Education Week

# SPOTLIGHT

2019


—Houston Cofield for Education Week

Ashley Palmer, a kindergarten teacher in Matthews, Mo., works with students on letter names using flashcards.

# CRITICAL THINKING

## EDITOR'S NOTE

Educators are finding ways to improve critical thinking skills among their students. In this Spotlight, check out tips for teaching problem-solving, explore how teachers are boosting reading comprehension, and discover how educators are teaching students to critically evaluate media sources.

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*Published on October 8, 2019, in Education Week*

# Students Learn More From Inquiry-Based Teaching, International Study Finds

## Experiment had 17,000 students in 4 countries

By Sarah D. Sparks

Introducing math and science through inquiry- and problem-based instruction can pay off throughout elementary school, according to a massive international series of studies.

Education economists Emma Näslund-Hadley and Rosangela Bando, of the Inter-American Development Bank, and Paul Gertler of the University of California, Berkeley, conducted 10 randomized controlled experiments with more than 17,000 students in Argentina, Belize, Paraguay, and Peru, four countries working with the Inter-American Development Bank to implement inquiry-based math and science programs.

The researchers randomly assigned preschool, 3rd, and 4th grade classes to use either inquiry-based instruction or the standard math and science instruction in their schools—which generally involved teacher lectures, memorization, and practice. (While students in most countries were assigned by class, in Peru students were taught in small groups of four to seven students, and so they were assigned individually.)

The studies were laid out last week in a working paper of the National Bureau of Economic Research. The findings come as more schools in the United States and throughout the Americas explore problem- and inquiry-based programs, particularly in science and math. These are the largest-scale randomized trials on the approach, and the first to look at preschool students as well as those in elementary grades.

### Difference in Practice

A typical lesson looked very different in the standard and inquiry-based classes.

"When kids did hands-on experiments in [a standard] science class, the teacher was doing the experiment in front of the class—no opportunity for hands-on learning," Näslund-Hadley said.

In a unit on ratios in Belize, for example, a teacher in a typical math class would explain the definition of a ratio and demonstrate basic problems; students then spent the rest of the period practicing problems, before being quizzed.

In the inquiry class, by contrast, the teacher compared the number of students wearing short- and long-sleeved shirts and similar examples within the classroom to start students thinking about the concept, then paired off students to come up with their own definitions of what a ratio could be. The class worked though exercises on how ratios might be used in real life, such as using colored rods of different lengths to measure their desks and look at the relationships between the unit length and the number of rods needed to measure. Then the teacher and class discussed their findings and decided on a revised definition of the ratio concept.

Inquiry- or problem-based learning has taken off in recent years in U.S. schools in the wake of Common Core State Standards and Next-Generation Science Standards, as well as in schools around the world.

—Meggan Haller/Keyhole Photo for Education Week

First graders Devlin Griffin, Kollin Coleman, and Ledger Hardy wait nervously to determine whether the "nest" they engineered with aluminum foil will support the weight of a raw egg in a "tree" of paper towel rolls. The exercise was part of an inquiry-based science lesson last year at Hutchens Elementary School in Mobile, Ala.

"What we saw with respect to gender was the teachers appear to have implicit gender biases and tend to focus more on the boys in the classroom," she said. In projects that involved more group and class discussions and collaboration, that problem was exacerbated. Näslund-Hadley said the countries have since been working to provide more training before and during implementation to encourage teachers to involve students more equitably.

Still, the studies found inquiry- or problem-based instruction could prove more cost-effective than standard instruction, particularly for improving achievement for low-income students. (Average incomes in the countries range from just over $4,000 a year in Paraguay to $12,440 a year in Argentina, in U.S. dollars.)

Using the inquiry-based instruction, the researchers found the cost of increasing math test scores by a tenth of a standard deviation in a year was just over $18 per student in math and under $18 per student in science.

"It's interesting to observe that it not only works, but works in a variety of contexts. That makes the investment more worthwhile," said Bando of the Inter-American Development Bank. She noted that the bank has since been working with the governments to provide the framework and materials for the curriculums for free.

The researchers compared the range of scores on standardized math and science tests in each group before starting to implement the inquiry-based instruction, and then again seven months later. They found that in the classes that used inquiry-based instruction at least four days a week during that time, students improved significantly more in math and science than students in the regular classes. The average student in inquiry classes performed 0.14 of a standard deviation higher than the average student in a standard class in science and 0.18 of a standard deviation higher in math by the end of the school year.

Students across grades and across countries showed similar benefits from the inquiry-based classes, including the preschoolers.

"It's fascinating because when we have discussed the possibility of doing this research with governments in the region, they said, 'Oh, the children must be too young to do anything like this,'" Näslund-Hadley said, "and now they've actually noted that that is possible for younger children to think like a scientist."

"Clearly it is possible to work scientific and mathematical thinking from a very, very early age without making it ... rote memorization," she said.

At that rate of improvement, the researchers estimated the average student in inquiry-based math and science classes for four years would perform nearly two-fifths of a standard deviation better than their peers in math and more than one-fifth of a standard deviation better in science. Standard deviation is the measure of how a given set of test scores vary.

## Gender Gaps and Costs

While both boys and girls improved in inquiry-based classes, the researchers found that boys improved faster, widening the gender achievement gap. Overall, boys in inquiry classrooms improved by .22 of a standard deviation over peers in math, compared to girls improving .15 of a standard deviation more than peers in standard classes. The same held in science, with boys improving .18 of a standard deviation, compared to a tenth of a standard deviation for girls.

"That was highly shocking," Näslund-Hadley said. "It's not that girls lost ground from the inquiry; they grew more than boys [in standard classes.] The bump in improved learning was so much greater for the boys. ■

### What Is an Inquiry-Based Lesson?

New research suggests students can benefit from inquiry- and problem-based instruction in math and science classes, even in very early grades.

Programs and approaches can vary, but researchers found some common elements:

- Students are presented with a question or problem that they must work on collaboratively to solve or explain.
- Students learn both to seek outside credible sources and to collect their own data to investigate the problem.
- Students work with others to develop theories and explanations.
- Teachers incorporate explicit instruction and scaffolding at relevant points during the inquiry, connecting the content students have learned and the processes they used to complete the activity to other core concepts and ways students could solve similar problems in the future.

*Published on June 6, 2019, in Education Week's Digital Education Blog*

# Does Technology Help Boost Students' Critical Thinking Skills?

By Alyson Klein

Does using technology in school actually help improve students' thinking skills? Or hurt them?

