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Three Visionary Projects Using AI in Education

by Sarah Hampton

One of my favorite things about our Summer of AI is learning about cyberlearning projects and how they might benefit future students. In this post, I want to showcase three projects that caught my attention because they use AI in different ways and for different ages. When we began in June, I was thinking AI might be mostly about robots in STEM classes or general AIs like Siri or Alexa. But now, after learning about these three example projects and many more, I realize that the future might be more about specialized AIs giving teachers information and ways to personalize learning. Sometimes this is behind the scenes, like the first project I highlight. Sometimes, like the third project, a robot is used in Mandarin class (instead of in a technology class). Let us know what you think about these projects and their potential to change how you teach and learn @CIRCLeducators!

1. **Project:**

Human/AI Co-Orchestration of Dynamically-Differentiated Collaborative Classrooms

Figure 1. Left: A teacher using Lumilo while her students work with Lynette, an ITS for equation solving, in class (from Holstein et al., 2018b); Right: A point-of-view screenshot through Lumilo.

> “This project will create and demonstrate new technology that supports dynamically-differentiated instruction for the classroom of the future. This new vision centers on carefully-designed partnerships between teachers, students, and artificial intelligence (AI). AI-powered learning software will support students during problem-solving practice, providing either individual guidance (using standard intelligent tutoring technology) or guidance so students can effectively collaborate and tutor each other. These learning activities are constantly adjusted to fit each student’s needs, including switching between individual or collaborative learning. The teacher “orchestrates” (instigates, oversees, and regulates) this dynamic process. New tools will enhance the teacher’s awareness of students’ classroom progress. The goal is to have highly effective and efficient learning processes for all students, and effective “orchestration support” for teachers.”

Why I’m Interested:

- Capitalizes on the strengths of students, teachers, and technology
- Creatively addresses differentiation and individualized instruction
- Promotes collaborative learning
- Relevant for all subjects

Learn More:

http://kenholstein.com/JLA_CodesignOrchestration.pdf
Teacher smart glasses (Lumilo)

2. **Project:**

Using Gaze in a Reading Tutor

> “The big question the PIs are addressing in this project is how to unobtrusively track silent reading of novice readers so as to be able to use an intelligent tutoring system to aid reading comprehension… This pilot project builds on previous work in vision and speech technology, sensor fusion, machine learning, user modeling, intelligent tutors, and eye movements in an effort to identify the feasibility of using eye tracking techniques, along with other information collected from an intelligent reading tutor, to predict reading difficulties of novice/young readers.”
>
> “The project’s most important potential broader impacts is in establishing a foundation for exploiting gaze input to build intelligent computing systems that can be used to help children with reading difficulties learn to read and read to learn.”

Why I’m Interested:

- Targets reading comprehension which would help students in all subjects
- Could decrease student frustration
- May identify and intercept issues early translating to great academic gains over time
- Interacts personally with all students simultaneously in ways one teacher could not
- Allows for meaningful individual reading practice

Learn More:

Perhaps because this was a pilot program, no further information has been published. As a teacher looking toward the future and wanting to shape the conversation as it’s happening, I want to know more! I want to

know what happened during this exploratory project and how similar projects could build on their work.

3. **Project**

[Transforming World Language Education using Social Robotics]

Figure 2. Students interacting with RALL-E robots.

> "The social robot being developed in this project is designed to act as a language partner for students learning a foreign language, in this case those learning Chinese. It augments classroom instruction, providing for the learner a robot companion to converse with. The hypothesis is that social robots can make interactions with language speakers more exciting and more accessible, especially for less commonly taught languages. The embodied robot is designed not only to converse with learners but also to point and nod and gesture at particular people and objects, helping to direct the attention of learners and interact socially with learners in ways that a non-embodied simulation cannot."

Why I'm Interested:

- Opens access for learning languages like Mandarin and Hindi that are spoken by hundreds of millions of people around the world but are not routinely offered in American schools
- Could easily be used in formal and informal settings
- Applies robotics beyond STEM subjects

Learn More:

https://circlcenter.org/interactive-robot-for-learning-chinese/

Thank you to James Lester for reviewing this post. We appreciate your work in AI and your work to bring educators and researchers together on this topic.

References

Holstein, K., McLaren, B. M., & Aleven, V. (2018b). Student learning benefits of a mixed-reality teacher awareness tool in AI-enhanced classrooms. In C. Penstein Rosé, R. Martínez-Maldonado, U. Hoppe, R. Luckin, M. Mavrikis, K. Porayska-Pomsta, B. McLaren, & B. du Boulay (Eds.), Proceedings of the 19th International Conference on Artificial Intelligence in Education (AIED 2018), 27–30 June 2018, London, UK. (pp. 154–168). Springer, Cham. http://dx.doi.org/doi.org/10.1007/978-3-319-93843-1_12

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Considering Techquity in the Classroom

By Merijke Coenraad

Merijke Coenraad is a PhD Candidate in the Department of Teaching & Learning, Policy & Leadership in the College of Education at the University of Maryland. She is a former middle school teacher. Her research focuses on the intersections of educational technology and equity including the creation of materials, platforms, and experiences in partnership with teachers and youth through participatory design methods.

Flashback to a Spanish Classroom (2016)

Chromebooks out. Hushed silence. Each student leaned over their computer. Tension in the air. I yell, "GO! " and with one word, the room erupts and groups hurriedly work together to identify vocabulary words before their classmates. In loud whispers students ask their partners for words, "Calcentines, who has socks?" One mistake and the group will have to start over; the stakes are high, and no star student can single handedly win the game for their peers.

Quizlet transformed flashcards, a time consuming (and often lost or forgotten) physical learning tool into a digital learning experience. My students practiced their vocabulary words through drills and games all week and on Friday, we played Quizlet Live.

When I was still in the classroom, I loved to bring new technology into my social studies and Spanish lessons. I got excited discovering tools like EdPuzzle and Padlet when they were first breaking onto the education stage. With 1 to 1 Chromebooks in my middle school classroom, there was hardly a class period where students were not somehow connected to technology and each of these technologies meant creating a new account. Looking back, I realize that I was naïve while teaching. As I brought tool after tool to my students, I didn't think deeply about the data collection ramifications and the way that the very tools that could enhance learning might be treating my students inequitably and perpetuating the structural racism and human biases that I worked each day to dismantle. The educational technology that I brought into my classroom had positive effects, but it also had hidden consequences, most of which I might never know.

