RESULTS

with

CHEMISTRY: CONCEPTS AND APPLICATIONS,
CHEMISTRY: MATTER AND CHANGE,
and
PHYSICS: PRINCIPLES AND PROBLEMS

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With the publication of the National Science Education Standards in 1996, educators throughout the United States have been inspired to raise the academic bar. It is more important than ever to ensure that our schools are reaching for the highest in science academic achievement so that all children will be prepared to explore current and future frontiers of science and technology.

Knowledge of chemistry and physics concepts is critical to the understanding of how the world functions. It is imperative that our high schools impart this knowledge as well as the skills necessary to critically evaluate evidence that is labeled "scientific." We need to look at high schools that are engaging their diverse student populations and producing results, and use those as models for the rest of the country.

This report describes 13 schools in seven districts that have been successful in teaching chemistry and physics concepts, as evidenced by student performance and attitude, feedback from students and parents, and responses from teachers. These results demonstrate the benefits of effective chemistry and physics curricula programs, as well as successful teaching practices.

The schools that use the chemistry and physics programs described here share several other critically important characteristics.

- All show improved student performance.
- All have created exciting climates within their schools to encourage learning.
- All monitor student progress during the school year to ensure effective instruction.
- All demonstrate the importance of maintaining high expectations for all students, not just the brightest or most privileged.

The leaders and teachers of the schools described herein are eager to share their results and to see their practices and experiences spread to many other schools. Please feel free to contact the people identified in each article. We've provided telephone numbers, fax numbers, addresses, and e-mail addresses whenever possible to make communication as easy as possible.

Let's learn from the example set by these schools. In doing this, we can help our children become the successful learners they need to be to face the challenges and promises of the 21st century.

Introduction

Results. More than at any time in recent history, attention is focused on the results our schools produce. With the *No Child Left Behind Act* of 2001, expectations have been raised and student performance standards have been identified. In turn, states have set target goals that students must meet if they are to make "Adequate Yearly Progress."

Science education is guided by the National Research Council's National Science Education Standards. The Standards describe a vision of the scientifically literate person and present criteria that will allow that vision to become reality for all students. Science teachers and administrators are called to challenge students to become inquisitive and active science learners.

To achieve the high goals set by the Standards, educators and others involved in science education reform need an array of state-of-the-art strategies and tools. Their toolbox must include the highest quality inquiry-based curricula—supporting the Science Standards and forming a flexible learning system that provides options to enable all students to reach high standards.

Chemistry: Concepts and Applications, ***Chemistry: Matter and Change***, and ***Physics: Principles and Problems***:

- **Fully support the National Science Education Standards for Content.** Each *Teacher Wraparound Edition* includes linkage charts to clearly show which Content Standards are met in each lesson.
- **Provide a balance of explicit and implicit teaching strategies.** Each combines the best research on "reform" curricula with proven "traditional" curricula, incorporating the active involvement of students to make sense of important scientific ideas.
- **Include opportunities for inquiry, scientific discussion and debate, and problem solving.** Each Student Edition includes a wide array of lab experiences and problem-solving exercises to support students as they build science skills.
- **Offer a variety of instructional methods for all ability levels.** Resources include Differentiated Instruction strategies in the *Teacher Wraparound Edition* to meet individual needs, supplements for intervention, and enrichment activities to challenge high-achieving students.
- **Offer a range of technology options to enhance skills, promote critical thinking, and connect the classroom to the world in which students live.** Multimedia resources include Exam*View*® Pro Testmaker CD-ROM, MindJogger Videoquizzes, Interactive Chalkboard CD-ROM, TeacherWorks™ CD-ROM, and links to Glencoe's Web site.

This report shares the stories of 13 schools in seven districts that have implemented one or more of the following programs: ***Chemistry: Concepts and Applications***, ***Chemistry: Matter and Change***, and/or ***Physics: Principles and Problems***. The common characteristic is results. All have implemented programs of instruction in science that have enabled them to raise the performance of their student populations. It is undoubtedly true that there is not one way for all children to learn, but it is essential that all children learn to meet the challenges of our ever-changing world.

I encourage you to explore how these programs can support excellence in standards-based scientific teaching and help our children be prepared for and productive in the 21st century.

Professor Frank E. Crawley
Department of Mathematics & Science Education
East Carolina University

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Brentwood High School

Brentwood School District, Brentwood, Missouri

Brentwood High School is located in the small city (2.5 square miles) of Brentwood, Missouri. Brentwood (pop. 7693) is just $9\frac{1}{2}$ miles west of St. Louis. Brentwood High School serves 254 students in grades 9 through 12. It is the only high school in the Brentwood School District. Because of its size, it offers the advantages of a private school at no additional expense to the Brentwood residents. The average class size at Brentwood is 12 to 15 students, which allows for a high degree of individualization of instruction to meet the needs of all learners. Brentwood High School emphasizes a strong college preparatory program, which includes honors and advanced coursework, and requires more credits for graduation than does the state of Missouri—28 units of credit instead of 22. Brentwood students also have the opportunity to earn college credits through the St. Louis University dual enrollment program, where they may earn up to 30 hours of college credit before graduation. As a result of this emphasis, Brentwood High School students' ACT scores are above the national average, and more than 90% of seniors are college bound with more than $580,000 in cumulative college scholarships.

Moving into the 21st Century

file photo

In the Fall of 2003, Brentwood High School adopted and implemented a new textbook for their 10th grade chemistry classes—***Chemistry: Matter and Change.*** Department Chair Rich Niemann shares, "We are a very small district, and the only high school. We teach chemistry in two semesters. The first semester all sophomores take Chemistry 1, and in the second semester Chemistry 2 is offered as an advanced course; not all students take it. Dr. Cranston (a fellow chemistry teacher) and I looked through about six or seven different books and their supplementary materials to choose a new chemistry textbook. We chose Glencoe's ***Chemistry: Matter and Change*** because it was written at a higher level than the text we had before, and it was a bit more challenging. The presentation of the material and the examples were clear, it provided a decent amount of math, and it included the answers to the problems in the back of the book. Overall, it was just a really attractive package and more complete than what we have used in the past. I think it will be a positive change."

Dr. Cranston adds, "Our last chemistry textbook was from the 60s or 70s. Though many of the packages we looked at out there for chemistry were similar, what stuck out about Glencoe's were the activities and the Mini Labs. The Mini Labs, for example, don't require a lot of advance preparation, and kids can read them, do them, discuss them, do a quick preliminary write-up and you can still have time left over in the period.

Expect more. Achieve more.

Also, there is almost an unlimited number of additional problems for students to use for practice. I think what you can do with ***Chemistry: Matter and Change*** is just unlimited."

Teaching with *Chemistry: Matter and Change*

Chemistry teachers at Brentwood High School are finding ***Chemistry: Matter and Change*** easy to use. Mr. Niemann finds that the layout of the book makes using it particularly easy. "The textbook is laid out and organized very well, with pretty colors and photographs. It also has good supplementary materials that go with it and a lot of mathematical background. It makes it easy to further explain things to students. For instance, I use the Example Problems worked out in the yellow highlighted boxes quite often with my students. Also, the way the text uses different colors, fonts, and sizes to highlight titles and vocabulary helps my students navigate the text." Dr. Cranston agrees, "The text is very user-friendly, attractive, and presented in a very interesting format, using different font sizes and colors, which is nice. I especially like that most of the reading assignments are less than five pages, and that each chapter is divided into sections with their own assessment questions. Our school encourages us to do multiple student assessments, and ***Chemistry: Matter and Change*** allows us to do just that. The assessment opportunities are almost limitless."