That's the question the Reboot Foundation, a nonprofit, asked in a new report examining the impact of technology usage. The foundation analyzed international tests, like the Programme for International Student Assessment or PISA, which compares student outcomes in different nations, and the National Assessment of Educational Progress or NAEP, which is given only in the U.S. and considered the "Nation's Report Card."

The Reboot Foundation was started—and funded—by Helen Bouygues, whose background is in business, to explore the role of technology in developing critical thinking skills. It was inspired by Bouygues' own concerns about her daughter's education.

The report's findings: When it comes to the PISA, there's little evidence that technology use has a positive impact on student scores, and some evidence that it could actually drag it down. As for the NAEP? The results varied widely, depending on the grade level, test, and type of technology used. For instance, students who used computers to do research for reading projects tended to score higher on the reading portion of the NAEP. But there wasn't a lot of positive impact from using a computer for spelling or grammar practice.

And 4th-graders who used tablets in all or almost all of their classes scored 14 points lower on the reading exam than those who reported never using tablets. That's the equivalent of a year's worth of learning, according to the report.

However, 4th-grade students who reported using laptops or desktop computers "in some classes" outscored students who said they "never" used these devices in class by 13 points. That's also the equivalent of a year's worth of learning. And 4th-grade students who said they used laptops or desktop computers in "more than half" or "all" classes scored 10 points higher than students who said they never used those devices in class.

Spending too much time on computers wasn't helpful.

"There were ceiling effects of technology, and moderate use of technology appeared to have the best association with testing outcomes," the report said. "This occurred across a number of grades, subjects, and reported computer activities."

In fact, there's a negative correlation between time spent on the computer during the school day and NAEP score on the 4th-grade reading NAEP.

That trend was somewhat present, although less clearly, on the 8th-grade reading NAEP.

"Overall usage of technology is probably not just not great, but actually can lower scores and testing for basic education [subjects like math, reading, science]," said Bouygues. "Even in the middle school, heavy use of technology does lower scores, but if you do have things that are specifically catered to a specific subject, that actually serves a purpose."

For instance, she said her daughter, a chess enthusiast, has gotten help from digital sources in mastering the game. But asking kids to spend a chunk of every day typing on Microsoft Word, as some classrooms do in France, isn't going to help teach higher-order thinking skills.

She cautioned though, that the report stops short of making a casual claim and saying that sitting in front of a laptop harms students' ability to be critical thinkers. The researchers didn't have the kind of evidence needed to be able to make that leap. ■

**Table 1.7 Average scale scores on 2017 NAEP, grade 4 reading, by hours spent every day on the computer at school for English/language arts work and school poverty level**

| Percent of students eligible for National School Lunch Program | Less than 30 minutes | About 30 minutes | About 1 hour | About 2 hours | About 3 hours | 4 hours or more |
|---|---|---|---|---|---|---|
| 0-25% | 246 | 241 | 240 | 230 | 234 | 219 |
| 26-50% | 234 | 230 | 228 | 223 | 217 | 199 |
| 51-75% | 226 | 222 | 220 | 216 | 204 | 192 |
| 76-100% | 213 | 211 | 206 | 200 | 188 | 180 |
| National average | 231 | 226 | 222 | 216 | 206 | 192 |

**Table 1.8 Average scale scores on 2017 NAEP, grade 8 reading, by hours spent every day on the computer at school for English/language arts work and school poverty level**

| Percent of students eligible for National School Lunch Program | Less than 30 minutes | About 30 minutes | About 1 hour | About 2 hours | About 3 hours | 4 hours or more |
|---|---|---|---|---|---|---|
| 0-25% | 284 | 282 | 282 | 279 | 273 | 264 |
| 26-50% | 275 | 269 | 269 | 270 | 267 | 249 |
| 51-75% | 266 | 259 | 259 | 261 | 256 | 250 |
| 76-100% | 255 | 248 | 250 | 252 | 246 | 237 |
| National average | 272 | 266 | 266 | 267 | 262 | 251 |

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# Critical Thinking Empowers Students and Staff at Tool Elementary School

**TAKE ONE STEP** into Tool Elementary School, and you'll encounter a small, yet mighty staff of educators who are passionate and excited about student learning. Located in Tool, Texas, Tool Elementary lies on the outskirts of Malakoff Independent School District. The school has a large number of economically disadvantaged students and a high mobility rate – but that hasn't dissuaded Principal Christal Calhoun from creating an effective learning environment with a robust curriculum.

"Every school has different needs, and the principal's role changes with those needs," said Calhoun. "I wear many hats – I give input on Response to Intervention, I'm the point-person for our instructional environment and curriculum support, but most importantly, I'm lead lover."

Currently in her sixteenth year as an educator, Principal Calhoun set faculty up for success by implementing Mentoring Minds' ThinkUp! system, ensuring that Tool Elementary's 250+ students are exposed to an education rooted in critical thinking, social and emotional support and compassion.

## Creating a Culture of Critical Thinking

When she first discovered Mentoring Minds eight years ago, Principal Calhoun knew it would be instrumental in helping Tool Elementary reach toward a new level of achievement. Over the years, educators at Tool Elementary have used Mentoring Minds' classroom resources for building a school-wide culture of critical thinking.

