Product Research

ThinkUp!™ SCIENCE

Supporting documentation for the development of **ThinkUp! Science**

ThinkUp! Science

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. 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 that "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 *ThinkUp! 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 *ThinkUp! 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 *ThinkUp! 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. *ThinkUp! 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). Concept Exploration and Concept Application are two components of *ThinkUp! 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 May 2018 STAAR® Science Summary Reports (TEA, 2018f) demonstrated a range of scores for students in grades five and eight. The total number of fifth grade students tested was 399,294. For the category Matter and Energy, fifth graders answered 69% of items correctly or an average of 4.2 items out of 6; for Force, Motion, and Energy category, fifth graders answered 72% of items correctly or an average of 5.7 items out of 8; for Earth and Space, fifth graders answered 67% of items correctly or an average of 6.7 items out of 10; and for Organisms and Environments, fifth graders answered 69% of items correctly or an average of 8.3 items out of 12. The total number of eighth grade students tested was 386,971. For the category Matter and Energy, eighth graders answered 66% of items correctly or an average of 7.2 items out of 11; for Force, Motion, and Energy category, eighth graders answered 67% of items correctly or an average of 6.1 items out of 9; for Earth and Space, eighth graders answered 66% of items correctly or an average of 7.2 items out of 11; and for Organisms and Environments, eighth graders answered 70% of items correctly or an average of 7.7 items out of 11.

The following indicate most likely the reasons for lower-range results: Dual-coded items, measuring students' abilities to relate science content to science process skills, were assessed at a high percentage per assessment, with 66% of the questions dual-coded for grade 5 and 57% of the questions dual-coded for grade 8. Dual-coded items require higher levels of thinking and are often more rigorous than items coded only to content standards. In addition, students must understand how hands-on opportunities and scientific investigation and reasoning 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 through hands-on investigations, provide exposure to and experience with rigorous content, and show a strong potential for improving outcomes for students no matter the level of student understanding. *ThinkUp! Science* provides an essential framework offering all students content integrated with the science process skills to encourage deep thinking, provide opportunities to make connections to the real world, practice a variety of levels of questions so that students must think more critically and inferentially about a variety of scientific applications, and give context to interpret vocabulary and determine word meaning. *ThinkUp! Science* offers instructional support in the form of pre-assessment, clarifying learning targets, concept exploration, concept development, concept application, formative assessment, intervention, and extending student thinking opportunities for cross-curricular connections and reflection for each TEKS.

Each *ThinkUp! Science Student Edition* includes units covering the content Texas Essential Knowledge and Skills (TEKS) for the specified grade level. Every unit begins with the component Getting Started, then moves to the component Instruction, followed by the Assessment component, and concludes with the component Extension. 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. *ThinkUp! 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. *ThinkUp! Science* serves as a student resource in meeting the rigor of the adopted 2017 Science TEKS that began implementation in August of 2018, and the STAAR® Science assessment.

In 2017, a team of educators from Mentoring Minds generated a list of traits they have observed throughout their education careers that were indicative of students who exhibited skillful thinking and deeper levels of thought. Based on their varied backgrounds of teaching and leadership experiences, elementary and secondary levels of curricula expertise, a range of 5–38 years working with children, observations of students, conversations with teachers, and 7 months of focused discussions, careful study, and deliberation, these educators collaboratively narrowed their lists to nine behaviors that students exhibited more times than not when thinking critically. Collectively, these nine behaviors *(adapt, collaborate, communicate, create, examine, inquire, link, reflect, and strive)* were entitled 9 Traits of Critical Thinking™ (Mentoring Minds, 2017). The nine traits, when explicitly taught, modeled, and practiced, can guide students in becoming more successful when engaging in cognitively demanding tasks and in social interactions at school and in life beyond the classroom. The traits should be emphasized in context with content-specific learning experiences that align to a trait during instruction. The traits help students become increasingly aware of thinking and more alert to mindful behaviors they can internalize and utilize to improve thinking behaviors.

Getting Started

The purpose of the Getting Started component is to introduce the unit focus TEKS concept and the critical thinking traits that support students as they learn, practice, and master the TEKS concept. This component also guides planning and instruction as educators use the diagnostic information provided by the online Pre-Assessment. Students also need to know the expectations or outcomes for each unit prior to engagement. Thinking expectations enable individuals to effectively evaluate the quality of thinking of others and self-assess their own thinking, determining individual progress and the improvement needed. When expectations for thinking are made explicit, evidence can be gathered, and judgments can be formed (Paul & Elder, 2000). With the emphasis on learning and thinking at the core of instruction within a school, the focus of the classroom shifts from acquisition of content to making meaning. TEKS Learning Targets are identified in the beginning of each unit in the student edition. These learning targets are visible to students in the Getting Started component of every student edition unit. With ThinkUp! Science, teachers can ensure that students know the purpose or the reason behind every learning experience, so the focus remains on the learning itself and not the work. Stobaugh (2013b, p. 137) states, “By establishing a focus on thinking, teachers can transform classrooms from mass-production classrooms with students able to answer fact-based questions to classrooms that embody real learning through thinking as students analyze, critique, and create.”

