TCM Teacher Created Materials

Smithsonian

STEAM Readers

Science • Technology • Engineering • Arts • Mathematics

Complete Supplemental Program Based on Respected Research and Literature

Introduction

STEAM is one content area (or five if you want to be precise) in which literacy can be cultivated and developed. It is a powerful approach to learning that is gaining momentum across the nation. As with many education initiatives, STEAM means different things to different people. Most people agree that STEAM is the integration of science, technology, engineering, the arts, and mathematics to design solutions for real-world problems.

Students must learn how to question, explore, and analyze natural phenomena. With these skills well in hand, students understand the complexity of available information and are empowered to become independent learners and problem solvers. Goals for developing literacy skills through STEAM content go beyond reading, writing, speaking, and listening.

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The *Smithsonian STEAM Readers* Logic Model

The Logic Model demonstrates how *Smithsonian STEAM Readers* is designed to develop fluent readers and critical thinkers. Evidence of this is suggested through its resources and activities, which are linked to positive outcomes for students. The goal of this table is to help visualize how implementing *Smithsonian STEAM Readers* can support and contribute to achieving school and district goals.

Figure 1—Logic Model

Problem Statement: There is a need for integrating science and engineering concepts into literacy-based curriculum.					
Outcome/Goal: To help students increase reading fluency and comprehension through STEAM concepts					
Theory of Action					
Educators implement evidence-based *Smithsonian STEAM Readers* literacy strategies and STEAM materials.	Students engage in and utilize *Smithsonian STEAM Readers* content and strategies.	Students will have increased reading, writing, and collaboration skills.	Students will have increased achievement in literacy and science skills.	Students will be prepared for secondary and post-secondary education success.	Students will become confident readers, able to comprehend and collaborate at higher levels.
Logic Model					
Assumptions	**Resources/Inputs**	**Activities**	**Outputs/Metrics**	**Outcomes**	**Impact**
• School districts are interested in and prepared to integrate science concepts into literacy instruction for K–5 students. • Students can improve reading comprehension, and science knowledge through regular, focused instruction. • High-interest texts engage students in reading and writing practice. • Technology is accessible.	• *Management Guide* includes best practices and key research. • Materials and lesson plans are developed through collaboration of experts in the field. • High-interest readers and text cards are available for students. • audio recordings and ebooks of readers and text cards • STEAM Challenges • assessments • student-guided activities	• 10-day lessons for K–5, and 7-part lessons for grades 6–8 • lessons for a variety of instructional settings: whole group, small group, collaborative practice, and independent practice • exploration of essential questions • explicit instruction in comprehension strategies and understanding of scientific phenomena • collaborative research and reflection opportunities for students with high-interest texts • STEAM activities and structured practice for students to engage with a variety of texts	• student engagement in texts and resources • meet or exceed expectations of ELA and NGSS standards • completion of lessons • formative and summative assessments • improvement in reading comprehension and collaborative skills	• knowledge of reading comprehension strategies • application of literacy skills to other more complex texts • greater achievement in ELA and science skills • engagement in reading, writing, speaking, and listening • consistent practice in reading a variety of texts • increased confidence in collaborative practices	• increased interest in literacy among students • creation of lifelong readers and critical thinkers • development of collaborative and critical thinking skills • preparedness for secondary and post-secondary education success

Fostering Content-Area Literacy

Guiding students through the effective use of comprehension strategies is usually considered the task of English or language arts teachers. However, comprehension strategies best serve students when they are employed across the curricula and in the context of actual learning. It is only then that students can independently use reading strategies successfully. All student texts were carefully curated to ensure that students have ample opportunities to build deep knowledge and develop relevant vocabulary for each topic. This range of complex texts provides students with multiple access points to building knowledge.

To become effective and efficient readers, students must employ a wide range of literacy skills. Students develop these skills by actively engaging with content-rich text and building breadths of knowledge and deep understandings of vocabulary related to the content (Duke and Cartwright 2021). Deep and purposeful interactions with diverse, challenging texts allow for students to evolve into independent thinkers who comprehend text and can question and delve deeper into it. Additionally, students are given opportunities to apply their learning to the engineering design process through STEAM Challenges that dare participants to take risks as they collaborate to find solutions. *Smithsonian STEAM Readers* serves as a valuable resource that supports students as they engage with the subject matter.

