Seattle, WA: Pear Press.

National Research Council. (2000). *How People Learn: Brain, Mind, Experience, and School* (2nd Ed.). Washington, DC: National Academy Press.

No Child Left Behind Act of 2001, Pub. L. 107-110, 115 Stat. 1427 (2002).

Project 2016. (1990). Effective Learning and Teaching. *Science for All Americans Online*. American Association for the Advancement of Science. Retrieved April 2010 from <http://www.project2061.org/publications/sfaa/online/chap13.htm>.

Sousa, David. (2001). *How the Brain Works*. Thousand Oaks, CA: Corwin Press, Inc.

Sprenger, M. (1999). *Learning and Memory: The Brain in Action*. Alexandria, VA: ASCD.

Stroupe, D. (2008, April). Do High School Teachers Know IPC and Biology Content? *The Texas Science Teacher*, 5-11.

United States Department of Education. (1987). *What works* (2nd Ed.). Washington, DC: U.S. Government Printing Office.