Teachers must be specific in making expectations explicit for a thinking classroom if they want students to participate and succeed in a thinking environment. Classrooms where science is taught can be work cultures or thinking cultures. In work cultures, an emphasis is placed on students completing assignments, often at a low cognitive level. Thinking cultures nurture students’ thinking skills (Ritchhart, 2002). Stobaugh (2013a) notes that teachers can train brains in a “thought-full” classroom just as people visit a gym to train their bodies to be stronger and more agile. Classrooms that reflect thinking climates encourage student questions and inquiries that focus on higher-order thinking and deepen learning experiences (Love and Stobaugh, 2018). ThinkUp! Science emphasizes a thinking environment and clarifies learning targets in each unit, so expectations are explicit, ensuring that students know they are expected to be active learners.

Students should be taught the importance of thinking critically and how critical thinking skills impact their future success. It is recommended that students be taught that improvement in thinking skills is like improvement in any sport or hobby. Emphasize that the development of thinking takes commitment as well as practice, practice, practice. Students must also understand that learning how to think critically develops and improves over time. With ThinkUp! Science teachers can ensure that students know the purpose or the reason behind every learning experience, so the focus remains on the learning itself and not the work. Stobaugh (2013b, p. 137) states, “By establishing a focus on thinking, teachers can transform classrooms from mass-production classrooms with students able to answer fact-based questions to classrooms that embody real learning through thinking as students analyze, critique, and create.”

In the *ThinkUp! Science Teacher Edition*, the Getting Started Component includes Clarifying the TEKS, Prerequisite Standards, Common Errors or Misunderstandings, Teacher-to-Teacher Tips, Pre-Assessment instructions, TEKS Learning Target, and Focus for the 9 Traits of Critical Thinking. To understand each trait, a descriptive statement is provided along with the engagement indicators or outcomes, strategies to facilitate trait development, and questioning prompts teachers might use to determine if students are exhibiting the traits are offered in the teacher edition. Icon representations of the traits appear in the student edition with opportunities to reflect on the usage or application of the focus trait(s) in each unit.

Instruction

The purpose of this component is to provide exploration and explanation for students and teacher of the unit focus standard(s), including an identification of the essential vocabulary. This component offers students an opportunity to learn and apply the unit focus stand(s) and receive immediate feedback and support. The Instruction component in the student edition includes Concept Exploration, Concept Development, Vocabulary Mastery, Concept Practice, Concept Application whereas the teacher edition includes the same components along with instructions to guide the implementation. In addition, the teacher edition includes Literature Connections for concept reinforcement and Formative Assessment to evaluate student understanding.

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 and that holds true today. The developers of *ThinkUp! Science* focused 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).

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).

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.

Questions can be utilized in any part of instruction whether it be 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. Questions help teachers assess students to ascertain if they are ready to respond to questions independently or if additional instruction is warranted. Questioning provides an opportunity for students to develop and practice the concept(s) as well as apply the unit concept(s) to real-world situations.

Research shows that formative assessment has a positive difference on student achievement. When teachers develop skill in utilizing formative assessment, relationships can flourish. After conducting 800 meta-analyses, Hattie (2012) found formative assessment to be an effective practice for impacting student achievement. Earlier, Stiggins (2002) noted that formative assessment was a practice that had a positive influence on learning. Shepherd (2000) expressed the importance of teachers inviting students to discuss not only their conceptual understandings but also misunderstandings. Formative assessment provides such an avenue for this to happen. *ThinkUp! Science* includes errors and misunderstandings in the teacher edition to alert teachers to common errors and misunderstandings in Science. This tool provides support to all teachers as they engage in conversations with students and offer specific feedback to attain meaning of science concepts. Black and Wiliam (1996) advocated for formative assessment as one of the best ways to increase or improve student achievement. *ThinkUp! Science* weaves formative assessment throughout the components of each unit.

Vocabulary is also 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 et al., 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 *ThinkUp! Science Student Edition* contains a vocabulary activity to reinforce essential vocabulary. The teacher edition provides instructions for implementing the Vocabulary Mastery: Science Vocabulary Builder activity with students. The teacher also has access to an instructional activity along with a formative assessment for determining student understanding of the TEKS vocabulary. 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.