Both teachers offered advice for others using ***Chemistry: Matter and Change.*** Mr. Niemann suggests, "Make sure that your students know how the book is set up and what resources it offers them, probably in the first five classes. This will benefit them in the long run."
Dr. Cranston adds advice on using the *Teacher Wraparound Edition*. "At the beginning of each chapter, there is a Resource Manager, which is very helpful. It explains the learning objectives, lists the activities, tells which National Science Standards are met, and what reproducible materials and transparencies are available for you to use." On the program itself, he comments, "I'd tell others to use the activities in each chapter—the Discovery Labs, the Problem-Solving Labs, the ChemLabs, and the Careers Using Chemistry. Personally, I want to start using the Careers Using Chemistry more and have my students write reports on different careers that use chemistry so they can see how these skills are used in the world. The book has a wide range of applications, and there may be too much stuff to use, but that's good because you can pick and choose based on the needs of your students."

Assessing Student Performance

Although Missouri does not have a state proficiency test for chemistry, Brentwood staff believe they will achieve positive results with ***Chemistry: Matter and Change.*** On the 2003 American College Testing (ACT) Exam, Brentwood students scored above the national and state averages for Science Reasoning, and they expect to maintain that level of excellence in the future.

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Cobb County School District

Sprayberry & Wheeler High Schools, Marietta, Georgia

Cobb County (pop. 616,000) is located just across the Chattahoochee River from Atlanta, Georgia. It is the third largest county in Georgia in population and covers more than 340 square miles. Cobb County School District is the second largest school system in Georgia and among the 30 largest in the United States. It has 64 elementary schools, 21 middle schools, and 15 high schools, and a student population of more than 100,000 that grows by about 2500 each year. Its student body is 58% Caucasian, 26% African-American, 9% Hispanic/Latino, 4% Asian/Pacific Islander, and 3% multiracial.

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The mission of the Cobb County School District is to guarantee a quality educational program for all students in a challenging, secure environment, where students will become critical thinkers who are knowledgeable, skillful and responsible, and who can succeed as lifelong learners in a richly diverse society. The Southern Association of Colleges and Schools has accredited all Cobb County schools. Fifteen schools have earned National Blue Ribbon awards, and 33 have been named Georgia Schools of Excellence.

Sprayberry High School and Wheeler High School both are located in northeast Cobb County, in the city of Marietta, a suburb of Atlanta. Sprayberry High School has been a State and National School of Excellence since 1994, was rated one of America's best schools by *Redbook* magazine in 2001–2002, and also was honored by *Business Week* magazine for Best Technology Innovation in the 1999–2000 school year. Sprayberry serves over 2000 students. In 2003, 29 Sprayberry students were named AP Scholars by the College Board in recognition of their exceptional achievement on the college level AP Examinations. Only 13% of more than 700,000 students who took the AP Examinations performed at a sufficiently high level to merit such recognition. Over 85% of Sprayberry graduates go on to college.

Wheeler High School serves approximately 1850 students. A unique characteristic of Wheeler High School is that it is home to the Wheeler Center for Advanced Studies, which opened in fall of 2000. The center is a magnet program that offers students a rigorous four-year advanced science, math, and technology program with a focus on either biotechnology or pre-engineering. About 81% of graduates of the Center for Advanced Studies go on to college.

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A Solid Foundation

Glencoe's ***Chemistry: Matter and Change*** is the chemistry program of choice at Cobb County Schools. At Sprayberry High School about 250 students in grades 10–12, but mostly 11th graders, use ***Chemistry: Matter and Change.*** Sprayberry chemistry teacher David Schertz shares, "I came out of the industry three years ago and went into teaching, so I have been using ***Chemistry: Matter and Change*** personally for two years. The year we were up for adoption, I voted to keep Glencoe's ***Chemistry: Matter and Change.*** I saw a preview of the textbook and materials and they looked better than the textbook we were using. I like the textbook because it is accessible to high school students. It pays attention to the important concepts and gets you there quickly. I also like that the lab activities really connect to the concepts being discussed."

Supporting Teachers

Mr. Schertz and Tiffany Stark (chemistry teachers at Wheeler High School), both find that ***Chemistry: Matter and Change*** supports the teacher, and they find it easy to use. Ms. Stark shares, "***Chemistry: Matter and Change*** is very easy to use. It is a well-organized textbook that clearly presents the basic concepts of chemistry. As a new teacher, the Resource Manager at the beginning of each chapter helps with pacing and lesson plans. Also, the practice problems and figures throughout the text help to reinforce concepts, allowing students to better understand the material."

Mr. Schertz believes ***Chemistry: Matter and Change*** saves him valuable prep time. "The book has so many things for us to use that it has made it easier on us. Over the last two years, we have done a good job of trashing our old homemade worksheets and activities. Most everything has been working well for us with this text, even the vocabulary. ***Chemistry: Matter and Change*** highlights the ideas and words that we think are important, which saves us a lot of time. One feature we really like is the Discovery Lab on the first page of each chapter. They take anywhere from 5 to 15 minutes to do, and you don't need sophisticated materials to do them. They are good teasers to get the students interested in the topic we are about to discuss."

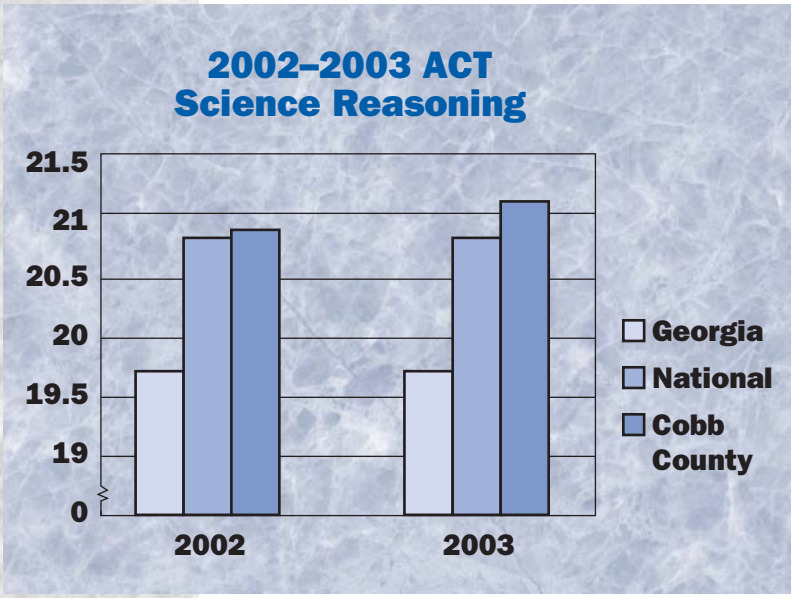
Though teachers at Cobb County are finding ***Chemistry: Matter and Change*** easy to use, the district has facilitated in-service trainings led by their Glencoe representative to familiarize the teachers with the labs and technology pieces included. Mr. Schertz shares his experience at an in-service: "We did a lot of hands-on activities, like walking through the experiments. The training really helped us to jump in and start using the labs and to understand why the book is put together the way it is, and why certain strategies are utilized. The training definitely helped us save some time in planning."

Engaging Students

According to Mr. Schertz, "***Chemistry: Matter and Change*** encourages students to get up and do chemistry, rather than just read about it." He says, "With this text, they do a lot of inquiry and hands-on activities, along with good science questions and practice, which is a good combination. All the universities and experts about instruction want us to be doing inquiry learning, and that is what this textbook stresses. ***Chemistry: Matter and Change*** has a variety of labs, and the students enjoy them a lot. By the end of the year, students are talking about the cool things they got to learn and that they got to 'play around' in this class, but they are not really 'playing around,' they are learning. I notice at the end of the year that my students are questioning a lot better, writing a lot better, and explaining their answers a lot better. So, I encourage others to take advantage of the labs and inquiry-learning opportunities, because they do a great job of explaining concepts that sometimes are hard to explain."

