



NOVA

SCHOOL *of the* FUTURE

EDUCATOR GUIDE



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NOVA Educator Guide

In a new age of information, rapid innovation, and globalization, how can we prepare our children to compete? Discover how the science of learning can help us reimagine the future of education for children, teachers, and policy makers.

This educator guide provides an overview of topics featured in NOVA’s School of the Future film. It outlines how research from cognitive neuroscientists, psychologists, and educators can help improve classroom pedagogy and school environments.



ABOUT SCHOOL OF THE FUTURE

A two-hour documentary produced by NOVA, School of the Future aired September 14, 2016, during PBS Spotlight Education Week. The film examines the challenges that many American students face in K–12 schooling and follows educators, neuroscientists, and psychologists working to reimagine a more equitable future for education in the United States. The film is available to stream online at <http://to.pbs.org/2clZyKT>.

PBS LEARNINGMEDIA COLLECTION

In this collection (<http://bit.ly/2eLc7y6>), you’ll find media resources that examine how the science of learning and technological innovations are together transforming the way we teach and learn.

THE LEARNING BENEFITS OF ACTIVE RETRIEVAL

Cognitive researchers say that if students don't tap into their long-term memory, information can fade and knowledge can be lost. What strategies are some teachers using to help students easily recall what they've learned?



Traditional studying habits such as highlighting information or rereading notes have been the default methods for students trying to cram for exams. These techniques may help students retain information, but only in the short term.

In the [Columbia Middle School Project](#), researchers found that even though tests are typically used for assessment, they can also promote long-term learning in students more efficiently than repeated studying. One research-based strategy that helps students learn more information for longer periods of time is called **active retrieval**. Studies suggest that providing students with the opportunity for retrieval practice—and ideally, providing feedback for the responses—will increase learning of targeted as well as related material.

Using this strategy, teachers give frequent, low-stakes quizzes on information students have been taught a day or two before. The quizzes are typically short—no more than six questions—and consist of short-answer or multiple-choice questions that can be administered online or face-to-face.

The following are [suggestions](#) on how to take advantage of the testing effect:

Ask students to provide “summary points” during a class. Setting aside the last few minutes of a class to ask students to recall, organize, and write down the main points of the lesson may go a long way in helping them remember these topics later.

Pretest to highlight important information and set instructor expectations.

By pretesting students before a unit or prior to a day of instruction, teachers may give students a heads-up about the types of questions that they need to be able to answer and the key concepts and facts they should pay attention to during class. This may help give students some much-needed focus.

Tell students about active retrieval. Teachers who tell their students how frequent quizzing helps them to learn, can empower them to take control of their own learning, for example, by using sample exams to prep for tests.

The research on active retrieval shows that even across different subject areas and teachers, students can still benefit from these techniques. Students—including special education and gifted students—were better able to remember information on which they had been previously tested using classroom quizzes compared to information that they simply reread or on which they weren't tested at all. This effect was shown to persist over time, even up to a year after initial classroom testing.

The implications of active-retrieval research can be extended to daily classroom practices: when long-term learning is the goal, educators and students should be encouraged to use low-stakes quizzes as a method to enhance learning.

RELATED RESEARCH

- [Improving student learning through the use of classroom quizzes: Three years of evidence from the Columbia Middle School Project](#)
- [Test-enhanced learning in the classroom: Long-term improvements from quizzing](#)
- [Test-enhanced learning in a middle school science classroom: The effects of quiz frequency and placement](#)
- [Test-enhanced learning: Using retrieval practice to help students learn](#)

MINDFULNESS TO RELIEVE STUDENT STRESS

School can be a time of intense stress for students. Emotional strain can come from pressures in class, among peers, at home, and even from students themselves.

By incorporating mindfulness interventions, such as meditation, directly into the classroom, students can learn body control techniques and use the time to raise and discuss mental health concerns in a nonthreatening way.



For some students, stress is a way of life. Children from low-income environments may bring with them the stress related to the economic, emotional, and physical hardships they face daily.

If confronted with additional stressors at school, students living in poverty may find it difficult to cope. Their reactions to stressful situations may trigger increases in heart rate, adrenaline, and stress hormone levels like cortisol. To help stressed-out students learn to relax, teachers can incorporate meditative and mindfulness techniques as part of their daily routine. Here are some **mindfulness exercises** to introduce calm into an otherwise hectic day:

Offer students calmer transitions. When it's time to go to lunch, ask students to take three deep breaths and then listen to the sound of a bell. Have students listen quietly until the sound fades away before moving on.