Four years after leaving the classroom to begin my PhD, my work focuses on one thing, Techquity, or the intersection of technology and equity. This focus is driven by the students I taught and the many times I saw technology act as both an access point and a barrier to their education. Even though I wasn't thinking about data collection, algorithmic bias, and the effects of AI for the students in my classroom, I was still focused on how technology helped and hindered my students' education. But those barriers and hindrances go beyond the devices and internet access I have long considered. In the last year, I have learned a lot about forces within and around technology that cause inequities. I have learned about the Coded Gaze of AI Technologies from Joy Buolamwini and the New Jim Code from Ruha Benjamin. I've learned about the biases inherent in the very design of technologies with Sara Wachter-Boettcher and how algorithms can be Weapons of Math Destruction from Cathy O'Neil. It has led me to focus on how I can not only be more cognizant of the biases of technology, but also teach students about them.

Techquity: Co-designing with Kids

To learn more about what kids think about Techquity concerns, I partnered with a youth design team to hear what they had to say about Techquity and learn which Techquity concerns were of the most interest to them. I find that kid insight is critical whenever I am discovering new topics to teach to students. The team was constructed of 7 Black youth between the ages of 8 and 13 who meet twice a week to design technologies and learn about being a designer.

Let's look a little bit at what the kids had to say about Techquity.

While they didn't have the vocabulary to name algorithmic bias or biases in voice recognition technology, the kids quickly began offering examples of how technologies can be good and bad and how even single technologies can have good and bad sides. For example, one group identified Siri as helpful because "she" can give information without typing, but they also were worried that Siri doesn't always understand them and "SIRI CAN LISTEN TO US!!!!" While the AI in their phones allowed the students to access all sorts of information, they were not immune to considerations of what it meant for a device to always be listening for, "Hey Siri…"

As our conversation turned and I introduced the kids to some common examples of Techquity concerns such as data collection, targeted advertising, misidentification by AI, and non-diverse tech design teams, the kids continued to describe their own examples. They could recollect times when they received targeted advertising based on location or a recent website visit.

Techquity Concerns

10 common Techquity concerns we discussed are:

- Algorithms (computer programs) don't treat everyone fairly

- Technology development teams are frequently not diverse
- Alexa, Google Home, and Siri are always listening to me
- I get personalized ads based on data companies collect about me
- Technology is not always accessible for individuals with disabilities
- Companies sell my data
- Sensors and systems like Alexa, Google Home, and Siri get confused about how I look or what I say
- People don't understand how technology works
- Machine learning and facial recognition isn't trained well enough to recognize everyone

The kids each ranked the 10 Techquity concerns from "very important to me" to "not very important to me." The two most highly ranked ideas were **algorithmic bias** and **non-diverse tech companies**. The kids were especially concerned that individuals who looked like them were not being represented on design teams when they themselves were and what this meant for the technologies being designed.

As their final design task, the kids designed ways to teach other kids about Techquity by drawing their ideas out on an online platform mimicking paper and pencil. Interestingly, the kids didn't want to move away from technology just because it could be biased, they just wanted it to be created in more equitable ways and to be used to teach others. Their teaching often included advanced algorithms and even AI. They designed scenarios using robots and adaptive software to allow other kids to experience obvious Techquity concerns and learn from their experiences. One girl, Persinna, explicitly discussed the three-member design team shown in her game as having 2 girls and 1 boy because "that is Techquity." Kabede felt very strongly that data collection by tech companies was a big concern. He started making connections to actual tools he knows such as DuckDuckGo, a search engine that does not profile users and focuses on user privacy.

What I Would Consider Now If I Were Still a Teacher

I'd start from what these kids already know about Techquity and how algorithms and AI are affecting their lives and build on that. I would educate students about the biases inherent in Google searches, which sort not by popularity of links as is commonly assumed, but based on user profiles and advertising. I would use Kabede's recommendation and have students use a search engine like DuckDuckGo to prevent tracking and allow for private searches. I would challenge students to think about where algorithms, AI, and technology design are already affecting their lives and how technologies might work better for some individuals than they do for others. We would talk about the sensors in automatic sinks, paper towel dispensers, and medical devices and how those sensors work based on light, but oftentimes work better for people with lighter skin. We would discuss Joy Buolamwini's experiences and work and talk about how machine learning training sets are often not adequate to identify all people well and how this has direct consequences for the use of AI in policing and surveillance.

While the students in my classroom wouldn't be the ones causing the technology bias, I would make sure they were aware of it and how it had direct implications for their lives. Most of all, I would base these discussions in students' lived experiences. Just like the kids on the design teams, it is inevitable that my students experienced technology bias, they just might not have had words for it or known why it was happening. The more I could teach my students and bring Techquity concerns to their knowledge, the more they could protect themselves (and their communities) and make educated decisions about their lives with technology. I know that my middle school students wouldn't give up their technology and knowing about the biases held by the designers of that technology probably wouldn't change their opinions of technology being, as Joshua said in the design session, "the best thing ever," knowing more about their digital footprint and how companies are using their information gives them a small advantage. In this case, knowledge of Techquity concerns could give them power over their data and their technology use.

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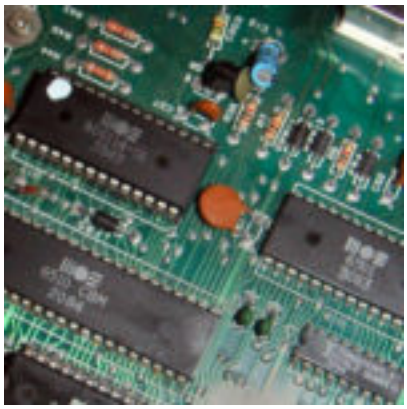
AI and Formative Assessment



by Sarah Hampton

In my last post, I talked about effective formative assessments and their powerful impact on student learning. In this post, let's explore why AI is well-suited for formative assessment.

1. AI can offer individualized feedback on specific content.
2. AI can offer individualized feedback that helps students learn how to learn.
3. AI can provide meaningful formative assessment outside of school.
4. AI might be able to assess complex and messy knowledge domains.

Individualized Feedback on Content Learning

I think individualized feedback is the most powerful advantage of AI for assessment. As a teacher, I can only be in one place at a time looking in one direction at a time. That means I have two choices for feedback: I can take some time to assess how each student is doing and then address general learning barriers as a class, or I can assess and give feedback to students one at a time. In contrast, AI allows for simultaneous individualized feedback for each student.

"AI applications can identify pedagogical materials and approaches adapted to the level of individual students, and make predictions, recommendations and decisions about the next steps of the learning process based on data from individual students. AI systems assist learners to master the subject at their own pace and provide teachers with suggestions on how to help them." (Trustworthy artificial intelligence (AI) in education: promises and challenges)

Going one step further, AI has the ability to assess students without disrupting their learning by something called stealth assessment. While students work, AI can quietly collect data in the background such as the time it takes to answer questions, which incorrect strategies they tried before succeeding, etc. and organize them into a dashboard so teachers can use that data to inform what to focus on or clear up the next day in class. *Note: As a teacher, I want the AI to help me do what I do best. I definitely want to see what each student needs*

in their learning. Also, as a teacher, I want to be able to control when the AI should alert me about intervening (as a caring human) instead of it trying to do something on its own that it isn't capable of doing well.