Seeing Results

The results Cobb County has been seeing have encouraged the schools to keep ***Chemistry: Matter and Change*** as the textbook program of choice. Mr. Schertz comments, "***Chemistry: Matter and Change*** prepares our students quite well for sciences they will take after, such as physics. The book is accessible to them, but it also challenges them. I think they can go on to any science class after using this text, because it just teaches good science." Ms. Stark agrees, "I think ***Chemistry: Matter and Change*** does a good job of preparing students for the classes they will take after. It does a good job of organizing the major concepts, so I think they are well prepared to move on to other sciences."



In Georgia, students are required to pass the Georgia High School Graduation Test (GHSGT) to graduate from high school. The GHSGT is taken in 11th grade, and it includes a section on science. In 2000–2001, 79% of Cobb County students passed the science section of the test, compared to 71% of their state counterparts. In 2001–2002, 84% of students passed the science section of the test, compared to 75% of their state counterparts. Cobb County teachers are expecting their students to excel on this year's GHSGT as well. Cobb County students also are performing well on the American College Testing (ACT) exam. In 2002 and 2003, Cobb County students scored above the national and state averages for Science Reasoning, as shown in the graph on this page.

In addition to scoring well on achievement tests, Cobb County science students have found success putting their classroom knowledge to work. In 2004, Cobb County School District had three high schools compete in the FIRST Regional Robotics competition, a team event where teams get six weeks to build robots to accomplish specific tasks. Wheeler High School was one of the participants, and not only did they win first place, but they also won the Chairman's Award at the Peachtree Regionals, the highest award given at the competition, and placed 19th in their division at the International Championships. Also, Wheeler's Chemistry Team placed 1st in the American Society of Chemists, Chemistry Division II competition.

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Gwinnett County Public Schools

Berkmar, Brookwood, Dacula, & Shiloh High Schools, Lawrenceville, Georgia

Gwinnett County Public Schools, located in the northeast metropolitan-Atlanta area, is the largest school system in Georgia and continues to grow, adding approximately 6000 new students each year. Gwinnett County Public Schools currently serves 128,856 students in 94 facilities, including 59 elementary schools, 16 middle schools, 15 high schools, and four alternative/vocational centers. The student body is currently 50.6% Caucasian, 21% African-American, 15.7% Hispanic/Latino, 9.7% Asian/Pacific Islander, and 3% of other races/ethnicities.

Gwinnett County Public Schools' mission is to pursue excellence in academic knowledge, skills, and behavior for each student, resulting in measured improvement against local, national, and world-class standards. The district maintains a rigorous Academic Knowledge and Skills (AKS) curriculum that is supported by high-quality instructional materials, ongoing assessments, and technology resources that meet the needs of all learners.

Jose L. Pelaez/CORBIS

Implementing Change

Gwinnett County Public Schools began an adoption process in the 2002–2003 school year to pilot and choose new curricula for all high school chemistry classes. Vicki Drake, chemistry teacher at Berkmar High School, recalls the process. "We were looking for a chemistry program that would meet our district's curriculum standards," Ms. Drake explains. "In reviewing the possibilities, we looked at readability, technology, the accuracy of the material, the quality of the supplemental materials, and how well the program met our AKS standards." The review narrowed down the possibilities to two publishers, and representatives from each of Gwinnett County's high schools were asked to pilot test the finalists for one semester. Ms. Drake says, "We evaluated each text to see how well it met the standards and how well it was received by the students." In the end, the district adopted ***Chemistry: Concepts and Applications*** for all of its 10th grade Tech Prep-level classes and ***Chemistry: Matter and Change*** for 10th grade College Prep, Honors, and Gifted classes. (See inset on page 9 for a description of Gwinnett County's use of ***Chemistry: Concepts and Applications***.) The high schools have been using these chemistry programs since the beginning of the 2003–2004 school year.

After adoption, the district was careful to provide adequate training for all of its teachers prior to implementation. Nyree Matos, a chemistry teacher at Berkmar High School, comments: "The program itself is very easy to implement, but you don't know just how many resources there are until you see them all."

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Practice Makes Perfect

One feature of ***Chemistry: Matter and Change*** that Gwinnett County's teachers have been extremely satisfied with is the program's focus on practice of important scientific skills and concepts. Jamie Basso, an honors chemistry teacher at Shiloh High School, explains, "***Chemistry: Matter and Change*** makes sure the kids are getting a lot of practice with the concepts. I think the students are getting a better overall understanding of chemistry, because the curriculum is spiraled and continues to review and build upon what they've already learned. I have my students complete review and assessment questions and that prepares them well for chapter tests. The questions also delve deep enough that they have to go past a superficial level and expand their knowledge."

Vicki Dobbs, chemistry teacher at Dacula High School, adds, "This text is so much more user-friendly than our previous book, and Glencoe gives a lot of support for the kids. It's written for their level, and the problems match the examples well. There's also a lot of lab time, where they get hands-on practice, so their lab skills are better."

Integrating Science and Mathematics

Another feature of ***Chemistry: Matter and Change*** that is working well for Gwinnett County Public Schools is its integration of mathematical concepts and problems. Ms. Basso says, "The best thing about ***Chemistry: Matter and Change*** for me is that, while it's easy enough for the kids to read, it still includes the depth of math concepts that we need. Our last text did not prepare students well enough for college-level classes, but this does. There are worksheets with math problems and a math handbook appendix that explains scientific notation and other concepts." Ms. Drake agrees: "I used to teach physics, and the students weren't prepared in terms of the math involved. I think now, with Glencoe, they will be better prepared for the math in physics classes."

High Expectations

The State of Georgia requires a statewide test, the Georgia High School Graduation Test (GHSGT), for high school graduation. The GHSGT includes sections on language arts, writing, math, social studies, and science, and is taken in 11th grade. In the 2002–2003 school year, the district's average on the science section was 83% passing, compared to a statewide average of 72%. In 2003–2004, the district maintained its average of 83%, while the state average decreased to 71%. As Ms. Drake explains, "***Chemistry: Matter and Change*** is a challenging program, and that is a good thing. It encourages critical thinking, which is what standardized tests are all about now."

Ms. Basso summarizes: "I think ***Chemistry: Matter and Change*** is a very well-rounded program that spirals learning, so that students start with a solid foundation and go on to deeper concepts. I certainly would recommend to other school systems that they give it a try." Pat Saulson, chemistry teacher at Brookwood High School, adds: "***Chemistry: Matter and Change*** does a very good job of incorporating the essence of what we need to teach kids in chemistry. I've been teaching chemistry for 31 years, and this is one of the best school years that I've ever had."

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Chemistry: Concepts and Applications at Gwinnett County Public Schools

In addition to adopting ***Chemistry: Matter and Change,*** Gwinnett County Public Schools also adopted ***Chemistry: Concepts and Applications*** for all Technical Preparation classes, beginning with the 2003–2004 school year. Leanne Foxworth, chemistry teacher at Brookwood High School, recalls the pilot testing of possible texts. "I personally piloted two options—Glencoe's ***Chemistry: Concepts and Applications*** and one other. The Glencoe program is much more straightforward and user-friendly for the students. That was a big part of my decision—whether or not students liked the book. The last book was too difficult and didn't have enough supplementary materials. We also had to make sure the program covered our Academic Knowledge and Skills (AKS) objectives." Jere Parker, a chemistry teacher at Dacula High School, agrees with Ms. Foxworth: "***Chemistry: Concepts and Applications*** is so much better than our previous text because of the simple fact of how well it meets the AKS goals we need to cover. This book covers every one of our guidelines, where the previous text only covered half. We also were impressed with the number and quality of materials that accompany the text. There are so many different materials and ways to approach learning."

