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total motivation™ science

Aligned to the Texas Essential Knowledge & Skills (TEKS)

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Mentoring Minds®
Critical Thinking for Life!™

Education is about the creation of a universally literate nation. Literacy includes reading, mathematics, technology, and science. Released data from the Third International Mathematics and Science Study (TIMSS) showed that the United States continues to have issues in science and mathematics education. Schmidt, McKnight, and Raizen (1997) reported that even the brightest students in the United States are failing to learn what is essential in mathematics, technology, and science. The American Association for the Advancement of Science (AAAS, 1989) initiated a long-term reform effort to bring improvements to the areas of science, mathematics, and technology education. Thus, developing science literacy is imperative for students to address personal decisions and those in the 21st Century. If students are to become careful consumers of scientific and technological information related to everyday lives, Schools must carefully seek resources to support meaningful instruction in science education to help students become careful consumers of scientific and technological information in their everyday lives, achieve mastery of grade specific TEKS, and develop college and career readiness.

With the passing of the 2015 Every Student Succeeds Act (ESSA), academic assessments are required by this federal law for "math and reading or language arts be administered annually in grades 3-8 and at least once in grades 9-12; science tests not less than once during grades 3-5, 6-9, and 10-12" (Mandlawitz, 2016, p. 1). The critical issue of accountability continues with ESSA, with assessments being used to help improve schools and inform instruction. The law allows the state and local levels the opportunity to create systems for accountability, resources, interventions and teacher evaluation systems. The federal requirements of *Every Student Succeeds Act* mandate that all students participate in the state assessment program. Therefore, assessment focused activities are interwoven into each unit of Total Motivation™ Science*,* whence the teacher can gather timely student information to readily and continuously maintain accountability for academic achievement standards.

Project 2061 (AAAS,1989; 1993), comprised of science, mathematics, and technology experts, played an eminent role in helping this nation reach consensus of what literacy is in science and in determining what students need in order to be successful now and in the future. Two reports surfaced as a result of Project 2061: *Science for All Americans* (AAAS, 1989) and *Benchmarks for Science Literacy* (AAAS, 1993). *Science for All Americans* imparts information on effective learning and teaching. Not only is science literacy defined, but it serves as a reference for teachers who may have deficits and need to acquire knowledge of science, mathematics, and technology. Many implications can be taken from the Project 2061 report *Science for All Americans* (1990). Application of the following statement can strengthen science programs on any campus: "Educators should build on the experiences that students bring to class; help them articulate what conceptions they already have of the natural world; and provide them with real-life, structured experiences where students can rethink or even restructure their conceptions in the face of new evidence and new explanatory ideas."

The report *Benchmarks for Science Literacy* identified sequences of basic goals that will help students achieve the science literacy goals identified in *Science for All Americans*. More specifically, this report states what students should know and be able to do at the end of grades 2, 5, 8, and 12 in science, mathematics, and technology. Teachers can also use this report to determine what to include in core science curricula, when to teach it, and why. In conclusion, information from these reports will enable teachers in elementary, middle, and high school to advance in science literacy and assist students' progress in the development of science literacy.

Both *Science for All Americans* and *Benchmarks for Science Literacy* have influenced the development of Total Motivation Science. This educator's resource places emphasis on developing science literacy with time to observe, explore, test ideas, construct models, think, and ask questions. As a result, exploration, questioning, critical thinking, and scientific reasoning play prominent roles in Total Motivation Science rather than placing emphasis on "the" answers and memorization of general facts.

While experts determine what constitutes science literacy, still others offer recommendations for the types of instructional experiences that help students understand what they are learning. Based on the report from the National Research Council (2007), *Taking Science to School: Learning and Teaching Science in Grades K-8*, a book was authored. This book utilized the research implications as case studies are shared, forming a basis for providing rigorous, engaging tasks in classrooms. In *Ready, Set, Science!,* Michaels, Shouse, and Schweingruber (2007) translated a synthesis of research into teaching and learning experiences relative to students in kindergarten through eighth grades. Four strands of science learning are adapted from this source: Understanding Scientific Explanations, Generating Scientific Evidence, Reflecting on Scientific Knowledge, and Participating Productively in Science. Science practitioners can defer to this source to plan productive discussions, design tasks, manage classrooms, and make learning visible for diverse learners as they stay on course to help students progress in science literacy. Total Motivation Science*, a* TEKS aligned resource*,* is evidence of how the implications of research can be incorporated into productive learning experiences.