Feedback That Helps Students Learn How to Learn

"Two experimental research studies have shown that students who understand the learning objectives and assessment criteria and have opportunities to reflect on their work show greater improvement than those who do not (Fontana & Fernandes, 1994; Frederikson & White, 1997)." (The Concept of Formative Assessment)

In the last post, I noted that including students in the process of self-assessment is critical to effective formative assessment. After all, we ultimately want students to be able to self-regulate their own learning. But, as one teacher, it can sometimes be difficult to remind students individually to stop and reflect on their work and brainstorm ways to close the gap between their current understanding and their learning goal. By contrast, regulation prompts can be built into AI software so students routinely stop and check for understanding and defend their reasoning, giving students a start on learning how to self-regulate.

For example, this is done in Crystal Island, an AI game-based platform for learning middle school microbiology, "students were periodically prompted to reflect on what they had learned thus far and what they planned to do moving forward…Students received several prompts for reflection during the game. After completing the game or running out of time, students were asked to reflect on their problem-solving experience as a whole, explaining how they approached the problem and whether they would do anything differently if they were asked to solve a similar problem in the future." (Automated Analysis of Middle School Students' Written Reflections During Game-Based Learning)

In-game reflection prompt presented to students in Crystal Island

Meaningful Formative Assessment Outside of School

Formative assessment and feedback can come from many sources, but, traditionally, the main source is the teacher. Students only have access to their teacher inside the classroom and during class time. In contrast, AI software can provide meaningful formative assessment anytime and anywhere which means learning can occur anytime and anywhere, too.

In the next post, we'll look at how one AI tool, ASSISTments, is using formative assessment to transform math homework by giving meaningful individualized feedback at home.

Assessing Complexity and Messiness

In the first post of the series, I discussed the need for assessments that can measure the beautiful complexity of what my students know. I particularly like the way Griffin, McGaw, and Care state it in Assessment and Teaching of 21st Century Skills:

> "Traditional assessment methods typically fail to measure the high-level skills, knowledge, attitudes, and characteristics of self-directed and collaborative learning that are increasingly important for our global economy and fast-changing world. These skills are difficult to characterize and measure but critically important, more than ever. Traditional assessments are typically delivered via paper and pencil and are designed to be administered quickly and scored easily. *In this way, they are tuned around what is easy to measure, rather than what is important to measure*."

We have to have assessments that can measure what is important and not just what is easy. AI has the potential to help with that.

For example, I can learn more about how much my students truly understand about a topic from reading a written response than a multiple choice response. However, it's not possible to frequently assess students this way because of the time it takes to read and give feedback on each essay. (Consider some secondary teachers who see 150+ students a day!)

Fortunately, one major area for AI advancement has been in natural language processing. AIs designed to evaluate written and verbal ideas are quickly becoming more sophisticated and useful for providing helpful feedback to students. That means that my students could soon have access to a more thorough way to show what they know on a regular basis and receive more targeted feedback to better their understanding.

While the purpose of this post is to communicate the possible benefits of AI in education, it's important to note that my excitement about these possibilities is not a carte blanche endorsement for them. Like all tools, AI has the potential to be used in beneficial or nefarious ways. There is a lot to consider as we think about AI and we're just starting the conversation.

As AI advances and widespread classroom implementation becomes increasingly more possible, it's time to seriously listen to those at the intersection of the learning sciences and artificial intelligence like Rose Luckin. "Socially, we need to engage teachers, learners, parents and other education stakeholders to work with scientists and policymakers to develop the ethical framework within which AI assessment can thrive and bring benefit." (Towards artificial intelligence-based assessment systems)

Thank you to James Lester for reviewing this post. We appreciate your work in AI and your work to bring educators and researchers together on this topic.

We are still at the beginning of our conversation around AI in Education. What do you think? Do the possible benefits excite you? Do the possible risks concern you? Both? Let us know @EducatorCIRCLS.

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AI and the Future of Education

by The Educator CIRCLS Team

Earlier this year, CIRCL, now CIRCLS,
hosted a panel of 22 experts in Artificial Intelligence (AI) to discuss two broad questions:

1. What will educational leaders need to know about AI in support of student learning in order to have a stronger voice in the future of learning, to plan for the future, and to make informed decisions?
2. What do researchers need to tackle beyond the ordinary to generate the knowledge and information necessary for shaping AI in learning for the good?

CIRCLS just released the report that came out of that panel discussion: AI and the Future of Learning: Expert Panel Report. In addition to the report, CIRCLS also hosted a webinar with 4 of the panelists to talk about the issues covered in the expert panel and the report. One of the topics discussed was classroom orchestration, which refers to how teachers support their students as they move between different kinds of activities (like individual work, small group work, and whole class discussion). Think about an orchestra and all work that goes into the beautiful music they play together. Orchestration in a classroom involves the multi-tasking role of the teacher, both behind the scenes and in real time, that makes a classroom work.

As a teacher, can you imagine a scenario for how AI could be helpful to you, for example, during small group work? Would it be helpful to have an assistant help you create groupings based on what you understand about each student, the relationships you've seen among them, what is known about grouping from the research literature, and what happened last week when you had breakout groups? An AI agent might be able to assist you like this in the future. Or what if you could have an AI agent in each breakout group? What if you could tell the AI agent to alert you if students were off-topic or if their interaction pattern suggested they were arguing and could benefit from your (teacher) presence? What if the AI agent could help assess whether the group seemed to be understanding the topic they were discussing or missing the point? As a teacher who can't be with all groups at the same time, an AI agent could augment your classroom orchestration abilities.

Pragmatically, there's a lot to do when breaking out into groups and this is just one way an AI assistant could help. What if the AI agent could help you reflect on what students said in a whole class discussion and make recommendations for what to do in tomorrow's class? What if the agent could give you a summary of who seems to be understanding and what they understand based on the assignment they turn in? What if the agent could also tell you if students are covering related materials in a different class and help you work with the other teacher? What would you want the agent to do to help you in your class? More importantly, in which cases will the AI be interfering with your teaching rather than enhancing it?

The AI and the Future of Learning: Expert Panel Report goes into other scenarios and we'll look forward to more opportunities to discuss the report. We're looking for more educators to join us in thinking about what the report says and in working with experts who want your input. If you're interested in learning more and potentially being part of future work with CIRCLS and other AI experts, please complete this form.

Introduction to Ambitious Mashups

by Merijke Coenraad

As an educator, you know better than anyone else how much educational technology is changing, particularly within the last year. The Center for Innovative Research in Cyberlearning (CIRCL) has worked with researchers for the last eight years as they have developed and investigated learning environments and technology that pushed the boundaries between technology and education. This community of researchers (and their partner teachers) has focused on how emerging technologies could be important for learners and adapted into the learning tools that would positively impact the education of students five or ten years later.