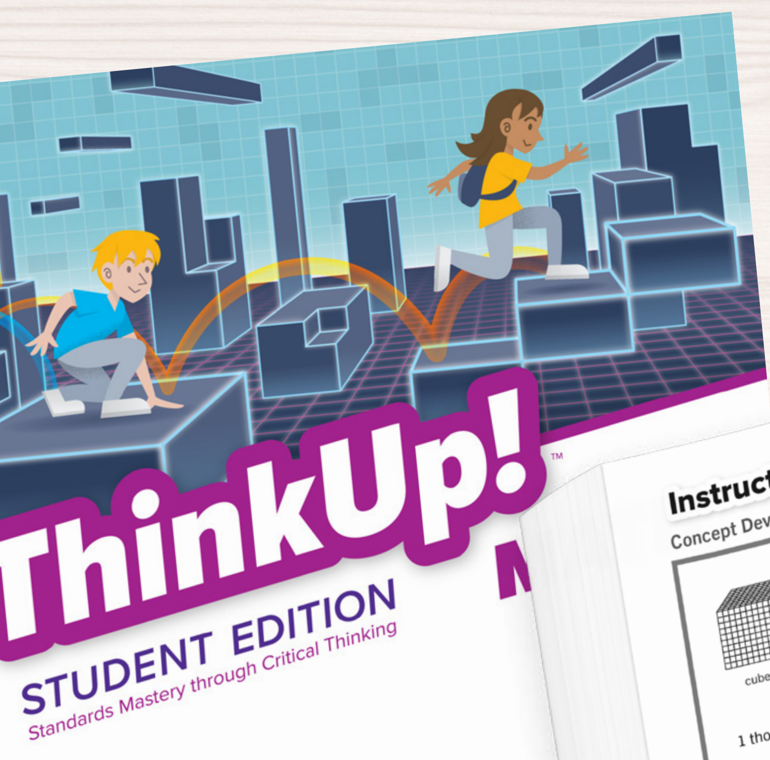

With ThinkUp! Standards Mastery System, teachers are guided in creating a thinking culture that promotes student engagement and deeper understanding, using cross-curricular activities to introduce students the 9 Traits of Critical Thinking™.

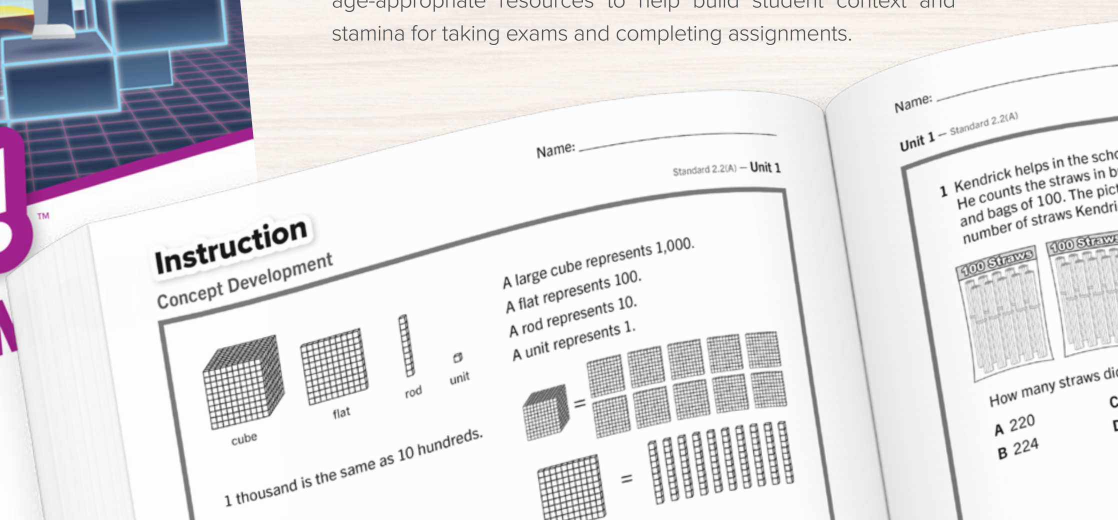
When it comes to change, Principal Calhoun believes "you have to start somewhere, otherwise you'll be dreaming and wishing forever." Her belief in ThinkUp! and the power of critical thinking is embedded in Tool Elementary's school culture, contributing to the lifelong success of students. Calhoun attributes successes at Tool Elementary to the dedicated teachers who always "go the extra mile."

"These teachers want the best for their students and they know they can get that with Think Up!," said Calhoun. "Our teachers are the real heroes that carry a vision for their students, and they work hard every day to achieve it."

## Using Classroom Time to Bridge Gaps in Experience

Students who are economically disadvantaged don't always have exposure to the same experiences that shape vocabulary and comprehension as their peers. For those students, teachers *are* their experience and models for vocabulary. ThinkUp! provides age-appropriate resources to help build student context and stamina for taking exams and completing assignments.



# Critical Thinking Empowers Students and Staff at Tool Elementary School

Educators at Tool Elementary understand that every learner is unique, and even if students are struggling, they are still learning. ThinkUp! emphasizes the importance of growth and risk-taking during instruction, helping students become confident learners.

> *"Just like anything else in life, if knowledge is easily obtained we tend not to appreciate it as much – learning is a process, and making mistakes is a critical part of the journey."*

## An Effective Framework for Educators

Many educators who enter Tool Elementary are in their first year of teaching, and Principal Calhoun is there to provide guidance. She believes in helping teachers become well-rounded instructors who are able to support students' social and emotional needs in addition to academic ones.

"Teachers need to meet students' needs first, and those needs aren't always educational – they're social and emotional, too," said Calhoun. "When educators understand this, they're able to build stronger relationships with students, and in turn, become well-rounded instructors."

The ThinkUp! Teacher Edition reinforces the importance of self-reflection for staff and acts as a support to educators throughout curriculum. Teachers are able to read through guiding questions that help adjust lessons to needed levels, and are encouraged to self-reflect throughout the semester to identify instructional challenges and opportunities.

"After implementing ThinkUp!, I had faculty members running to my office to share data with me because they're excited about the outcome," Calhoun said. "Our teachers feel comfortable using