Smithsonian STEAM Readers uses complex and content-rich texts to employ instruction and practice of reading comprehension strategies. Each informational text includes ample text features which support students as they navigate the text, providing support, locating important information, and discovering the purpose of the content.

The Importance of Informational Texts

Literacy demands in the twenty-first century are tremendous. In an increasingly global and information-rich society, students need to be eager to learn and seek answers, developing necessary skills to navigate informational texts they will come across in school, the workplace, and everyday life. Students also need to be able to read, write, and communicate collaboratively in a cross-cultural world (ILA 2016). According to Stephanie Harvey and Anne Goudvis in their book *Strategies That Work: Teaching Comprehension to Enhance Understanding*, "interesting, authentic nonfiction fuels kids' curiosity, enticing them to read more, dig deeper, and search for answers to compelling questions" (2007, 156).

Before Reading

Students engage in activities that set the stage for learning and make the text more relatable:

- preview the text
- study complex vocabulary
- make connections with the text
- generate questions about the text

During Reading

Students use strategies to actively read texts closely with different purposes:

- seek text-based answers to essential questions
- examine text structure
- visualize complex content
- read to gain and extend knowledge

After Reading

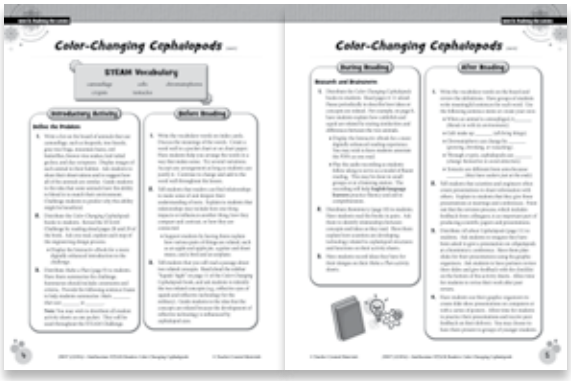
Students deepen their understanding and reflect on what they have learned:

- implement reciprocal reading and writing activities
- engage in research
- synthesize information
- craft written expository arguments

Research to Practice

Reading activities in *Smithsonian STEAM Readers* lessons for K–5 are organized using this three-part framework:

- Before Reading
- During Reading
- After Reading



Developing Academic Vocabulary

Research conducted over past decades has consistently found a deep connection between vocabulary knowledge, reading comprehension, and academic success (Baumann, Kame'emui, and Ash 2003). Kamil and Hiebert describe vocabulary as "a bridge between the word-level processes of phonics and the cognitive processes of comprehension" (2005, 4). This is a useful way to visualize the importance of vocabulary for young or struggling readers. It is not enough to give students a list of words and have them find definitions in dictionaries or glossaries. "Specifically, teachers must design tasks that will increase the effectiveness of vocabulary learning through reading practice" (Feldman and Kinsella 2005, 3).

Students with speech or language challenges can benefit from hands-on experiences and learning in cooperative groups. These experiences allow them to engage in learning that is fun, develop language, and connect with others, even if non-verbally. "Building a roller coaster or designing a board game with ELL students is a great way to share experiences and generate opportunities for conversations" (Maslyk 2016, 55).

Research to Practice

In *Smithsonian STEAM Readers*, vocabulary instruction is integral to the literacy lessons. Students need explicit vocabulary instruction before reading a text to better understand the content. *Smithsonian STEAM Readers* includes vocabulary activities designed to familiarize students with new vocabulary words, promote authentic practice, and encourage the understanding of meanings in context.

Writing Across the Content Areas

Teachers may wonder where writing fits within the STEAM curriculum. What do run-on sentences have to do with sound waves or designing water filters? Scientists and engineers need to communicate ideas. They frequently write articles, publish research, and record data and observations. Likewise, students are able to use writing to articulate complex terms and synthesize concepts. It is a tool that students can use to understand and investigate content and share their knowledge with others. Writing allows students to translate complex ideas into words and language that they understand.