The recent Ambitious Mashups report examines the work researcher teams did. You might have also seen our previous post encouraging you to attend the Ambitious Mashups Webinar. In case you missed it live, you can watch it here. As we reviewed all of the projects, we discovered that they together researchers with computer science expertise, knowledge of learning sciences theories and methods, and a firm commitment to investigating equity. More than just focusing on emerging educational technologies, CIRCL projects had a strong focus on groups that are marginalized within society and underrepresented in STEM professions such as students from marginalized races, girls, low-performing schools, low-income settings, students with disabilities, and students who are learning English.

Looking across projects, the CIRCL team found that researchers weren't concerned with just one technology, research method, or learning theory. These projects were ambitious, pushing the frontiers of research and technology and studying big learning goals, and they were interdisciplinary mashups, involving many elements together in novel integrations. Therefore, we have deemed the results of CIRCL to be ambitious mashups and worthy of review by not only researchers, but by educators as well. These ambitious mashups bring together a set of novel technologies in unimagined ways to tackle learning challenges. As educators who will soon be encountering these emerging technologies in the classroom, this report points to what you can expect from ed tech and questions to start asking yourself as the research ambitious mashups of the past eight years become the technologies of the next decade.

So, what did we learn from looking at all the cyberlearning research? Reviewing the research projects completed through CIRCL, the team identified five themes representing the elements of the cyberlearning research community:

- Artificial intelligence and Learning
- Learning Theories
- Research Methods
- Out-of-school-time Learning
- Trends at NSF and Beyond

In this series of posts, we are going to look across some of these themes because we at CIRCL Educators believe that there are many things to think about as the emerging technologies of cyberlearning begin to enter the classroom and there are already exciting findings that can influence your teaching!

After eight years of researching together, the CIRCL community has learned a lot about what it means to do innovative research at the forefront of educational technology. Being a CIRCL Educator, what have you learned? How can you create an ambitious mashup in your classroom? Tweet us @EducatorCIRCLS and tell us about your innovative technology use and stay tuned for future blogs in this series about CIRCL Ambitious Mashups.

Data Science in Ambitious Mashups

by Merijke Coenraad

Download the Report (PDF)

Visit the Report Website

This post will focus on **Trends at NSF and Beyond: Data Science**.

No matter what subject you teach, it is likely that data comes into play in your classroom. Whether it is statistical analysis of data in math, collecting and analyzing data in science, or analyzing historical and contemporary data to understand the present, data can be found in many classroom activities. A trend within CIRCL projects was harnessing the data revolution. With more and more data collected each day and the accessibility of data for you and your students, there are many ways you can learn from these projects and bring them into play within your classroom. For example, check out these two projects: STEM Literacy through Infographics and Data Clubs.

STEM Literacy Through Infographics

Created by a team of researchers from across the US, STEM Literacy Through Infographics focuses on helping students create infographics in both classroom and out of school settings to help students make visual, argumentative claims (watch a 3-minute video about the project). The project aims to provide students with the skills they need to ask and answer questions about their own lives and communicate that data to others through data journalism. This ambitious project brings together experts in educational technology, mathematics, and learning and mashes up data science, data visualization, and citizen science opportunities to help students make sense of the data that is available to them. If you're interested, you can try out infographics in your classroom using their helpful step by step guide "How to Make Infographics", classroom lesson plans and resources, and asynchronous professional development workshop.

Data Clubs

Data Clubs are designed by a team of researchers at TERC and SCIEDS to provide middle school students with data skills that allow them to visualize and analyze data about life-relevant topics. Within the lessons,

students write their own questions, collect their own data, and learn how to represent their data by hand and using computer software. This ongoing ambitious project uses design-based research collecting data about students' data dispositions and interviewing them about their experiences. It mashes up mathematics, informal learning, data visualization, and statistics to help students think about the who, when where, how, and why of data. Try out the currently available modules with your students!

These projects demonstrate the importance of quality data experiences for students and the role that data visualization can play in students learning from the large data sets that are available to them. Besides trying out materials from these projects, how can you use data science in your classroom? Here are some ideas:

- Explore infographics on Information is Beautiful and have students create their own by hand (as seen in Dear Data) or using a computer program.
- Engage students with visualization of climate change on Climate.org run by NOAA. The platform provides a number of data visualization environments in which students can explore climate data.
- Explore the Johns Hopkins US or World Coronavirus maps to discuss current trends (click on counties to see more specific data)
- Explore data visualization of the 2020 election from Statista or CISA to discuss trends in voting and the role that data visualizations play in data communication (consider showing this clip of CNN analyzers using live data visualizations to discuss visualizations in election reporting)
- Allow students to use data from Our World in Data and/or the CODAP platform to explore data and create their own visualizations
- Lead students in a discussion about data collection in their lives and the amount of data collected from their use of social media, online shopping, and other internet-connected activities. Provide students with the opportunity to critically analyze how companies are making money off of their data collection and what they could do to advocate for and protect themselves from harmful data use.

How do you use data in your classroom? Tweet us @EducatorCIRCLS and tell us about your innovative technology use and stay tuned for future blogs in this series about CIRCL Ambitious Mashups.

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Pedagogy Really Matters

by Sarah Hampton

Last January, we were lucky enough to have a conversation with Mike Sharples, the author of Practical Pedagogy 40 New Ways to Teach and Learn, 1st Edition. While we apologize for the delay in posting — we got a little busy with transitioning to remote and hybrid teaching — we think that pedagogy is more important than ever and want to share some timely insights from the conversation. This is the first of a series of posts and is a little about math and a lot about pedagogy. If you're here for the pedagogy but not the math, just stick with us past the example from my own math teaching journey.

I've always liked math as a subject, but as a student math class was never my favorite. Every year, math class went something like this.

- I showed up for class.
- I took out my home work and we reviewed it.
- My teacher would go over questions.
- I'd sit and listen to a lecture while I took notes.
- I tried a few guided practice questions.
- I went home and did my homework.
- Wash, rinse, repeat.

When I accidentally fell into teaching math, that was all I had ever known so that's how I taught, too. Fortunately, a few years into teaching, I was introduced to a professional development program specifically for math teachers hosted by a local college. The program professors allowed me to experience a different kind of math classroom! I learned new concepts by exploring first, then reflecting and articulating my nascient thoughts and defending my reasoning. In fact, the entire process was accomplished by me, the learner. That's not to say that the professors were absent or that their roles weren't important. They…

- created the learning environment and tasks
- motivated me

- intervened at critical moments
- prodded me to reflect and refine my thoughts
- helped me internalize the learning.