Mr. Parker and Ms. Foxworth both feel that the decision to choose ***Chemistry: Concepts and Applications*** is paying off, both for students and for teachers. Ms. Foxworth explains, "As a teacher, I like this textbook. It's traditional in terms of the chemistry concepts that are covered, but it also has the latest developments in the field with current examples. So, it's complete and has a good balance." Mr. Parker also feels that ***Chemistry: Concepts and Applications*** is providing their students with solid skills in scientific concepts. "This book is 1000 times better than what we used before," he says. "Before, we would have to go outside the book and supplement it, but this text has everything included. It has much more of the mathematics that will prepare the students for physics. The Mini Labs and Study Guides are great, too; they prepare students for tests and link into building vocabulary, tools, and concepts. I have some students who failed with the previous text and are repeating the class. They're doing much better this year, and I don't think it's because it's their second time through the class. It's because of ***Chemistry: Concepts and Applications.***"

Ms. Foxworth and Mr. Parker have found that ***Chemistry: Concepts and Applications*** is working for all their students. As Ms. Foxworth explains, "I have a lot of Special Education students that I'm trying to reach. They can follow the text easily; I think the headings make it easier for them to find what they need. They love the visuals and figures and tables, and visual learners need to analyze graphs and things in order to understand the concepts. I think the labs, especially the Mini Labs, are the best. They are unique, easy, short, and adaptable. The labs aren't 'cookbook' style; they are written in a more inquiry-type style that the students can get into." Mr. Parker adds, "I appreciate that there is a wide range of assessment materials. There are simple questions that test if the material was learned, in matching or multiple-choice questions. There are also much deeper questions that require critical thinking, and I often use those for extra credit for students that want to go further." Ms. Foxworth sums up her opinion of ***Chemistry: Concepts and Applications:*** "This book has lots of great ideas and fresh ideas, even for veteran teachers. Everything that I look for in a textbook is there. I've been teaching 20 years, and I thought I'd seen it all, but this is really a fresh approach."

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Montwood High School

Socorro Independent School District, El Paso, Texas

Montwood High School is located in El Paso, Texas. El Paso (pop. 563,662) is located on the border of two nations in the Rio Grande Valley at the southern tip of the Rocky Mountains. El Paso, and its sister city, Ciudad Juarez, (located in the Mexican state of Chihuahua) comprise the largest metropolitan area on the border between the United States and Mexico. In fact, the downtown areas of these two cities are within walking distance of each other.

Montwood High School is part of Socorro Independent School District, one of the fastest growing school districts in the state of Texas. The district educates more than 30,000 students a year through 21 elementary schools, seven middle schools, four high schools, one early childhood center, one alternative school, and a community education program. Eighty-two percent of the district's graduates are college bound. Montwood High serves over 2500 of the district's students in grades 9 through 12.

Getty Images

Finding the "Right" Text

In 2002, Montwood High School was looking for a new chemistry textbook for its nearly 700 students in 11th and 12th grade. Vicki Sanftner, Department Chair, explains, "It was a book adoption, so we scheduled meetings with all the publishers. Our Glencoe representative, who is very dynamic, was there right away with a complete set of materials for us to review. That impressed us immediately." Chemistry teacher Ken Weese agrees, "The presentation and the customer service provided by our Glencoe representative were just great!"

Montwood not only was impressed with their customer service, they also were impressed with ***Chemistry: Matter and Change.*** Ms. Sanftner comments, "I liked very much the content of the book and all the ancillary materials. The content was presented in such a way that it was easy to use. It just flowed really well, and provided good examples, good labs, and plenty of problems for practice. It also provided a lot of tools for me to use to teach and expand on in the classroom. Our old book was not informative enough. It also didn't have enough actual problems, and it was what I would call 'chatty.' It didn't get to the point, and a lot of chattiness does not work with our students, because many of them have problems reading." Mr. Casao adds, "***Chemistry: Matter and Change*** is better organized than our last text, and easier for students to read and understand. The illustrations are particularly helpful for students, and the problems are easier to understand.

Expect more. Achieve more.

With our last textbook, even some of the teachers were wondering what the textbook really wanted. We also really liked that ***Chemistry: Matter and Change*** came with a big package of supplementary materials that were pretty teacher friendly." Mr. Weese says, "I think ***Chemistry: Matter and Change*** was the best overall package that we saw. It was more usable and friendlier for teachers and students. My students can read it on their own and understand it, which is a plus."

Chemistry: Matter and Change was unanimously selected for adoption by the high schools in Socorro Independent School District. Montwood High School started using it with their students in the 2002–2003 school year. Ms. Sanftner adds, "I think a lot of our decision was because we knew our Glencoe representative would support our teachers. We knew she would always be around. Having a publisher who responds to your needs was very high on our list of concerns."

Positive Teaching Experiences

Ms. Sanftner shares her personal experiences using the program: "***Chemistry: Matter and Change*** is really easy to use. I use the quick demonstrations and labs, and my students just love them. The visuals in the textbook and on the transparencies are very informative and give the students an idea of what the text is talking about, but they don't overwhelm them. ***Chemistry: Matter and Change*** is an excellent textbook that is clear and concise, and students understand it."

Fellow chemistry teachers also report positive teaching experiences using ***Chemistry: Matter and Change.*** Mr. Casao shares, "***Chemistry: Matter and Change*** is easier to use because it is more cohesive. It provides the supplementary materials that we need for our students with special needs which is a big plus. This program also provides very good opportunities for kids to do inquiry learning with the various labs and activities included. I especially like the lab manuals. They keep students engaged with hands-on learning, so they can make real connections." One feature of ***Chemistry: Matter and Change*** that works really well for Mr. Casao is the focus on math. "The many problems and problem-solving hints work really well for my students. We are able to go through a problem and see where things come from. It removes a lot of the mystery of chemistry. I like that this program keeps the math in, because if kids are continuing on to college, they need the math, and I have found it very helpful."

Preparing for the Future

Teachers at Montwood believe that ***Chemistry: Matter and Change*** is preparing their students well for the future. Ms. Sanftner comments, "***Chemistry: Matter and Change*** does a good job of preparing our students for advanced chemistry courses, and I think that if they go into physics, they will also have a good background, because it does a good job of strengthening their math skills, which is important for physics." Mr. Casao adds, "I think since using ***Chemistry: Matter and Change*** my students' mathematical skills have improved, which is essential. These improved math skills will help them in upper-level science classes, and even in college. Before, we had several students dropping out of chemistry each semester because their math skills were not adequate, but now their skills are improved. I think this is a result of the numerous opportunities ***Chemistry: Matter and Change*** provides for practice, and that the examples they provide are ones that kids can relate to."

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Orange County Public Schools

Cypress Creek & University High Schools, Orlando, Florida

Orange County Public School District serves Orange County, Florida, which encompasses the metropolitan area of Orlando in the central part of the state. The Orange County public school system is the 14th largest district out of the 16,000 districts in the United States. Orange County Public Schools' 166,818 students represent the vast diversity of Florida. The student body is 40.6% Caucasian, 28.4% African-American, 25.8% Hispanic/Latino, 3.8% Asian/Pacific Islander, 1.2% multiracial, and 0.4% Native American/Alaskan Native. Orange County currently serves its students with 151 elementary, middle, high, and alternative/exceptional education schools, as well as 19 workforce education technical centers and community schools.

Bob Daemmrich/Stock Boston

A History of Excellence

Orange County Public Schools take pride in a long history of excellence and a highly qualified teaching staff. Over 35% of the district's teachers hold advanced degrees and many have won prestigious awards. Mike McKee, Science Department Chair at Cypress Creek High School, and Jane Nelson, Science Department Chair at University High School, are no exception. Mr. McKee is a 2003 Radio Shack National Teacher Awardee, and Ms. Nelson has been honored with the Presidential Award for Excellence in Science Teaching, the Disney American Teacher Award, and was inducted into the National Teachers' Hall of Fame in 2000.

Supporting Students

Physics: Principles and Problems currently is being used with approximately 250 physics students at Cypress Creek and about 125 students at University High School. Part of the appeal of the physics program at Cypress Creek and University High Schools is the ***Physics: Principles and Problems*** program. As Mr. McKee states, "There aren't many physics textbooks out there that fit the niche that Glencoe's does. Some books are too basic, and some are too advanced. ***Physics: Principles and Problems*** has enough math, so that it has some 'meat' to it, without being too hard."