Take five. Have children who are too young or too restless to do regular meditation sit quietly and make a mental note of five things they can see. Follow that by asking them to close their eyes and count five things they can hear. Finally, ask them to pay attention to five things they can touch.

Set up a quiet corner. Create a space in the classroom where children can go to deal with difficult emotions. It might have pillows and be stocked with stuffed animals, calming books, or smooth stones. It should be inviting for students and not feel like a punishment.

Studies have shown that mindfulness interventions can actually reduce stress for students. Researchers conducted a six-week trial with 101 healthy sixth-grade students in which two history teachers, who were trained in mindfulness meditation, led students in a short period of silent meditation at the beginning of the class period. Initial meditation periods lasted only 3 minutes, while final meditation periods lasted as long as 12 minutes. Following each daily meditation, students were asked to record their reactions in a journal.



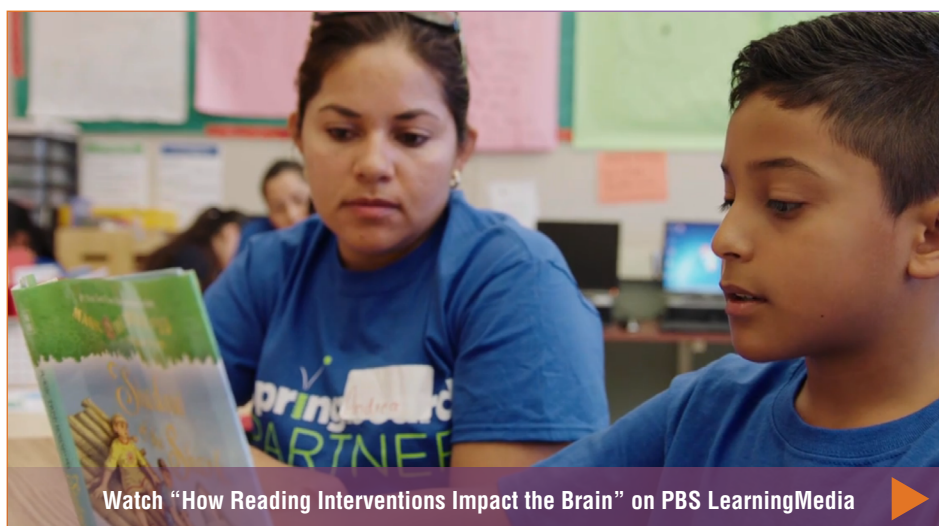
At the conclusion of the study, 92 percent of students reported a perceived benefit of the meditation practices as either an increase in relaxation and decrease in anxiety or as an increase in the ability to focus or concentrate. After practicing meditation on at least one occasion, 82 percent of students reported feeling more focused or concentrated or having less distraction, and 88 percent reported feeling more relaxed and calm or having a decrease in stress, anxiety, worry, or tension.

RELATED RESEARCH

- [NIH: Mindfulness-based interventions in schools—a systematic review and meta-analysis](#)
- [NIH: Mindfulness meditation may reduce risk of suicidal thoughts in middle schoolers](#)
- [NIH: A randomized controlled pilot trial of classroom-based mindfulness meditation compared to an active control condition in 6th grade children](#)
- [NPR: When teachers take a breath, students can bloom](#)

STOPPING SUMMER SLIDE

The loss of academic skills during the summer—known as **summer slide**—can have a significant impact on learning, especially for low-income students who may have more difficulty bouncing back during the school year. When young students fall behind in reading, for example, it creates a learning gap that can extend well into middle and high school. Programs that encourage parents and teachers to join forces to promote reading during the summer and after school can go a long way in helping students stay on track.



Despite how much students learn during the school year, studies suggest that those impressive gains can be erased quickly over the summer when there are fewer resources and less guidance. Some reports state that students can lose months of academic progress if they don't stay engaged in their learning during summer vacation.

There is consistent evidence that low-income children have the greatest need for summer interventions and may benefit from them the most. The following are research-based best practices for designing a program to combat summer slide:

Include the whole family. Parental involvement has been shown to be a predictor of whether children readduring the summer. Students whose parents are actively engaged in their summer reading tend to experience less learning loss.