This experience changed how I thought math class could look. **That summer, I fully understood that how we teach is just as important as what we teach. In other words, pedagogy really matters.**

We all use pedagogies every day, but it may be something we do unintentionally. Take a minute to think about your "go to" approach to teaching and learning. What happens on a typical day in your classroom? Maybe you're likely to teach through lectures followed by guided practice. Maybe you facilitate class-wide conversations about your content. Maybe you organize your classroom into pods of students (or breakout rooms these days!) for collaborative learning.

Something to consider–no matter what you typically do, that teaching approach is well-suited for some types of learning goals but ineffective for others. You know the typical math classroom I talked about in the beginning of the post? That's a type of direct instruction pedagogy. In fact, parts of it are really effective for some things. For one, teachers can disseminate information quickly. For another, it's great when students have very little prior knowledge about a topic. Unfortunately, this pedagogy is not the most effective for things like long-term retention or transfer. By contrast, constructivist pedagogies like those used by the program professors are effective for deep learning, motivation, and engagement. (You can read more constructivist pedagogies in three previous posts–Learning Scientists and Classroom Practice, Practitioner POV of Constructivist Approaches, and The Benefits and Obstacles of Constructivism.)

Too often, we get stuck in a pedagogical rut and force our daily learning goals to fit our routine teaching style. Instead, we need to start purposefully thinking about which pedagogies best support our daily goals. In this series, I want to draw your attention to the pedagogies you use and introduce you to some you may not be familiar with so you can expand your teaching toolkit.

Teaching should be about meeting students where they are, and different pedagogies help us reach different students at different points in their learning journeys. The more learning theory and instructional strategies we understand, the more intentional we can be about selecting approaches that engage more of our students and meet their needs.

The more pedagogies we know → the more we can choose from → the more targeted we can make the approach to hit the learning goals → the better our students can learn

How often do you change up your pedagogies? When are you most likely to make changes to your pedagogies? Are you in a teaching rut now? Think about the best teacher you've ever had. What pedagogies did that teacher use?

In the next post, we'll look at the role of pedagogy when teaching with technology and how we can use different pedagogies to up our pandemic teaching game. If necessity is the mother of invention, then learning about different pedagogies is more important now than ever. You don't have to be an expert in a new pedagogy to use it in your classroom. I hope you find one that you are excited to try!

Related Resources:
Innovating Pedagogy 2021
Innovating Pedagogy website with links to all Open University Innovation Reports
Mike Sharples Keynote at Cyberlearning 2019

What do you think? Let us know @EducatorCIRCLS.

This post is part of the Practical Pedagogy Series
In Educator CIRCLS, we've been doing the messy, fun, and challenging work of learning through discussions of our reading of Practical Pedagogy 40 New Ways to Teach and Learn, 1st Edition. We were lucky enough to have a conversation with Mike Sharples, the author. We feel we are emerging from those conversations as more informed and effective educators! We would love you to share your thoughts and join the conversation.

CIRCLS | Center for Integrative Research in Computing and Learning Sciences

Assessment Webinar Resources

Educators, Artificial Intelligence, and the Future of Learning

Watch the recording.

- The Future of Mathematics Education: Using Artificial Intelligence to Provide Efficient Feedback by Cristina Heffernan and Dr. Hilary Kreisberg
- Technology can help teachers and students succeed in the Formative Assessment Process by Cristina Heffernan
- How Teachers Can Learn From Artificial Intelligence by Alina von Davier and Esther Care
- Using Innovative Methods to Explore the Potential of an Alerting Dashboard for Science Inquiry by Rachel Dickler, Janice Gobert, and Michael Sao Pedro
- Algorithmic Bias in Education by Ryan Baker and Aaron Hawn
- The Research Behind Inq-ITS
- Episode 87: Janice Gobert & Inq-ITS by Podclair

AI products discussed:

- Inq-ITS
- ASSISTments
- Duolingo

Meet the Practitioner Panelists:

Aaron Hawn

Research Affiliate, The Penn Center for Learning Analytics

Co-Founder and Managing Member, Thirteen Ways Consulting, LLC

Twitter: **@hawn_aaron**

Aaron's Statement on AI:

As a former teacher/testing administrator and current researcher, I see the potential for AI to rewire schools' relationship with assessment and accountability, winning back time for instruction, trust in results, and opening new windows onto student skills. At the same time, I see that potential passing us by if teachers, education leadership, communities, and students are not engaged as partners from the start, designing AI tools for how real classrooms work and towards impacts that matter.

Nancy Foote
Conceptual Physics Teacher,
Higley Unified School District (AZ)
Twitter: **@MrsFoote**

Nancy Foote, MEd, is currently a Conceptual Physics teacher in Gilbert AZ. She worked as an Industrial Chemist for the Sherwin Williams Company before obtaining her Master's degree and teacher certification. Nancy has been in education for more than 30 years as a teacher, principal, staff development coordinator, teacher on special assignment. and curriculum coach. A National Board Certified Teacher, Nancy is also a recipient of the Presidential Award for Excellence in Mathematics and Science Teaching.

Nancy's Statement on AI:

Before I met Inq-ITS, and through them AI, I was floundering in the dark. I was trying to grade hundreds of lab reports, trying to determine who understood what, how to intervene when necessary, and how to help my students think like scientists. That wasn't even taking the quality of the writing into consideration. Now, thanks to Inq-ITS and their masterful use of AI, I can be a teacher again. I can intervene at the perfect time. I can help students exactly when they need it with the intervention that they need. I have become a mind reader. Most importantly, my students are thinking like scientists.

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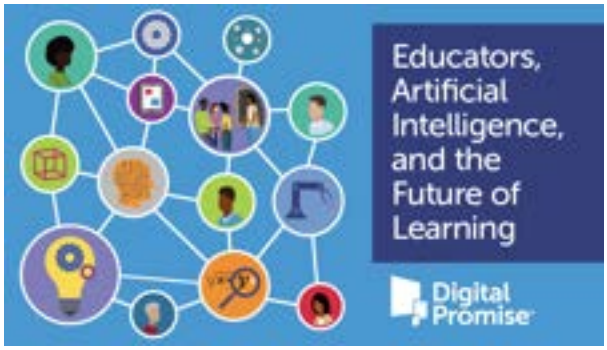
Teacher Support Webinar Resources

Educators, Artificial Intelligence, and the Future of Learning

Watch the recording.