Writing to Learn

If a student is an exemplary writer in one discipline, it does not mean that they will have the same success writing in another (Gentry, McNeel, and Wallace-Nesler 2014). The writing required in STEAM careers often has a different voice and requires a different skill set from the writing required in social studies or language arts. A wide variety of writing assignments and activities can help students become actively engaged in STEAM. All of these writing formats encourage students to think about science, technology, engineering, arts, and math and connect prior knowledge or experiences with new learning:

- predictions and observations
- observation journals
- data collection tables
- prototype diagrams
- charts and graphs

Writing to Apply

When students use their new knowledge to write in a more formal manner, they are writing to apply. In these activities, students are asked to analyze and synthesize information and then communicate their thoughts in coherent, organized manners. This type of writing can be more challenging for students because they need to not only understand the content and be able to process it at a higher level but also communicate it using strategies of the writing process, features of the chosen genre, and conventions of the grade level. Opportunities for students to write as a means to communicate understanding may include the following:

- conclusions
- reflections
- expository writing
- opinion papers
- data summaries and analysis
- proposals

Research to Practice

Throughout *Smithsonian STEAM Readers*, there are opportunities for students to write analytically. A variety of writing assignments encourage discussion, develop critical-thinking skills, and help students become actively engaged. Writing is woven throughout the lessons and includes diverse activities that allow students to demonstrate mastery of content.

The Reading and Writing Connection

Reading and writing are interactive processes that use similar strategies. When taught together, they reinforce each set of skills and improve achievement. Together, reading and writing create an atmosphere of communication in which critical thinking is an integral part of the process. Teachers who promote higher-order thinking skills with both reading and writing processes will help develop critical thinking among their students.

Readers and writers engage in similar processes. “Composition and comprehension both involve planning, composing, and revising” (Roe and Smith 2009, 255). Students can be explicitly shown how the two processes are connected.

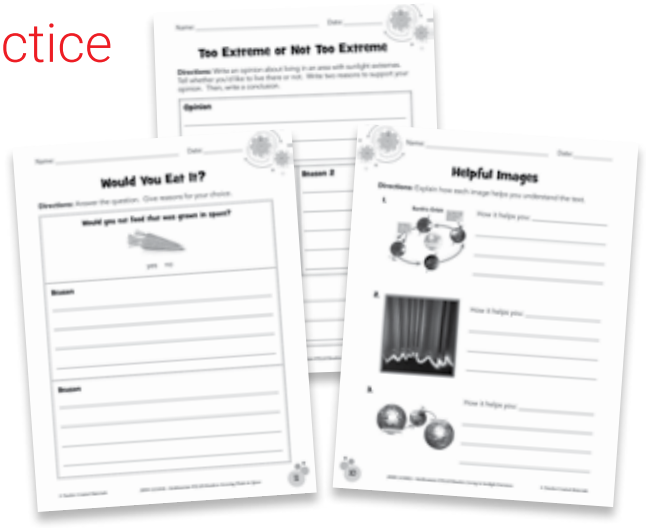
Readers	Writers
• Have a purpose for reading (before, during, and after reading).	• Have a purpose for writing (prewriting, revising, and editing).
• Use prior knowledge to make connections to a particular topic.	• Use prior knowledge when writing about a topic.
• Make predictions.	• Provide foreshadowing.
• Interpret the writer's meaning.	• Construct meaning.
• Change comprehension strategies while reading.	• Change and develop meaning while writing.
• Reread to clarify meaning.	• Rewrite to clarify meaning.

Writing is often the expression of ideas and thoughts gathered while reading. Textbooks can be heavily loaded with difficult vocabulary words and complex concepts that are challenging for students to understand. Encouraging students to both read and write helps them process the information presented. When students read content without writing about it, they miss a crucial step in the process of comprehending information.

Writing helps create the bridge between content knowledge and understanding. A wide variety of writing assignments and activities can help students become actively engaged in their learning. Additionally, writing activities promote active learning, encourage discussion, engage all students, and develop critical-thinking skills.

Research to Practice

Reading and writing activities in this series are woven throughout the lessons to make content more meaningful.



STEAM Education and the Makers Movement

STEM has become a common educational acronym over the past decade. Creativity is another essential component for innovation. The need for creative thinkers helped to launch the STEAM movement, as well as the Makers Movement. "The *A* is where STEAM and making intersect. It is at this intersection where student engagement soars" (Maslyk 2016, 10). Blending arts principles with STEM disciplines prepares students to be problem-solvers, creative collaborators, and thoughtful risk-takers. Even students who don't choose careers in STEM or STEAM fields will benefit because these skills can be translated into almost any career.

Rodger W. Bybee (2013, 64) summarizes what is expected of students as they join the workforce:

> *As literate adults, individuals should be competent to understand STEM-related global issues; recognize scientific from other nonscientific explanations; make reasonable arguments based on evidence; and, very important, fulfill their civic duties at the local, national, and global levels.*

Likewise, STEAM helps students understand how concepts are connected as they gain proficiency in the Four Cs: creativity, collaboration, critical thinking, and communication.