Align summer reading with school curriculum. Match books with classroom materials from the previous school year to reinforce learning or provide reading lists that give students a head start for the upcoming school year.

Maximize participation.

Students must participate to reap the benefits of a summer reading program. To attract and retain readers, summer programs should offer incentives to attract students and to reward their effort.

Offer a wide assortment of books.

A variety of high-quality titles will keep students coming back for more. Soliciting student input on which books to include will help keep stories interesting and fresh.



Reading books during the summer is the strongest predictor of academic gain for students. For policy makers trying to close the achievement gap, offering at-risk students additional summer instruction to help them master required skills can pay off during the school year by avoiding remedial costs. Partnerships between schools and public libraries to take advantage of specific expertise and support for staff development have the potential to make the most of resources that will benefit children and their families.

RELATED RESEARCH

- [Rand Corporation: Making summer count: How summer programs can boost children's learning](#)
- [Collaborative Summer Library Program](#)
- [U.S. Department of Education: Become an “education coach” and keep the summer slide at bay all season](#)
- [PBS: Summer reading tips for parents of kindergartners, first graders and readers & writers](#)

HOW “GRIT” CAN HELP STUDENTS TO BE SUCCESSFUL

What gives some students the edge? Researcher Angela Duckworth calls it **grit**, the perseverance and passion to pursue long-term goals. Gritty students have stamina, and stamina is what helps them to succeed.

Grit is not a solution for all struggling students. But grit exercises can help some students develop goals just beyond their reach and the tenacity to see them through.



Watch “How Teaching Grit Improves Student Outcomes” on PBS LearningMedia

For students to get better in any skill, they must challenge themselves to do something they couldn’t do before, get feedback, and then do it all over again. That is the basis of grit, the psychology of effort.

Dr. Duckworth and her colleagues identified grit during interviews with professionals in investment banking, painting, journalism, academia, medicine, and law. Their hypothesis is that self-discipline in the form of grit is a better predictor of success than even IQ. The result of their extensive research shows that highly self-disciplined teens outperformed their more impulsive peers on every academic-performance variable, including report-card grades, standardized achievement test scores, admission to a competitive high school, and attendance.

Programs that build self-discipline can help students take ownership of their academic achievement. Here are some tips to help students learn to persevere:

Practice cognitive control. The area of the brain in charge of focus and attention keeps growing into early adulthood. To exercise this part of the brain, students should be encouraged to play games or engage in activities that require attention to

detail, such as putting jigsaw puzzles together or practicing a piece of music over and over again. These types of activities help students build perseverance.

Use process praise. The positive feedback that students receive should be descriptive and give them specific information about how they might act in the future. Instead of simply saying “good work,” share observations about what exactly the child is doing well, such as “good job sharing toys with your classmates.”



Remind students about their successes. Research shows that children who hear stories about how family members overcame obstacles are more resilient in the face of challenges. Remind children of specific moments when they worked hard to learn a new skill or master a difficult task.

Students with grit believe that their skills can grow with effort. Students who build resilience in the face of obstacles learn not to fear failure. Instead, they learn to see it as part of the learning process.

