

Psychologists' research is helping to make educational technologies more fun—and more effective.

## CE Corner

# CE

## CONTINUING EDUCATION USING TECHNOLOGY TO CAPTIVATE LEARNERS: NEW RESEARCH FROM PSYCHOLOGISTS

BY KIRSTEN WEIR

**V**ideo games aren't usually the first place parents and teachers turn to help kids learn, yet a growing body of research suggests that they can impart educational benefits—even the commercial games designed for pure entertainment. “Well-designed games are inherently engaging. They suck you in,” says Valerie Shute, PhD, a professor of educational psychology and learning systems at Florida State University.

Games can provide practice in such key domains as problem-solving, systems thinking, computational thinking and creativity, Shute says. She measured persistence, spatial abilities and problem-solving among undergraduate students who spent eight hours playing the popular commercial video game “Portal 2,” a first-

person perspective puzzle game. She found that players showed improvements in all three of the domains (*Computers & Education*, Vol. 80, No. 1, 2015).

Middle school teachers might not be ready to assign “Portal 2,” for homework, but other new educational technologies are changing the way students learn both in schools and out. From virtual reality to personalized intelligent tutoring systems, the possibilities for educational technology are almost limitless, says Danielle McNamara, PhD, director of the Science of Learning and Educational Technology Lab at Arizona State University, which creates game-based methods to understand and improve the learning processes involved in reading comprehension and writing.

“If you can dream it, we can probably build it,” she says.

Building the tools is only the first step, however. There's a lot to learn about how tech devices can benefit learners and educators, and how those benefits differ from discipline to discipline. “What does the teacher actually need, what does the student need and how can we support the use of technology?” McNamara asks.

To illuminate those details, psychologists are collaborating with researchers in fields such as education, computer science and learning sciences. As they do, they are discovering new ways in which technology can make learning more engaging, more effective and more fun.

### GAMING FOR GOOD

Many technologies, including video games, can serve a dual purpose. While games can help players develop certain cognitive skills, they can also help scientists measure and study those skills, Shute says. She embeds what she calls “stealth assessments” into games to collect data about the players' abilities as they play—no surveys or multiple-choice tests required. Stealth assessments can be an effective way to track hard-to-measure cognitive skills, such as problem-solving, persistence and creativity, she says. “You're playing the game and meanwhile the stealth assessment is pulling out evidence and making calculations under the hood.”

In one demonstration of the technology, she turned to a popular commercial game called “Plants vs. Zombies 2.” In the game, players try to block advancing zombies using plants with different properties, such as the ability to freeze zombies, shoot fire at them or blow them up. Shute and her colleagues embedded an assessment that measured middle school students' problem-solving skills as they played the game. She found the stealth assessment outcomes correlated with traditional non-game measures of problem-solving, such as Raven's Progressive Matrices—a test that asks subjects to predict the next pattern in a series by making inferences from provided information—and

PREDRAG VUCKOVIC/GETTY IMAGES

### CE credits: 1

**Learning objectives:** After reading this article, CE candidates will be able to:

1. Describe how video games can both improve and measure student learning.
2. Discuss how intelligent tutoring systems can improve learning outcomes.
3. Discuss barriers and/or challenges to implementing educational technologies more widely.

For more information on earning CE credit for this article, go to [www.apa.org/ed/ce/resources/ce-corner.aspx](http://www.apa.org/ed/ce/resources/ce-corner.aspx).

MicroDYN—a system that measures subjects’ ability to acquire knowledge from the environment and apply it to a complex problem (*Computers in Human Behavior*, Vol. 63, No. 1, 2016).

Shute says her dream is for commercial video games to come with research-based consumer-information labels, akin to nutrition labels on food boxes, that would report which cognitive skills are likely to improve after a certain amount of game play. “Kids would love to play, and the parents would know that the games have cognitive ‘nutritional’ value. People would just clamor for such a game,” she says.

MADE-TO-ORDER EDUCATION

Learning scientists are also designing educational games for more traditional school-based lessons. For example, game-based systems are often used in intelligent tutoring systems—computer-based programs that provide immediate, personalized feedback and context-specific hints to students as they work through a reading assignment or a set of problems. By customizing lessons for individual learners, the systems can vastly extend the reach of a single educator.

In their lab at Arizona State, McNamara and her colleagues design game-based intelligent tutoring programs to help students improve writing skills

APA is hosting **Technology, Mind & Society**, an interdisciplinary conference exploring interactions between humans and technology on April 5–7 in Washington, D.C. For more information or to register, visit <https://pages.apa.org/tms>.