Based on previous findings, the Committee on Conceptual Framework for the New K-12 Science Education Standards (National Research Council, 2012) recognized the need for a framework that directly identifies a broad set of science expectations for students. This committee noted the need for an organizational framework that spans multiple years of school and results in students developing scientific habits of mind, focusing on depth of issues, and resulting in life-long learners who can face future challenges of society. The document, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas,* defined a structure for the improvement of K-12 science education (NRC, 2012). There are numerous statements that offer guidance for science literacy to science practitioners. One statement is, "The theories, models, instruments, and methods for collecting and displaying data, as well as the norms for building arguments from evidence, are developed collectively in a vast network of scientists working together over an extended period" (NRC, 2012, p. 27). Introduction, Critical Thinking, and Homework are components of Total Motivation Science that complement the direction offered by the committee's statement.

Science opens new avenues for exploration and offers students lifelong enrichment opportunities. Every school is responsible for science education, and for engaging students in science practices that deepen their understanding of the core ideas. Students should be provided opportunities to carry out scientific investigations and to gain knowledge of science practices, concepts, and core ideas. If students are to engage in discussions on science related issues, learn to be critical consumers in their everyday lives, and continue to learn about science throughout their lives, then they need a relevant and well-designed science learning curriculum with appropriate instructional resources.

Student data from the Spring 2016 STAAR® Science Summary Report (TEA, 2016) demonstrated a range of scores for students in grades five and eight. The total number of fifth grade students tested was 363,919. For the category Matter and Energy, fifth graders answered 70% of items correctly or an average of 5.6 items out of 8; for Force, Motion, and Energy category, fifth graders answered 70% of items correctly or an average of 7.0 items out of 10; for Earth and Space, fifth graders answered 68% of items correctly or an average of 8.1 items out of 12; and for Organisms and Environments, fifth graders answered 71% of items correctly or an average of 9.9 items out of 14. The total number of eighth grade students tested was 352,976. For the category Matter and Energy, eighth graders answered 69% of items correctly or an average of 9.6 items out of 14; for Force, Motion, and Energy category, eighth graders answered 63% of items correctly or an average of 7.5 items out of 12; for Earth and Space, eighth graders answered 66% of items correctly or an average of 9.3 items out of 14; and for Organisms and Environments, eighth graders answered 68% of items correctly or an average of 9.6 items out of 14.

Several reasons might account for the lower-range results. The following reasons indicate most likely why students answered in the lower range: Dual-coded items per assessment has increased in number and higher levels of thinking for the assessed Scientific Investigations and Reasoning skills have been included in the STAAR assessments. Also, students must understand how hands-on opportunities from the classroom apply to assessment items. As evidenced by these results, there appears to be a need for quality resources that support the implementation of science content, investigation and reasoning skills through hands-on investigations, and shows a strong potential for improving outcomes for students no matter the level of student understanding. Total Motivation Science provides an essential framework that offers all students exposure to content dual-coded to the Scientific Investigation and Reasoning Skills that encourage deep thinking, and opportunities to make connections to the real world, a variety of levels of questions so that students must think more critically and inferentially about a variety of scientific applications as well as about using context to interpret vocabulary and determine word meaning. Total Motivation Science offers instructional support in the form of formative assessment, intervention, and extending student thinking opportunities for each TEKS.

Total Motivation Science will excite students about science. This resource is designed to enable students to build on, revise, and refine their knowledge and abilities. Using Total Motivation Science as a comprehensive supplemental resource to science instruction, students will become curious about the world around them and how the world works. Total Motivation Science supports students' meaningful learning in science. Total Motivation Science, which delivers content in both print and digital formats, captured the 2016 Teachers' Choice™ Award for the Classroom. Teacher evaluator comments include: "A must for every classroom: It has everything"; ". . . to go into the depth of the TEKS that my students need to be successful"; "the complete package"; ". . . able to use vocabulary in a meaningful way"; "hands-on activities"; "relevant"; "aligned with our state standards . . . also at the rigor needed."