Research to Practice

This series immerses students in STEAM with:

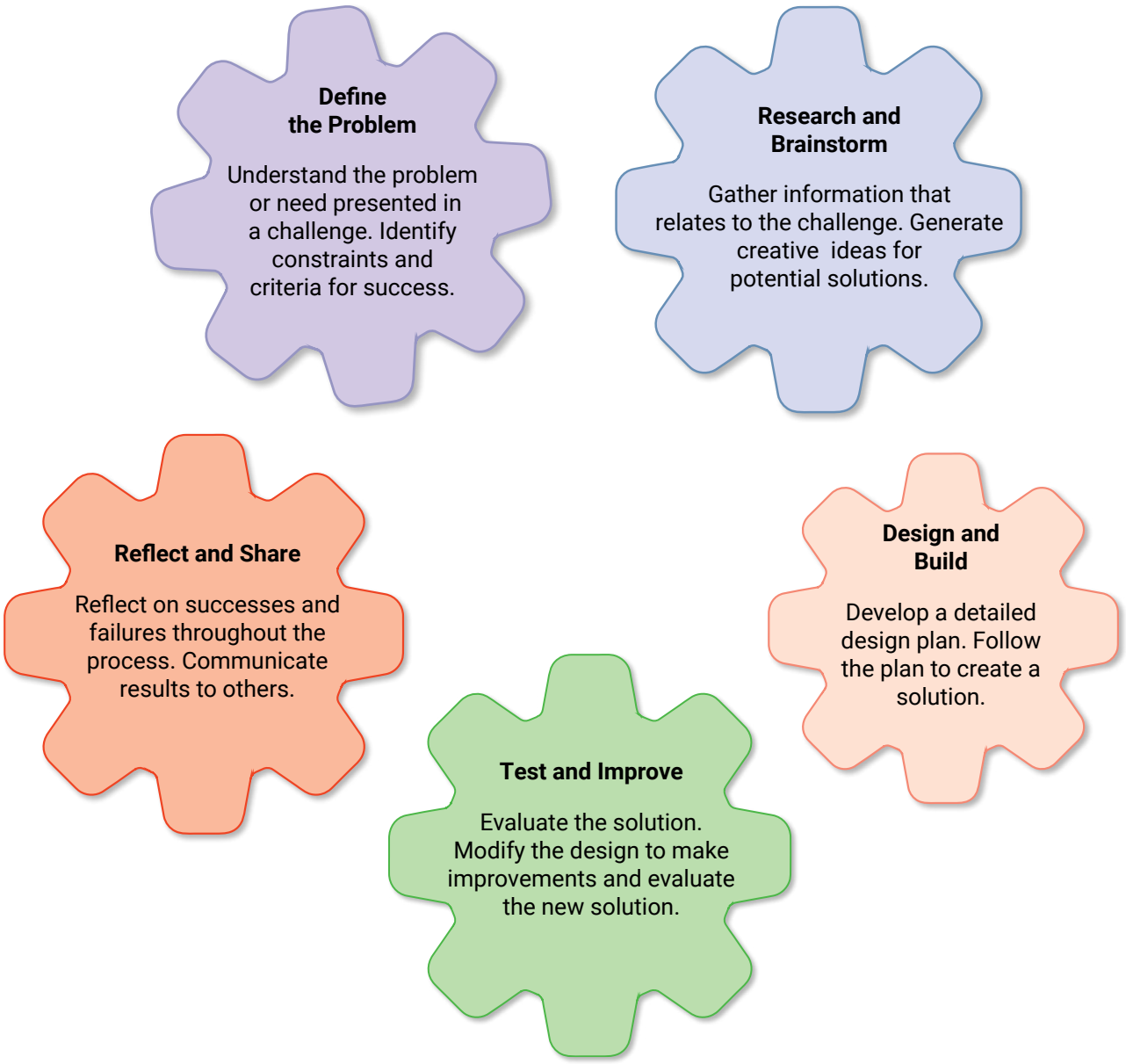
- Informational texts that explore **engineering innovations** and **solutions to real-world problems**, highlighting how each STEAM component (science, technology, engineering, arts, and math) applies.
- STEAM Challenges that prompt students to use **creativity**, **collaboration**, **critical thinking**, and **communication skills** to find solutions.
- Content and images that inspire **curiosity**, **perseverance**, and **wonder** about the world.

