ForwardED

The latest news from the
Wisconsin Center for Education Research
UW–Madison School of Education
SPRING 2020

PRE-K THROUGH HIGHER EDUCATION

Fractions and Brain Imaging

The EdNeuroLab Zeroes in on Math Learning

In 2012, Edward Hubbard, an assistant professor in UW–Madison's Department of Educational Psychology, created the Educational Neuroscience Lab to understand—through functional magnetic resonance imaging (fMRI)—how physical changes that occur in children's brains as they learn may help improve education practices.

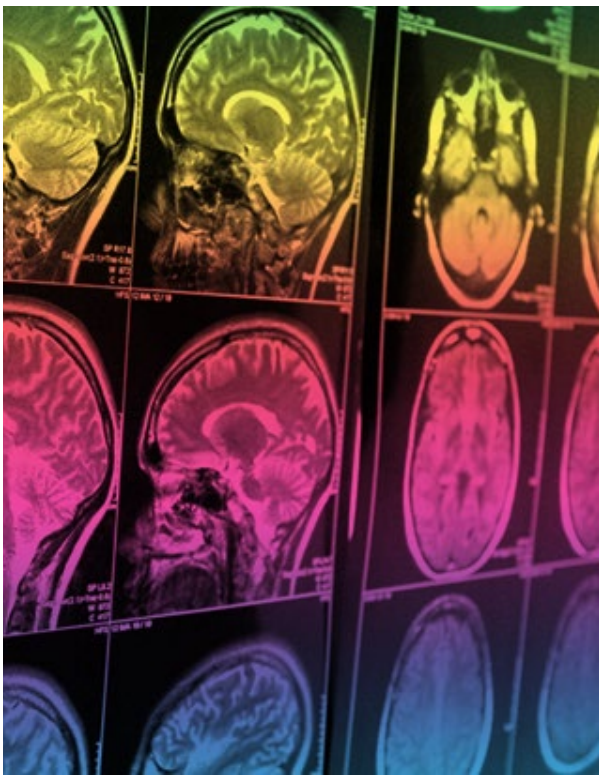
"We use the same type of MRI scanner hospitals use, but it's tuned differently," explains Hubbard, a cognitive neuroscientist at the Wisconsin Center for Education Research who directs a 40-member team at the EdNeuroLab which focuses on numerical cognition, synesthesia and autism spectrum disorders. "This scanner picks up blood flow signals in the brain. By knowing where blood is going, we can tell which parts of the brain are active when kids do different things, like reading or computing math problems."

Fractions hold a special interest. "They're a hurdle many children struggle to get over," says Hubbard. "However, research shows that fifth graders who understand fractions do better in algebra—the gateway to higher math skills critical to success in STEM."

From the lab's inception, Hubbard has collaborated with Percival Matthews, an associate professor of educational psychology in UW–Madison's School of Education and director of the MELD (Mathematics Education Learning & Development) Lab. With a mutual interest in improving fraction learning, the researchers joined forces on a five-year study called LAMBDA (Longitudinal Analysis of Mathematical Brain Development and Abilities), funded by a $1.9M grant from the National Institutes of Health.

Inside

For an expanded version of this newsletter, visit wcer.wisc.edu/news/newsletter.



WCER's Ed Hubbard and Percival Matthews are collaborating to improve fraction learning through brain imaging.

(Continued from page 1)

LAMBDA is exploring important questions about fractions, such as: Why are they hard to learn? What brain systems support fraction learning? How do these systems develop in schoolchildren?

Doing the math

Hubbard and Matthews also collaborate with researchers and educators outside UW−Madison on LAMBDA, including Jake McMullen, a well-known scientist from the University of Turku in Finland. While other education researchers are studying fractions, Hubbard says nobody is exploring this intersection of fractions and educational neuroscience.

This one-of-a-kind longitudinal study, ending next year, has followed 400 children for four years from the Madison Metropolitan School District, Middleton-Cross Plains, Verona, Waunakee and Monona Grove who enrolled in LAMBDA in second and fifth grades. For five hours a year, students participate in behavioral sessions and fMRI scans at the Waisman Center.