ABOUT CE  
“CE Corner” is a continuing education article offered by APA’s Office of CE in Psychology.

To earn CE credit, after you read this article, purchase the online exam at [www.apa.org/ed/ce/resources/ce-corner.aspx](http://www.apa.org/ed/ce/resources/ce-corner.aspx). Upon successful completion of the test—a score of 75 percent or higher—you can immediately print your CE certificate.

The test fee is \$25 for members and \$35 for nonmembers. The APA Office of CE in Psychology retains responsibility for the program. For more information, call (800) 374-2721.

and reading comprehension. With their “Writing Pal” program, students receive customized advice and comments as they play a game that prompts them to practice basic writing strategies (*Computers and Composition*, Vol. 34, No. 1, 2014).

“Writing Pal” and other intelligent tutoring systems can help fill an important gap, says McNamara. “For students to improve their writing, they need dedicated, deliberate practice with feedback. But they just don’t get enough of it,” she says. Teachers with five or six classrooms of 30 kids each simply don’t have time to assign essays and provide feedback on a regular basis, she says. Tutoring systems can change that.

Contemporary forms of intelligent tutoring systems have been around since the 1980s and have been applied to subjects ranging from algebra and geometry to medicine and law. In a meta-analysis, Wenting Ma, PhD, then a graduate student at Simon Fraser University, and colleagues reviewed intelligent tutoring systems across subjects and student age levels. They found the systems led to better learning outcomes compared with teacher-led, large group instruction and textbook learning, though they did not outperform small-group or one-on-one human tutoring (*Journal of Educational Psychology*, Vol. 106, No. 4, 2014).

As the technology and research advance, intelligent tutors are poised to make an even bigger impact, learning scientists predict. McNamara says researchers are designing the next generation of intelligent tutors to integrate feedback and

learning strategies across disciplines. If a student is struggling to comprehend a physics lesson, for instance, the system might present a game designed to improve reading comprehension, allowing the student to practice reading skills and physics skills in parallel to maximize success.

“We’re starting to work toward the idea of linking together these adaptive systems,” McNamara says.

SEEING THE INVISIBLE

Newer technologies can take education in even more futuristic directions. Virtual reality is one area that both students and scientists are excited about because it is bringing the world to students. “With virtual field trips, students can visit other places without having to leave the classroom,” says Matthew Koehler, PhD, a professor of educational psychology and educational technology at Michigan State University.

And augmented reality—which blends virtual reality with real sights and sounds—can help students visualize phenomena, such as chemical reactions, that would otherwise be invisible. “If you’re only given the real world, you don’t get to see the hidden mechanisms and unobservable elements,” says Robb Lindgren, PhD, a professor of curriculum and instruction at the University of Illinois at Urbana-Champaign who has a background in psychology and learning sciences.

Lindgren is exploring new ways to teach complex topics by drawing from research on the science of embodiment and learning. He’s studying augmented reality systems that enable



Augmented reality—which blends virtual reality with real sights and sounds—can help students visualize phenomena that would otherwise be invisible.

students to engage with abstract science and math concepts through gestures and bodily movements. When learning about gas pressure, for instance, students study the movement of gas molecules by letting their hands “be” virtual molecules that collide with the wall of a container.

In one such project, Lindgren and his colleagues created an interactive simulation to teach middle school students about how objects move in space. In this project, kids use their bodies to predict how an asteroid will move as it travels through space and encounters forces such as the gravitational fields of nearby planets. Compared with students who watched a desktop animation of the same concepts, those who used their bodies to predict the asteroid’s path learned more,

were more engaged and reported more positive attitudes toward science (*Computers & Education*, Vol. 95, No. 1, 2016).

“They’re embedding themselves into the system to understand how it works,” Lindgren says. “It’s not just hands-on learning, but hands-in learning.”

Immersive technologies could be a particularly good fit for informal learning environments such as museums and science centers, which often have the flexibility and freedom to try new things, Lindgren says. In a project known as Move 2 Learn, Lindgren and H. Chad Lane, PhD, an associate professor of educational psychology at the University of Illinois at Urbana-Champaign, are collaborating with other researchers and museum practitioners on embodied learning and interactive

FURTHER READING

**Cognitive Development in Digital Contexts**  
Blumberg, F.C., & Brooks, P.J. (Eds.)  
2017

**Virtual, Augmented, and Mixed Realities in Education**  
Liu, D., Dede, C., Huang, R., & Richards, J. (Eds.)  
2016

**Exploding the Castle: Rethinking How Video Games & Game Mechanics Can Shape the Future of Education**  
Young, M.F., & Slota, S.T. (Eds.)  
2017

**What Is Technological Pedagogical Content (TPACK)?**  
Koehler, M.J., Mishra, P., & Cain, W. (Eds.)  
*Journal of Education*, 2013

**Learning Technologies and the Body: Integration and Implementation in Formal and Informal Learning Environments**  
Lee, V. (Ed.)  
2014

educational technology projects. In one collaboration with the Frost Museum of Science in Miami, Lane worked on an exhibit that teaches young visitors about the Everglades. The children “splash” through a virtual river, part the grass to find an alligator nest or move a submerged log to reveal a school of minnows.