Learn more about TeachFX:

- How voice AI can help create more equitable classrooms by Jennifer Carolan
- Every minute counts, especially for English learners by Kristin Pierce
- Discourse in the Japanese vs. American math classroom by Daniel Lee



Visions for how AI can support teachers and classrooms:

- Robots and Agents to Support Collaborative Learning by Sandra Okita and Sherice N. Clarke
- Virtual Peers and Coaches: Social and Cognitive Support for Learning by Judith Fusco, Wendy Martin, H. Chad Lane, and Catherine Chase
- Pedagogical Agents: Back to the Future by W. Lewis Johnson and James Lester

Meet the Practitioner Panelists:

Kip Glazer, Ed.D.
Principal, San Marcos High School, Santa Barbara, CA
Twitter: @kipglazer

Kip Glazer, Ed.D. is a High School Principal in Santa Barbara, CA. She had been a classroom teacher and technology coach prior to becoming a school administrator. She is a native of South Korea and moved to the United States as an adult. Her experience of being an immigrant who learned to speak English as an adult has

shaped her personal and professional identity.
She has a doctorate in Learning Technologies from Pepperdine University. She is interested in all things technology and how they impact learning.

Kip's Statement on AI:
As a literature lover, I am interested in the good, the bad, and the ugly side of technologies that have been extensively explored in science fiction. As much as I see the potential for incredible benefits of AI in the classrooms to support the teachers and students alike, I am equally concerned about its misuse by people whose intentions may not align with the mission of public education. I firmly believe that teachers and administrators must be provided with the right type of training to be able to support all our students, and we all have an important role to play when it comes to creating the future with AI.

Pati Ruiz, Ed.D.
Researcher, Digital Promise
Twitter: @pati_ru
Pati Ruiz is a researcher with the Learning Sciences Research team. Prior to joining Digital Promise, Pati spent 16 years as a high school computer science teacher, Spanish teacher, and K – 12 administrator. Pati has also taught public school leaders and pre-service teachers in both the U.S. and Mexico and helped design online learning experiences for computing and information technology faculty focused on diversifying undergraduate computing programs.

Pati's Statement on AI:
As a former Spanish and computer science teacher, I think a lot about emerging technologies and how they apply in learning contexts. Recently, I have been focused on AI and how it affects students, their families, and communities. I am particularly interested in the consequences (intended and unanticipated) of these emerging AI technologies on historically excluded students, specifically Latinx, Black, Indigenous, and students with disabilities. Working with the Center for Integrative Research on Computing and Learning Sciences (CIRCLS), I have seen work ranging from Intelligent Tutors and systems designed to adapt and personalize learning, including some that are developing pedagogical agents and robots. I've also seen work that seeks to minimize bias and promote equity in AI, projects using computer vision, natural language processing and speech technologies. Of all of these efforts, I consider the work to promote equity and accountability in AI to be the most important and I created this list to focus on those issues.

Kelly Thomas
Special Education Teacher, Newport News School District (VA)

Kelly Thomas is currently a Special Education teacher in Newport News, VA. Previously, she worked as a Customer Operations Manager for Sentara Health Plan for ten years. Kelly also owned and operated her own daycare home for seven years which sparked her love of teaching. She started in elementary education as an instructional assistant before obtaining her Bachelor's degree and teacher certification. She has been in education for more than twelve years in one capacity or another.

Kelly's Statement on AI:

Before TeachFX, my direct instruction approach could be described as traditional, as it pertained to the ratio of teacher talk to student talk. I taught lesson content material and my students responded when asked to do so. Students were and still are encouraged to demonstrate lesson mastery in a "I do, We do, You do" gradual release method. The goal was and is for students to skillfully move from dependence to interdependence to independence. Now, thanks to Teach FX, my students feel more empowered to create and drive their learning experience. Teach FX has helped me become a skilled practitioner and/or facilitator towards that end. I now am aware of the ration between my teacher talk time and my student's talk time. As a special education teacher, I am very aware of the importance of wait time, however I hadn't considered that wait time occurs both after I speak as well as after my students speak. I am becoming more comfortable with periods of silence which used to be very uncomfortable for me. I find now that my students are more engaged with each other as well as myself! I love teaching and my students grow and thrive daily as they demonstrate their love of learning!

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Culturally Sustaining Pedagogies in Hybrid/Virtual Teaching and Learning Environments

By Zelia Capitão-Tavares and Megan Pattenhouse

At Educator CIRCLS, we've been thinking a lot about Culturally Responsive Teaching (CRT) and most recently Culturally Sustaining Pedagogies (CSP). We had the opportunity to talk to teacher Zélia Capitão-Tavares, an HP Teaching Fellow to learn more about what CRT looks like in her classroom and what she learned from the transition to hybrid/virtual teaching. Zélia Capitão-Tavares is a Hybrid Teacher Digital Lead Learner (Elementary Teacher) in Toronto, Ontario. Here is what she shared.

How did you establish alliances in your learning partnerships with students and their families and what did that look like in an online/blended learning environment?

I continue to connect with families on a regular basis. For example, before school starts and after the first week of school I usually call all of my families for 15-minutes. Then, I call again after the first week in case parents have any questions. Since informal drop-ins are not available right now due to strict distancing protocols, I've been depending on digital surveys to learn about how parents get their children excited, how families work through challenges with their students, and other details. For example, in one interview, I learned from a parent that their child doesn't like people touching their shoulder (due to issues with peripheral vision) as it startles them and they prefer not to be touched. This feedback from parents is invaluable as an educator and helps me create stronger partnerships with the student and the family.

I gather information about my students through a survey that includes standard questions like best contact information, preferred name, and also questions like what sparks their interest at home, what strengths do parent(s)/guardian(s) see and how their child overcomes challenges. For example, how do they work through their feelings, making a plan and following through or when a change in schedule happens, how might they react. By beginning to understand a bit about how the student deals with varying situations that may be amplified in a classroom setting (brick & mortar or virtual) I have better insights into how to program whole class or small group instruction. Another aspect of the survey is where parent(s)/guardian(s) share a bit about themselves and if/how they would like to support our class community. For example, would they like to volunteer for class activities, excursions, lead a mini workshop, share a life experience and so on.

How do you create a sense of trust and safety for your students and their families in an online/blended learning environment?

It's all of the "human parts" with students and you can pick up on social cues face-to-face in a way you can't when you're online. This is harder when they're online. Students are not their true selves when they're sitting in front of the computer online with the camera off or on (seeing themselves on a screen for a prolonged period of time). In their own home you're dealing with things beyond your control.

When they're home, students are highly attuned with what's going on around them. So, we start with cameras on, then turn them off for the duration of the lesson and wrap up by turning cameras back on. If students want to participate and answer a question they can turn their camera on if they are comfortable. That is working well in my classroom for now, especially because I know they're giving me a carefully curated show in a way. Consider this since they are hyper aware of what they are sharing because their families are listening, something that is not part of their learning experience in a brick and mortar class setting.

How are you learning more about what would help your students feel safe and trusting from their perspective and experience in an online/blended learning environment?