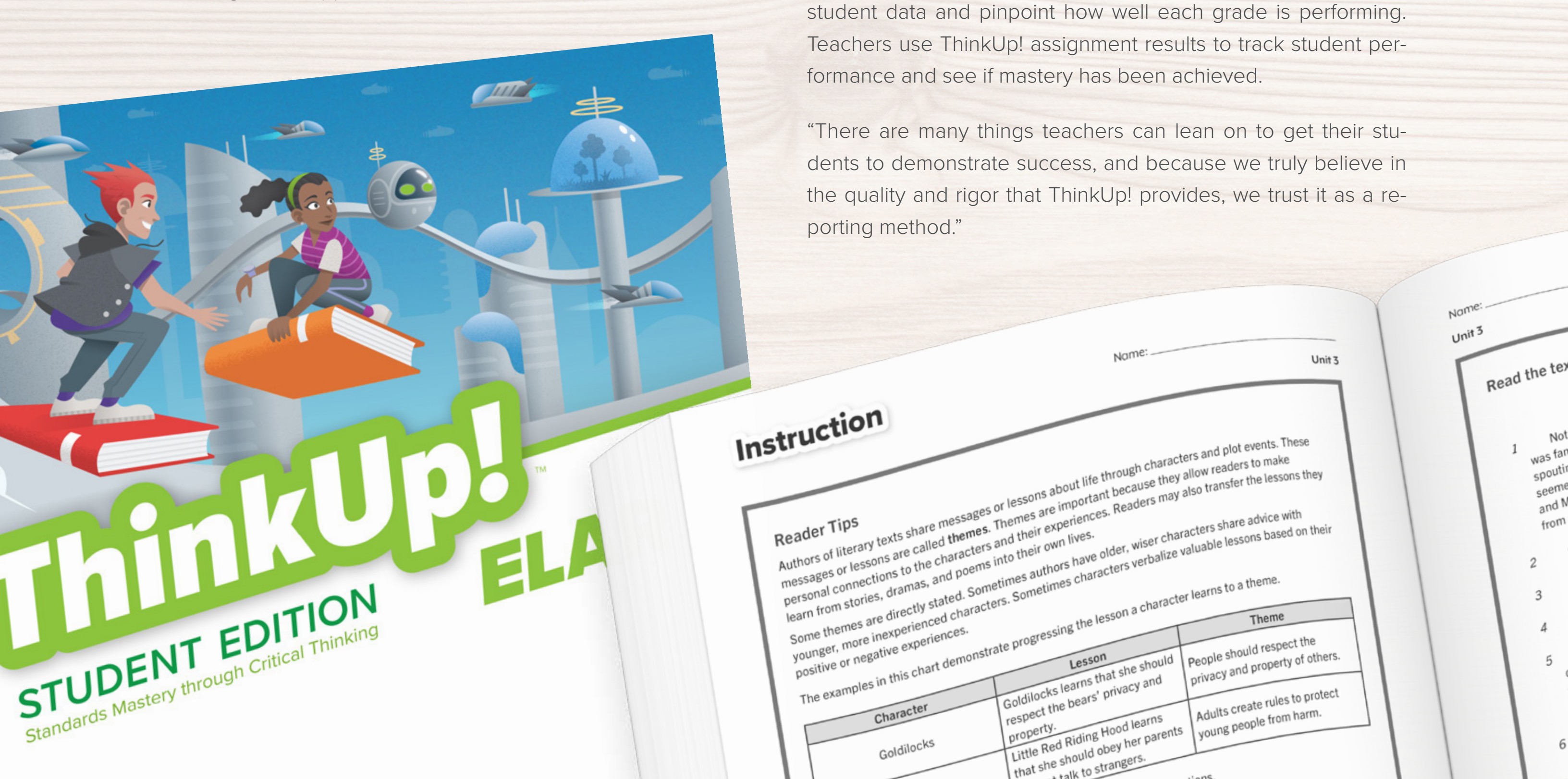

ThinkUp! data to gauge student growth and identify what adjustments they can make in the classroom to support the process."

Tool Elementary is a 1:1 school, and beginning in third grade, every student receives a Chromebook to use for schoolwork. As education continues to go digital, more and more states are moving student assessments online – making it imperative that learners feel comfortable using technology.

"Our third- through fifth-grade teachers recently started giving online interim assessments in English, reading and math, and were shocked when students were using tools on their Chromebooks, such as the highlighter, without being prompted to do so," Calhoun said. "Students were using strategies they learned to do on paper to work through the exams, and we've attributed that to ThinkUp!'s digital activities."

Every three weeks, faculty at Tool Elementary meets to examine student data and pinpoint how well each grade is performing. Teachers use ThinkUp! assignment results to track student performance and see if mastery has been achieved.

"There are many things teachers can lean on to get their students to demonstrate success, and because we truly believe in the quality and rigor that ThinkUp! provides, we trust it as a reporting method."



# Critical Thinking Empowers Students and Staff at Tool Elementary School

## Creating STAAR Students

In third through fifth grade, Texas students are required to take STAAR exams, which cover reading, writing, math, science and social studies. To help students prepare for these assessments, teachers at Tool Elementary use ThinkUp!'s Concept Checks to help students review key subject matter. ThinkUp! lessons are used to anticipate state expectations for student mastery, and are incorporated throughout curriculum to supplement student learning.

"The worst feeling for any teacher is to work so incredibly hard to prepare students, but have it not be deep enough to help them succeed on a state assessment – ThinkUp! helps us avoid that," said Calhoun.

Every three weeks, Principal Calhoun meets with teachers to ask about student averages with Mentoring Minds to make sure student performance aligns with mastery goals. Since ThinkUp! sets learning targets at the beginning of every lesson, teachers feel confident that they're students are working toward the appropriate skill targets.


[See how critical thinking empowers students and staff at Tool Elementary School.]

Over the years, Tool Elementary staff have surpassed their goal for each student to pass the STAAR exam, and now produce high percentages of mastery in each grade level for reading and math.

## Mentoring Minds Nurtures Students and Staff

Tool Elementary has earned national and local recognition for its successes, including being named a National ESEA Distinguished School and a National Blue Ribbon Schools nomination. And, as testament to her hard work and passion for education, Principal Calhoun was named 2019 NAESP National Distinguished Principal for Texas.

Teachers at Tool Elementary do everything they can to help students experience a great level of success. To provide a top-of-the-line education for students, faculty invests in products that prioritize quality over quantity, and offer a level of rigor that meets the expectations they have for students.

"The support that Mentoring Minds has shown us means everything," said Calhoun. "From providing sponsorships to product support, their team does so many things that show that they are working in the education industry to positively impact the lives of students and educators."

Through critical thinking, teacher support and a principal who prioritizes compassion, students at Tool Elementary are set up for success – no matter their background.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*Published on December 3, 2019, in Education Week's Special Report: Getting Reading Right*

# More Than Phonics: How to Boost Comprehension For Early Readers

By Sarah Schwartz

MATTHEWS, MO.

What do you do when you hear a word you don't know? In Ashley Palmer's kindergarten class, you stop. And you talk about it.

Palmer, a teacher at Matthews Elementary School in Missouri's New Madrid district, was telling a story about a family of toy lions during one morning lesson when she got to the word "lass."

"That's one of our vocabulary words," she told the group of children sitting cross-legged on the rug. Then she led the students in clapping out its one syllable, then segmenting the sounds: /l/, /a/, /s/.

"It's another word for 'girl,'" Palmer said. "Sometimes when I line you up for bathroom break, instead of saying girls, or ladies, I can say, 'If you are a—"

"Lass!" the students shouted out, as some sat up on their knees. "'If you are a—lass—you can line up,'" Palmer finished.

