Edge
CAROLINA EDUCATION REVIEW

Also in this edition:

Targeting reading: Can we improve childhood literacy?

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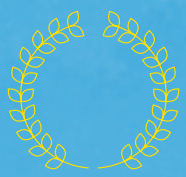

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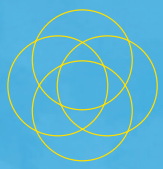

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We seek productive and meaningful partnerships across disciplinary and institutional boundaries, working with all stakeholders within and beyond formal institutions of education. A well-educated, diverse, and empowered public is key to addressing social inequities and injustices; promoting and supporting the health and well-being of all; and ensuring the competitiveness and prosperity of our state and nation.

Advancing Knowledge

We produce cutting-edge knowledge, and pursue innovative, research-based solutions to the most pressing problems of educational theory, practice, programs, and policy in North Carolina, the nation, and beyond.

A message from the Dean of the UNC School of Education

Greetings!

Welcome to the inaugural edition of "Edge," a new magazine that highlights research at the School of Education at the University of North Carolina at Chapel Hill.

We are a research-intensive organization focused on achieving equity in educational access and outcomes for all learners in a diverse and just society. We pursue innovative, research-based solutions to the most pressing problems of educational theory, practice, programs, and policy in North Carolina, the nation, and beyond.

The "Edge" highlights our faculty members' cutting-edge work and the ways in which their research is impacting and transforming teaching, learning, and educational policy, as well as the preparation and professional growth of educators and leaders in our schools. In this volume you'll meet these researchers:

Lynne Vernon-Feagans has worked since 2004 developing a powerful program that helps teachers better instruct struggling readers. By using webcams, the "Targeted Reading Intervention" enables on-campus coaches to watch as teachers in high-need rural schools work one-on-one with students – and then provide on-the-spot feedback. In our cover article, Lynne and I talk about some of the challenges in teaching reading with Susan Gates of the analytics firm SAS. Susan was a leader in the production of the recent Business Roundtable report "Why Reading Matters and What To Do About It."

Kihyun "Kelly" Ryoo is conducting leading research on new ways to teach science. Building on her doctoral work at Stanford, she has developed new tools that use visualizations and interactive animations to teach science concepts to middle school students – especially English language learners. It's promising, impactful work that has attracted support from the National Science Foundation, the National Academy of Education, and the Spencer Foundation.

Keith Sawyer is a nationally recognized leading researcher on creativity and the teaching of creativity. Yes, he says, creativity can be taught! He describes some of his findings and describes how classroom instruction needs to change if we want to nurture creative thinkers.

Jeffrey Greene is developing new ways to analyze data that explores the way we learn. He's applying those findings to "digital literacy," tools we need to more accurately understand our changing world. For this and other work, Jeff received the 2016 Richard E. Snow Award for Early Contributions from Division 15 of the American Psychological Association.

Dana Thompson Dorsey, equipped with a legal training background, has written about the landscape of desegregation and the effects of increasing racial isolation among students in our schools. Now she is building on that work to develop new understandings of the compounded effects of geographic isolation among rural minority students.

These are but some examples of the work we pursue as educational researchers, aimed at developing deeper understandings of teaching and learning. We generate knowledge that inform how we prepare teachers, school counselors, principals and assistant principals, superintendents, other educational administrators, and educational researchers.

As you thumb through "Edge," know that we invite collaboration, seeking ways to build on each other's strengths in tackling tough problems. So, give us a call!

I look forward to hearing from you!

Fouad Abd-El-Khalick, Dean
School of Education
University of North Carolina at Chapel Hill

Targeting reading: Can we improve childhood literacy?

Researcher: Lynne Vernon-Feagans

In U.S. schools, struggling readers need more help than they are now getting. Only about 36 percent of fourth graders were proficient in reading, according to the 2015 National Assessment of Educational Progress. The benchmark is important because research has demonstrated that children who are not reading proficient by the fourth grade lag through the remainder of their schooling.

The Business Roundtable, a national organization of corporate chief executive officers, recently issued a report – "Why Reading Matters and What To Do About It" – urging policy changes to support efforts to improve reading proficiency among U.S. students in the K-3 grades. It urges states to adopt a range of policies with the aim of improving reading instruction in the early grades.

A faculty member at Carolina's School of Education – Lynne Vernon-Feagans – has led a research program that has developed and is evaluating a reading intervention that has been shown to be highly effective in helping teachers who work with struggling readers. Through the Targeted Reading Intervention, reading experts at the campus in Chapel Hill use webcam technology to

watch teachers in distant schools work with struggling readers, coaching the teachers in the TRI technique.

Carolina's School of Education hosted a conversation about the Business Roundtable report and the Targeted Reading Intervention. The participants were Vernon-Feagans and Susan Gates, special advisor on education at SAS Institute, the analytics and data management software firm based in Cary, N.C. Gates had a leading role in developing the Business Roundtable report. Fouad Abd-El-Khalick, dean of Carolina's School of Education, moderated the discussion. Following is an edited transcript of their conversation.

Fouad Abd-El-Khalick: Susan, can you please describe for us briefly what the Business Roundtable report found regarding the need for improvement in early literacy?

Susan Gates: The Business Roundtable was concerned about the skills gap that is being experienced by companies across the United States and here in North Carolina as well, including at SAS where I work, and they realized that third grade reading proficiency is a milestone in children's education continuum and that if you don't achieve third grade reading proficiency, you have children who are four times more likely not to graduate from high school. You also have children who then are not going into post-secondary training and education and children who will struggle to develop soft skills like critical thinking and communications, which are vital in the business community today and will continue to be necessary as we look down the road.

So the Business Roundtable put together a task force that was spearheaded by our CEO, Dr. Jim Goodnight, to better understand third grade reading proficiency, its impact on our economy, and then to determine how can we make sure more children are reading proficient. Here in North Carolina, 62 percent of fourth graders, based on the latest data, are not reading proficiently. The Business Roundtable came up with the six policy recommendations that states can put into place to strengthen and increase third grade reading proficiency.

Fouad Abd-El-Khalick: Lynn, while you think about preservice teachers or practicing teachers in the classrooms, what does the research show us on how we can better prepare teachers to both teach reading, as well as help struggling readers?

Lynne Vernon-Feagans: I want to say that the Business Roundtable report is really excellent and you have really looked at the research, which is not always the case on these reports. It's definitely true that in the United States and in North Carolina, we're not doing a good enough job in helping all of our children learn to read by third grade. Teaching reading is not easy and I think the general public sometimes underestimates the complexity of teaching children how to read, especially children who don't get it right away.

I've spent a long time trying to think about this. And we have developed some principles and an intervention that really works.

Teachers often come out of undergraduate institutions, including ours, with skills to teach kids who will easily learn to read no matter what curriculum. But there are many children who really need direct instruction in reading, and teachers are not always prepared to do that. So I think we could do a better job at our universities in helping our undergraduates be better teachers of reading and there are a variety of ways to do that.

A lot of it is just having more classes in methods but the other that we've learned is that teachers actually learn by doing. We have learned through research that teachers who go to workshops or even teachers in classrooms who just listen to lectures, that's not how they learn. They learn by working with children and seeing what works. In our program, because we work a lot with low-wealth schools, where we have 70 to 80 percent of the children that are reading below grade level, we use webcam technology to Skype or FaceTime into the classroom and watch the teacher as she's instructing reading and give her real-time feedback.

"In U.S. schools, struggling readers need more help than they are now getting."