The Engineering Design Process

The most essential component of STEAM education is the engineering design process. This process is an articulated approach to problem solving in which students are guided through the iterative process of solving problems and refining solutions to achieve the best possible outcomes. "It is important to point out that these components do not always follow a set order, any more than do the 'steps' of scientific inquiry. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that just isn't working out" (NGSS Lead States 2013, 2). The lessons in *Smithsonian STEAM Readers* provide opportunities for learners to interact with challenges in multiple ways.

Research to Practice

Each lesson in this series presents students with a STEAM Challenge that guides them through the **engineering design process** to solve a problem.



The 5E Model

The BSCS 5E Instructional Model describes five phases of learning that follow the constructivist learning theory (Bybee 2015). In this theory, new knowledge is built upon existing knowledge and experiences. The 5Es include *engage, explore, explain, elaborate,* and *evaluate.* Each of these phases of learning helps to focus students on learning objectives while connecting objectives to prior knowledge and alternate applications of new knowledge.

Connecting the Engineering Design Process and the 5E Model

The lessons in *Smithsonian STEAM Readers* support both the engineering design process and the BSCS 5E Instructional Model. This table includes a description of what students will do during each section of the lesson and the corresponding stages of the engineering design process and the 5E model.

Lesson Section(s) and Activities	Engineering Design Process Stage	BSCS 5E Instructional Stage
Introductory and Before Reading Activities Engage students in the lesson by revealing the STEAM Challenge, including the constraints and criteria.	Define the Problem	Engage
During Reading and After Reading Activities Have students explore the content of the reader and gather any relevant information for the challenge.	Research and Brainstorm	Explore
STEAM Challenge Have students use what they have learned to explore and create design options independently and in teams. Have teams use their design plans to build a solution.	Design and Build	
Have teams test their designs and explain their results. Challenge teams to elaborate on their understanding of the concepts by optimizing their designs.	Test and Improve	Explain and Elaborate
Assessments Have students reflect throughout the process and evaluate their work at the end, sharing their reflections with others. Evaluate students with assessments for progress monitoring and summative purposes.	Reflect and Share	Evaluate

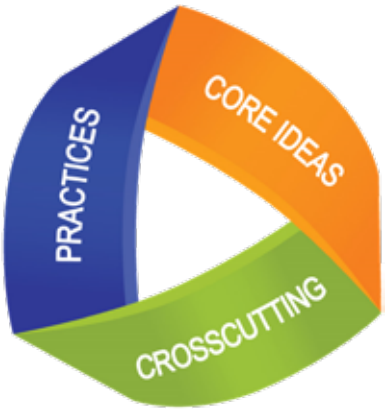
Next Generation Science Standards

The Next Generation Science Standards (NGSS) aim to help educators cultivate students' natural curiosity, push creative boundaries, and get students excited about science and technology. The NGSS were developed from the *Framework for K–12 Science Education* (National Research Council 2012). The Framework provides a sound, evidence-based foundation for standards by drawing on current scientific research—including research about the ways students learn science effectively—and identifies the science all K–12 students should know.

The developers of the NGSS recognized that a deep understanding of science concepts requires more than rote memorization of key ideas and science facts. There is a critical need for students to understand relationships among concepts and how to apply what they have learned to find solutions to new challenges. To do so, the standards integrate three important dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas.

NGSS Dimensions

- The **Science and Engineering Practices** describe behaviors that scientists and engineers engage in as they investigate and build models and theories about the natural world. They include the practices that engineers use as they design and build models and systems.
- **Crosscutting Concepts** are big ideas that link the domains of science.
- The **Disciplinary Core Ideas** describe—at each grade from kindergarten through high school—what each student should know in physical science, life science, Earth and space science, engineering, technology, and applications of science.



Research to Practice

To meet the needs of students and teachers, lessons in this series support the dimensions of the Next Generation Science Standards: **Science and Engineering Practices**, **Crosscutting Concepts**, and the **Disciplinary Core Ideas**.

Differentiating for All Learners

Today's classrooms are filled with students of varying backgrounds, reading abilities, and learning styles. A teacher's ability to differentiate instruction and respond effectively to the needs of a variety of learners is critical to the success of any program (Henry and Pianta 2011). *Smithsonian STEAM Readers* includes specific callouts which offer suggestions for challenging and supporting students. These options differentiate what is taught, how it is taught, and the products students create to show what they have learned.