Assessment

The purpose of this component in *ThinkUp! Science* is to provide students an opportunity to apply the unit focus standard(s) in a context that mimics high-stakes testing. Teachers can use the two pages of Concept Check in the student edition to monitor student learning and to make instructional decisions regarding the need for interventions or reinforcement for individual students or the class. The questions address the TEKS that are aligned to the unit standard(s) and include questions dual-coded to Science Process Skills.

Students are provided independent practice with this component, enabling the teacher to evaluate students' proficiency and knowledge about the TEKS. Rather than confirming that students have memorized certain items of information, assessments monitor students' understanding, reasoning, and ability to apply knowledge. According to NRC (1996), 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. In the Concept Check, 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 page of questions in the Concept Check are related to content, while the second page of questions are a mix of content questions and questions dual coded to both a content and a process TEKS. Teachers can also glean test-taking tips, instructions for the Concept Check activity, and prompts to encourage students to share strategies utilized during assessment in the teacher edition. A chart, entitled "Chart Your Success," identifies the standards assessed in each unit and the standards tested in the Concept Check. 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.

Reporting Category Assessments offer summative assessment for the content within each reporting category while including questions that are dual-coded to Science Process Skills. Following the units that correlate with each reporting category, a comprehensive assessment is provided in the student edition, resulting in a total of four assessments. This assessment includes at least 40% of questions that evaluate both a Scientific Investigation and Reasoning TEKS (Process TEKS) and the Content TEKS.Instructions for the Reporting Category Assessment are located in the teacher edition.

Intervention

The purpose of the Intervention component is to provide engaging strategies and instructional activities that support students who have demonstrated the need for intervention and support in order to show mastery of the unit focus TEKS standard(s). This component is offered in the teacher edition. During a focus group meeting in 2018, teachers shared their appreciation that interventions would be included in the ThinkUp! resources. With high-stakes testing and the complexity such assessments bring, teachers indicate their desire for this component. Students must enter assessment with a firm understanding of the standards for which they will be assessed. When formative assessments are intertwined with instruction, teachers can readily determine where the gaps are and with whom. The problem typically lies in teachers not having time to design an intervention or even know what intervention might be appropriate. Like reteaching, an intervention needs to be different to and align to the focus of the lesson. *ThinkUp! Science* offers interventions in every unit that can be used for immediate reteaching or be used in the Response to Intervention (RTI) process so that a teacher is following district and campus RTI regulations.

Marzano (2010) recommends that reteaching to one child or a small group occur as close to the previous instruction as possible.

Extension

The purpose of the Extension component is to provide students an opportunity to relate and explore the learning of the unit focus standard(s). In the student edition cross-curricular activities integrate critical thinking traits, science, literacy, and other curricular areas for levels 5 and 8. All levels provide students opportunities to reflect on the unit concept(s), critical thinking traits(s), and/or student performance. Research indicates that one of the most important parts of the learning process is reflection. Students need opportunities to reflect about their experiences and what they have learned. Reflection seems to influence more productive learning.

Each *ThinkUp! Science* unit for levels 3, 4, 6, and 7 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.

In the teacher edition, instructions are provided to help the teacher support the students in extension tasks. Teachers are also invited to participate in a reflection on instructional effectiveness.

The featured opportunities are included to help students apply and extend unit learning beyond the school. Authentic, practical activities that can be experienced in science at home define the science Home Connection. Activities 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). 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.

Additional Resources

The remaining sections of each Student Edition include a Laboratory Safety Contract to promote safe practices and a Science Glossary. 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. In the teacher edition, the same tools plus numerous other resources are provided to help the teacher with successful implementation of *ThinkUp! Science*, ranging from background information for Unpacking the Standards, Frameworks for Critical Thinking, Answer Coding Tables to English Language Proficiency Standards.

Critical thinking continues to be 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 indicated 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). Hobgood, Thibault, and Walberg (2005) note that a large focus today is being given to the students and their abilities to think critically. Other educators agree on the importance of teaching students how to think critically and to reflect on their learning (Stobaugh, 2013a, 2013b; Love and Stobaugh, 2018). Based on what students are tasked to do, *ThinkUp! Science* clearly shows it is imperative for students to communicate their scientific thinking coherently and clearly to peers, teachers, and others. Mentoring Minds development teams agree that the emphasis on thinking processes (Mentoring Minds, 2017) will lead to new levels of student performance. Thus, thinking is embedded into the learning experiences in the student editions and plays an important part in the teacher editions.