“When kids gesture and move while interacting with the creatures in the exhibit, they are actually grounding their thinking in those movements,” Lane says. “When they have a chance to move their bodies in ways that link to content, they learn better.”

SUPPORTING TEACHERS

Despite the promise of video games, virtual reality systems and other technologies as educational tools, a significant barrier keeps them from widespread implementation: Schools don’t yet agree on how technology should fit into education. “Some schools say we should disallow mobile phones, and others get everybody a mobile device. They’re all over the place,” Koehler says. “Schools are short on time and they’re short on money. They do what they think is going to work, but it’s not often data driven.”

And, he says, teachers aren’t often trained in how best to make use of tech tools. “We know teachers use technology in their personal lives, but they often don’t use it in classrooms. There’s a barrier there because it’s not exactly clear what they should be doing with technology in their classrooms.”

Some researchers are also worried that schools are embracing tech tools before they have





THE COLLEGE OF  
CLINICAL PSYCHOLOGY  
AT ARGOSY UNIVERSITY

Argosy University is a non-profit institution.

"I INTRODUCE MY ACTUAL CASE EXAMPLES  
TO THE CURRICULUM TO ADD RELEVANCE  
AND CONTEXT."

At the College of Clinical Psychology at Argosy University, a non-profit institution, we believe in a practitioner-scholar model of training. Our programs offer a rigorous curriculum grounded in theory and research, while also offering real-world experience. What's more, all our PsyD programs have received accreditation from the American Psychological Association (APA), certifying that they meet the industry's standards.

Learn more at [clinical.argosy.edu/monitor](http://clinical.argosy.edu/monitor)

Arizona School of Professional Psychology at Argosy University

American School of Professional Psychology at  
Argosy University | Southern California

American School of Professional Psychology at  
Argosy University | San Francisco Bay Area

Florida School of Professional Psychology at Argosy University

Georgia School of Professional Psychology at Argosy University

Hawai'i School of Professional Psychology at Argosy University

Illinois School of Professional Psychology at  
Argosy University | Chicago

Illinois School of Professional Psychology at  
Argosy University | Schaumburg

Minnesota School of Professional Psychology at  
Argosy University

American School of Professional Psychology at  
Argosy University | Northern Virginia

DR. MICHAEL LYNCH

Dean, Clinical Psychology Programs at  
Argosy University | Northern Virginia

*Dr. Lynch employs an integrated  
approach to the instruction and  
mentorship of his students.*

\*The Doctor of Psychology in Clinical Psychology Program at Argosy University, Atlanta, Chicago, Hawaii, Orange County, Phoenix, San Francisco Bay Area, Schaumburg, Tampa, Twin Cities and Northern Virginia is accredited by the Commission on Accreditation of the American Psychological Association (APA). Questions related to the program's accredited status should be directed to the Commission on Accreditation: Office of Program Consultation and Accreditation, American Psychological Association, 750 1st Street, NE, Washington DC 20002 Phone: (202) 336-5979 / E-mail: [apaacred@apa.org](mailto:apaacred@apa.org) / Web: [www.apa.org/ed/accreditation](http://www.apa.org/ed/accreditation)

Argosy University is accredited by the WASC Senior College and University Commission (985 Atlantic Ave., Suite 100, Alameda, CA 94501, [wscuc.org](http://wscuc.org)). Programs, credential levels, technology, and scheduling options are subject to change. Not all online programs are available to residents of all U.S. states. Administrative office: Argosy University, 601 South Lewis Street, Orange, CA 92668 ©2018 Argosy University. All rights reserved. Our email address is [materialsreview@argosy.edu](mailto:materialsreview@argosy.edu)

See [auprograms.info](http://auprograms.info) for program duration, tuition, fees and other costs, median debt, salary data, alumni success, and other important information.