Above-Level Support

All students need a firm foundation in the core knowledge of the curriculum. Learners may not know much of this information before a lesson begins. Activities and end products can be adapted for all learners. Some examples may include:

- questions that require higher-order thinking skills
- opportunities to extend and apply learning to more complex situations

On-Level Support

Support is provided for learners to successfully analyze texts and the engineering design process. Some examples may include:

- graphic organizers to support thinking
- open-ended activities to allow students to share their learning in diverse ways

Below-Level Support

Differentiation strategies help teachers vary instructional techniques and materials to make content more concrete. These strategies offer extended support for learners, including:

- concrete representations to build and demonstrate comprehension
- extra time for guided practice

Multilingual Learners Support

Multilingual learners are being introduced to content and language simultaneously. Although students may have acquired social language skills, the language of school is academic in nature. Scaffolding is provided in the series to add context to language and to connect content to students' lives.

- Extra time is given to practice applying vocabulary from the text.
- Context is built into texts and activities.
- Content is supported through graphics, illustrations, and other visual images.
- Listening, speaking, reading, and writing activities support the four domains of language acquisition.

Universal Design for Learning Tools in This Series

In addition to the leveled texts and opportunities for scaffolding offered by the lessons, *Smithsonian STEAM Readers* includes a variety of tools to help teachers make the learning accessible for all students.

- Audio recordings of texts model fluency and offer support for all learners.
- Ebooks support student learning through video, audio, and other digital tools.
- Graphic organizers support visual learners and language learning.
- Leveled texts support all learners.
- STEAM Challenges incorporate student choice and open-ended responses.

Using Technology to Improve Literacy

Research shows that "technology—when implemented properly—can produce significant gains in student achievement and boost engagement" (AEE 2014, para. 1). Students need to use technology to "explore and create" rather than simply as practice or test preparation (AEE 2014, para. 4).

Instructional Settings for Digital Pathways

The digital learning resources provided in *Smithsonian STEAM Readers* offer opportunities to add greater accessibility beyond print resources through images, audio recordings, videos, and read-along ebooks. These resources enhance student learning in a variety of instructional settings, support English language acquisition, and further content and literacy learning.

Whole Class

This grouping is best suited for introducing a text or for teaching specific content-area concepts. In this setting, every student engages with the same text at the same time. Projecting texts or STEAM Challenges creates a large canvas for a shared literacy experience.

Small Group

Students can navigate to texts or digital activity sheets. This limits transition times and fosters engagement. By using built-in digital tools, teachers can help students focus on specific language, fluency, and content-area skills.

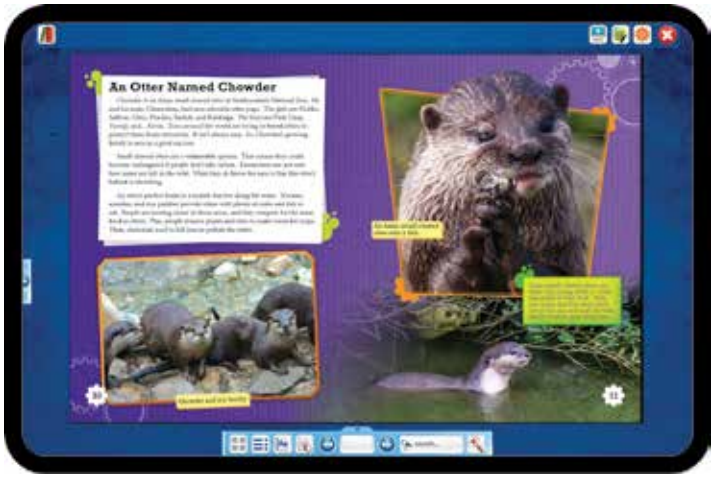
Independent Practice

Students use the digital tools to navigate texts on their own. The interactive features can be used to increase rigor and allow students to extend their own knowledge. Digital displays and audio recordings allow students to approach texts through diverse media.

Research to Practice

Each kit in this series features a variety of digital resources that help teachers weave technology into literacy instruction:

- **Professional audio recordings** of each book serve as models of fluent reading and provide additional support for English language learners and struggling readers.
- **Interactive texts** provide digital spaces in which students can interact with the content of the texts. To build fluency in reading, students can click to hear the text read aloud. Engage students with relevant additional activities, which allow for fluency practice and building twenty-first century skills.



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