Coaching we know really works. But it's very expensive for schools. And especially in North Carolina, which isn't the wealthiest state in the union, it was a challenge to think of how you can coach teachers. But through webcam technology, we Skype with teachers in Nebraska and Texas and New Mexico and we've shown that you can really make a difference in early reading with kids when classroom teachers are really prepared to teach reading.

The need for professional development

Fouad Abd-El-Khalick: You mentioned teachers who are in preservice training still at the university, and you mentioned teachers who are in the field, and you brought this notion of coaching or mentoring teachers as they are working in the classrooms. That's really important because one-shot professional development workshops or a little bit of lecturing at teachers is not going to get us there. But at the same time, you talked about the expense and the difficulty of coaching teachers, especially in rural areas or teachers who are already out there in the classroom. Susan, I want to get your reaction to some of these comments regarding the need to work with teachers in preservice or in their classrooms.

Susan Gates: I think you need to do both. What the Business Roundtable report discusses is trying to enhance the skill set while these are preservice students so that they truly develop the skills for teaching early reading and, frankly, teaching early math, which is related to third grade reading proficiency and early science and hone in on that.

Another piece that is concerning to the Business Roundtable and to us here in North Carolina is making sure that principals understand early childhood development, making sure that they understand how literacy skills are developed so they can then manage, for lack of a better term, an elementary school where this work is going on.

And there also needs to be perhaps looking at licensure and certification to encompass those early years. Here in North Carolina we have a birth-to-kindergarten license and then a kindergarten-to-fifth grade. The BRT report talks about that it really needs to span at least pre-K into those early elementary grades. It gives the principals flexibility but at the same time you can then include course work on early literacy instruction.

The Business Roundtable Recommendations

The Business Roundtable, an organization of CEOs from around the country, issued a report – "Why Reading Matters and What To Do About It" – calling for policies aimed at improving third grade reading proficiency.

1. Expand access to high-quality pre-K learning opportunities
2. Offer high-quality full-day kindergarten that ensures a successful transition to elementary school
3. Use student assessments and data systems to track student progress
4. Equip educators in pre-K-grade 3 to help students become strong readers
5. Require systematic interventions for struggling readers in grades K-3
6. Coordinate governance of pre-K and grades K-3 to promote efficiency and maximize impact

http://businessroundtable.org/why-reading-matters

Fouad Abd-El-Khalick: Lynne, I do want to go back to what I know is something you've worked with for years and years and years. It's called the Targeted Reading Intervention. You talked about Skyping or using webcam technology to visit with teachers in their classrooms from a distance which enables you to work across a whole state in rural areas and other classrooms. Can you give us a better sense of what this reading teacher intervention looks like and what does your research show about its effectiveness?

Lynne Vernon-Feagans: We have been working with teachers who are already out in the field but I agree with you that we have to do a better job at the preservice level and that's including here at UNC and all of our universities around the country, not just in North Carolina. But I do think we have not used technology like we should have. For instance, at the preservice level what I would love in our School of Education is that we use these webcams to actually do some of the student teaching. So instead of having me go out and watch a student teacher, it's much more efficient for me to use webcam technology.

One of the advantages of being in North Carolina is we do progress monitoring in the classroom. And what our intervention does is it takes that progress monitoring information, which means that classroom teachers are assessing their children in reading over the course of the year. They have to do that three times for all children, but for the children that are struggling they do it much more often.

But what teachers struggle with is: "What do I do with this information that will improve my instruction?" That's what our program does. It links those assessments with information that the teacher can use to help individual struggling readers in their classroom. Our program does the big five, which is all of the aspects of reading that are important and the teacher works with an individual child for 15 minutes a day.

A lot of people say: "But she doesn't have time to do that, right?" But what we're trying to do is to get the teacher to change the way she thinks about reading instruction. We have evidence from our research that the children in the classroom who have been targeted with our intervention actually make huge gains in reading. But every child in that classroom also gains compared to, in these randomized control trials, that we have now been doing for 12 years. We're hoping that the kind of intervention that we've developed can make a difference for teachers. And I really think this is the way in which we can begin to start to help all of our children, but especially those struggling readers.

The need for better assessments

Fouad Abd-El-Khalick: So Targeted Reading Intervention could do two things. It could take university expertise into classrooms to help practicing teachers or in-service teachers, but also bringing the real classrooms to our and other institutions to bring the classrooms into the training of preservice teachers, to that's a very interesting model to move forward.

But, both of you have talked about assessment. Susan, I want to go back to one of the recommendations of the Business Roundtable which is the need for better assessments. Can you please talk a little bit about what needs to be done in that area?

The Targeted Reading Intervention

The Targeted Reading Intervention is a research project developed by Lynne Vernon-Feagans, the William C. Friday Distinguished Professor of Early Childhood, Intervention and Literacy at UNC-Chapel Hill's School of Education. TRI employs trained coaches with reading expertise using remote webcam technology to provide one-on-one, ongoing support for teachers working with struggling readers in rural, Tier 1 schools. Vernon-Feagans's research, which has been supported by $15 million in grants from the National Science Foundation and other funders. It has been endorsed by The Annie E. Casey Foundation Blueprints for Healthy Youth Development, The Rand Corporation Promising Practices Network, and included in the "Best Evidence Encyclopedia." It has been used in more than a half-dozen North Carolina counties and in several states.

http://www.targetedreadingintervention.org/

Susan Gates: First you need to think about assessments broadly. It's not just taking kids' tests. You're talking about very young children here. So, what needs to be assessed and understood? Here in North Carolina, we're looking at the children from birth through age 8, which is the end of the third grade, and figuring out along that continuum what needs to be understood.

There's a fantastic initiative underway in North Carolina called the NC Pathways to Grade-Level Reading. That is an initiative of over 100 stakeholders, including many experts such as Lynne, to determine indicators that need to be identified, assessed, and the data captured around those, beginning with everything from low-birth-weight babies, then to looking at what skills do children have as they enter kindergarten. There's a lot of work in North Carolina. In fact, North Carolina is spearheading it on kindergarten entry assessments so that kindergarten teachers, when that child enters their door, have better understanding of where the child is, not only in literacy but in all subjects.

And then assessments, that Lynn can speak to much better than I, as the child progresses toward third grade. How is that child progressing toward literacy skills and other skills necessary to obtain by the end of third grade?

Fouad Abd-El-Khalick: So the most important thing I hear you also saying, this is not about testing. Assessment is really just getting a diagnostic sense of where students are, how they are moving towards interventions. Lynne, can you tell us a little bit about how you use assessment and how can data, and formative assessments and diagnostic assessments help teachers as they work with struggling readers to lift their performance?

Lynne Vernon-Feagans: Generally there are two areas that many children struggle with in learning how to read. The first is what we call letter-sound correspondence. A lot of children have trouble understanding how that symbol, like for instance, the letter "c" never makes that sound, right? So, learning the alphabet doesn't always really help kids. They have to know that the "c" stands for the "kuh" sound, right? A lot of children have a lot of trouble with that, especially when it's in the context of a word. Knowing what those different sounds are. That's called decoding. And so the assessments in mCLASS try and get at that in a way so that the teacher would understand, 'Oh, this child is either very good at this or not very good at this."

The other area where children have problems is in reading comprehension which is related to their understanding of vocabulary, connected discourse, being able to summarize a story, those kinds of skills.