Each unit in *ThinkUp! Science* contains integrated thinking within activities, questioning prompts or assessment items. 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. The models used to structure critical thinking throughout *ThinkUp! Science* are Revised Bloom's Taxonomy (Anderson et al., 2001), Webb's Depth of Knowledge (2002), and Hess' Cognitive Rigor Matrix for Science (Hess, 2010a; 2010b; 2013). The framework used to develop the thinking traits is the 9 Traits of Critical Thinking™ (Mentoring Minds, 2017). These cognitive models were used by the product developers to stimulate and develop students' higher order thinking skills and make extensions to the real world. More so, the 9 Traits of Critical Thinking™ provide direction for developing intellectual behaviors that are characteristic of strong critical thinkers.

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 *ThinkUp! 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.

Encouraging and fostering thinking is central to student learning. In education, a shift from a focus on content to an emphasis on thinking skills is apparent. Thinking must be integrated with content to make meaning and deepen learning. Costa and Kallick (2009, p. 5) state that the standards "suggest that successful instruction in skillful thinking should be done *while* teaching subject matter instead of *in addition to* teaching subject matter. Thinking and subject matter content are neither separate from nor in opposition to each other. The implication is that a student cannot demonstrate mastery of any of these required standards without performing one or more important thinking skills." Thus, the resource *ThinkUp! Science* addresses all student expectations in the TEKS with critical thinking woven into the instruction and learning experiences.

Acknowledging the needs of the user is crucial in designing educational products that are effective in improving teacher and student performance and resulting in academic achievement. Recognizing this, the Science Product Development Team at Mentoring Minds acted to gather external input. In September of 2018 an opportunity was extended by Mentoring Minds to glean information from educators. A Science Focus Group (2018), comprised of teachers and administrators currently using Mentoring Minds *Motivation Science*, assembled in east Texas for feedback on several topics. The major purpose was to preview and to provide feedback about the design and content of the new resource *ThinkUp! Science*. Sample science units from the teacher and student editions were available for previewing and gathering timely input. Discussion questions included the following: (1) What do you see as the greatest strength? (2) What do you see as a weakness? (3) Is there a component you would like to see added? (4) What feature or component stands out to you as engaging for students and teachers? (5) How do you think this resource will support teachers as they implement and students as they master the new standards? (6) What support would you look for in a teacher edition for lesson planning? Comments given by the focus-group attendees were positive and specific about the new components, features, and layout. Feedback indicated educators were pleased to see elements in the new resource included such as pre-assessments, teacher reflection, TEKS clarification, prerequisite standards, learning targets, opportunity for student reflection, and alignment to the standards. Science educators specifically complimented the layout, cross-curricular connections, question stems, and the inclusion of common errors or misconceptions in the *ThinkUp! Science* resource.

Insight garnered from this meeting indicated that educators approved of the deeper focus on critical thinking and how it was embedded into the science content. Also, favorably noted was ThinkUp! is more of a teaching tool and not just a test prep tool. All observations and comments yielded favorable responses about the new product design, coupled with feedback indicating how these elements contributed to improvements to a Mentoring Minds science resource currently used or in use by some of the focus group attendees. The information collected was analyzed and used to improve *ThinkUp! Science*. Mentoring Minds advocates that gathering input of the customers *and* using the input to inform the development of resources must be a continual part of the process for producing educational tools of higher-quality.

The developers of *ThinkUp! 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 (TEA, 2017a; 2017b; 2018a; 2018b) and sample released questions (TEA 2018g; 2018h) 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, 2018c; 2018d; 2018e; 2018f) were used to design learning activities, assessment items, and develop *ThinkUp! Science*. *ThinkUp! Science* is also based on the Gradual Release of Responsibility Model (Pearson and Galagher, 1983; Levy, 2007). While this model was associated early with reading, research indicates that this approach can be used successfully in other content areas including math and science and is associated with higher levels of student achievement. Students are guided through the learning process with multiple and varied opportunities for practice and application to achieve independent mastery of targeted student expectations.

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 *ThinkUp! Science Teacher Edition* provides teachers with basic science background for each unit. After reviewing National and Texas Standards, participating in a study of the literature, having conversations with practitioners, gathering feedback from a focus group comprised of teachers and administrators, the need for and the development of this science resource was confirmed. The rationale for the development of *ThinkUp! Science* is based upon an analysis of research, children's literature suggestions, and input from practitioners.

ThinkUp! 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. This focus ensures *ThinkUp! Science* is appropriate, effective, and current. Bloom's Taxonomy and Depth of Knowledge (Anderson, 2001; 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 *ThinkUp! Science* are many, including standards-based instruction, hands-on investigations, critical thinking, ongoing monitoring, and real-world applications. The contents of *ThinkUp! 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 *ThinkUp! Science* as a resource for strengthening science content and pedagogy with an intentional integration of critical thinking.

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