Continuing to send letters, messages or emails to families and students to continue communicating appreciation, and informing everyone of upcoming class activities or events. One such opportunity was our STEM Kit project where each student had supplies delivered to their homes. In the letter I wrote:

> I hope this mystery STEM Kit will bring a new adventure, spark creativity, innovation and that our class community is able to be a part of each other's learning journey. When possible, join our scheduled class meet-up and drop-in sessions as we explore the mystery STEM Kit through experiential learning at-home. Together we will build our communication, problem solving, decision making and critical thinking skills.

This activity is an opportunity to build students' global competence, enrich their learning, and social-emotional learning skills. These competencies foster deep learning through engaging experiential learning that incorporates creativity, inquiry, entrepreneurship, collaboration, leadership, communication, global citizenship, character, critical thinking and problem solving.

"We are in the same storm, but not in the same boat." - Damian Barr

I am grateful to all of you, as students in our class community throughout this school year; especially during this pandemic. We are each experiencing things differently, and although we may not always see each other, I see YOU! Beyond the face-to-face and the video conferences: I see your efforts, your contributions, your imagination, your mindfulness, your caring, your supporting, your struggling and your big emotions. You offer so much more than completing school tasks which is very appreciative as you meet learning goals however, you are also being a friend to a friend, give a helping hand at home, make someone smile and just take time for yourself and your own well-being. I see you. And, I am grateful for you just being you.

We have a few more weeks together, navigating through this storm and it will look different for each of us. I hope this mystery STEM Kit will bring a new adventure, spark creativity, innovation and that our class community is able to be a part of each other's learning journey.

When possible, join our scheduled class meet-up and drop-in sessions as we explore the mystery STEM Kit through experiential learning at-home. Together we will build our communication, problem solving, decision making and critical thinking skills.

Sincerely, Ms Tavares :)

This is an example of a message about the STEM kit that I personalized and sent to a student.

How would you manage potential cultural conflicts around respect and trust in an online/blended learning environment?

I have worked through cultural conflicts in the online environment through conversations. When I was guiding students through their ideas and a discussion of Black Lives Matter movements, I knew parents were listening. After the lesson, I got questions from parents including “What do you mean hate is taught?” It’s a different thing when parents are listening to what I’m saying in the moment. In this case, I ended up having another mini-lesson with parents around these same topics. Parents are usually not in the classroom, and not present for these discussions. This was very difficult for me when I started teaching, but with experience, I’ve become very open to welcoming parents into my classroom as visitors. I can see why teachers would find this very challenging because you’re not just communicating with students, you’re communicating with anyone who is in the household.

In my class community, families are always welcome to share their skills and experiences with the students. So parents are used to coming in to share and stay for 15-minutes or half a day. The children really enjoy that and so do the parents.

In our class community we discuss how anti-racist education is not an event as we have ongoing discussions, access to resources and opportunities to ask questions. Throughout our school year we talk about how hate is taught within our environments and how we can engage in discussions with family and friends to acknowledge

our privilege and how we must be an ally and speak up (with assistance from an adult as needed). With remote learning or virtual school we began to rely on using digital learning tools more and more to communicate our ideas, share thinking and ask questions.Flipgrid has been an effective tool for students to record responses that are moderated by the teacher. Students appreciate that there is a lot that can still be learned and they can be engaged in discussions happening in the world around us, locally and beyond, while we all practice physical distancing. Being able to find the words to share with family and friends about why they are taking part in local Black Lives Matter protests using digital tools was impactful

Another group that students were able to connect with during the COVID-19 pandemic is the McMurrich LGBTQ Connects Club. This is a student led initiative, and is inclusive for all students who identify as LGBTQ community members and their allies. The club's purpose is to bring LGBTQ members together to promote awareness of impacting issues and prevent homophobic comments, behaviours and attitudes within the McMurrich community. An opportunity to reimagine the activities that normally happen at school was taking our face-to-face club and going online. This allowed us to provide a safe virtual space for students to share reflections, ask questions, connect and celebrate. Taking on discussions or issues as they arise as teachable moments is an opportunity to rethink practices and social norms to deconstruct the gender dichotomy. Our class community, friends, or however you choose to address your students, we provide a space for students to come together beyond the instructional day.

What routines/rituals have you found useful during distance learning for your student?

The use of digital learning tools for synchronous and/or asynchronous learning provided students with various entry points to share and demonstrate their learning as well as seek support and feedback. I am reminded of the impact of student voice and to advocate for my students by providing varying leadership opportunities. I was able to make use of digital tools like Flipgrid in providing a student with their own Topic (or Group) to support passion projects. One such example is using Flipgrid for students to share their screen and provide a detailed guided tour of each room in the Minecraft challenge, along with a few student designed how-to videos to show building or coding tips.

During the spring of 2020 this looked very different at different times. In wanting to respect the amount of time students are expected to be online, I had 30-minute synchronous meetings per week, and then focused on team meetings. I also had office hours and drop in sessions for students to access as needed. During that time I ended up being very busy and had two breakout rooms one with me and one with our teaching partner, Ms Taisley Isaac. Ongoing connections with families by reaching out at least once per week and sometimes twice per week with a phone call or a socially-distanced home visit. All students had a device even if it was the parents' phone as they were awaiting a board device to be delivered to their home. During our scheduled or drop-in office hours, I was able to address a few barriers for students by doing things like scribing for them because it was hard for them to type their notes, for example, developing keyboarding skills or typing on their

parents' phone. My students would ask me to type for them and they knew they could have that 1:1 support with me during office hours. At the beginning of this crisis, it was valuable knowing that I already had an existing relationship with my students, but that would change in September 2020 with new students (30+) who I have never met and will need to forge this relationship with them due to pending school closures.

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Models for Science Learning: Answering the NGSS Call

By Korah Wiley

Korah Wiley is a learning sciences researcher at Digital Promise with over ten years of classroom teaching experience. Her prior work as a STEM researcher instilled a passion for making the STEM fields more accessible to students and educators.

As a student, I loved all the animal-related topics—topics about plants…not so much. When I became a biology teacher and got to the section on plant biology and photosynthesis in the curriculum I was using, I knew that I, like my students, would need to "hit the books". However, I quickly found myself deep in the world wide web of teaching and learning resources available online, because I knew that reading a textbook was only going to take my understanding so far. To really understand the material deeply enough to teach it, I needed a multimedia resource. I searched high and low and finally found an animation of the process at a level of detail that would give me the confidence that I understood the process well enough to answer my students questions and support them in their learning process.

The learning process that I sought to engage my students in wasn't the standard, memorize this information and take a test in a couple of weeks. Rather, it was the kind of learning called for by the Next Generation Science Standards (NGSS)—the three-dimensional integration type. At that time, the North Carolina School of Science and Mathematics was one of the lead state partner organizations for the development, adoption, and implementation of the NGSS. In preparation for the 2010-2011 school year, the science department dean shared the draft NGSS documents and essentially said, "This is the future of science learning and we will help lead the way." So, as a department, we revised our current curriculum and instruction to align with the call of the NGSS to engage students in the practices of science and engineering with the goal of developing an integrated understanding of disciplinary core ideas and crosscutting concepts.