Each Total Motivation Science Student Edition includes units covering the content Texas Essential Knowledge and Skills (TEKS) for the specified grade level. Every unit contains a minds-on introduction (investigation activities), guided practice questions, check for understanding questions, critical thinking activities, a journaling prompt, formative assessment, homework activities, vocabulary activities, and parent support. A glossary is located in the back of the Student Edition. Each Reporting Category section concludes with a comprehensive unit assessment comprised of the TEKS addressed in the units. Additional educator resources are available for each grade level on the Mentoring Minds' company website. Total Motivation Science is an instructional and assessment resource that can assist teachers as they address Science TEKS. This educator's tool emphasizes student understanding of ideas essential to science literacy. Total Motivation Science serves as a student resource in meeting the rigor of the 2010 Science TEKS and the STAAR® Science assessment.

Introduction—Direct instruction that is dominated by science lectures, front-of-the-class demonstrations, and rote memorization of isolated facts, definitions, or explanations does not build depth in conceptual understanding (Bransford, Brown, and Cocking 2000; Ruby 1999). The National Science Education Standards (NRC, 1996) stressed that the inquiry-based strategy become the key approach for teaching and learning science. The developers of Total Motivation Science focuse d on inquiry as a central emphasis in each unit.

Scientists engage in many different activities. Some fit the stereotype of experimentation while others are seen to be creative, nonlinear, and messy (NRC, 1996). In Texas, three different types of investigation were noted in the new TEKS: descriptive, comparative, and experimental. In Total Motivation Science introductory activities, all three types of investigation are addressed. The introductory activities in each unit begin with a science investigation to engage students in learning science. These minds-on or experiential activities involve students in the scientific investigation and reasoning skills needed to be successful in science. The introductory activities connect students' personal experiences to further capture their attention; students' questions are encouraged to deepen comprehension; and guided questions are used to probe for understanding.

Questions lead to understanding, yet it is typical for classroom observations to exhibit few if any students asking questions. Observations seem to indicate students sitting in silence with their minds inactive as well. Sometimes, the questions students ask tend to be shallow and nebulous which might demonstrate that they are not thinking through the content they are expected to learn. If educators' goals are for students to think, then educators must stimulate and cultivate thinking with questions (Paul, 1990). When educators serve as facilitators, model the art of questioning, and then provide students with a variety of questions or questioning stems that probe the ideas or content being studied, students can independently learn to develop and apply critical thinking about their own learning. The Committee on Conceptual Framework for the New K-12 Science Education Standards (National Research Council, 2012) emphasized the important role questioning plays in science education: "Asking questions is essential to developing scientific habits of mind. Even for individuals who do not become scientists or engineers, the ability to ask well-defined questions is an important component of science literacy, helping to make them critical consumers of scientific knowledge" (NRC, 2012, p. 54).

Guided Practice Questions—Guided Practice Questions offer students opportunities to monitor conceptual understandings with the teacher serving as a facilitator prior to students responding independently. The Teacher Edition suggests ways to teach students to reason through each part of the question. Studies show that the art of asking questions, with an emphasis on higher-level thinking, can advance student achievement. Marzano, Pickering, and Pollock (2001) shared how teachers can increase their effectiveness in teaching and learning by using research findings on questioning strategies. An important conclusion showed learning to increase in classrooms where teachers asked questions related to essential content rather than questions teachers believed would interest students (Alexander, Kulikowich, & Schulze, 1994; Risner, Nicholson, & Webb, 1994). Redfield and Rousseau (1981) reported that knowledge level questions resulted in less learning than higher-level questions that encouraged students to use their analytical thought processes.

The Guided Practice Questions can be utilized in whole group, small group, or pairs. An emphasis is placed on the think-aloud strategy. Teachers model how to think about the questions by verbalizing each step of their own thinking. These questions may be used to review information with students, thereby providing students with needed practice before completing problems independently. Guided Practice Questions help teachers assess students to ascertain if they are ready to respond to questions independently or if additional instruction is warranted.

Check for Understanding—This section of Total Motivation Science provides independent practice, enabling the teacher to evaluate students' proficiency and knowledge about the TEKS. Rather than confirming that students have memorized certain items of information, assessments need to monitor students' understanding, reasoning, and ability to apply knowledge. Assessment and learning are so closely related that if all the outcomes are not assessed, teachers and students might limit their expectations for learning science to only the outcomes that are assessed (NRC, 1996). In the Check for Understanding section, a group of questions assess students about the science content, while also assessing a Scientific Investigation and Reasoning TEKS. If responses to these questions are incorrect, teachers should assess the type of question asked. For example, the first set of questions are related to content, while the second set are dual coded to both a content and a process TEKS.

