TEACHING SCIENCE to STUDENTS with LEARNING DIFFERENCES
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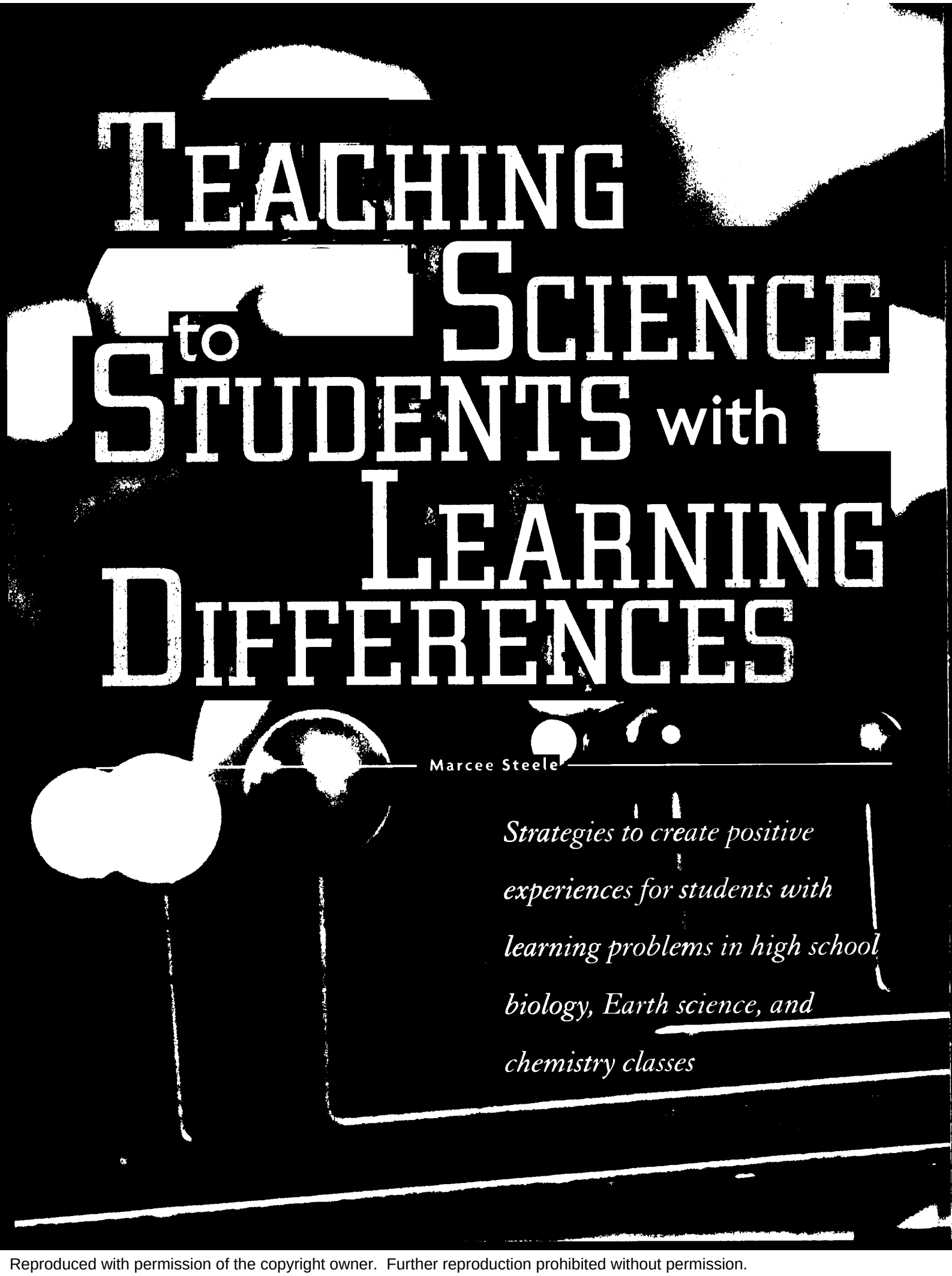

Recent legislation, such as No Child Left Behind and the Individuals with Disabilities Education Act amendments of 1997 and 2004, emphasizes the importance of teaching students with mild disabilities in the general education classroom using the general curriculum. Consequently, students with learning problems take a variety of science courses, including biology, chemistry, and Earth science, that require complex cognitive skills such as problem solving, critical thinking, evaluating, analyzing, and interpreting data. Many of these students, in fact, are in college preparatory courses and tracks. Because of the emphasis on high-level thinking skills, science courses may be particularly challenging for students with learning problems. This article summarizes some common characteristics of students with learning problems who typically take high school science courses and presents modifications for instruction to help these students and their teachers experience success.