The whole process is deceptively simple—it took less than 60 seconds—but this kind of embedded vocabulary instruction is a key piece of Matthews' overhauled early reading program. Just five years ago, only about 14 percent of the school scored proficient on the state's annual assessment. The numbers have grown steadily to the point where this year, 80 percent of the students met the standard. In 3rd grade, the numbers reached 95 percent.

In the literacy world, there's a perennial concern that focusing on foundational skills will come at the expense of giving kids opportunities to practice language and enjoy stories. But researchers and educators say that it's not only possible to teach useful vocabulary and meaningful content knowledge to young children—it's necessary.

A body of research has shown that once students can decode, their reading comprehension is largely dependent on their language comprehension—or the background and vocabulary knowledge that they bring to a text, and their ability to follow the structure of a story and think about it analytically.

Before students can glean this kind of information from print, experts say, they can do it through oral language: by having conversations about the meaning of words, telling stories, and reading books aloud.

At Matthews, an explicit, systematic approach to phonics instruction has helped drive the big jumps in student achievement—but it's only one part of the equation, said Angie Hanlin, the school's principal. The school took on a complete restructuring of its reading program, which included changing the way teachers planned and taught vocabulary and reading comprehension.

"Putting a phonics patch on a reading program or on a school is not going to teach all students to read," Hanlin said. "It is not going to fix it, and it's not going to drive up the data."

This is the premise behind the Simple View of Reading, a framework for comprehension first proposed by researchers Philip B. Gough and William E. Tunmer in 1986, and confirmed by later studies.

The simple view holds that reading comprehension is the product of decoding ability and language comprehension. Kids who can't decode words won't be able to read, no matter how much vocabulary they know, or how much they know about the world. But the opposite is also true: If they don't have this background knowledge, children won't be able to understand the words that they can read off the page.

## Engaging With Rich Content

"Decoding has a really outsized role on reading comprehension in the early grades," said Gina Cervetti, an associate professor of education at the University of Michigan, who studies the role of content-area knowledge in literacy. "But as students consolidate their decoding, very quickly that equation shifts."

As students progress into 2nd, 3rd, and 4th grades, texts become more challenging—there are bigger words, harder concepts, and more assumptions about what students already know about the world.

Kids need to start engaging with rich content early on, so that once they are expected to read it on the page, they understand what's going on. If they haven't de-

—Houston Cofield for Education Week

Ava Newton, a student in Ashley Palmer's kindergarten class, points at the projector screen during a reading comprehension lesson.

veloped that foundation, it's hard to catch up quickly, said Cervetti.

"To learn words well, you need to encounter them again and again," said Margaret McKeown, a senior scientist at the Learning Research and Development Center at the University of Pittsburgh, and an expert in vocabulary instruction. As very young children learn words, they start to form connections in the brain—links that join synonyms together, or relate words that are used in similar situations. This gives bigger, harder words a place to land when students learn them, McKeown said. "The concepts aren't new," she said. "They're just more sophisticated or refined ways to describe similar things."

At Matthews Elementary, teachers meet once a week to go through their foundational skills lessons and read-aloud books. The curriculum they use identifies vocabulary words that can be embedded in lessons. But the teachers also look for words in the text that their students specifically might struggle with.

In this week's kindergarten class, one of those words was "living room." Palmer had introduced the word earlier that week—a lot of her students didn't have a space in their homes that they called by that name. In this day's lesson, she asked students to recall it, asking questions: What kind of room has a couch? A chair?

Matthews is in a small, rural county, where the majority of students receive free and reduced-price lunch. Hanlin said that a lot of books, even for young readers, assume life experience her students don't have. So teachers build on the knowledge that students do have. For example, Hanlin said, students might not know the word "cathedral." But they do know the word "church."

It's important to do this kind of planning ahead, said Tanya Wright, an associate professor of education at the University of Michigan, who studies oral language, vocabulary, and knowledge development.

Before a teacher reads a text to or with students, she needs to read it herself, Wright said. "You're going to know where you need to stop, where you need to explain." Ahead of time, teachers should plan child-friendly definitions, or figure out how they might use props or movements to demonstrate the word.

But this kind of planned vocabulary instruction may not be happening in most schools. In a study published in 2014, Wright and her colleagues observed the way teachers discussed vocabulary in 55 kindergarten classrooms. They found a general lack of planned and purposeful instruction—most teachers weren't talking about a word more than once or selecting words in any systematic way.

**52%** of teachers believe students can understand written text with unfamiliar words even if they don't have a good grasp of phonics.

SOURCE: Education Week Research Center

There are ways to draw out more conversation about vocabulary words, McKeown said. One strategy comes from an unlikely place: improv comedy groups.

In improv, comedians are taught to say, "Yes, and … to build off of the scenario that their fellow performers create. The same framework can help kids build related vocabulary. Take the word "cautious," McKeown said.

A student asked to use the word might say that he had to be cautious, because someone was riding a bike fast near him. The teacher can agree, and then expand on that same idea: "You had to be careful because it might be dangerous if someone hit you with their bike."

"You're always adding more words that are associated with the [main] word, demonstrating a greater context for words," McKeown said.

In a read-aloud that afternoon, Palmer's kindergarten class heard another story about a lion—this time, one that had escaped from the zoo and befriended a little girl. As the lion curled up for a nap in the girl's house, Palmer paused on the words "lions sleep a lot." She turned to give the students on the rug a puzzled look.

"Is that true?" she asked. She referenced a nonfiction book the class had read the day before, about lions in the wild. "They like to sleep and lie around 20 out of the 24 hours!" Palmer said.

As she continued to read, she made more links back to the nonfiction text, explaining as she went what was real and what was make-believe, adding in extra details that the nonfiction book hadn't covered. She made these implicit connections explicit for her students.

## Building Knowledge

Still other schools are turning to curricula that are purposefully structured to build knowledge—diving deeply into specific content areas, even in the very early grades. These curricula are based on the theory that all students need a similar foundation in core domains—like literature, the arts, science, social studies, and history—so that they have the knowledge base to support comprehension.

Educational theorist E.D. Hirsch is widely credited as the originator of this idea. His 1987 book, *Cultural Literacy: What Every American Needs to Know*, argued that schools need to expose students to the body of knowledge that authors and speakers will expect them to have. This idea has seen a resurgence in popular conversation more recently through author Natalie Wexler's 2019 book, *The Knowledge Gap: The Hidden Cause of America's Broken Education System—and How to Fix It*, which criticizes U.S. schools for prioritizing skills-based instruction over the teaching of content.