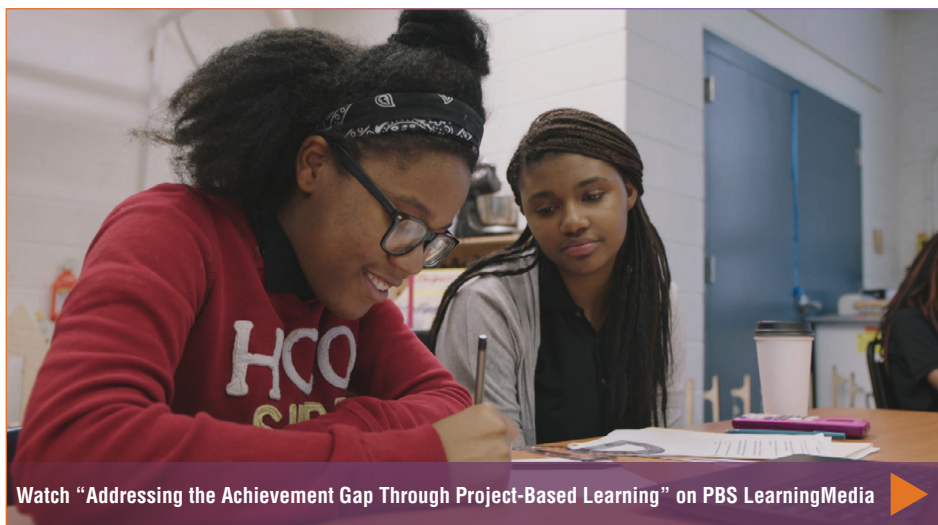
RELATED RESEARCH

- [University of Pennsylvania: Grit: Perseverance and passion for long-term goals](#)
- [University of Pennsylvania: Self-discipline outdoes IQ in predicting academic performance of adolescents](#)
- [PBS: Try, try again: Helping your seven-year-old develop grit](#)

ENGAGING STUDENTS WITH PROJECT-BASED LEARNING

How can teachers motivate students and encourage them to participate in their own learning?
How can they get students to acquire knowledge on their own and not just for a test?

Although project-based learning is not new, recent research on learning emphasizes the impact that projects with real value have on student motivation, cognition, instruction, and retention. The result of this type of student-centered learning is to help children build thinking strategies that apply to real-world problems.



Watch “Addressing the Achievement Gap Through Project-Based Learning” on PBS LearningMedia

Project-based learning is a comprehensive classroom approach designed to engage students in the investigation of authentic problems. To benefit from project-based instruction, students need to be cognitively engaged with the activity over an extended period of time. Studies show that a number of factors should be considered when designing a project intended to motivate students to learn and broaden their understanding of a topic. The following are critical design elements of project-based learning:

Varied and new. Students are interested in projects when tasks are varied and include some aspects that are new to them.

Authentic. When the problem is authentic and has perceived value, students show the most motivation.

Challenging. The problem must offer some cognitive engagement, meaning that students need to think about the various ways to solve it and choose the best option. With challenging projects, students are willing to exert the amount of effort necessary to gain success.

Closure. Encourage students to create products to solve the problem. These types of projects are most likely to sustain interest.

Choice. The process offers options about what work is needed and how it should be accomplished. Students need to exercise choice on what to work on, how to work, and what product to generate.



Collaboration. Complex problems benefit from a cooperative effort. Research suggests that carefully designed collaborative projects enhance student achievement and attitudes about learning.

Projects that motivate and engage learners can come in all different shapes and sizes, such as developing a plan to reduce food waste in the school cafeteria or redesigning a city with decreased automobile emissions. Successful project-based learning requires much knowledge, effort, persistence, and self-regulation on the part of students. Studies show that teachers who consider prior knowledge and the thinking skills of students in the group have the best chance of designing projects that support learners so that they feel like they are able to succeed.

RELATED RESEARCH

- [University of Michigan: Motivating project-based learning: Sustaining the doing, supporting the learning](#)
- [PBS LearningMedia: Integrating disciplines in project-based learning](#)
- [You for Youth: Project-based learning](#)

IN SEARCH OF ELUSIVE SLEEP

American teenagers don't get enough sleep, and their health is suffering because of it. Studies show that sleepy teens are more likely to suffer from depression and to engage in risky behavior such as drinking and smoking.

Shifting circadian rhythms, jam-packed schedules, and early school start times are making a difficult problem even worse. What does research say about the effect of sleep deprivation on teens, and what can be done about it?

As children go through puberty, they experience changes in their sleeping cycles,. At the same time, they are also experiencing more independence through the choice of extracurricular activities and more sleep interference from electronic devices. As teens navigate these changes, sleep is likely to suffer. While more than nine hours of sleep is recommended each night for high school students, studies have found that, on average, a majority of adolescents report sleeping less than eight hours each school night.

Altering school schedules can be a difficult issue. But when multiple stakeholders are gathered at the table, change is possible and students benefit. The results from a three-year research study, conducted with more than 9,000 students in eight public high schools in three states, showed that high schools that start at 8:30 a.m. or later allow for more than 60 percent of students to obtain at least eight hours of sleep per school night. Teens who got at least eight hours of sleep per night were more likely to report that they had good health and were less likely to be depressed or use caffeine or other substances. Other positive findings of later school start times included significant reduction in local car crashes, less absenteeism, less tardiness, and higher scores on national achievement tests.