Children can have deficits in both of these areas or one of them. What's important is to make sure that the assessments in the schools have those. Right now I think we have pretty good assessments but just Susan, as you said, these are very young children, so assessing a child in kindergarten or even in Pre-K is very difficult. They're not used to being tested. I think we're doing a pretty good job. I really think that North Carolina is ahead of many states in doing these assessments. But the problem has been that the assessments are not linked to the instruction the teacher needs to use. When we've done our focus groups, that's what we've found. They say, "Oh yes, we're using these mCLASS scores, but we don't know how those are linked to the reading curriculum that we're using in our classrooms."

The need to link assessments to improving instruction

Fouad Abd-El-Khalick: What's of high interest to us at the School of Education is trying to take these assessments and make use of big data, data analytics, so that the linkage between these assessments and teacher progress reports for the students and what to be done could be sort of facilitated through artificial intelligence and data mining that would really close the, at least the effort gap, and make these things more accessible to teachers as they work with struggling readers.

Susan, you list a large number of policy recommendations so the trick question is, if you were to focus on two or three that you think are maybe precursors, the first stepping stones, you know, the first step in a thousand-mile journey, what would be the policy recommendations that you would like to highlight today.

Susan Gates: There are three of them. There are six recommendations in the BRT report. No state has implemented all six of them and a group of CEOs that are being led by Dr. Goodnight from SAS are committed to making sure that North Carolina is the first to get all six of these recommendations in place.

The first two really are to make sure we get a comprehensive, aligned system. I think that's what has to be done before some of these other steps can be taken. So what the CEOs are urging Governor Cooper and the General Assembly to do is to create a comprehensive birth-to-eight system that is fully aligned with very clear accountability in it, so that it is implemented well and we can start to see that results are being achieved. That effort is already underway and so we are hopeful that when the recommendations are presented to the General Assembly at the end of the year, that they are vetted, modified if necessary and implemented.

The second is closely related. Within that birth-to-eight system in North Carolina, the data is housed in different departments or agencies and it's not talking to each other. If we're going to have a comprehensive system, we need the data within that system talking to each other.

And then the last one is that we have one of the highest quality PreK programs in our state. It's a national model, it's known as NC PreK. Right now there are 55 percent of eligible children are not able to get into the program. So the CEOs are requesting that NC PreK be opened up so that more eligible children can access the program.

Fouad Abd-El-Khalick: I want to go back to this notion of assessment and accountability. Lynne, is there a tension between large sets of assessment data that are targeted towards helping struggling readers read and accountability data? Or do you see these two sets talking to each other as part of your research and part of your intervention?

Lynne Vernon-Feagans: Well, they are definitely related. And of course, teachers now are somewhat evaluated based on the assessments in the classroom, because they need to show that their children are making progress and that's the way they are accountable for the learning in the classroom. I think a lot of what we might need from places like SAS is a way for teachers and principals to interpret the data that they get.

They get this massive amount of data that now is available through the state, through all kinds of things, on the children in their schools. But they're not sure how to use that information to make a difference for individual children.

If businesses and schools work together to try and think about how we can make these accessible and understandable teachers and the principals that would be really valuable.

Watch the Conversation

You may view the conversation between Dean Fouad Abd-El-Khalick, Susan Gates and Lynne Vernon-Feagans on our YouTube channel.

https://www.youtube.com/watch?v=ibbEbJraBRI

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Harnessing interactive visualizations to improve K-12 science instruction

Researcher: Kihyun "Kelly" Ryoo
Article by Mary Lide Parker

Kihyun "Kelly" Ryoo embarked on her research journey informed by her own experience. A native of South Korea, Ryoo faced a struggle during graduate school at Stanford University. While earning her master's and doctorate degrees, she worked to create online learning materials for pre-med students. Having majored in health education in Korea, she knew the concepts being taught. But learning the technical scientific terminology was a new barrier.

It's an insight that drove Ryoo's initial research as she worked to develop and evaluate instructional plans and technology that support teaching scientific phenomena and concepts before introducing the vocabulary that defines or describes them.

As a doctoral student at Stanford, Ryoo worked with Bryan Brown, an associate professor at Stanford's Graduate School of Education, using web-based software to teach students with a "content-first" approach, allowing students to first gain an everyday language understanding of phenomena before transitioning to the

The Background

In an effort to help K-12 students deepen their understanding of science, new standards for the teaching and learning of science – the Next Generation Science Standards (NGSS) – call for "three-dimensional" science learning through which students integrate their understanding of 1) disciplinary core ideas, 2) crosscutting concepts, and 3) science and engineering practices. Since the adoption of the NGSS, researchers have been developing and evaluating ways to effectively teach with the standards. One area of study involves the use of "interactive visualizations," such as simulations, animations, and virtual modeling environments. When carefully scaffolded, these technologies have been shown to help students integrate disciplinary core ideas (such as chemical reactions), crosscutting concepts (such as energy), and use science practices (such as modeling) by providing visual representations of abstract scientific phenomena that students can manipulate and discuss.

The Edge

Interactive visualizations have been shown to be effective in three-dimensional science learning because the technology facilitates the learning of scientific concepts and ideas while also encouraging students to engage in science practices, such as talking with each about their learning, their hypotheses and their findings. Kihyun "Kelly" Ryoo, supported by a National Science Foundation CAREER grant, is working to explore how the technology can be used to improve learning of science among all students, including English learners (ELs). There's a large achievement gap in the sciences between ELs and native English speakers, or non-English learners (non-ELs). As the EL population across the United States continues to expand, schools need effective methods to teach ELs, including meeting the new science standards.

use of scientific language and vocabulary. The study involved 49 minority students who were randomly assigned into two groups for analysis: a treatment group (taught with everyday language prior to using scientific language) and a control group (taught with scientific language). Using a pretest–posttest control group design, they assessed students' conceptual and linguistic understanding of photosynthesis. The results indicated that students taught with the "content-first" approach developed significantly improved understanding when compared to students taught in traditional ways.

A paper Brown and Ryoo co-authored from the study – "Teaching Science as a Language: A 'Content-First' Approach to Science Teaching" – won the 2009 Journal of Research in Science Teaching Award. (Brown & Ryoo, 2008)

At Carolina's School of Education, Ryoo has built from that research, further developing and evaluating visualization technologies to teach science to middle school students. Supplementing or replacing lectures by teachers, the interactive visualization technologies – which include web-based animations, simulations, and models – are designed to be engage students, allowing them to manipulate the animations that illustrate complex scientific phenomena, such as how energy and matter are involved in photosynthesis and cellular respiration.

Prompts within the animations ask students to generate their own explanations for phenomena. The animations give instant feedback as students make choices within the animations.

Ryoo has found that when working in groups with the animations, students readily discuss their ideas, a key objective of the research.

Incorporating visualization technologies into instruction

Researchers across the country are developing assessments, curriculum materials, and new technologies to help students and teachers engage in Next Generation Science Standards (NGSS) practices.

Ryoo has focused her work on using technology to develop those types of materials specifically for English learners (ELs), and do so in ways that also benefit native English speakers, or non-English learners (non-ELs).

Ryoo won a prestigious National Science Foundation Early Career Development Grant in 2016 to support and extend her work. The five-year grant is being used to fund research in which Ryoo works with eighth grade science teachers to improve their instruction for ELs through the use of visualization-rich inquiry projects and instruction.

Ryoo's most recent work examines the short-term and long-term effects of using visualization technologies to promote NGSS-aligned science learning for eighth grade ELs and students whose first language is English, called non-ELs. In this study, the ELs are students in mainstream classes who speak another language at home but are fluent in conversational English.

This study involves four low-income schools, six science teachers, one ESL teacher and four units of inquiry. In the first year, she and her team have designed lesson plans and technology that covers two units of inquiry on chemistry. The second year will cover two units on life science. During the third and fourth year, all four units will be implemented, and the fifth year will focus on developing and refining the materials for teachers.