The notion that background knowledge informs understanding isn't very controversial. But proposals about exactly what knowledge schools should prioritize definitely are. Many teachers reject the idea of a shared literary canon, for example, arguing that it upholds a Eurocentric approach to American education that privileges the knowledge and histories of white Westerners at the expense of people of color.

But Jared Myracle, the chief academic officer in Jackson-Madison County schools in Tennessee, sees providing this kind of background knowledge as an equity issue.

Students from low-income families often don't come into school with the same depth of academic language that students from higher-income families do, limiting their ability to make meaning from what they read, he said. In Jackson-Madison county, the data bore out this divide: Schools where the vast majority of students received free and reduced-price lunch were trailing the district when Myracle started there in 2017.

Now, students spend an hour every day doing basic skills instruction—like naming and writing letters, practicing phonological awareness, and learning phonics—and an hour on what's called "listening and learning." These lessons teach topics through conversation and read-alouds—in kindergarten, they learn about plants, 1st grade is early civilizations, and 2nd graders cover systems of the human body.

Kristin Peachey, an instructional coach at Pope Elementary School in the district, said that talking about complex topics lets students engage at a higher level than they would through text at this early age.

A coherent unit of study also provides opportunities for teaching comprehension, said Cervetti, the University of Michigan professor. "You can't really reason about things in very sophisticated ways unless you know something about them," she said.

Students should have the opportunity to discuss questions that are open-ended, without a single answer, during read-alouds, said Wright. "If we're telling kids to think quietly and only be listeners and not participants in the read-aloud, then that's not optimal for their learning."

At Pope Elementary, teachers plan and talk through the questions they'll ask during read-alouds, said Peachey. Take a recent 2nd grade lesson about Greek mythology, she said. After teachers read the story "Atalanta and the Golden Apples," students were asked to reflect on characters' motivations: Why would Atalanta only marry someone who could beat her in a footrace?

Imparting a deep understanding of subject matter, and teaching children to think analytically—that takes time, said Myracle. "It's pretty easy to see gains on the foundational skills side, once you implement a systematic [phonics] program," he said. Knowledge-building is a longer process.

Myracle believes that the payoff will be worth it. But he worries that some districts will try on a content knowledge focus like a passing fad, dismissing it before they have the opportunity to see any effects.

"My biggest fear is that districts that are starting to do some of this work to build knowledge in early grades, that they won't stick with it," Myracle said. "The gains are going to be longer in coming." ■

*This story was produced with support from the Education Writers Association Reporting Fellowship program.*

—Getty

*Published on April 9, 2019, in Education Week's Inside School Research Blog*

# Two Ways to Add 'Computational Thinking' to Middle School Science

By Sarah D. Sparks

TORONTO

The Next Generation Science Standards call for science teachers to bring more "computational thinking" into middle school science. Two pilot projects at the American Educational Research Association meeting highlight why that's difficult, and two potential ways to do it.

Computational thinking draws on concepts from computer science—including organizing and analyzing data and modeling—to link science, technology, engineering, and math concepts and help students think about complex problems. As the use of technology and complex problem-solving becomes a bigger part of the workplace, education and business leaders alike have pushed for the concept to become a bigger part of STEM classes.

"This can be a very powerful strategy for students to learn science concepts as well as important problem-solving skills across various disciplines," said Danielle Cadieux Boulden, a researcher with North Carolina State University.

But it has proven tricky to integrate, she said. "The problem is, even though computational thinking has recently been very widely embraced, there's really no consensus pathway of how this is going to look in classroom practices," Boulden said. "Computational thinking is not yet entirely embraced by the K-12 community and in particular with the teachers—they are not exactly sure what this is going to look like in practice with their students."

At a symposium on the subject at AERA this week, researchers from North Carolina State University and from the University of Colorado, Boulder, highlighted two pilot programs to use computer modeling and environmental sensors to use computational thinking to enhance standard science units.

## Telling Computational 'Stories'

In Colorado, researchers Alexandra Gendreau Chakarov and Quentin Biddy are developing a series of "storylines," scenarios based on real-life news events that set up students to collect data and solve problems using environmental sensors. The researchers, along with partners at Utah State University, are piloting the curriculum with three science teachers and one integrated STEM teacher of 200 students in grades 5-8. The teachers learn to frame science concepts through computational thinking and co-develop storylines over four summer workshops.

For example, in one storyline, students watched a video about a school being closed due to mold exposure. The video launched a discussion of mold's life cycle, health effects, and how it could be found and dealt with in their own school. Students used digital environmental sensors to test for mold near bathrooms, drinking fountains, and other areas on campus, then collected and analyzed the data. At one school that actually found mold, the class developed a report and mold remediation plan which they presented to the principal.

While the curriculum is still in development, the researchers found after the first pilot, 82 percent of the students reported wanting to do another sensor-based project again, and 88 percent understood links between their computational activities and the science concepts in the standards.

The sensors cost about $100 for four students, but Chakarov said in the next iteration, the researchers are testing micro-bit sensors which provide a wider variety of information and cost about half that.

### Modeling Diseases: 'Bumping' and Blocks

In a separate project, North Carolina State University researchers think teaching students to code and model before helping them understand what they could use the skills for is putting the cart before the horse.

In a curriculum unit exploring epidemics, students first modeled a disease in person walking around the class and bumping into one another to "transfer" an illness as the teacher tracked the number of students infected in each iteration. That exercise allowed them to explore basic data collecting and predictions before starting to model on computers.

"The embodied-cognition activity actually allowed the students to embody the science ... and so it allowed us to talk about the benefits of joining that within a modeling environment instead of having to keep track of this by hand," said Jennifer Houchins of North Carolina State University. "So it allowed for that connection to why we would want to be doing this in a modeling environment."

The team initially taught students to model from scratch using an open-source tool called Blockly, but later modified the program to provide a set of example analysis code that students modify and take over throughout the class as they learn the scientific concepts and coding practices. They also embedded video-based tutorials to help students and teachers with coding specific pieces of the model, such as incorporating the time period in which different types of viruses are contagious.

"We're offloading some of that overwhelming nature of coming into a blank environment and not really knowing how to get started," Houchins said. "They use a prebuilt model to do some initial scientific exploration, get more comfortable with the environment and then they start modifying the code there. Taking over coding themselves allowed students to feel more ownership ... But also it allowed us to get the students into more complex scientific topics a little more quickly because they weren't having to learn [coding the analysis] at the same time."