Ms. Nelson adds, "***Physics: Principles and Problems*** has the right amount of information and lots of examples, without being overwhelming. There are multiple labs, lots of hands-on activities, and applications to everyday life. If you do the activities and the labs, you're going to reach every student at some point in the discussion."

Expect more.
Achieve more.

Lela VanLoon, another physics teacher at Cypress Creek High School, agrees with her colleagues: "I think ***Physics: Principles and Problems*** is very student-friendly. It has a lot of visuals and diagrams so students can understand what they are reading. ***Physics: Principles and Problems*** is a powerful tool for a student-centered class in which the students learn by doing. The program provides students with an excellent resource from which to base their hypotheses and, more importantly, their conclusions."

Supporting Teachers

In addition to supporting students, Mr. McKee, Ms. Nelson, and Ms. VanLoon have found that ***Physics: Principles and Problems*** provides the resources that they need as teachers. As Mr. McKee says, "The resource materials that come with ***Physics: Principles and Problems*** are really good. The enrichment activities are great, and the labs are good, too. My philosophy is that a textbook shouldn't dictate the entire program. This textbook is flexible and allows you to pick and choose what you'd like to use, or change the order of topics. For example, I use a lot of the Mini Labs, but sometimes I'll expand them into longer labs, because they can get to the heart of misconceptions."

Ms. Nelson adds, "I find the supplemental materials very helpful. I also use a lot of the Inquiry Labs. It's a very user-friendly program."

Looking to the Future

Florida uses the Florida Comprehensive Assessment Test (FCAT), as a statewide exit exam required for high school graduation. As of the 2003–2004 school year, the FCAT now includes a science section. Mr. McKee, Ms. Nelson, and Ms. VanLoon feel that ***Physics: Principles and Problems*** will help prepare their students for passing the FCAT. Mr. McKee explains: "The FCAT aligns with the Standards, and the book is aligned with the Standards, too. The FCAT makes the assumption that the kids are doing lots of labs. If the kids are not doing labs, they will not do well on the test. I think ***Physics: Principles and Problems*** is helping to prepare the students for the FCAT by offering so many lab activities."

Ms. VanLoon administers the Force Concept Inventory (a multiple-choice test designed to assess student understanding of basic concepts in Newtonian physics) to her students each year and is pleased with the results. Ms. VanLoon says, "During the 2002–2003 school year, my students scored about 23% on the FCI (Force Concept Inventory) pre-test and 54% on the post-test. That's much higher than the national average of 47% on the post-test. I expect that the post-test scores at the end of this year will show even more improvement."

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Richardson Independent School District

Lake Highlands & Richardson High Schools, Richardson, Texas

Richardson Independent School District is a large school district located in northern Dallas County, Texas, covering a total of 38.5 square miles. Sixty percent of the district is located in the city of Dallas, 35% is in Richardson and 5% is in Garland. Through four high schools, nine junior high schools, one freshman center, 40 elementary schools, and one alternative-learning center, Richardson Independent School District serves almost 35,000 students annually. The student body reflects the rich diversity of the Dallas area. The students are 42.4% Caucasian, 24.3% African-American, 24% Hispanic/Latino, 8.9% Asian/Pacific Islander, and 0.4% Native American. Students represent 93 countries and 86 languages.

Richardson Independent School District has a long history of excellence, including being named a "Best Practice District" in 2001–2002 by the National Center for Educational Accountability. One of the district's four high schools, Lake Highlands High School, was honored as a 2002 National Blue Ribbon School and was named one of the top high schools in the United States by *Newsweek* magazine. An impressive 90% of Richardson Independent School District's students attend college upon graduation, and over $15 million was offered in scholarships to their 2003 graduates.

Making a Change

Rebecca Mitchell, a chemistry teacher at Lake Highlands High School, remembers their district's 2000–2001 adoption cycle for new chemistry textbooks. "We needed a more user-friendly text with the right amount of math for our students, and we found it in ***Chemistry: Concepts and Applications.*** The AP and Pre-AP teachers decided on ***Chemistry: Matter and Change.***" Molly Dixon, who teaches both regular-level and Pre-AP chemistry at Lake Highlands, comments: "The way they are written, both ***Chemistry: Concepts and Applications*** and ***Chemistry: Matter and Change*** are easy for our students to read. We like how they make concepts clear."

Lake Highlands High School adopted both chemistry programs in the 2001–2002 school year, and Richardson High School followed in the 2002–2003 school year. At Lake Highlands, approximately 240 students are taught with ***Chemistry: Matter and Change*** in 10th and 11th grades, and approximately 250 students are taught with ***Chemistry: Concepts and Applications*** in 10th, 11th, or 12th grades. At Richardson High School, there are approximately 140 students using ***Chemistry: Matter and Change*** and 300 students using ***Chemistry: Concepts and Applications*** in 10th–12th grades.

Expect more. Achieve more.

Making Science Accessible

Ms. Mitchell appreciates how ***Chemistry: Concepts and Applications*** has made scientific concepts more accessible to her students. She states, "My students are engaged with ***Chemistry: Concepts and Applications.*** I've even had parents comment that they are surprised by how much their son or daughter likes their chemistry class, and that's got to be partly a reflection on the book. Students will thumb through the book when they don't have to, get caught on an interesting page, and actually read. They didn't do that with our last textbook!"

Erica Price, a chemistry teacher at Richardson High School, agrees. "The students understand the diagrams, and the text is written simply so that they can understand the concepts. ***Chemistry: Matter and Change*** includes more mathematical concepts and math problems, but everything is explained clearly. The book shows a breakdown of how to do the problems, and that really works for the students. I see my students using their textbooks now much more than with our previous text, and their skills have improved because of that. They're not afraid to pick up the textbooks and use them as reference tools."

In addition to making scientific concepts accessible to students, Ms. Mitchell, Ms. Price, and Ms. Dixon also feel that ***Chemistry: Concepts and Applications*** and ***Chemistry: Matter and Change*** make concepts relevant to students' lives and the world outside the classroom. As Ms. Mitchell explains, "One of the things that I immediately liked about ***Chemistry: Concepts and Applications*** is all the practical connections. It points out how chemistry is tied to biology and other areas of science, but also to history and career possibilities and so on. Showing how concepts are interconnected really gets the students' attention. I've even had a few kids who have said 'I'm going to go into chemistry' or 'maybe I'll be a chemist or a pharmacist,' and I think that's great."

A Solid Foundation

With students engaged in their chemistry classes, Ms. Mitchell, Ms. Price, and Ms. Dixon feel that both programs are giving their students a solid foundation in science. Texas is implementing the Texas Assessment of Knowledge and Skills (TAKS) examination in several subject areas, including science, as a graduation requirement. As Ms. Price comments, "Both ***Chemistry: Concepts and Applications*** and ***Chemistry: Matter and Change*** correlate perfectly with our state science standards, so we can make sure we are covering everything the kids need to know for the TAKS Exam."

The state average ACT score in 2003 was 20.5. Lake Highlands scored an average of 22.4 and Richardson a 21.0. If both schools' recent scores on the American College Testing (ACT) Exam are any indication, they have reason to be confident about the new TAKS science section.

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San Jacinto High School

San Jacinto Unified School District, San Jacinto, California

The community of San Jacinto is located in Southern California's rapidly growing Inland Empire. San Jacinto is located 84 miles east of Los Angeles and 90 miles north of San Diego.