For this study, Ryoo's main questions include:

- What are the immediate effects of visualization-rich inquiry units on ELs' and non-ELs' science learning?
- What are the long-term effects of such units on ELs' and non-ELs' delayed learning after three months?
- Are there any differences between ELs and non-ELs in their science learning after engaging in such units?

The technology

With Ryoo's technology, normally unobservable scientific phenomena are animated on tablets or computers – such as an illustration of molecular properties and animating the continuous motion of atoms and molecules over time.

Developing the visualization software involved multiple design cycles. To begin, Ryoo and her colleagues tested a pilot group of eight graders on their understanding of energy and matter in chemistry, particularly properties of matter and chemical reactions. The researchers assessed students' prior ideas about energy and matter in chemistry, and used the wide range of student naïve conceptions they identified to align the intervention with energy and matter science concepts included in the NGSS and North Carolina standards.

After honing in on the target concepts, Ryoo and her colleagues met with all the teachers involved in the study to design and refine their visualization technology and web-based inquiry-curriculum materials. The big questions: do the visualizations properly address their students' naïve or misconceptions? How can visualizations be incorporated into a scaffold structure to engage all students in discourse-rich science practices (such as generating evidence-based arguments)?

To answer these questions, Ryoo and her team focused on how to guide students' learning with visualizations, such as

what types of prompts should be used (e.g., explanations, claim-evidence-reasoning) to help students understand the target concepts while interacting with visualizations. This project targeted all students in the classroom with varying levels of English proficiency. Ryoo and her colleagues made revisions based on the feedback they received from teachers. After multiple design cycles, the end product for this particular study includes two units in chemistry. Next year, Ryoo and her colleagues will repeat the process to produce two more units, for a total four projects.

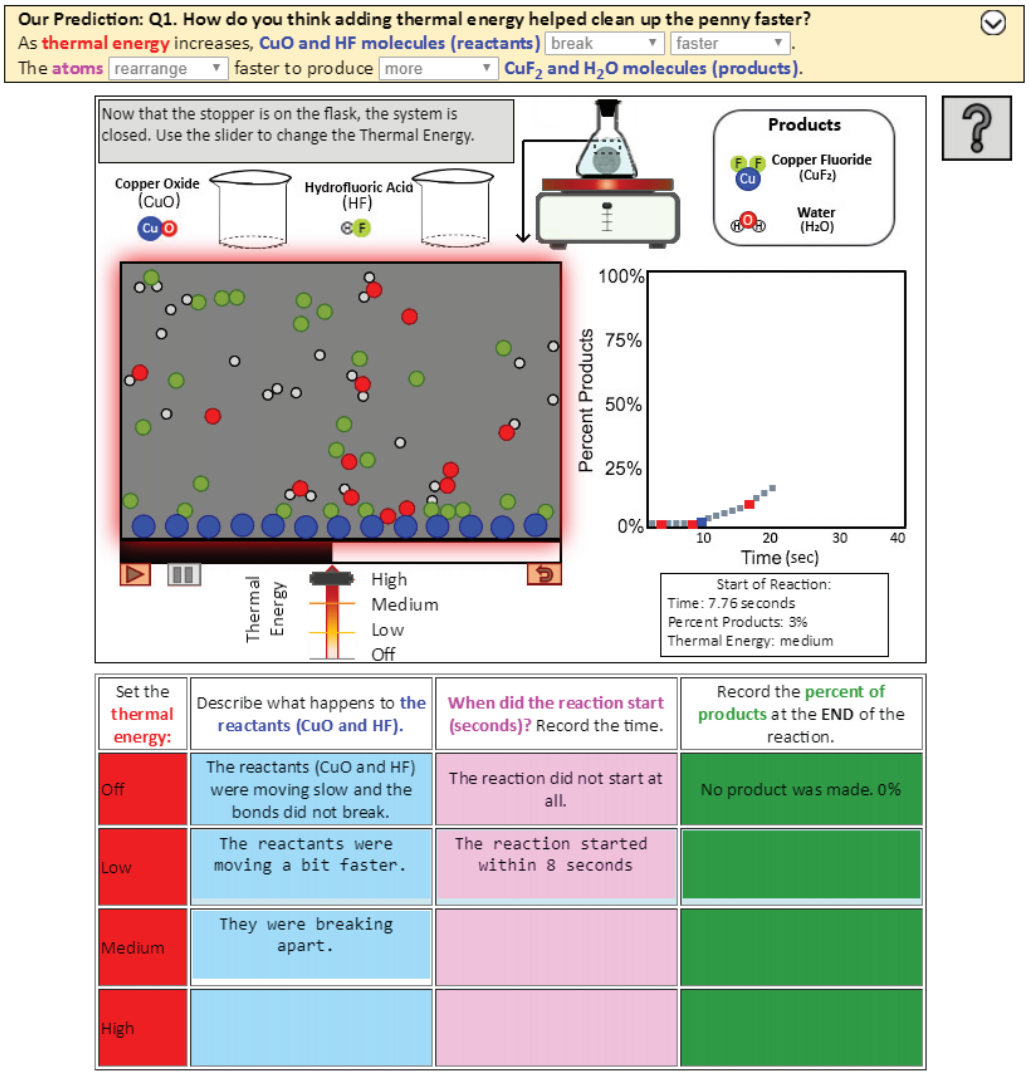
In the classroom

Simply handing technology over to the students is not effective, Ryoo has found. Discussion and engaging prompts, as well as carefully designed

More English learners than ever

Many different definitions are used to classify English language learner populations. Ryoo's group defines English learners (ELs) as a heterogeneous group of students who speak English as a second language, who are fluent in everyday English, and who receive instruction in mainstream science classrooms.

Of the school-age population (ages 5 to 17) nationally, more than one in five speaks a foreign language at home, according to the Center for Immigration Studies. While the greatest concentrations of these students live in California, Texas, Nevada, and New York, the numbers are increasing across the country. In North Carolina, one in seven students speaks a foreign language at home.



One of Ryoo's visualizations to explore the relationship between thermal energy and chemical reactions.

scaffolds, are crucial. While all the curriculum materials Ryoo developed are online, she worked closely with her participant teachers to ensure each lesson included appropriate discussion.

One of Ryoo's main goals is to have the students use language to make sense of science. Her earlier research shows that pairing ELs with non-ELs increases comprehension and participation in scientific discourse as the students talk about their understandings of what they are studying.

Students who are learning English have the opportunity to listen to their peers describe science in that language. Ryoo's earlier work also shows that when they work together with non-ELs using scaffolded visualizations, ELs are engaged in more scientific discourse, engaging in the practice of science.

To cover Ryoo's unit, the teacher begins the class with an opener, and then students work in pairs using one computer. Each unit includes a different scientific inquiry and series of steps. Teachers can initiate small group discussions or big group discussions depending on how they want to teach the class.

The students begin with making a prediction about the target concept. They explore the visualizations, and then they engage in the same questions. The visualization prompts each student to make a claim, and use evidence from the visualization to support that claim.

What comes next

After completing one unit, the results of Ryoo's study shows that ELs and non-ELs showed significant improvement in their understanding on both the post-test and subsequent delayed test of the target concepts.

In addition to the benefits of using visualizations to engage and improve proficiency in the sciences among all students, Ryoo's technology also makes high-quality science teaching tools available to schools with minimal resources.