Students with learning problems

The first step in assisting students with learning problems in the science classroom is to be aware of the characteristics they may share. The most prevalent learning-problem categories represented in general education high school science courses include communication disorders (CD), Attention-Deficit/Hyperactivity Disorder (ADHD), emotional and behavioral disorders (EBD), and learning disabilities (LD). Although the technical definitions for these categories are distinctly different, students with these problems share many common characteristics, such as deficits in processing skills, memory, language, and attention. Familiarity with these characteristics enables teachers to make modifications that will help students with learning problems succeed.

One of the most common characteristics of students with learning problems is a deficit in processing skills (Salend 2005). Students with LD and some students with ADHD have compromised visual processing skills and therefore experience difficulty interpreting what they see. LD and ADHD students may have trouble, for example, interpreting chemistry illustrations of electrons, ions, and even the periodic table. In fact, although these illustrations provide clarification for most students, they could make the information more confusing to students with visual processing problems.

If students have auditory processing problems commonly associated with LD, ADHD, and CD, they will have trouble understanding science information presented in lecture format or class discussion. For example, it may be difficult for students with auditory processing problems to understand directions for activities involving multiple procedures, such as mineral identification. If a teacher explains all of the steps for classifying minerals —observing characteristics, placing samples into groups, and recording results on charts—students with LD may not be able to complete the task because of confusion with the multistep auditory information presented.

Motor processing problems could make labs very difficult and potentially unsafe for students with learning, attention, and behavioral problems. If required to use flasks, microscopes, solutions, or other materials in the lab, students with learning problems may have difficulty handling the materials and equipment and be unable to complete the lab successfully.

Memory deficits are common in students with LD and ADHD; these students often have problems remembering what they see and hear. In addition, some students may have trouble using specific strategies they have been taught or deciding which strategies to use to help them remember information (Mercer and Mercer 2005). If an Earth science class is studying the ocean, for example, students with LD could have difficulty remembering key concepts such as causes of currents and tides, parts of continental margins, and parts of deep ocean basins. These students might be able to recall concepts about oceans that are very basic or that they already know (e.g., that oceans are saline) and retain key information about oceans that is repeated throughout a unit; however, it may be very difficult to remember new information.

Receptive and expressive oral language problems are common characteristics of students with CD and LD (Salend 2005). In chemistry, biology, or Earth science classes, *receptive language problems* (difficulty understanding the language of others) will lead to problems in understanding important but often difficult vocabulary, such as *heterozygous, bryophyte, ventifacts, thermocline,* and *kilopascal;* interpreting abstract concepts, such as stoichiometric quantities, geologic column, and homeostasis; and even comprehending teachers' explanations. The many components involved in these abstract concepts will make them difficult to interpret, and students with LD and CD may not comprehend the teacher explanation that could illuminate the concept for other students. Because of the language problems, the elaborate verbal explanations for key science ideas could further confuse students. Discussion in biology of the details of cellular concepts such as organelles, homeostasis, and anaerobic respiration may be overwhelming for some students. If students have *expressive language problems* (difficulty producing meaningful language), it will be extremely difficult for them to work with lab partners to discuss procedures, results, and conclusions and make presentations to the class even when they understand the material.

Social, emotional, and behavioral problems often present in students with ADHD and EBD can also lead to difficulties in the high school science classroom. Attention problems for example, make it difficult for students

to complete long-range projects involving several steps. If teachers assign research projects at the beginning of the semester with outlines, bibliographies, visuals, reports, and presentations due at different points, students with ADHD and EBD can have trouble completing all of the components. For example, students may have difficulty following through on all aspects of a chemistry project involving reading a chapter and answering questions on density, completing a lab measuring objects and recording density figures, preparing graphs to display results, writing a report describing all aspects of the project, and then presenting orally to the class.

When required to work with lab partners and cooperative groups, students with EBD and ADHD that have social deficits (e.g., disruptive behavior and inability to get along with others or understand social situations) will have difficulty. Disruptive students often will also have difficulties with science lab assignments resulting in safety issues such as breaking equipment, not paying attention to lab rules, or spilling materials.

Modifications for students with learning problems

To help students with these characteristics and related behaviors in high school science classes, several teaching and learning strategies are beneficial. Collaboration among the science teacher, other content teachers, and the special education teacher is an excellent starting point. Expertise about science content provided by the science teacher and teaching modifications from the special education teacher offer a valuable combination for designing science instruction based on the individual needs of students.