Critical Thinking—Critical thinking is an important issue in education today. Attention is focused on quality thinking as an important element of life success (Huitt, 1998; Thomas & Smoot, 1994). In the 1950s, Bloom found that 95% of the test questions developed to assess student learning required them only to think at the lowest level of learning, the recall of information. Similar findings indicated an overemphasis on lower-level questions and activities with little emphasis on the development of students' thinking skills (Risner, Skeel, & Nicholson, 1992). As Hobgood, Thibault, and Walberg (2005) noteed, "Now, a considerable amount of attention is given to students' abilities to think critically about what they do." As noted by NSES (1996), inquiry-based teaching and learning is essential to effective science instruction. It provides a platform where critical thinking can surface naturally. When students use their critical thinking abilities integrated with content instruction, depth of knowledge can result. Teachers would do well to refrain from limiting science instruction to lectures, rote memorization, and other strategies that exercise only lower levels of thought as opposed to incorporating those that build conceptual understanding (Bransford, Brown, & Cocking, 2000; Ruby, 1999).

Each unit in Total Motivation Science contains a critical thinking section with an activity and/or questions. Students will be able to use their newly acquired knowledge to expand their thinking skills. Practicing critical thinking skills provides opportunities for students to communicate new learning at higher cognitive levels, connect learning to other content areas, or apply learning in new contexts. The critical thinking component will provide opportunities for students to apply thinking skills when completing assignments, taking tests, and acquiring new information. Students can also use their critical thinking abilities to transfer conceptual meaning to their everyday lives.

Science Journal—Each Total Motivation Science unit includes a journal prompt, integrating writing, science, and critical thinking. Students are given the opportunity to creatively express what they have learned. Science journaling will help students link new information with previous knowledge. Recording their thoughts and newly formed ideas on paper helps students internalize important science content. Using a journal to connect information will help students understand the concepts as they are being taught. The journal activities will reiterate the knowledge they have learned and allow students to be creative and comprehend what they have learned through written expression. Students may also use journaling activities to analyze, evaluate, and reflect what they are learning.

Homework—Authentic, practical activities that can be experienced in science at home define the science homework. Each unit contains homework for students to complete. Homework will differ for each unit, pending the content of the lesson. Studies involving multi-sensory teaching experiences show students achieve more gains in learning than when taught with merely a visual or an auditory approach (Farkas, 2003; Maal, 2004). Active engagement with the use of multi-sensory instruction appears to create the optimal learning setting (Stahl & Fairbanks, 1986).

Parent Activities—Homework pages will include parent activities. Parents can become involved with their students learning by completing the simple tasks, questions, or discussion with their students. Research indicates that when parents become actively involved in the education of their children, academic success increases.

Vocabulary—Vocabulary is important in comprehending meaning of texts. Research on vocabulary substantiates the necessity of providing systematic vocabulary instruction due to the following conclusions: a relationship exists between vocabulary and achievement; comprehension improves when students have a direct connection between the word and word meaning; some vocabulary is specific to the content of a subject and must be taught in context; and fluent use of vocabulary is vital to student achievement. The ability of students to achieve in content areas is dependent upon language (Buxton, 1998; Lee & Fradd, 1998). Science and math require specialized vocabulary. Mastering content-specific vocabulary can be a challenge for all students, especially when there are some everyday words with different meanings in the math and science disciplines (Carlson, 2000). No one can depend on the assumption that students will learn the necessary vocabulary by chance. All students need and benefit from direct vocabulary instruction (Gunning, 2003; Vacca, Vacca, Cove, Burkey, Lenhart, & McKeon, 2003). The values of providing a systematic approach to teaching content vocabulary are many.

Students have to understand vocabulary in order to comprehend the academic content they encounter in school. Stahl and Fairbanks (1986) revealed that when specific vocabulary from academic subject areas is selected as the focus of instruction, the result was a 33 percent increase in vocabulary comprehension. Therefore, it appears when students are taught specific content vocabulary in each subject area at each grade level, students have an excellent opportunity to acquire the academic background knowledge they need to understand the subject area content. Teaching content vocabulary using a systematic approach appears to be a powerful tool for student success (Marzano & Pickering, 2005). Furthermore, research firmly documents that academic background knowledge has an effect on academic achievement. Any intervention for the achievement of students should identify increasing students' content vocabulary knowledge through direct instruction as a leading priority (Marzano, 2004). Word-learning strategies include learning how to use reference aids. Word-learning strategies are important for English learners and native English speakers, as reported by Carlo, August, and Snow (2005).