"Some students have moved away, but 80 percent remain in the study," Hubbard says. Students undergoing orthodontic treatment have also dropped out, as metal braces and MRI magnetic fields don't mix.

For their contribution to the study, students receive $50 for the MRI scan and $10/hour for behavioral sessions.

Why do parents enroll their children in LAMBDA? Ana Stephens, whose son joined the study at age 10 and is now in his final year as an 8th-grader, explains: "I hope my decision to enroll Brady in the study contributes, eventually, to improving educational outcomes for students."

Stephens is a WCER researcher whose own work also centers on mathematical thinking. "I have no experience in neuroscience, but it's interesting to see how parts of the brain are activated when engaged in different tasks and what eventual implications that might have for how we teach and how students learn."

As for Brady, he says, "Having my brain scanned sounded cool and I also liked being paid to participate." He looks forward to seeing the results of the study and while he'd like a picture of his brain, Brady can no longer participate in MRI scans because he wears a permanent retainer.

The EdNeuroLab team performs all its fMRI scans at UW-Madison's Waisman Center. Photo by Michael Anderle.

One key finding: ratio perception

"Through fMRI, we think we have identified a brain system that might be really important for learning about fractions in ways other education researchers and cognitive neuroscientists haven't appreciated, which is ratio perception," Hubbard shares some LAMBDA insights.

With brain imaging, the EdNeuroLab team has been able to show that in the right side of children's brains, before any formal fraction instruction, second-graders already can understand basic, non-symbolic ratios, such as dot patterns and line lengths. The researchers have observed through fMRI that the same brain systems are activated when adults and students in 5th and 8th grades are computing symbolic fractions.

"It suggests we're on the right track," says Hubbard. "Kids are learning fractions by taking these pre-existing brain systems and through educational experiences, retooling them to compare symbolic fractions."

Even so, Hubbard is astounded that we know relatively little about how educational experience is shaping brains. "Here we are in the 21st Century running the largest uncontrolled experiment on brain development in the history of humanity. We start children learning at age two through college. And we have little idea what we're doing to those brains."

Another important calculation

Through LAMBDA, Hubbard and Matthews are illustrating why becoming competent in fraction learning is so important, especially in STEM fields.

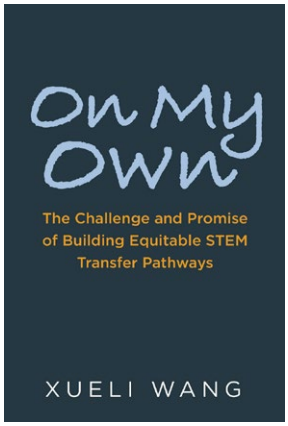
But there's another powerful reason why being good at math is crucial for child development.

"Ample evidence shows that math is more important than reading, and individual differences in math skills are a better predictor of life outcomes," says Hubbard, referencing a longitudinal study from the United Kingdom that followed children into adulthood.

"Children who did well on A-level math exams, independent of reading skills, had higher levels of full-time employment and income later in life, and lower rates of substance abuse and depression by age 30."

Publications/Findings From WCER Researchers

NEW BOOK ON STEM



"On My Own: The Challenge and Promise of Building Equitable STEM Transfer Pathways"

In her first book, Xueli Wang follows 1,670 two-year college students navigating STEM and prospective transfer in the Midwest. Wang reveals complexities and inequities shaping students' four momentum trajectories: linear upward, detoured, deferred or taking a break. She names the disparate systemic and institutional structures to address to better cultivate an equitable pathway to STEM bachelor's degrees.

MULTILINGUAL LEARNERS

"Design Principles for Engaging Multilingual Learners in Three-Dimensional Science"

To address the urgent STEM opportunity gap for multilingual learners—the most rapidly-growing K-12 student subgroup—"Making Science Multilingual," a joint program of WIDA and National Science Teaching Association, devised eight principles on the integration of contemporary, three-dimensional science and language-in-use pedagogies. These principles will guide educator resource development and be used to critically examine how well educator resources support equitable inclusion of multilingual learners in rigorous science learning.

INTERNSHIPS

"How do Students Conceptualize the College Internship Experience?"