All of the schools in Ryoo's study are Title One low-income schools, with little or no access to the kind of technology that can align their curriculum with the expectations set forth by NGSS. One of Ryoo's main objectives with this work it to make her high-quality curriculum materials widely available.

At the end of the project, all the materials will be posted online so that any science teacher in the country can access them for free.

Ryoo's work demonstrates that rigorous inquiry-based instruction with carefully scaffolded visualization technologies engages all students in science practices and improving their understandings of complex scientific phenomena, while also closing English learners' achievement gaps in middle grades science.

Resources

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History of NGSS

The Next Generation Science Standards (NGSS) are K–12 science content standards. Standards set the expectations for what students should know and be able to do. The NGSS were developed by states to improve science education for all students.

The federal government was not involved in the effort to develop the NGSS. It was state-led, and states are deciding whether or not to adopt the NGSS. The work was undertaken by the National Research Council, the National Science Teachers Association, the American Association for the Advancement of Science and Achieve, a nonprofit education reform organization that works with states to raise academic standards, improve assessments and strengthen accountability. The NGSS effort has been supported by the Carnegie Corporation of New York. No federal funds were used to develop the standards.

Cultivating creativity in classroom learning

Researcher: R. Keith Sawyer

In today's knowledge societies, schools need to teach content knowledge in a way that prepares students to use that knowledge creatively; and, they need to impart thinking skills, 21st century skills, to students. Most schools have not yet become creative learning environments. There are many challenges ahead for schools that hope to foster creative learning. Contemporary research suggests that achieving creative learning will require us to transform teaching in all subjects. The learning sciences are providing us with an increasingly rich knowledge base for how to do that (Sawyer, 2012b). Unfortunately, schools today are designed around common-sense assumptions that are opposed to creative learning.

The first among these assumptions reduces knowledge to a collection of *facts* about the world and *procedures* for how to solve problems. Facts are statements like "The earth is tilted on its axis by 23.45 degrees," and procedures are step-by-step instructions like how to do multi-digit addition by carrying to the next column.

A second problematic assumption is that the goal of schooling is to get

The Background

Knowledge economies of the future will require and reward thinkers – people who are able to work and think creatively, generating new ideas, new theories, new products, and new knowledge. Creative thinkers need to be able to critically evaluate what they read, express themselves clearly, and understand scientific and mathematical thinking. Traditional schooling today is largely based on "instructionism," in which students are expected to acquire and retain knowledge of facts and procedures, attaining mastery of what is already known. To become creative problem solvers, students need learning environments that encourage them to develop deeper conceptual understandings and the ability to generate their own new knowledge.

Learning sciences research shows us how to create learning environments that cultivate creative thinking. We know that creative learning is more effective if the process is guided appropriately, allowing learners freedom to improvise their path through disciplinary knowledge. In creative learning environments, teachers improvise with their students. But there's a tension between giving students greater freedom, and the structures of required curricula, assessments, learning goals and teacher practices. Sawyer calls this the "teaching paradox." Grounded in his research of how creativity is taught among jazz musicians, painters, designers and other artists, Sawyer has identified avenues of study that can lead to recommendations for negotiating the teaching paradox.

The Edge

Sawyer describes in his research that: (1) creative learning requires that students create their own knowledge, a constructivist process that involves *emergence*; (2) creative learning requires *collaborative emergence*, with teacher and students working together to build new knowledge; (3) *collaborative emergence* occurs in the presence of unavoidable tensions of the *teaching paradox*; (4) negotiating the teaching paradox requires that teachers and classrooms engage in *disciplined improvisation*; (5) disciplined improvisation allows for the creative benefits of collaborative emergence, yet guided by teacher practices, curricular structures, and learning goals that guide and aid students in their own process of creative learning.

The creative schools of the future are strongest in teaching what instructionism cannot: Creative learning requires collaborative emergence and creativity on the part of the student.

these facts and procedures into the student's head. People are considered to be educated when they possess a large collection of these facts and procedures. A third assumption guiding traditional learning environments is that teachers know these facts and procedures, and their job is to transmit them to students. It follows that, fourth, simpler facts and procedures should be learned first, followed by progressively more complex facts and procedures. The definitions of "simplicity" and "complexity" and the proper sequencing of material were determined either by teachers, by textbook authors, or by asking expert adults like mathematicians, scientists, or historians—not by studying how children actually learn. A final assumption of non-creative learning environments is that the way to determine the success of schooling is to test students to see how many of these facts and procedures they have acquired. This traditional vision of schooling is known as *transmission and*

acquisition (Rogoff, 1990), the *standard model* of schooling (OECD, 2008), or *instructionism* (Papert, 1993). Instructionism emerged in the industrialized economy of the early 20th century. Most schools continue to be largely based on an instructionist model of teaching and learning.

But the world today is much more technologically complex and economically competitive, and instructionism is increasingly failing to educate our students to participate in this new kind of society. Economists and organizational theorists have reached a consensus that today we are living in a knowledge economy, an economy which is built on knowledge work (Bereiter, 2002; Drucker, 1993).

In the knowledge economy, memorization of facts and procedures is not enough for success. Educated graduates need a deep conceptual understanding of complex concepts, and the ability to work with them creatively to generate new ideas, new theories, new products, and new knowledge. They need to be able to critically evaluate what they read, to be able to express themselves clearly both verbally and in writing, and to be able to understand scientific and mathematical thinking. They need to learn integrated and usable knowledge, rather than the sets of compartmentalized and decontextualized facts emphasized by instructionism. They need to be able to take responsibility for their own continuing, life-long learning. Instructionism is particularly ill-suited to the education of creative professionals who can develop new knowledge and continually further their own understanding; instructionism is an anachronism in the modern innovation economy.

Characteristics of effective learning environments

The research emerging from the new sciences of learning is in direct contrast to instructionism; this research suggests that effective learning occurs in learning environments that share the following characteristics:

An emphasis on deeper conceptual understanding. Scientific studies of expertise demonstrate that expert knowledge includes facts and procedures, but simply acquiring those facts and procedures does not prepare a person to work creatively with that knowledge. Factual and procedural knowledge is only useful when a person knows which situations to apply it in, and exactly how to modify it for each new situation. Instructionism results in a kind of learning that is very difficult to use outside of the classroom. When students gain a deeper conceptual understanding, they learn facts and procedures in a much more useful and profound way that have much higher likelihood of transferring to real-world settings.

The importance of building on a learner's prior knowledge. Learners are not empty vessels waiting to be filled. They come to the classroom with preconceptions about how the world works; some of them are basically correct, and some of them are misconceptions or naïve conceptions. The best way for children to learn is in an environment that builds on their existing knowledge; if teaching does not engage their prior knowledge, students often learn information just well enough to pass the test, and then revert back to their misconceptions outside of the classroom.

The importance of reflection. Students learn better when they express their developing knowledge – either through conversation or by creating papers, reports, or other artifacts – and then are provided with opportunities to reflectively analyze their state of knowledge.

In instructionism, creativity is not necessary for learning, because learning is equated with mastery of what is already known. But within the newer understanding of how students learn that is emerging from the learning sciences, the conceptual understanding that underlies creative behavior emerges from environments in which students build their own knowledge (Scardamalia & Bereiter, 2006), through exploratory talk (Mercer, 2000), and sustained argumentation (Andriessen, 2006). The constructivist view emerging from learning sciences research is that learning is always a creative process (Sawyer, 2003a).

Toward embracing and releasing 'disciplined improvisation'

There are many challenges ahead for schools that hope to foster creative learning. Many educational leaders and policy makers have focused on the institutional, administrative, and political challenges that make it difficult for schools to explore more innovative organizational forms. These are *external* forces that make creative teaching and learning difficult. In contrast, I present *internal* forces that make creative teaching and learning difficult.