Each unit in Total Motivation Science contains a vocabulary activity. Understanding essential vocabulary is critical to success of mastering each concept. Students need to understand the meaning of science vocabulary terms in order to understand the concept of the TEKS being taught. Thus, students will learn to use accurate language to describe science content. By reviewing terms associated with each Science TEKS, students' knowledge of words and their meanings will be enhanced. In conclusion, the vocabulary activities will lead students to combine previous knowledge to new concepts, making meaningful connections.

Reporting Category Assessment—Following the units that correlate with each reporting category, a comprehensive unit assessment is provided. This assessment includes at least 40% of questions that evaluate both a Scientific Investigation and Reasoning TEKS (Process TEKS) and the Content TEKS.

The remaining sections of each Student Edition contain content-specific terms and a progress-monitoring tool. The glossary, applicable to each grade level, is listed by term and definition. The glossary can be used for a quick review or as a reference for those students having difficulty with vocabulary words. A chart, entitled "Chart Your Success," identifies the standards assessed in each unit and the standards tested in the Reporting Category Assessments. This feature allows students to chart individual test-taking performance, encourages students to take responsibility for their learning by seeking additional assistance on scientific concepts identified by the charted data, and encourages students to observe individual progress over time. Following the assessment, teachers and students may review the data and work together to create individual learning goals.

Teacher Edition—When teachers of science display a passion for knowing why and invite students to join in scientific understanding, then teachers nourish that curiosity present in the minds of their students (NRC 1996, p. 37). The Teacher Edition of Total Motivation Science provides teachers with basic science background for each unit. This teacher resource includes literature that connects to the Science TEKS, prerequisite standards, guided practice strategies, directions and questions to guide inquiry, vocabulary activities, Formative Assessment, Interventions, and Extending Student Thinking activities, aligned questions to the English Language Proficiency Standards, answer keys, and a list of helpful websites. The rationale for the development of Total Motivation Science is based upon the aforementioned analysis of research, and children's literature suggestions. After reviewing National and Texas Standards, participating in a study of the literature, having conversations with practitioners, gathering feedback from teachers and administrators, the need for and the development of a science resource was confirmed.

Evidence from research validates that a successful academic program must include time for students to practice what they are learning and experiences to perform the tasks for which they are to demonstrate competence. Often, students appear to spend more time on rote learning rather than on concept development, investigating, and higher-order thinking abilities (Boaler, 1998; Wood and Sellers, 1996). Although these studies reflect mathematical findings, they are indicative of instructional practices observed in several science classrooms as noted by the educator input shared with the authors of Total Motivation Science. Memorization of general science information as opposed to leading students to achieve literacy in science appears to be a common observation. Becoming science literate takes time; thus, science education programs must recognize the importance of relevant and engaging tasks that begin in the early years and continue throughout one's schooling if science literacy is the goal.

The developers of Total Motivation Science reviewed research-based evidence on how students learn, gathered input from a wide array of scientific experts and educators, collaborated about relevant reform efforts on teaching and learning in science, studied and analyzed the standards and sample released questions, and employed individual expertise and collective judgment as they designed a resource to lead students into the 21st century. Science resource documents from the Texas Education Agency (TEA, 2010-2011; 2012; 2015) were used to design learning activities, assessment items, and update Total Motivation Science.

Total Motivation Science focuses on the standards which are the eligible Texas Essential Knowledge and Skills. These standards are grouped into four Reporting Categories for elementary and middle schools, and five Reporting Categories for high school. This focus ensures Total Motivation Science is appropriate, effective, and current. Bloom's Taxonomy and Depth of Knowledge (Hess, 2004; 2005; Webb, 2002) are incorporated to stimulate and develop students' higher order thinking skills, encouraging rigor and depth in thinking. Examples of evidence-based techniques and/or principles found in Total Motivation Science *are many,* including standards-based instruction, active teaching, hands-on investigations, critical thinking, ongoing monitoring, and real-world applications. *The contents of* Total Motivation Science are aligned with these criteria for improving student performance. With the TEKS and evidence-based research as key guiding points, the Mentoring Minds' Science Product Development Team developed Total Motivation Science as a resource for strengthening science content and pedagogy.

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