Over the course of the unit, students learned to incorporate human behaviors and properties of different diseases to chart and predict different epidemics.

The researchers are still developing the pilot in the next year. "Creating a well-balanced curriculum is time intensive and requires many iterations in order to get it right," Houchins said. "You have to make important design decisions to support students in both the [computational thinking] and science practices. Getting that balanced is really critical, so that you're not striving to one side or the other." ■

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## COMMENTARY

*Published January 7, 2019, in Education Week's Next Gen Learning in Action Blog*

# 5 Steps to Teaching Students A Problem-Solving Routine

By Jeff Heyck-Williams

When I visited a 5th grade class recently, the students were tackling the following problem:

If there are nine people in a room and every person shakes hands exactly once with each of the other people, how many handshakes will there be? How can you prove your answer is correct using a model or numerical explanation?

There were students on the rug modeling people with Unifix cubes. There were kids at one table vigorously shaking each other's hand. There were kids at another table writing out a diagram with numbers. At yet another table, students were working on creating a numeric expression. What was common across this class was that all of the students were productively grappling around the problem.

On a different day, I was out at recess with a group of kindergartners who got into an argument over a vigorous game of tag. Several kids were arguing about who should be "it." Many of them insisted that they hadn't been tagged. They all agreed that they had a problem. With the assistance of the teacher, they walked through a process of identifying what they knew about the problem and how best to solve it. They grappled with this very real problem to come to a solution that all could agree upon.

Then just last week, I had the pleasure of watching a culminating showcase of learning for our 8th graders. They presented to their families about their project exploring the role that genetics plays in our society. Tackling the problem of how we should or should not regulate gene research and editing in the human population, students explored both the history and scientific concerns about genetics and the ethics of gene editing. Each student developed arguments about how we as a country should proceed in the burgeoning field of human genetics, which they took to Capitol Hill to share with legislators. Through the process, students read complex text to build their knowledge, identified the underlying issues and questions, and developed unique solutions to this very real problem.

Problem-solving is at the heart of each of these scenarios and is an essential set of skills our students need to develop. They need the abilities to think critically and solve challenging problems without a roadmap to solutions. At Two Rivers Public Charter School in the District of Columbia, we have found that one of the most powerful ways to build these skills in students is through the use of a common set of steps for problem-solving. These steps, when used regularly, become a flexible cognitive routine for students to apply to problems across the curriculum and their lives.

### The Problem-Solving Routine

At Two Rivers, we use a fairly simple routine for problem-solving that has five basic steps. The power of this structure is that it becomes a routine that students are able to use regularly across multiple contexts. The first three steps are implemented before problem-solving. Students use one step during problem-solving. Finally, they finish with a reflective step after problem-solving.

### Before Problem-Solving: The KWI

The three steps before problem-solving: We call them the K-W-I.

The "K" stands for "know" and requires students to identify what they already know about a problem. The goal in this step of the routine is two-fold. First, the student needs to analyze the problem and identify what is happening within the context of the problem. For example, students identify that they know there are nine people and each person must shake hands with each other person. Second, the student needs to activate their background knowledge about that context or other similar problems. In the case of the handshake problem, students may recognize that this seems like a situation in which they will need to add or multiply.

The "W" stands for "what" a student needs to find out to solve the problem. At this point in the routine, the student always must identify the core question that is being asked in a problem or task. However, it may also include other questions that help a student access and understand a problem more deeply. For example, in addition to identifying that they need to determine how many handshakes in the math problem, students may also identify that they need to determine how many handshakes each individual person has or how to organize their work to make sure that they count the handshakes correctly.

The "I" stands for "ideas" and refers to ideas that a student brings to the table to solve a problem effectively. In this portion of the routine, students list the strategies that they will use to solve a problem. In the example from the math class, this step involved all of the different ways that students tackled the problem from Unifix cubes to creating mathematical expressions.

This KWI routine before problem-solving sets students up to actively engage in solving problems by ensuring they understand the problem and have some ideas about where to start in solving the problem. Two remaining steps are equally important during and after problem-solving.

### During Problem-Solving: The Metacognitive Moment

The step that occurs during problem-solving is a metacognitive moment. We ask students to deliberately pause in their problem-solving and answer the following questions: "Is the path I'm on to solve the problem working?" and "What might I do to either stay on a productive path or readjust my approach to get on a productive path?" At this point in the process, students may hear from other students that have had a breakthrough or they may go back to their KWI to determine if they need to reconsider what they know about the problem. By naming explicitly to students that part of problem-solving is monitoring our thinking and process, we help them become more thoughtful problem-solvers.

### After Problem-Solving: Evaluating Solutions

As a final step, after students solve the problem, they evaluate both their solutions and the process that they used to arrive at those solutions. They look back to determine if their solution accurately solved the problem, and when time permits, they also consider if their path to a solution was efficient and how it compares with other students' solutions.

The power of teaching students to use this routine is that they develop a habit of mind to analyze and tackle problems wherever they find them. This empowers students to be the problem-solvers that we know they can become. ■

*Jeff Heyck-Williams is the director of curriculum and instruction for Two Rivers Public Charter School.*

## COMMENTARY

*Published on June 11, 2018, in Education Week's EdTech Researcher Blog*

# Critically Thinking About Critical Thinking

By Beth Holland

A few years ago, in an EdTechTeacher workshop, a teacher made a comment that stuck with me: "I want my students to be able to *sit with a problem.*"

This middle school science teacher found herself frustrated with her students' frantic rush to just get the answer - assuming that only one existed. Instead, she wanted her students to develop the skills that would allow them to deeply examine a problem, to form new questions, and then to seek out novel solutions. In other words, she wanted her students to engage in *critical thinking.*

The challenge with teaching critical thinking is that it is really hard to define. Some view it as a component of inquiry. Others associate it primarily with the scientific method. The Oxford Dictionary defines critical thinking as "thinking critically," but does not describe exactly what that may entail.

Professor Michael Fullan, advisor to the Ministry of Education in Ontario and Deeper Learning advocate, also associates critical thinking with problem solving and asserts that students should learn to use a variety of digital technologies to design, manage, and solve problems as well as make effective decisions (Fullan, 2013). However, I have recently found myself pondering the original question from that middle school teacher. I wanted to gain a better understanding of what skills ultimately led to that ability to engage in problem solving and decision making. Ironically, I found myself critically thinking about critical thinking and decided to do some research.