CE Corner

been thoroughly vetted by scientists. "My concern is that we haven't asked the basic questions: What are people learning through the use of these technologies, and to what extent do these technologies facilitate transfer to real-world use?" says Fran Blumberg, PhD, a professor of counseling psychology at Fordham University who studies children's attention and problem-solving in the context of digital learning settings.

Plus, Blumberg adds, technology changes so quickly

educational games and programs are designed for children and adolescents, she adds, the area is ripe for more psychologists to get involved.

Lindgren is optimistic that educational technologies can help students learn. But for those tools to live up to their promise, he says, psychologists and other research scientists should get involved at earlier stages of development. Too often, he says, educators work backward, figuring out what they can do with whatever tech tools

For educational technologies to live  
up to their promise, psychologists  
should get involved at  
earlier stages of development.

that new technologies often hit the market even before their predecessors have been adequately evaluated by researchers. "I can appreciate that there are wonderful new directions one can go with educational technology, but we still need to look at what are we getting out of these experiences before we race to the next technological innovation," she says.

The fast-paced nature of the tech market means researchers might always be playing catch-up. Still, she says, psychologists' research skills and understanding of human cognition and behavior make them well suited to helping answer basic questions about educational technologies. Since so many

are readily available instead of designing or selecting a device because it solves a particular problem.

"We need to shift the model to get psychologists and researchers and educators involved in the design of these tools," he says. "Learning scientists and psychologists have often felt left out of this issue of the design of educational technology, and it's incredibly important that they be a part of figuring this out." ■

● For an in-depth look at learning and technology research being conducted at Carnegie Mellon University's LearnLab, read "Turning Classrooms into Learning Laboratories" in the *Monitor's* monthly "Lab Work" series at [www.apa.org/monitor/2018/01/classrooms-laboratories.aspx](http://www.apa.org/monitor/2018/01/classrooms-laboratories.aspx).

transforming the future



AMERICAN PSYCHOLOGICAL FOUNDATION

THANK YOU  
2017 APF DONORS

FOUNDER  
(\$250,000+)

Walter Katkovsky, PhD  
Beth N. Rom-Rymer, PhD  
Dr. Marian R. Stuart

STAKEHOLDER  
(\$100,000-\$249,999)

APA Division 1 - Society for  
General Psychology\*  
John and Polly Sparks Foundation

PIONEER  
(\$50,000-\$99,999)

The Estate of Virginia McKeachie  
Pearson

TRENDSETTER  
(\$25,000-\$49,999)

American Psychological Association (APA)  
EBSCO  
Mrs. Carol and Mr. Nick Spielberger\*

INITIATOR  
(\$10,000-\$24,999)

Academy for Cancer Wellness\*  
The American Insurance Trust  
Conveo Publisher Services  
Dr. Y. Barry Chung  
Mrs. Sandra M. Fowler  
Dr. J. Bruce and Mrs. Robin Overmier  
Dr. James Campbell and  
Mrs. Sheri Schember Quick\*  
Dr. Linda Richardson and  
Dr. Rodney Lowman  
Morgan T. Sammons, PhD, ABPP\*  
Dr. Arlene Steinberg  
Dr. W. Bruce Walsh  
Mr. Daniel I. Wechsler\*  
Mr. Leonard Wechsler\*  
Mr. Neil Wechsler\*  
Dr. Stephen A. Werbel\*

ADVOCATE  
(\$5,000-\$9,999)

Corporate Synergies Group, LLC  
Cushman & Wakefield  
Dr. Rosie Philips Davis and Mr. John Davis\*  
Florence L. Denmark, PhD\*  
Dicandrien Inc.\*  
Douglas C. Haldeman, PhD\*  
Kaiser Permanente  
Terence M. Keane, PhD  
Steve Kincaid, PhD  
Liberty Mutual  
William A. MacGillivray, PhD, ABPP  
Dr. Katherine C. Nordal\*  
PAR Inc.\*

PROPONENT  
(\$1,000-\$4,999)

Dr. Maricedes Acosta-Martinez  
AFS 401(k) Retirement Services, LLC\*  
Dr. H. Elliott Albers  
Judith E. N. Albino, PhD\*  
Mona M. Amer, PhD  
Dr. Franklin R. Ampy  
Dr. Barry S. Anton  
APA Division 12 - Society of  
Clinical Psychology\*  
APA Division 29 - Society for the  
Advance of Psychotherapy\*  
Association of Practicing Psychologists  
Steven D. Axelrod, PhD\*  
Bank of America  
Laura H. Barbanel, EdD\*  
BDO\*  
J. Gayle Beck, PhD\*  
Dr. Camilla Benbow and David Lubinski\*  
Sharon Berry, PhD\*  
Mr. Andrew P. Boucher  
Dr. Deborah J. Brief\*  
Dr. Kathleen S. Brown\*  
Dr. Ronald T. Brown\*  
Dr. Merry Bullock\*  
Dr. Margaret S. Bynoe  
Dorothy W. Cantor\*  
Dr. Edward Castañenda\*  
Connie S. Chan, PhD\*