My research shows that: (1) creative learning requires that students create their own knowledge, a constructivist process that involves *emergence*; (2) creative learning requires *collaborative emergence*, with teacher and students working together to build new knowledge; (3) collaborative emergence occurs in the presence of unavoidable tensions that I have called the *teaching paradox*; (4) negotiating the teaching paradox requires that teachers and classrooms engage in *disciplined improvisation*; (5) disciplined improvisation allows for the creative benefits of collaborative emergence, yet guided by teacher practices, curricular structures, and learning goals that guide and aid students in their own process of creative learning.

The effectiveness of disciplined improvisation is not easy to achieve, because it's inherently a tension between two forces, both of which are necessary and both effective when in combination. I referred to this tension above as "the teaching paradox."

Embracing the 'teaching paradox'

The teaching paradox faces all educators who hope to design creative learning environments. Whereas instructionist classrooms are almost completely top down, with no room for emergence or creativity to occur, creative classrooms will be much more bottom up. The creative schools of the future are strongest in teaching what instructionism cannot: Creative learning requires collaborative emergence and creativity on the part of the student.

Creative learning is more effective learning if the process is guided appropriately. The best way to foster creative learning is *not*—as many might intuitively assume or often advocate—to allow learners complete freedom to improvise their own path through disciplinary knowledge; it is, rather, to guide them in a process of disciplined improvisation. A caution: Schools are complex organizations with many structures and constraints; these structures serve important functions and cannot simply be abandoned.

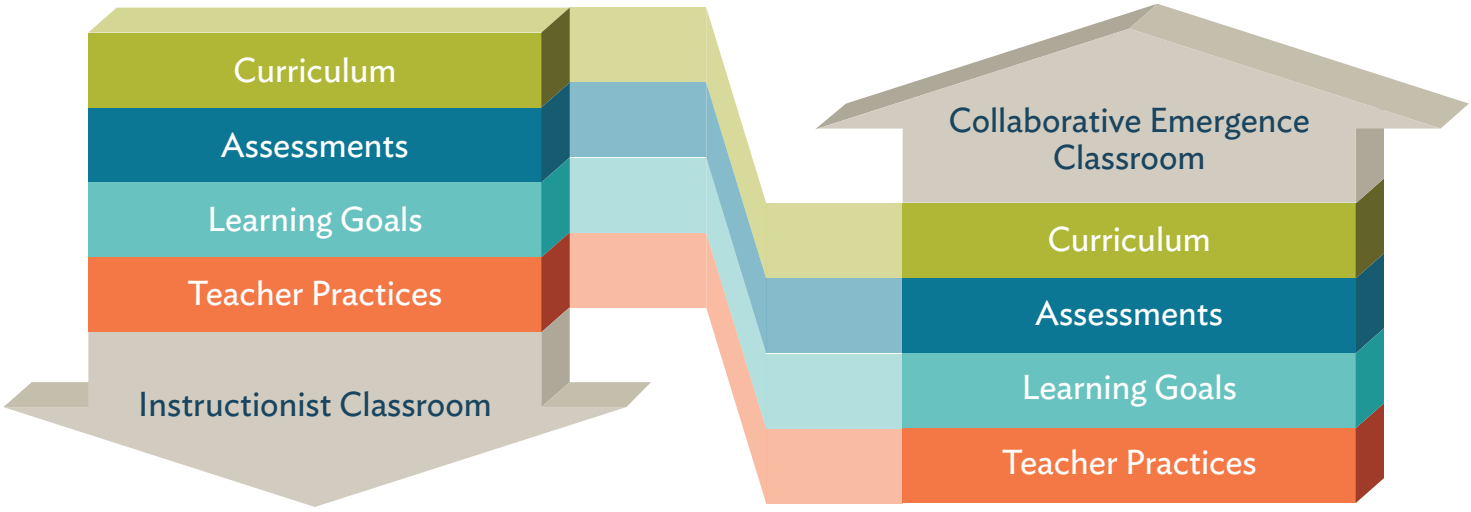
Effective creative learning involves teachers and students improvising together, collaboratively, within the structures provided by the curriculum and the teachers. But this collaborative emergence, a bottom up group process, must be guided effectively by (at least) four top-down structures: (1) curriculum, (2) assessments, (3) learning goals, and (4) teacher practices. In too many schools today, these top-down structures are overly constraining, and do not provide room for the disciplined improvisation that results in collaborative emergence. And yet, effective learning environments will always need curricula, assessments, learning goals, and teacher practices.

To transform schools to foster greater creativity in students, these four top-down structures need to change: (1) The curriculum should provide opportunities for multiple learning trajectories that could result from a creative inquiry process; (2) Assessments should incorporate and reward the sort of deeper conceptual understanding that results from creative learning, and they should accommodate potential differences in learning sequence and outcome; (3) Learning goals should explicitly incorporate creative learning. Schools and districts should ensure that the expected learning outcomes do not emphasize breadth over depth; and (4) Teacher professional development should be based in creativity research, and in research in the content areas—for example, science education research that explores the appropriate role of guiding scaffolds in the unavoidably unpredictable and emergent process of creative learning.

Directions for further research

Modifying schools away from instructionism toward disciplined improvisation leads directly to the teaching paradox. Fortunately learning sciences research provides guidance to educators for how to design solutions. Education researchers should work to provide research and practical recommendations for how to teach for creativity. We need research efforts that can help teachers, administrators, and curricular developers negotiate the teaching paradox.

Potential research questions include:
What is the optimal balance between scripts, routines, and activities on the one hand, and creative improvisation on the other?



What is the best way to educate preservice teachers to prepare them to optimally negotiate the teaching paradox?

Decades of research on constructivism in education have demonstrated that the most effective learning occurs when the learners' discovery and exploration are guided by scaffolds – structures put in place by the teacher. What is the right degree and type of scaffolds, that result in the most effective creative learning? Answering this question will require substantial research in the content areas, because the appropriate scaffolds will change with the nature of the content knowledge and with the level of the learner.

What is the optimal balance of general creativity education, and domain-specific creative learning? What role can the arts play in domain general and domain specific creative teaching and learning?

Designed instruction always has a desired learning outcome. The term "curriculum" represents the structures that are designed to ensure that learners reach those learning outcomes – whether textbooks, lists of learning objectives, or lesson plans. What lesson plans and curricula will guide learners in the most optimal way, while allowing space for creative improvisation?

These research questions are becoming increasingly central to the interdisciplinary field known as the learning sciences (Sawyer, 2012b), a group of education researchers that are exploring the fundamentally constructivist observation that effective learning requires the learner to create and recreate their own knowledge.

Constructivist learning theory has always presented a challenge to educators: What learning environment can best support learners as they engage in their own creative and constructivist process of learning? In this sense, the teaching paradox is not new; it has always been at the core of attempts to work out the implications of constructivism for teachers and curriculum developers.

Creative learning is the core of all effective learning. The cognitive processes underlying creativity and learning are essentially identical – they both involve the emergence of the new in the mind of the individual. Creative learning environments are those that foster collaborative emergence, improvisational group processes where the outcome cannot be predicted from the individual mental states and goals of the participants, and where all members of the group – teacher and students alike – participate in the unfolding flow of the encounter.