San Jacinto students are served by San Jacinto Unified School District. The district services approximately 7029 students in four primary (K–4), one intermediate (5–6), one middle (7–8), and two 9–12 high schools. The student body is 47% Hispanic/Latino, 43% Caucasian, 4% Native American, 2% African-American, 2% Filipino, and 1% Asian. With the exception of the high schools, which operate on a traditional schedule, all other schools follow multitrack, year-round calendars. Due to increased enrollment in recent years, the district is in the process of building three new elementary schools, and expanding the San Jacinto High School. Two elementary schools are scheduled to open in July 2004, and the high school expansion project is expected to be complete for September 2004.

San Jacinto Unified School District has a three-part goal: "to continually improve student attendance, achievement, and access to more diverse and challenging learning." As a result, San Jacinto High School students have the opportunity to pursue higher education through coursework at the University of California at Riverside during the summer, and to spend part of each academic day in classes at Mt. San Jacinto College. Also, a new program, laboratory science, introduces physics and chemistry starting in the freshman year.

Meeting Student Needs

About four years ago at San Jacinto High School, students were experiencing difficulties with the math skills required for chemistry. Upon reviewing ***Chemistry: Concepts and Applications,*** the teachers realized it was easy to read, provided good examples, and had lots of supplementary materials. San Jacinto High School ran a pilot test of ***Chemistry: Concepts and Applications*** in one class for one year, and then the next year they implemented it schoolwide. In the 2003–2004 school year, approximately 150 students in 10th through 12th grade were using ***Chemistry: Concepts and Applications.***

San Jacinto also uses ***Physics: Principles and Problems*** in its 12th grade physics class. Physics teacher Harry Ebeling comments, "We have been using ***Physics: Principles and Problems*** for some time—at least for the eight years that I have been here—and it serves our students well. Glencoe's physics program is excellent for our students, and gives them a good foundation to go into college physics. It does a better job of transitioning into college courses than other programs I have seen."

Expect more. Achieve more.

Supporting Teachers

Chemistry: Concepts and Applications and ***Physics: Principles and Problems*** not only meet the needs of San Jacinto students, but its teachers as well. As Mr. Ebeling explains, "I like the way the books are laid out, and the fact that there are a lot of support materials—a lot of places to get information, not just from the textbook. ***Physics: Principles and Problems*** is particularly easy to use. I think that you can pick and choose and pull from the program what you need, and not have to worry about diminishing the education at all. The program seems to have a lot of support for teachers."

Mr. Ebeling also finds that ***Physics: Principles and Problems*** supports inquiry learning. "This program is science-based, so obviously there are a lot of labs that go hand-in-hand with what we are teaching. The labs in this book are very good for the discovery process, and they let you see that there are more uses for physics."

Measuring Success

In California, student achievement is measured by the California Standardized Testing and Reporting, otherwise known as STAR. STAR includes the California Standards Test (CST), California Alternative Performance Assessment (CAPA), California Achievement Test (CAT/6), and Spanish Assessment of Basic Education (SABE/2). The CST tests students on course-specific standards. Chemistry and physics are both courses with course-specific standards tested by the CST. In 2002, San Jacinto students scored well on the CST. The percentage of 10th grade chemistry students scoring Basic to Advanced was 83%; whereas fellow students in the county scored 64% and fellow state students scored 80%. For physics, San Jacinto students also outscored their counterparts with 91% scoring Basic to Advanced, compared to 75% in the county, and 83% in the state.

Success is measured in many ways. Mr. Ebeling shares, "I had a student who is now at The Ohio State University and is part of their honors program in engineering. I think the book had something to do with that because it gives a good foundation and overview of the concepts that students need to know for college."

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Other Comments

Ease of Use and Flexibility

Glencoe's ***Physics: Principles and Problems*** is the best high school physics program on the market, especially for helping teachers to teach. It has just about everything you need for a full physics program. There are a lot of neat ideas on how to do simple, quick, hands-on explanations of concepts. The nice thing is that there are different levels of activities and you can pick and choose, especially in labs. You can go with something very cheap or something more high-tech. I'm very impressed with the variety of materials.

John Gray, Teacher
Atchison High School, Kansas

There are so many resources in ***Chemistry: Matter and Change*** and ***Physics: Principles and Problems*** for teachers to use. There are plenty of opportunities in both books to assess student learning. There's practice during each chapter, chapter tests, and plenty of supplemental materials for assessment. I would recommend these textbooks to any teacher for an introductory chemistry or physics course.

Stephanie Dieker, Teacher
Richland R-1 High School, Missouri

I think ***Chemistry: Matter and Change*** is easy to use because everything is laid out for you. It is easy to look at the chapters with the standards because it is outlined for you. It is also easier for the students to read. The CD-ROM with lesson plans makes planning simple because you don't need to carry the entire book around with you—you can just print off the CD-ROM. I also can print the transparencies from the CD. The test generator allows you to generate questions. The *Teacher Wraparound Edition* shows everything—what resources to use, how to reach different learners, etc. And the interactive CD that comes with it is pretty neat. ***Chemistry: Matter and Change*** is a great book. I would recommend it to other schools for use in either their general or honors chemistry classes.

Yvette Williams
Washington High School, Georgia

I find ***Chemistry: Matter and Change*** easy to use. It is pretty consistent throughout and the information is set up so it flows well for the students. I like the concept mapping, and I like to use the questions at the end because they are really aligned with what is in the chapters. I like the questions where they are actually doing some writing, since students are required to do more writing across the curriculum. I like where they have to work through a question and write out how they would solve it.

Teresa Massey
Open Campus High School, Georgia

I like the questions in ***Chemistry: Matter and Change,*** it offers a wide range of questions, with a good variety of applications. I go through and pick and choose the questions I want. I like the different levels, for more gifted students. I also like the cumulative review to bring back concepts from previous chapters.

Linda Correia
Evans High School, Georgia

Content/Skills-Building

I like ***Chemistry: Matter and Change*** and ***Physics: Principles and Problems*** because they give good explanations and offer plenty of opportunities for students to practice and apply what they've learned. I like that each chapter has corresponding labs to reinforce the concepts. There are a lot of open-ended questions and open-ended labs, so students need to think and analyze and go beyond what they are given to look at.

Stephanie Dieker, Teacher
Richland R-1 High School, Missouri

In ***Chemistry: Matter and Change,*** I really appreciate the real-world examples. I also like the review questions; they're excellent for test practice.

Hiral Shah, Teacher
Pflugerville High School, Texas

In ***Chemistry: Matter and Change,*** I like the CD-ROM textbooks. There are an adequate number of problems; they provide a comprehensive review for the students. It also has a good lab section, portfolio sections, and assessment package. It goes along with our curriculum and goes away from just pen-and-pencil tests—it has good skills assessment. I think the CD-ROM is a bonus, because a lot of kids check out a CD instead of a textbook.

Carl Pfaff
Tucker High School, Georgia

In ***Chemistry: Matter and Change*** I love the focus transparencies. I also like the forensic inserts; I have done a couple of those and the kids love them. I love the challenge problems, and we also use the CD-ROM, which is excellent for the students. It definitely provides appropriate tools and opportunities to assess student learning. At the bottom of the *Teacher Wraparound Edition,* I like the portfolio suggestions and I use them a lot. It is authentic assessment instead of just the test bank. ***Chemistry: Matter and Change*** is a dynamic resource and it has made my first year of chemistry teaching a good one.

Termerion McCrary
Booker T. Washington High School, Georgia

I like the way ***Chemistry: Matter and Change*** is set up for the students. It is so much easier with the colored and boldface headings and subtitle headings, and it points out things that are more important. The objectives and vocabulary are in each section. There is also a good summary at the end of every chapter where the study guide is located. I also like the standardized test practice.

The chemistry textbook we used before ***Chemistry: Matter and Change*** had the step-by-step process, but it was not in-depth, and the Discovery Labs and Mini Labs are much better than the labs in the other book. Also, ***Chemistry: Matter and Change*** makes connections to other sciences and has CD-ROMs for the students that come with the book. There are a lot more supplemental problems than in the other book and there are reference sites for going online. I also like that it has information about careers in chemistry, because kids are always asking, 'Why do I need to use this?' It also connects this class to other classes or other science classes, and if the students can relate to something else they learn it better.