In this working paper, Matthew Hora and colleagues examine how students understand and conceptualize internships using the freelisting method to document words or phrases most salient to students. Results indicate the most salient terms were: "experience," "learning," "paid" and "connections." Findings show students' insights and self-reflection about internships are important to include in reframing the employability debate to avoid one-size-fits-all approaches to internship design.

"How Financial, Sociocultural, and Institutional Barriers Intersect to Inhibit Participation in College Internships"

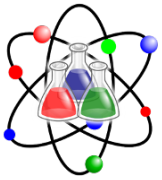
This study led by Matthew Hora examines surveys and focus groups held with students at five postsecondary institutions: a community college, a Historically Black College and University, and three comprehensive universities. Findings show 64 percent of students who did not participate in internships wanted to, but were unable to due to full- or part-time jobs, heavy course loads and lack of opportunity in their disciplines. Researchers argue postsecondary institutions should not mandate or advocate for internships until and unless they address these obstacles to participation.

JOB MARKET

"How … Does Industry Experience Influence how Faculty Teach Cognitive, Inter-, and Intrapersonal Skills in the College Classroom?"

Researchers discuss how industry experience influences the way STEMM faculty teach teamwork, oral and written communication, problem-solving and self-directed learning skills in 2- and 4-year postsecondary institutions. While industry experience is positively associated with higher rates of skills-focused instruction, Matthew Hora and his team suggest that policies aimed solely at hiring faculty with industry experience will be of limited utility without a corresponding focus on training in teaching and instructional design.

SCIENCE ASSESSMENT



"Obtaining Necessary Parity through Academic Rigor (ONPAR)"

WCER's ONPAR program (Obtaining Necessary Parity through Academic Rigor) develops and researches innovative science assessments that use visuals, action, sound and language to communicate to and from students in the assessment environment. ONPAR has been piloted successfully nationwide with more than 5,000 students over three years. The materials have been licensed by Activate Learning, a science curriculum company, and will be publicly available for school districts to use in the 2020-21 school year.

MATH

"Using Machine Learning to Overcome the Expert Blind Spot for Perceptual Fluency Trainings"

Most STEM instruction requires students to see meaningful information in visual representations. However, some students have difficulty in acquiring perceptual fluency. Researcher Martina Rau used a machine-learning model that mimics human learning from perceptual fluency trainings. This experiment compared a machine-developed training to one developed by a human. Results show the machine-developed training was more effective for low-performing students.

DIGITAL LEARNING

"Improving the Effectiveness of Digital Educational Tools"

Researcher Annalee Good and her colleagues are conducting an ongoing study of digital tools in K-12 classrooms, with collaborators from Vanderbilt University. Additional support from the JPB Foundation and the Institute for Research on Poverty allowed researchers to link analyses of digital tool use, as well as data from school districts, providers of digital tools, the National Student Clearinghouse and unemployment insurance to evaluate student outcomes after students leave the K-12 education system. Findings will be shared later in 2020.

News

First analysis of UW System Hmong undergrads finds low and declining enrollments, grad rates

A team of HMoob (Hmong) American undergraduates mentored by researchers in WCER's Center for Research on College-Workforce Transitions (CCWT) has completed the first analysis of University of Wisconsin System student data disaggregated by race and ethnicity for the state's largest Asian ethnic population. They find that except for UW–Oshkosh and UW–Green Bay, UW System enrollment of HMoob Americans is proportionally low and declining, particularly at UW–Madison.

African Americans take on more debt for grad school. But there is some good news.

According to a study by WCER researchers Jaymes Pyne and Eric Grodsky, when seeking graduate and professional degrees, African Americans take on over 50 percent more debt than white students. On the upside, African Americans also see a bigger payoff for earning such degrees. Whether or not that payoff is enough to make up for the additional debt burden is unclear.

For more findings, news and events, visit: wcer.wisc.edu/news/newsletter.

Wisconsin Center for Education Research
SCHOOL OF EDUCATION
UNIVERSITY OF WISCONSIN-MADISON

1025 West Johnson Street, Suite 785, Madison, Wisconsin 53706
608.263.4210 | wcer.wisc.edu
Media inquiries: Janet.Kelly@wisc.edu | Contact the editor: armitage2@wisc.edu