Dr. Jean Lau Chin\*  
Dr. June W. J. Ching  
Dr. Rosemarie and  
Dr. Christopher J. Ciccarello  
Dr. Rosemary Ciullo  
Dr. Joan M. Cook  
Corporate Communications Group\*  
Dr. Christine A. Courtois  
Dr. Kermit Crawford  
Dennis Debiak, PsyD  
Dr. Lyne Desormeaux\*  
Dr. Margarita L. Dubocovich  
Mr. George A. Dunn, Jr.  
Dr. Marilyn T. Erickson  
Dr. Anne M. Etgen\*  
Dr. Gerald D. Fischbach  
Raymond Alexander Folen, PhD, ABPP\*  
Dr. Angela L. W. Franklin  
Virginia S. Frazier, PsyD  
Mr. Leonid A. Freytor  
Dr. and Mrs. E. Scott Geller  
Dr. Terry S. Gock\*  
Dr. Barbara E. Golden\*  
Mr. Jesse Goldner and Ms. Judith Cromwell

Dr. Marjorie Gondre-Lewis  
Dr. UnJa Hayes  
Michael L. Hendricks, PhD, ABPP\*  
Dr. Kim L. Huhman  
Dr. Yasmin Hurd  
Mary C. Jacob, PhD  
Dr. Kevin Jones  
Gwendolyn P. Keita, PhD  
Patricia Keith-Spiegel, ScD, PhD  
Dr. Jennifer Kelly\*  
Dr. Douglas C. Kimmel\*  
Dr. Jean King  
Dr. Sara F. Kriger  
John M. Lagos, PhD  
Dr. Story Landis  
Dr. Kimberly Leary\*  
Michael LeBlond, PhD, MBA\*  
Dr. Russell B. Lemle  
Dr. Philip G. Levendusky\*  
Dr. Patricia Logan  
Dr. Jeanne E. Manese  
Dr. Jana N. Martin  
Dr. Joe L. Martinez, Jr.

Dr. Kenneth I. and Ms. Cheryl M. Maynard  
Sheila and Richard McCarty  
Dr. Micah L. McCreary  
Susan H. McDaniel, PhD, ABPP\*  
Dr. Susan McPherson  
Dr. Nancy R. McWilliams  
Mrs. Roberta M. Meier\*  
Anne J. Miller, PhD  
Miller's Supplies at Work  
Dr. Michael Mobley  
Dr. Olivia Moorehead-Slaughter\*  
Dr. Susan L. Morrow  
Bernard F. Natelson and Lisa Raufman  
Dr. Genevieve Neal-Perry\*  
Drs. Rae Nishi and Felix Eckenstein\*  
Oxford University Press  
Dr. Nicola Petitti  
Dr. Natalie Porter  
Dr. Pamela T. Reid\*  
Dr. Alma Rodenas-Ruano  
Dr. Joseph G. Schaller  
Dr. Richard J. Seime  
Dr. Sarah Shelton  
Dr. Kenneth Sher\*  
Dr. & Mrs. Andrew Shiva  
Dr. Sandra L. Shullman\*  
Simons Foundation  
Dr. Elizabeth T. Slater  
SP+ Parking  
Jeffrey H. Spector, PsyD  
Derald W. Sue, PhD\*  
Elisabeth R. Straus  
Dr. Beverly Daniel Tatum\*  
Terrapin Systems LLC  
The Ultimate Software Group, Inc.  
Dr. Melba J. T. Vasquez and Mr. Jim Miller\*  
Dr. Jonathan and Mrs. Carolyn Vitriol  
Wayne Weiten, PhD\*  
Susan K. Whitbourne, PhD, ABPP and  
Richard D. O'Brien, PhD\*  
Diane J. Willis, PhD  
Erica H. Wise, PhD\*  
Dr. Phyllis M. Wise  
Dr. Frank C. Worrell  
Dr. Philip G. Zimbardo and  
Dr. Christina Maslach\*

\*DENOTES PAYMENT ON PRIOR PLEDGE | FOR THE FULL DONOR LIST, VISIT [WWW.APA.ORG/APF](http://WWW.APA.ORG/APF)