Yvette Williams
Washington High School, Georgia

What we like about ***Chemistry: Matter and Change*** is the labs—they are something that the kids can relate to and this book brings in ways that kids can understand—why you would use this concept or lab in real life. For the students it is understandable and readable and the chemistry is not too difficult for the college-bound students. Some of the books we looked at were more college-like books and this book did not seem too overwhelming.

The other thing is that the book talks about careers for the students. That material really works for me because I have my students go further and they do a research assignment on that career. I also like the Mini Labs because we can do those pretty quickly; we teach for 100 minutes, so it gives you a chance to do a Mini Lab and something else.

Teresa Massey
Open Campus High School, Georgia

Chemistry: Matter and Change does a good job with assessment and [offers] different ways to approach concepts with questions, models, and pie charts. They aren't just referring back to the text—they have students actually do something with the information and interpret something new.

Linda Correia
Evans High School, Georgia

Student/Parent Response

My students really like ***Chemistry: Matter and Change***. They like doing lab activities to apply what they've learned. I have more students this year who enjoy chemistry than when we were with a different text last year.

Stephanie Dieker, Teacher
Richland R-1 High School, Missouri

I think Glencoe has the best high school physics book out ***(Physics: Principles and Problems)***. The kids love the book because of all the colors and the illustrations that are easy to understand. I think there's a better attitude now toward physics class than with our previous textbook, because of the visuals and the clear explanations. The students can read the book and understand it.

John Gray, Teacher
Atchison High School, Kansas

Most of the students who have gone on to college and come back feel that they were pretty well prepared for college by ***Chemistry: Matter and Change.*** When I look at it from the perspective of students taking college-level courses, I think this book does a good job. Part of the battle is that some students don't like chemistry, but when you can make it so that they really understand, they like it a lot better and I think this book does that—it makes chemistry interesting.

Glencoe's ***Chemistry: Matter and Change*** is a wonderful teaching tool in the classroom. I especially like how the text uses content and real-life experiences to help students learn. The text is user-friendly to the students as well as to parents helping with student learning.

Teresa Massey
Open Campus High School, Georgia

Appendix

Research Supporting Content and Instruction
A Selected Annotated Bibliography

The following descriptions of research provide a brief overview of findings in chemistry and physics education and science education in general. Each of these, along with additional research, has played a role in informing the development of ***Chemistry: Concepts and Applications***, ***Chemistry: Matter and Change***, and ***Physics: Principles and Problems.*** The authors for each program continue to update the materials as new studies are published and new research on instructional methods becomes available. The sum of the knowledge revealed by these studies continues to support and enhance the philosophy of this program.

American Association for the Advancement of Science (AAAS), Project 2061. (1993). *Benchmarks for Science Literacy.* Washington, DC: AAAS.

This document outlines the fundamentals of science literacy and provides a solid foundation upon which national and state science standards were based.

Armbruster, B. B. (1996). Considerate texts. In D. Lapp, J. Flood, & N. Farnan (Eds.). *Content area reading and learning: Instructional strategies.* Needham Heights, MA: Allyn & Bacon, 47–57.

Comprehension is improved when main ideas appear prominently in introductions, summaries, and headings, not buried within paragraphs.

Banks, J. A. (2001). *Cultural Diversity and Education: Foundations, Curriculum and Teaching.* Boston: Allyn and Bacon. (4th edition of *Multiethnic education: Theory and practice.*)

Effective strategies for teaching include using examples from many cultures, helping students understand implicit bias, and using a variety of teaching skills for diverse groups.

Barr, B. B. (1994). Research in Problem-Solving: Elementary School. In D. L. Gabel (Ed.), *Handbook of Research on Science Teaching and Learning*. New York: Macmillan, 237–247.

Problem solving is supported by student-generated questions related to discrepant events, guidance in asking productive questions, activities causing students to reflect on strategies they used, helping students evaluate their hypotheses, and social interaction related to the problem before the experiment.

Barton, M. L., & Jordan, D. L. (2001). *Teaching reading in science: A supplement to the Second Edition of Teaching Reading in the Content Areas Teacher's Manual.* Aurora, CO: Mid-continent Research for Education and Learning.

This resource describes some of the latest research on reading and learning science and provides tips for helping students to utilize textbooks more effectively.

Black, P., & William, D. (1998). Assessment and classroom learning. *Assessment in Education,* 5(1): 7–74.

There is no single, simple method for formative assessment; a variety of approaches are successful. An extensive research review indicates that formative assessments produce significant learning gains. Achievement gains associated with formative assessment appear to be greater than most other interventions. Student self-assessment increases understanding of science concepts and critical thinking ability.

Bransford, J. D., Brown, A. L, & Cocking, R., (Eds). (1999). *How People Learn: Brain, Mind, Experience, and School.* Washington, DC: National Academy Press.

Students need to understand major concepts, build a base of factual information, and know how to apply their knowledge. Class discussions help students develop language for expressing science concepts, making ideas explicit, and providing reasoned arguments. Effective problem solvers constantly monitor their understanding and adjust their strategies as they work.

Center for Science, Mathematics, and Engineering Education (CSMEE). (2000). *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning.* Washington, DC: National Academy Press.

Meta-analyses done in the 1980s on the inquiry-based curriculum projects of the 1960s and 1970s (e.g. BSCS), show that inquiry-based teaching produced positive results in cognitive achievement, process skills, and attitudes toward science. Additionally, students can do investigations prior to learning vocabulary. As they build explanations for their observations, the names (vocabulary) for the concepts become useful and meaningful. The words are symbols for their understanding.

Corno, L. (1994). Student volition and education: Outcomes, influences, and practices. In B. J. Zimmerman and D. H. Schunk, (Eds.). *Self-regulation of learning and performance.* Hillsdale, NJ: Erlbaum, 229–254.

Attractive, relevant-to-students presentations of key concepts motivate students to learn.

Dickson, S. V., Simmons, D. C., & Kameenui, E. J. (1995). *Text organization and its relation to reading comprehension: A synthesis of the research.* (Technical Report No. 17). Eugene, OR: National Center to Improve the Tools of Education, University of Oregon.

A synthesis of research finds that the following characteristics assist reading comprehension:

- Page layout that makes the organization of the content evident
- A consistent pattern within each lesson or chapter
- Providing students with explicit instruction on the text structure.

Education Trust. (1999). *Dispelling the myth: High poverty schools exceeding expectations.* Washington, DC: The Education Trust.

Higher achievement is associated with the use of simulation and application software.

Fellows, N.J. (1994). A window into thinking: Using student writing to understand conceptual change in science learning. *Journal of Research in Science Teaching,* 31(9), 985–1001.

Writing is a powerful classroom assessment tool, enabling science teachers to see how well students understand concepts and whether they have misconceptions.

Gabel, D.L. (Ed.). (1994). Handbook of research on science teaching and learning: A project of the National Science Teachers Association. New York: Macmillan.

This resource provides an overview of seminal research in science teaching and learning.

Good, T. L. & Brophy, J. E. (2003). *Looking in classrooms.* Boston: Pearson Education, Inc.

Questions that require students to analyze or apply information produce more learning than questions that ask students to simply recall or recognize information.

Griffin, C., Simmons, D. C., & Kmeenui, E. J. (1992). Investigating the effectiveness of graphic organizer instruction on the comprehension and recall of science content by students with learning disabilities. *Journal of Reading, Writing & Learning Disabilities International,* 7(4), 355–376.

Graphic organizers are highly effective. They combine the linguistic mode (words) with the nonlinguistic mode (symbols, lines, arrows). They can be used with descriptive, time-sequence, process, generalization, and concept patterns.

Helgeson, S. L. (1994). Research in Problem-Solving: Middle School. In D. L. Gabel (Ed.), *Handbook of Research on Science Teaching and Learning*, New York: Macmillan, 248–268.