Aspiring to create creative schools

The school of the future will be filled with creative learning environments that result in deeper mastery of content knowledge, and the ability to think and act creatively using that knowledge. In those creative schools, students learn content knowledge; but in contrast to the superficial learning that results from instructionism, they learn a deeper conceptual understanding that prepares them to go beyond and build new knowledge. They learn collaboratively, in ways that help them externalize their developing understandings and fosters metacognition. They learn to participate in creative activities based on their developing knowledge – how to identify good problems, how to ask good questions, how to gather relevant information, how to propose new solutions and hypotheses, and how to use domain-specific skills to express those ideas and make them a reality.

All schools want students to learn as much as possible, as effectively as possible. To accomplish this goal, schools should be designed based on learning sciences research. This research is beginning to provide suggestions for how to foster creativity in the face of the teaching paradox (e.g., Sawyer, 2011a).

Education researchers and funding agencies should invest more resources in the study of creative teaching and learning. Teacher professional development should build on this research, to help teachers understand how to foster creative learning through disciplined improvisation.

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Innovation grounded in science

Carolina's new **Master of Arts in Educational Innovation, Technology and Entrepreneurship** is designed to equip students to design and build the learning environments of the future. In a collaboration with Carolina's Kenan-Flagler Business School, School of Information and Library Science, and Department of Computer Science we've developed a program that can help edupreneurs take ideas grounded in learning sciences to market.

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Building new paths to critical thinking

Teaching 'digital literacy' for the Information Age

Researcher: Jeffrey A. Greene
Article by Alyssa LaFaro

English author Neil Gaiman said, "Google can bring you back 1,000 answers. A librarian can bring you back the right one." The point: In the ever-deepening information well of the Internet and other digital environments, how do we find truthful, evidence-based answers? We do it by teaching the students of the 21st century how to become critical thinkers, a feat that requires both self-regulated learning and epistemic cognition.

Even though today's students have grown up in the Information Age, this does not make them "digital natives" according to Greene. Research indicates that many students struggle with learning online, and in particular with self-regulated learning and epistemic cognition. To make matters worse, students can fall into bad habits, such as failing to check the reliability of a source — something that can damage their ability to think critically. If you teach a swimmer how to breaststroke but not proper breathing patterns, they'll flounder.

As online resources become more essential in modern classrooms, the need for students to properly use digital literacy skills becomes more important. The Internet is an incredibly valuable resource – when students know how to use it effectively. Using the Internet can help students move beyond non-linear learning, provide access

The Background

Critical thinking has been defined as "purposeful reflecting and reasoning about what to do or believe when confronting complex issues, taking into account relative context." Researchers have studied the importance of critical thinking in classrooms since the 1960s. Educators have tried to teach it for much longer than that. But teaching how to think critically is difficult because it is not something the human brain does naturally. While critical thinking is difficult to teach, it's essential in today's workforce and in everyday life. Should I open a 401K and how much should I put into it? Do I send my children to public or private schools? How do I choose the best candidate in a presidential election? All of these questions require critical thinking. And in today's Information Age, critical thinking requires that students have digital literacy.

Digital literacy refers to a person's ability to use digital technology and information to find, evaluate, create, and communicate knowledge. To be truly digitally literate, two critical components need to be understood: self-regulated learning, the collection of skills needed to plan, control, and evaluate one's own learning; and epistemic cognition, the knowledge and skills to appropriately vet, integrate, and even create modern digital information sources.

Among learning scientists is a widening acceptance of the need to study epistemic cognition and self-regulated learning concepts together. In the past, they've been observed and researched as separate concepts. But both are essential to build critical thinking knowledge, dispositions, and skills in students.

The Edge

Jeff Greene has developed new ways to analyze data from "think-aloud protocol" – or TAP – to measure how people self-regulate their learning and enact epistemic cognition as they work to find answers to questions and to solve problems. By studying the interplay of these two types of mind work, Greene has demonstrated how TAPs can be used by researchers to study complex learning behaviors. His findings suggest avenues by which understandings of epistemic cognition and self-regulated learning can be incorporated into teacher preparation programs to help teachers instill critical thinking skills in their students – steps toward developing stronger digital literacy skills.

resources such as maps, charts and graphs, illustrations and interactive sites that the student can control. This is where self-regulated learning comes into play. Successful, self-regulated learners make effective plans that can be monitored for effectiveness and efficiency, adapted when needed, and ultimately followed through even when things get tough.

These skills are essential for successful digital experiences, Greene says.

However, self-regulated learning is not all that's needed. Students can be self-regulated without using critical thinking

skills. Epistemic cognition extends learners' abilities by helping them construct, evaluate, and use the knowledge they consume.

Greene says that to successfully prepare students for the demands of the 21st century, researchers must continue to study epistemic cognition — a critical aspect of critical thinking. It helps individuals determine what they actually know versus what they believe, doubt, or distrust. People make decisions using learned epistemic cognition practices every day.

Greene gives the example of choosing to keep money in a bank. Most people simply assume it's safe because they've grown up among parents and others who they trust telling them it is okay. As a result, making that choice does not involve a very conscious evaluation process. As people confront more complex problems, if they continue to rely only on what other people tell them, they often lack the knowledge, skills, and dispositions to really think through them successfully.

People also need to know how to evaluate sources of information, sorting reliable ones from unreliable ones, and have an understanding of how knowledge is developed within disciplines. For example, people understand that their medical doctor has had years of specialized training that gives them expertise that can be relied upon.

Thinking out loud to gain critical knowledge

For more than 20 years, researchers have hypothesized the connection between epistemic cognition and self-regulated learning, but many empirical results are the product of self-report measures with questionable validity. Additionally, critical thinking is difficult to measure through the surveys, polls, or questionnaires used in self-report studies. A more efficient technique for gathering data on such topics is think-aloud protocol (TAP) analysis. Developed in the 1980s from protocol analysis techniques used by K. Anders Ericsson and Herbert Simon, TAP requires research participants to verbalize their thought process as they engage in a task — a much more dependable process for measuring self-regulated learning than self-reports after learning, or outside of the learning context.

Previous researchers have succeeded in coding TAPs to show cognitive and metacognitive thinking patterns — a dictionary, so to speak, for translating the undiscovered language of the brain. (Azevedo, 2005) The phrase "I understand that," for example, is coded as a "judgment of understanding," or the study participant's ability to comprehend the material in front of them. Through Greene's expansion of this dictionary, epistemic cognition can also be measured in this way.

The key with TAPs, however, is to encourage participants to report only their thoughts, not explain what they're thinking. That's because previous research has shown that by asking participants to explain their thinking process while learning can actually alter that thinking process, therefore fouling the measurements.

Although TAPs seem like a better option than self-report measures for this type of research, it's important to note how intensive they are. Thirty minutes of data collected from TAPs may involve more than 1,000 phrases that require coding and up to six hours of work, according to Greene. And, given the number of codes, this research method needs a lot of participants in order for researchers to understand how each code relates to learning. Through collaboration with student colleagues, Greene has developed a procedure for aggregating TAP codes into a smaller set of variables that are simpler to study.

Greene and his research team have used the TAP coding procedure to capture self-regulated learning and epistemic cognition as they occur in students. For example, in one study they asked 20 undergraduates to participate in a 90-minute session, which began with a short demographic questionnaire and a 20-minute knowledge pretest. Then, the following learning task was read aloud:

> *"Imagine that you have been asked to write a five-page paper for an undergraduate elective class in public health on whether taking a daily vitamin pill is helpful for normal, healthy adults. You decide to consult sources on the Internet. We have provided you with a list of pages that came up after your first search, which you may consult if you wish. You are also free to consult any other webpages you wish."*

The student participants were asked to verbalize every single thing they thought or read during their 30-minute session navigating the Internet, which was audio and video recorded. After, they spent 20 minutes taking a posttest identical to that of the pretest. Upon comparing both test results, Greene observed significant improvement in posttest responses, and that this improvement was related to digital literacy processing, suggesting that self-regulated learning and epistemic cognition are related to knowledge gains in the digital learning environment. (Greene, Yu & Copeland, 2014) Greene has since built on this inquiry with a larger study.