Although substantial research shows benefits of starting school later, many school districts find that making the change is a hard sell. Later start times change routines not only for students, but also for teachers, bus drivers, school staff, and especially parents.



Getting stakeholders to a place where they are willing to make changes takes time. Here are some ways to help build a consensus so that students get the sleep they need:

Start early with education. Scientific data is a good start, but personal anecdotes and success stories from other school districts may give the issue a human touch.

Engage the community. Involve students, educators, and parents of teens, but don't forget local business owners, union leaders, and elementary school parents who may be adversely affected by any change in start times. Listen to what they have to say and understand their concerns.

Create a task force. Work with school officials to investigate a plan for later start times that addresses possible obstacles. Invite those with differing perspectives to join the discussion. Develop a number of scenarios (starting 20 minutes later versus 30 minutes versus 40 minutes) to give policy makers a choice.

Reach out to neighboring districts. If game times are a problem, ask school officials to reach out to other school districts to see if they are interested in making start-time changes too. Sometimes it's easier for many communities to move to later start times together.

Be flexible. Big changes can take time to implement. If schools need to phase in later start times in a year or two or over several years, consider it positive progress. Keep the momentum going until later start times are the norm.

The research is clear about how later start times positively affect the health and well-being of students. But communities ultimately have to work together to decide if and how to sync school schedules with teen sleep cycles for the promise of an easier day for their students.

RELATED RESEARCH

- [Examining the impact of later high school start times on the health and academic performance of high school students: A multi-site study](#)
- [Frontline: From ZZZZZ's to A's](#)
- [American Academy of Pediatrics: School start times for adolescents](#)
- [WGBH: Neighboring towns join forces for later high school and middle school start time](#)

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About NOVA

Now in its 43rd season, NOVA is the most-watched prime time science series on American television, reaching an average of five million viewers weekly. The series remains committed to producing in-depth science programming in the form of hour-long (and occasionally longer) documentaries, from the latest breakthroughs in technology to the deepest mysteries of the natural world. NOVA is a production of WGBH Boston. NOVA airs Wednesdays at 9pm ET/PT on WGBH Boston and most PBS stations. The director of the WGBH Science Unit and Senior Executive Producer of NOVA is PAULA S. APSELL.

About PBS

PBS, with 350 member stations, offers all Americans the opportunity to explore new ideas and new worlds through television and online content. Each month, PBS reaches nearly 100 million people through television and nearly 33 million people online, inviting them to experience the worlds of science, history, nature and public affairs; to hear diverse viewpoints; and to take front row seats to world-class drama and performances. PBS' broad array of programs has been consistently honored by the industry's most coveted award competitions. Teachers of children from pre-K through 12th grade turn to PBS for digital content and services that help bring classroom lessons to life. PBS' premier children's TV programming and its website, pbskids.org, are parents' and teachers' most trusted partners in inspiring and nurturing curiosity and love of learning in children. More information about PBS is available at www.pbs.org, one of the leading dot-org websites on the Internet, or by following **PBS on Twitter**, **Facebook** or through our **apps for mobile devices**.

School of the Future is airing as part of SPOTLIGHT EDUCATION, a special week of primetime news, public affairs and documentary programming on PBS stations focusing on the brightest ideas and toughest challenges facing today's students and America's education system. Short-form and full episodes from the week, interactive content modules and a social hub for SPOTLIGHT EDUCATION will be available on www.pbs.org and Americangraduate.org. SPOTLIGHT EDUCATION also kicks-off of a year-long teacher support campaign—"Teach Boldly"—led by PBS and local member stations across the country. Major funding for SPOTLIGHT EDUCATION is provided by the Corporation for Public Broadcasting (CPB) as part of **American Graduate: Let's Make it Happen**, a long-term public media initiative to help all students graduate from high school ready for college and careers.

School of the Future is made possible by:

American Graduate: Let's Make it Happen is public media's long-term commitment to supporting community-based solutions to help keep youth on the track to a high school diploma and beyond. Supported by the **Corporation for Public Broadcasting** (CPB), more than 128 public radio and television stations have joined forces with more than 1,700 partners and at-risk schools across 48 states and one territory.

Carnegie Corporation of New York supports innovations in education, democratic engagement, and strengthening international peace and security. In education, Carnegie's goal is for American public education to prepare all students with the knowledge, skills and dispositions they need to be active participants in a robust democracy and to be successful in the global economy.

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