It is not possible or reasonable for science teachers to have skills in individualizing instruction for all types of disabilities and needs; at the same time, it is not possible for special education teachers to be experts in all content subjects, especially at the secondary level. Therefore, teaming efforts help both teachers meet the challenge of successfully teaching students with learning problems in high school courses (Norman, Caseau, and Stefanich 1998).

Because high school students have different teachers throughout the day, all of whom may be using different forms of instruction appropriate for their subject area, collaboration is especially important. If high school teachers use similar strategies to enhance content instruction, students with learning problems will be able to practice and generalize those strategies across subjects and classes (Bulgren, Deshler, and Schumaker 1997).

One of these strategies that may improve motivation and achievement is to help students set goals for science class, such as improving their test grades using study strategies or editing lab reports more carefully for writing style and content. In discussing their research study on motivation in science, DeBacker and Nelson concluded that classes emphasizing goals and student monitoring

of progress toward those goals give students a feeling of control. The authors suggest that seeing science goals lead to other educational goals and accomplishments provides students motivation to achieve (2000). For example, if a particular study strategy helps students improve their grades on science tests, they may try the same approaches for other content subjects and see improvement there as well. These goals may also provide focus for students who have learning problems so that they can continue to strive for strong performance.

Consideration of different learning and teaching styles is another recommended strategy for effective science instruction of students with learning problems. Goodnough's case-study descriptions of high school science instruction suggest that science lessons can be "personalized" to help students succeed—teachers provide choices based on students' learning styles and differences to make instruction and evaluation more appropriate (2001). A variety of learning methods is more likely to make new material more meaningful and therefore attainable for students (Goodnough 2001). Vranesh suggests modifications such as writing a variety of reports, observing, discussing, participating in group activities (e.g., sharing data and ideas), creating websites, doing hands-on activities, and reflecting (2002). Varying instruction can make classes more interesting and meaningful for all learners.

Science teachers can use learning strategies to assist students in their study of science; in this way, teachers not only present science content, they teach students *how* to study science (Bulgren, Deshler, and Schumaker 1997). This approach is not only valuable for students

with learning problems, but for all students who need assistance reading, memorizing, and organizing difficult science content. For example, even at the high school level it is helpful to review the difficult and technical vocabulary at the beginning of new lessons and chapters. Going over textbook structure and organization helps students with processing difficulties make use of chapter questions, summaries, headings, glossaries, and other available textbook features (e.g., some textbooks offer supplemental material online, such as electronic flash cards for vocabulary review) (Salend 2005). Teachers can help students organize their notes by including a metacognition component where students reflect upon their reading and notes.

Mnemonics—picture cues, keywords, association clues, and acronyms—are among the memory devices that teachers can use to assist with recall of content (Bulgren, Deshler, and Schumaker 1997). For example, to memorize elements in the periodic table or the phases of the cell cycle, teachers or students can generate sentences with the first letter of each word representing the terms in sequence. Students learn to develop their own examples for subsequent assignments after watching teachers use them for specific content, and students could certainly apply the strategies to other subjects, as well.

FIGURE 1

Strategies for Teaching Science to High School Students with Learning Problems.

- Collaborate with other content and special education teachers to coordinate strategies and methods for success.
- Assist students in setting and monitoring appropriate science goals.
- Integrate varied methods and activities, such as visual demonstrations, PowerPoint, videos, and technology simulations into science lessons based on student learning styles.
- Model use of learning strategies such as verbal rehearsal and previewing key concepts in chapters to help students read, organize, and memorize science content.
- Review vocabulary prior to science lessons.
- Provide an overview of the science textbook's organizational features, such as charts, introductory sections, definitions, and summaries.
- Use mnemonics for content to be memorized.
- Use visual displays such as outlines, webs, and charts to introduce and highlight key ideas.
- Relate science content to overall themes and organizing concepts such as change, ecology, and equilibrium.

Science teachers can use visual displays such as flow charts, outlines, and graphic organizers to introduce and organize new and challenging information for the introductions and conclusions of lessons. Illustrations and animations, which can be downloaded from the internet, help clarify complex topics. Finally, relating science content to key issues and organizing concepts such as systems, environment, and technology can help students with learning problems focus and prevent frustration with an overwhelming number of details (Salend 2005).

Enhancing students' experiences

The strategies described in this article (summarized in Figure 1) are not complex; however, using modifications when appropriate enhances the experience of students with learning problems in the science classroom, and increases their chances of success. In addition, these ideas could assist students without learning problems who are struggling with complex science content in high school. Even students in honors and Advanced Placement courses are often deficient in the use of learning and study strategies. These techniques would make their work more efficient and effective, as well. ■

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