Even more importantly, perhaps, this work has revealed that Greene's techniques are a viable method of preparing, analyzing, and representing TAP data regarding these phenomena. Lastly, the study further demonstrated how TAP data collection and analysis can be successfully applied by researchers to the study of students' complex behaviors when learning science topics in the multimedia, hyperlinked contexts of the Internet.

Different subjects require different skill sets

As teachers prepare students for continued education and for demands of outside-the-school endeavors, it's important to teach them how to think critically in discipline-specific manners.

The ways scientists make arguments, for example, is very different from how historians make arguments. And the essential elements needed to create an effective discourse in biology vary greatly from the knowledge required to successfully compete in a literary debate.

Greene and his research team utilized TAPs again to address the differences in self-regulated learning skills for those studying science and those studying history. For the study, 94 college-aged students were asked to explore either a history- or science-focused digital library. These computer-based learning environments feature curated collections of pictures, videos, texts, maps, simulations, and other multimedia forms.

Like the earlier study, students were given a 20-minute pretest and posttest to test knowledge gains after completing a specific task using the information within the digital libraries. Those assigned to the history library were tasked with understanding the origins and controversies regarding the construction of the Blue Ridge Parkway.

The group focused on science was asked to understand the phase change process of substances as they move from solid to liquid to gaseous states. Students in both groups spent the next 30 minutes verbalizing their thought processes, which were both audio- and video-recorded by the research team.

Applications in the classroom

So many of the evolving standards and goals for education involve critical thinking and self-regulated learning, according to Greene. When teachers ask students to "analyze," "evaluate," "interpret," or "argue," what they really want is students to think critically. But the climate in the classroom has to be one that effectively supports, models, and rewards this skill.

For example, if a teacher says it's important to think critically, but the only assessments she gives are multiple choice tests, then her students aren't going to learn how to think critically. Likewise, if a teacher stresses the importance of being a self-starter in today's world, but there are no opportunities to have voice in the classroom, the students are going to struggle to become more autonomous.

Teachers need to talk the talk and walk the walk, according to Greene. Educators who teach self-regulated learning explicitly model it their lessons — and reward it.

Research has shown that some of the most productive educational environments for building critical thinking skills are constructivist in nature. Constructivist classrooms are extremely student-focused, offering them autonomy to explore and solve problems to a point in which they can eventually teach their peers. The teacher works to build scaffolds that guide students in constructing their knowledge claims. (Muis, K. R., & Duffy, M. C., 2013)

Teacher epistemic belief systems are vital to the success of the classroom and, ultimately, dictate the outcome for students' success at solving complex problems.

The next challenge involves continued research into how epistemic cognition can be incorporated into teacher preparation programs — something that will not only strengthen teaching technique, but change the course of the education system as a whole.

The future of this research

Little empirical research shows how self-regulated learning and/or epistemic cognition processing varies from website to website, according to Greene. To tackle this topic, he and his team are collecting and analyzing TAP data surrounding self-regulated learning and epistemic cognition to determine how students' evaluations of websites affect how they self-regulate and learn with them. For example, do people who critically evaluate websites learn more — or even better — than those who do not? This seems like an obvious question, but more evidence is needed to truly answer it.

The phenomenon of "ego depletion" — the feelings of exhaustion that can result from having to regulate cognition and emotions when encountering challenging information online — is an additional topic Greene hopes to study in the future. People only have a certain amount of energy for engaging in things that require effort such as managing emotions, completing challenging tasks, and engaging in critical thinking. Once that energy is tapped, those processes become more and more difficult to complete. Ego depletion may have factored heavily during the 2016 presidential election, according to Greene. People regularly exchanged harsh commentary and shared defeated attitudes in response to the overstimulation of information received from social media sites on a daily basis. Greene wants to know how these environments affect critical thinking, and whether or not consuming information from websites with content that differs from your own belief system leads to further ego depletion.

Another area of new study: Greene and his team are also analyzing data from a study of professors reading various articles from all types of websites on a single controversial issue — such as the reproducibility "crisis" in psychology — to see how they enact epistemic cognition. The study will provide much needed insight into the discipline-specific nature of epistemic cognition. The participating professors represent a wide range of fields that include those closely related to the topic being studied such as sociology and anthropology, to much more unrelated fields like physics and chemistry.

Applying this knowledge within classrooms is one of the big next-steps. With additional funding, Greene hopes to collaborate with educators to develop self-regulated learning and epistemic cognition training programs to help them teach students how to become better digital learners.

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Measuring the effects of isolation

Researcher: Dana Thompson Dorsey
Article by Michael Hobbs

Isolation hurts children. Across a range of disciplines, studies have documented that social isolation in childhood generates persistent detrimental effects – on individuals' health, self-perceptions and aspirations, motivation and educational attainment. Adults who were socially isolated as children have been shown to be less resilient when confronting new situations and have less capacity to adapt to different or changing environments.

Evidence of the harm of isolation, drawn from social science research, has played a role in educational policymaking and in the legal landscape surrounding schooling in America. Social science research that demonstrated harms of isolation was at the heart of the landmark 1954 U.S. Supreme Court ruling in Brown v. Board of Education desegregation case.

In that decision, justices considered the effects of racial segregation, concluding that isolating children of similar age and qualifications solely based on their race "generates a feeling of inferiority as to the status in the community that may affect their hearts and minds in a way unlikely ever to be undone."

The Brown decision led to three decades of efforts to desegregate public schools in most of the country. That period has been followed in more recent years by a phase during which schools have re-segregated by race. In fact, schools today are more racially segregated than they were in the late 1960s.

Dana Thompson Dorsey has researched that history, describing the legal landscape of desegregation cases and why desegregation was needed to reduce the impacts of social isolation on black children. Thompson Dorsey's work is informed by a background that includes a law degree from the University of Pittsburgh and several years of work as an attorney in racial discrimination issues. She also earned a Ph.D. in Administrative and Policy Studies from the University of Pittsburgh's School of Education.

Compounding effects of rural isolation?

Now Thompson Dorsey is extending her research, examining whether the effects of geographic isolation compound those of racial segregation.

In a Spencer Foundation-supported project, Thompson Dorsey is building on work she has done exploring attitudes among high school students, teachers and principals in rural counties in North Carolina, a state with more rural students than Montana, North Dakota, South Dakota, Wyoming, Colorado, Nebraska, Kansas, and Oklahoma combined.

Using a Diversity Assessment Questionnaire (DAQ) developed at Harvard University to collect survey data, Thompson Dorsey has found that students in racially segregated schools were keenly aware of their inferior schooling conditions, which led to lower academic aspirations. The findings suggested that some rural youth were academically prepared for higher education but were less prepared socially and emotionally to live away from their rural communities and pursue further education.

Thompson Dorsey is working to investigate attitudes among students and school personnel to identify how rurality might compound feelings of isolation among rural students. Her work is aimed at helping to fill a gap in understanding as there has been little research on creating culturally responsive educational policies and practices that promote health, safe, and more equitable schools for racial minority youth in rural settings.

"Evidence of the harm of isolation, drawn from social science research, has played a role in educational policymaking and in the legal landscape surrounding schooling in America."

Notes

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