William Graham Sumner, a professor of sociology from Yale University, was one of the first scholars to examine the construct of critical thinking. In 1906, he sparked controversy within the field of sociology as he examined the idea of critical thinking through the framework of Darwin's theory of evolution. Sumner advocated that critical thinking requires cultivation within an environment that would nurture its development. As students evolve in their thinking, they develop the habits of constantly weighing evidence, resisting bias, and viewing the world as something "open to unlimited verification and revision" (Sumner, 1906, p. 632).

At the 8th Annual International Conference on Critical Thinking and Education Reform, scholars Michael Scriven and Richard Paul (1987) expanded on this work and defined critical thinking as the "process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action." Based on this statement, critical thinking transcends content and context to play a role in reasoning, decision making, and problem solving. As such, critical thinking requires more than just the acquisition of information or the demonstration of problem solving or decision making skills. When students engage in critical thinking, they mitigate bias and preconceptions by thinking rationally, reasonably, and empathetically. By doing so, they acknowledge complexity and endeavor to examine it through logical analysis and deep inquiry (Scriven & Paul, 1987).

In 2016, the World Economic Forum published The Future of Jobs report. It projected that by 2020, the top skills valued by employers would be complex problem solving and critical thinking. More recently, the *Worldwide Educating for the Future Index* published by the Economist Intelligence Unit argued that the education systems of the future need to help students "master a suite of adaptable interpersonal, problem-solving and critical thinking skills" (Walton, 2017, p. 4). Beyond preparing students for the workforce, the *Worldwide Educating for the Futures Index* intimates that students need critical thinking skills to be informed members of an increasingly complex, diverse, and global society.

As Sumner stated in 1940,

> [Students] educated in [critical thinking] cannot be stampeded by stump orators and are never deceived by dithyrambic oratory. They are slow to believe. They can hold things as possible or probable in all degrees, without certainty and without pain. They can wait for evidence and weigh evidence, uninfluenced by the emphasis or confidence with which assertions are made on one side or the other. They can resist appeals to their dearest prejudices and all kinds of cajolery. Education in the critical faculty is the only education of which it can be truly said that it makes good citizens (pp. 633-634).

Through this historical exploration of the concept of critical thinking, I confirmed one tenet that I already knew: critical thinking has been an objective of education since long before the start of the 21st century. However, it also continues to be an increasingly important skill not only to prepare students for the future of work but also for the future of society. ■

*Beth Holland is a doctoral candidate at Johns Hopkins University and an instructor at EdTechTeacher.*

## COMMENTARY

*Published on May 17, 2019, in Education Week*

# Teens Need to Be Able to Discern Fact From Fiction. That's Where Adults Come In

### Parents and teachers should team up to take on media literacy

By Mike Stone

This summer, a new California law goes into effect, aimed at supporting media literacy in my home state's school systems. Effective July 1, the statute requires the state Department of Education to provide online resources on media literacy for use by school districts. And some U.S. senators have reportedly floated similar legislation at the national level. These efforts can't come soon enough, given how fast unreliable and provocative online information is dividing the country and challenging the very stability of our democracy.

Laws can only go so far, however. We need to get teachers and parents involved in grassroots efforts to promote media literacy at all levels of education. If you have a high school student in your household as I do, it's time to talk with other parents, reach out to the social studies department, and get organized. If you are a teacher, you should either embrace whatever proactive measures your students' parents want to make or be the first to encourage such a coalition. We need leadership on both sides.

It's become clear that "fake news"—the heralding of misinformation as verified fact or the dismissal of verified fact as misinformation—affects the way adolescents relate to one another and their understanding of the world around them, and thus could have serious negative effects on society in the future. According to market research from the brand-intelligence firm Survata, 65 percent of teens talk about politics weekly at school, and 66 percent regularly discuss "fake news." What's more, 60 percent of teens said fake news made their conversations either tension-filled or confusing.

Teens increasingly distrust all media and are active in the political rhetoric dividing our country as never before. Last

—Getty

year, Pew Research Center found 89 percent of teens were online either "almost constantly" or "several times a day." A few years earlier, Common Sense Media found teens get most of their news online and on social media in particular. It's imperative for their intellectual development, as well as the country's future, that they become citizens who can distinguish between fact and fiction as they participate in our democracy.

A parent-teacher coalition could create a politically agnostic baseline for media literacy, nudging kids to pause and critique before accepting reports as true. For instance, as a basic rule, teens should be taught to vet the source of a news story and analyze whether it offers a balance of views or just argues a predetermined opinion and is inflammatory. Parents and teachers are natural leaders for this initiative. If they team up, they'd be especially formidable agents for better media literacy. While a 2015 survey from Common Sense Media found that 30 percent of teens believe their parents know "a little" or "nothing" about what social media apps and sites they frequent, the kids also said moms and dads have the largest impact on determining what is appropriate online.

There are blueprints for success when it comes to parent-aided school programs attacking social ills. With teenage drinking on a historic decline and unwanted pregnancies at an all-time low, it is reasonable to assume that the active efforts of parents and educators to ingrain common-sense principles in kids have paid off.

In the same vein, parent-teacher coalitions should launch dedicated groups on social media. Members of the coalitions can follow the same Twitter, Facebook, and Instagram pages of various media organizations and share items for discussion. Coalition members do not have to be on all of these social platforms, but they should be encouraged to be on as many as they feel comfortable with. As a group, they should monitor and analyze social-media reactions to news around issues that matter to adolescents, such as school shootings, body image, and the #MeToo movement. Such online discussions can inform parents how to supplement the current-events discussions their kids are having in social studies class. These instances also offer opportunities for parents, teachers, and students to hone their own fact-checking skills by checking links to see which sources of information are fake and which are authentic.

Parents need to act now because technology is emerging that will strain the concept of "seeing is believing." The software is out there to create fake videos by overlaying a person's face on another's body. Other artificial intelligence systems are being developed that can actually fabricate faces, reproduce someone's exact speech patterns, and show detailed cityscapes that don't exist.

For the foreseeable future, separating credible content from falsehoods will be homework for teens and adults alike. The most basic level of media literacy—the encouragement of critical thinking—should be as much as a part of academic study as decoding red, yellow, and green lights. The information superhighway needs driver's ed. like never before. ■

*Mike Stone is senior vice president of marketing at Airship, a customer engagement platform for media outlets such as NBCUniversal, The Wall Street Journal, and the BBC.*



Published by Editorial Projects in Education, Inc.
6935 Arlington Road, Suite 100
Bethesda, MD, 20814
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