The Research Base for

Glencoe Biology

Standards-Based Biology White Paper

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Standards-Based Biology

The National Science Education Standards consist of four overarching principles (**Appendix 1**) and a total of 50 specific standards in the areas of Science Education, Science Assessment in Science Education, Science Content (broken down by topic area and grade levels), Science Education Program, and Science Education System. To say that the Science Standards have raised the bar for science education in the United States is truly an understatement. Never before has science education been guided by a national set of principles and standards. Never before have our science education goals been set this high. And never before have science teachers and administrators been this challenged to meet goals of excellence in science programs.

Science teachers always have worked to motivate students to read science texts, coordinate visual and verbal information, and study using effective, research-proven strategies. However, most teachers also have limited resources and must choose how much time and energy to devote to helping students develop these strategies while still allowing them to become self-reliant and independent learners. Administrators and teachers are challenged to reach multiple goals, simultaneously helping students to:

- understand and remember standards-based science and apply it to new contexts,
- perform well on high-stakes achievement tests,
- prepare to succeed in their next science course, and
- become productive and scientifically literate citizens.

The Science Standards describe a vision of the scientifically literate person and present criteria for science education that will allow that vision to become reality. But now, more than ever, science educators are struggling to find appropriate resources to help them meet the ideals set by the Science Standards. This paper focuses on the Science Standards as they apply to high school, as well as the resources now available to those involved in biology education.

Changing Pedagogy: Inquiry-Based Science Learning

Research shows us that teachers cannot simply transfer knowledge to students by lecturing or assigning readings. Students have to take an active role in their own learning. To accomplish

this, science programs must include ample opportunities for students to explore, experiment, question, debate, discuss, and discover. This is not to say that teachers are removed from the educational process. Rather, the learning experience should include an appropriate balance of explicit and implicit instruction.

Explicit instruction occurs when teachers and textbook authors clearly explain science concepts and problem-solving strategies to students in a direct, low-inference fashion (Duffy, 2002). Explicit instruction provides students with needed background knowledge on how, why, and when to use learning and studying strategies. This leads to learner independence (Zimmerman, 1998, 2000, 2001) and productive dispositions toward achievement (Alderman, 1999). Explicit instruction is critical to good science teaching, because exclusively using implicit instruction often fails to equip developing students with the necessary reading, writing, and studying strategies (Graham & Harris, 1994, 2000).

Implicit instruction occurs when students figure out for themselves how to grapple with problems and construct conceptual knowledge (Pressley et al., 1992; Shulman & Keislar, 1966). This occurs when students engage in project-based and subject-integrated science activities, open-ended science labs, and science fair projects.

The Science Standards consistently emphasize that learning science should be an active process.

- Teaching Standard A: Teachers of science plan an inquiry-based science program for their students.
- Science as Inquiry/Content Standards (Grades 9-12): As a result of activities in grades 9-12, all students should develop (a) abilities necessary to do scientific inquiry and (b) understandings about scientific inquiry.
- Science Education Program Standard B: The program of study in science for all students should be developmentally appropriate, interesting, and relevant to students' lives; emphasize student understanding through inquiry; and be connected with other school subjects.

This emphasis on inquiry learning, through laboratory activities and other methods, has been echoed in the position statements of the National Science Teachers Association and the National Association of Biology Teachers (**Appendix 2**) that strongly support the Science

Standards. The repeated recommendations to use an inquiry approach reflect the growing trend toward constructivism in science education. Constructivism is based on the idea that students construct their own knowledge in a process that is both individual and social.

Teachers, curricula directors, and administrators are left with a difficult task: How can we design a science program that provides the right balance of implicit and explicit instruction and includes a curriculum with the proper, age-appropriate content and ample opportunities for exploration and inquiry learning?

Supporting the Science Standards with *Glencoe Biology*

One of the concepts explained in the Science Standards is that the Standards themselves are meant as descriptive ideals and guidelines. They represent what can be accomplished, but leave the specifics of implementation to others. The responsibility for putting the vision of the Standards into action belongs to everyone with an interest in science education: teachers, students, administrators, policy makers, assessment specialists, scientists, teacher educators, parents, local community members, curricula developers, and publishers. Glencoe/McGraw-Hill, one of the nation's largest textbook developers, has risen to the challenge of the Science Standards and created an inquiry-based program for *Glencoe Biology*.