For effective problem solving, science process skills and content should be integrated over several weeks, using hands-on, inquiry activities and concentrating on problem-solving skills. Improving students' problem-solving skills leads to a more positive attitude and to self-confidence in students' science abilities.

Hodson, D. (1998). *Teaching and learning science: Towards a personalized approach.* Buckingham, United Kingdom: Open University Press.

Writing helps students connect science knowledge, inquiry processes, values, and vocabulary with everyday language and students' experiences.

Holliday, W. G., Yore, L., & Alvermann, D. E. (1994). The reading-science learning-writing connection: Breakthroughs, barriers, and promises. *Journal of Research in Science Teaching,* 31, 877–894.

Pronunciation and other decoding skills are prerequisites to comprehension.

Jonassen, D., & Carr, C. (2000). Mindtools: Affording multiple knowledge representations for learning. In S. LaJoie (Ed.), *Computers as Cognitive Tools,* Mahwah, NJ: Lawrence Erlbaum Associates, 165–196.

Computer technology offers several kinds of tools for learning—organization tools (databases, concept mapping), dynamic modeling tools (spreadsheets, modeling software), knowledge construction tools (hypermedia), and conversation tools (e-mail and online discussion).

Lee, O., & Fradd, S. H. (1998). Science for all, including students from non-English language backgrounds. *Educational Researcher,* 27(4), 12–21.

ELL students benefit from authentic communication and a variety of communication, including writing, speaking, drawing, using tables, and making graphs.

Lemke, J. (2002). Teaching All the Languages of Science: Words, Symbols, Images, and Actions. http://academic.brooklyn.cuny.edu/education/jlemke/papers/barcelon.htm.

Drawing can powerfully express spatial and quantitative meaning; verbal forms (reading, writing and speaking) are better for reasoning.

Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom Instruction that Works.* Alexandria, VA: Association for Supervision and Curriculum Development.

This resource describes effective methods of teaching and classroom management that apply to all disciplines. Some key components that apply to ***Chemistry: Concepts and Applications, Chemistry: Matter and Change,*** and ***Physics: Principles and Problems:***

- Cooperative learning has a highly positive effect when compared with strategies in which students compete with each other and strategies in which students work on tasks individually.
- When practicing processes, have students state the subcomponent they will practice and set criteria for success; provide a variety of activities; have students self-assess, and provide feedback on only the targeted skill.
- Focused practice, in which one aspect of a complex, multi-step process is targeted, is effective when practicing scientific inquiry.

Marzano, R. J. (2000). *A new era of school reform: Going where the research takes us.* Aurora, CO: Mid-continent Research for Education and Learning.

The many variables that make up teacher effectiveness are grouped into three categories: instruction strategies, curriculum design, and classroom management. Effective curriculum design includes clear and organized learning objectives as well as well-spaced and paced activities that help students meet objectives.

Matthews, B. (2004). Promoting emotional literacy, equity and interest in science lessons for 11–14 year olds: The improving science and emotional development project. *International Journal of Science Education,* 26(3), 281–308.

Students can increase their interest in science, as well as develop social and emotional skills, through collaborative group work in mixed-gender groups.

National Institute of Child Health and Human Development. (2000). Report of the National Reading Panel. *Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and Its Implications for Reading Instruction: Reports of the Subgroups* (NIH Publication No. 00-4754). Washington, DC: U.S. Government Printing Office, 4-52. http://www.nichd.nih.gov/publications/nrp/report.htm

A variety of comprehension strategies have been shown to significantly improve comprehension—comprehension monitoring, cooperative learning, graphic organizers, question answering, question generation, and summarizing. Learning vocabulary in context is valuable.

National Research Council. (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

The National Science Education Standards provide the foundation for state science standards. The national standards describe content standards as well as standards for teaching, professional development, and assessment.

National Research Council and the Institute of Medicine. (2004). *Engaging schools: Fostering high school students' motivation to learn.* Committee on Increasing High School Students' Engagement and Motivation to Learn. Board on Children, You, and Families, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Students are motivated by instruction connected to their pre-existing understandings, interests, and real-world experiences, active involvement in problem solving and real-world applications, and varied instruction that is appropriately challenging.

Palincsar, A. S., & Brown, A.L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction,* 2, 117–175.

Comprehension strategies include making readers aware of their own cognitive processes, guiding readers, modeling the strategies, and having readers practice these strategies until they are internalized. Reciprocal teaching by students is effective. Students predict, ask questions about the text, seek clarification, and summarize.

Pressley, M. (2002). *Reading instruction that works: The case for balanced teaching.* 2nd Ed. New York: Guilford Press.

Effective comprehension strategies include questioning, visualizing, clarifying, elaborating, inferring, concluding, summarizing, and predicting.

Rivard, L.P. (1994). A review of writing to learn in science: Implications for practice and research. *Journal of Research in Science Teaching,* 39(8), 969–983.

Meaningful writing tasks can lead to improved student learning in science. Students can increase their understanding when they put concepts into their own words. Writing is a tool for making sense of new information. Authentic writing tasks in which students communicate with a real audience, rather than a teacher, are more effective.

Rosebery, A., Warren, B., & Conant, F. (1992). Appropriating scientific discourse: Findings from language minority classrooms (Working paper 1–92). Cambridge, MA: TERC.

ELL students can learn science inquiry and concepts while learning English. Through scientific inquiry, students develop abilities in reasoning, observation, and logical analysis.

Sadler, D. R. (1989). Formative assessment and the design of instructional systems, *Instructional Science.* 18, 119–44.

Self-assessment by pupils is an essential component of formative assessment. Students need to know the learning objective, their current level of understanding, and steps to take to reach the objective.

Saul, E. W. (Ed). (2004). *Crossing Borders in Literacy and Science Instruction: Perspectives on Theory and Practice.* Newark (DE): International Reading Association and Arlington (VA): National Science Teachers Association.

These authors discuss the latest research on how to teach reading and other literacy strategies while teaching science.

Schwab, J. (1966). *The Teaching of Science.* Cambridge, MA: Harvard University Press.

By reading and discussing reports of scientific research, analyzing the process and evaluating alternative experiments or explanations, students build an understanding of scientific inquiry as it is used by scientists.

Scruggs, T. E., Mastropieri, M. A., Bakken, J. P., & Brigham, F. J. (1993). Reading versus doing: The relative effects of textbook-based and inquiry-oriented approaches to science learning in special education classrooms. *The Journal of Special Education,* 27(1), 1–15.

This study suggests that students with learning disabilities learn more with an inquiry-oriented approach.

Shymansky, J. A., Kyle, W. C., & Alport, J. M. (1983). The Effects of New Science Curricula on Student Performance. *Journal of Research in Science Teaching,* 20(5), 387–404.

Inquiry-based teaching can lead to enhanced critical thinking, inquiry abilities, and positive attitudes toward science.

Stadler, H., Benke, G., & Duit, R. (2001). How do boys and girls use language in physics classes? In H. Behrendt, H. Dahncke, R. Duit, W. Graber, M. Komorek, A. Kross, P. Reiska, (Eds.) *Research in Science Education—Past, Present, and Future.* Dordrecht, Boston, London: Kluwer Academic Publishers.

Students strengthen their understandings of concepts and vocabulary when they reformulate their understandings using everyday language and personal analogies.

Texley, J. & Wild, A. (2004). *NSTA Pathways to the Science Standards: Second High School Edition.* Arlington, VA: NSTA Press.

This resource describes an overview of successful practices for high school science education, including incorporating science standards, assessment, professional development, and teaching methods.

Willows, D. M. & Houghton, H. A. (1987). *The psychology of illustrations: Basic research* (vol. 1). New York: Springer-Verlag.

High-quality visuals encourage students' mental images that help them recall information better than does text or lower-quality visuals.

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