Glencoe Biology responds to the need of science educators for curricula that accomplish multiple goals. To help educators reach the Science Standards' goals, each curricula must:

- support the recommended content Standards,
- give students consistent opportunities for active and extended science inquiry,
- provide opportunities for scientific discussion and debate,
- provide various tools to regularly assess student understanding, and
- connect science to other areas of learning, including natural phenomena and science-related social issues that students discover in everyday life.

The program allows students to discover concepts within each of the Content Standards, giving them opportunities to make connections between scientific concepts and the real world. The *Teacher Wraparound Edition* includes Chapter Organizers at the beginning of each chapter which clearly outline the Science Standards covered in each section.

Summary

The National Science Education Standards have provided a gold standard in science education. More than ever before, science teachers are being called upon to challenge their students to become inquisitive and active science learners. To achieve the high goals set by the Science Standards, educators and others involved in science education reform will need to use an array of state-of-the-art strategies and tools. Their toolbox must include inquiry-based curricula that support the Science Standards in every way. Glencoe/McGraw-Hill is proud to offer *Glencoe Biology*. With its focus on inquiry learning, differentiated instruction and continuous assessment, teachers can help all their students achieve the goals set by the National Science Education Standards, now and in the coming years.

Appendix 1

Science Standards' Four Principles

- Science is for all students.
- Learning science is an active process.
- School science reflects the intellectual and cultural traditions that characterize the practice of contemporary science.
- Improving science education is part of systemic educational reform.

For more information, see the National Research Council's National Science Education Standards (1995) available at www.nap.edu.

Appendix 2

Statements on Inquiry Learning and Laboratory Activities

NSTA Position Statement — *The National Science Education Standards*:

The National Science Teachers Association strongly supports the National Science Education Standards by asserting that:

> Teachers, regardless of grade level, should promote inquiry-based instruction and provide classroom environments and experiences that facilitate students' learning of science.
> Inquiry should be viewed as an instructional outcome (knowing and doing) for students to achieve in addition to its use as a pedagogical approach.
> Science programs should provide equitable opportunities for all students and should be developmentally appropriate, interesting and relevant to students, inquiry oriented, and coordinated with other subject matters and curricula.

Adopted by the NSTA Board of Directors, January 1998. For more information, see www. nsta.org.

NABT Position Statement — Role of Laboratory and Field Instruction in Biology Education

> The most effective vehicle by which the process of inquiry can be learned appears to be a laboratory of field setting where the student experiences, firsthand, the inquiry process. Laboratory and field study have also been demonstrated to be effective means for comprehension, understanding and application of biological knowledge. . . Thus, study in a laboratory and/or field setting is an integral and essential part of a biology course.

Adopted by the NABT Board of Directors September 1990. Revised 1994, 2005. For more information, see www.nabt.org.

References

Alderman, M. K. (1999). *Motivation for achievement.* Mahwah, NJ: Lawrence Erlbaum Associations.

Graham, S. & Harris, K. R. (1994) Implications of constructivism for teaching writing to students with special needs. *Journal of Special Education*, 28, 275–289.

Graham, S. & Harris, K. R. (2000). The role of self-regulation and transcription skills in writing and writing development. *Educational Psychologist*, 35, 3–12.

Pressley, M., Harris, K. R., & Marks, M. B. (1992). But, good strategy instructors are constructivists! *Educational Psychology Review* 4, 3–31.

Rakow, S. J. (Ed.) (2000). *NSTA Pathways to science standards: Guidelines for moving the vision into practice, Middle school edition.* Arlington, VA: NSTA Press.

Shulman, L. S. & Keislar, E. R. (Eds.) (1996). *Learning by discovery: A critical appraisal.* Chicago, IL: Rand McNally & Company.

Zimmerman, B. J. (1998). Academic studying and the development of personal skill: A self-regulatory perspective. *Educational Psychologist*, 3, 73–86.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of Self-Regulation.* San Diego, CA: Academic Press, pp. 13–39.

Zimmerman, B. J. (2001). Theories of self-regulated learning and academic achievement: An overview and analysis. In B. J. Zimmerman & D. H. Schunk (Eds.), *Self-regulated learning and academic achievement: Theoretical perspectives.* Mahwah, NJ: Erlbaum.