Finding this photosynthesis animation was great, because 1.) it helped me to understand photosynthesis better and 2.) I could use it to engage my students in the science practice of using a model to understand

natural phenomena, particularly ones that are invisible to the naked eye. My students and I went on a journey inspired by the NGSS to learn more than just the what and why of photosynthesis, we were also learning the how. Learning how photosynthesis took place led us to an even more interesting question, what if? What if human cells could harness light and make energy? (It's actually not as far-fetched as it sounds; Goodman & Bercovich, 2008.)

The question of "what if" led me down new paths when I joined a team to develop a middle school, STEM enrichment program for minoritized and first-generation, college-bound students, called Labs for Learning. What if we developed the program curriculum to engage the participants, rising 7th graders, in a rigorous learning experience, similar to the curriculum we developed to align with the NGSS? Would it be too much for students who were barely in middle school and in woefully under-resourced middle schools at that? Encouraged by the learning experiences we were supporting for our high school students, we took a chance!

I was responsible for teaching biology topics to the 7th graders, which, to my chagrin, included even more about plants! I relied on what I knew worked, the photosynthesis animation that was so helpful for me and my high school students. The animation, for all its awesomeness, was just out of reach for the middle school students, who were really intimidated by the names of the molecules and complexes. Wanting to figure out a way to still use the animation, (knowing that it could help them develop a deeper understanding of key concepts like energy and matter transformation), I told them to just focus on the process and ignore the names. (I figured if they understood the process then they could learn the names later.) This scaffolding ultimately led to physical reenactments of the process, where we turned the abbreviations of the molecule and complex names into initials of the characters. We all had a fantastic time, they all learned the process, and many were inspired to learn the full names of their characters. (It was so exciting to watch!)

These experiences stuck with me when I was deciding on my dissertation focus. In particular, there were three things that followed me into graduate school:

1. the limited number of resources available to support secondary students in understanding the mechanism of biological phenomena,
2. the deep capacity of middle school students for mechanistic reasoning, and
3. the power of a well-designed animation to support robust learning for me and my students.

To help with these problems, I decided to create a photosynthesis animation that focused on the mechanism of photosynthesis such that middle school students (and their teachers) could develop the type of scientific and integrated understanding called for by the NGSS.

After making the animation, I embedded it into an online photosynthesis unit in the Web-based Inquiry Science Environment (WISE) to evaluate whether and to what extent it supported students to meet the NGSS

performance expectation for photosynthesis (MS-LS1-6). I found that, similar to my Labs for Learning experience, middle school students are capable of understanding far more complex ideas than we give them credit for (publication under review). Even with as little starting knowledge as knowing the inputs and outputs of photosynthesis, namely that carbon dioxide and water go into the plant and sugar (glucose) and oxygen come out, they were able to learn the biochemical mechanism of the process. While the assessment boundary for the photosynthesis performance expectation states that assessment for the standard does not include the biochemical mechanism of photosynthesis, my findings along with those of numerous other studies say that the middle school students can handle it and can benefit from it in their future STEM learning (Ryoo & Linn, 2012; Russ et al., 2008; Krist et al., 2018). The framework documents for the NGSS, too, recognize the need for understanding mechanisms when developing and constructing scientific explanations (National Research Council, 2012). Answering the call of the NGSS and other ambitious science reform efforts to support students in developing integrated and multi-dimensional science knowledge requires an exploration of mechanisms.

Admittedly, deep exploration into unfamiliar topics is scary, especially as a teacher who is expected to know the answers. But what better way can a teacher support students in the learning process than if they join the process themselves? As the world changes, and learners can look in many places for answers, what they need is not the answer, they need a model of how to learn in a world where information abounds. Such a model will position students to know more than just the answers. They will know how to discover, how to use the wealth of resources available to them to find out. That's what we can model for our students by learning with them.

At the rate that new information is being generated there is no way any one person can know everything. I suggest, find resources that push you to your edge and invite your students to also explore the edge of their knowledge and ability. You might not know the biochemical mechanism of photosynthesis, for example, but that's okay, you can learn with them. Find a resource that helps you and scaffold it to help them. Doing so will model for your students how to move from not knowing to knowing a little more, and a little more.

When you do this, you can also help them understand why it matters, and more importantly, why it matters to you. Share with them what's interesting about the topic to you. Invite them to explore their ideas and share their experience to find out why it matters to them. Position them as pioneers in a space that could make that knowledge worth knowing for someone else. Invite them into the world of imagination and what if; prompting them with, this is the current state but what could be?

These are just some of the learning adventures that you can take with your students. The NGSS is an invitation to deeper more meaningful discovery and learning, for the students as well as the teachers. Your students need a brave guide into the world of the unknown. If you can find resources that allow you to share that space with them, they will appreciate your guidance and example of how to learn throughout their life.

Now that I've done this work, I understand how exploring the mechanisms of different phenomena creates rich and transformative learning experiences for ourselves and our students. With the world moving and changing as fast as it is, we need to support students in learning as much as they can, which oftentimes is more than we think!

Acknowledgments. I need to note that the animation discussed here was created in collaboration with a multistakeholder design team, that included disciplinary experts, learning scientists, software developers, teachers and students. My dissertation work was funded by the National Science Foundation (DRL: 1418423; 1813713).

References:

Krist, C., Schwarz, C. V., & Reiser, B. J. (2018). Identifying essential epistemic heuristics for guiding mechanistic reasoning in science learning. Journal of the Learning Sciences, 28(2), 160–205. doi: 10.1080/10508406.2018.1510404

National Research Council. (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, D.C.: National Academies Press. doi: 10.17226/13165

Russ, R. S., Scherr, R. E., Hammer, D., & Mikeska, J. (2008). Recognizing mechanistic reasoning in student scientific inquiry: A framework for discourse analysis developed from philosophy of science. Science Education, 92(3), 499–525. doi: 10.1002/sce.20264

Ryoo, K., & Linn, M. C. (2012). Can dynamic visualizations improve middle school students' understanding of energy in photosynthesis? Journal of Research in Science Teaching, 49(2), 218–243. doi: 10.1002/tea.21003

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Learning Environments Webinar Resources

Educators, Artificial Intelligence, and the Future of Learning

Watch the recording.

Meet the practitioners:

Sarah Hampton
Middle and Secondary Math Teacher
Twitter: @S_W_Hampton

Sarah's Statement on AI:
As a leader in Educator CIRCLS, and the wife of a programmer, it's safe to say I'm somewhat of a technophile. I'm typically and happily an early adopter of ed tech. I've witnessed the positive difference the right technology under the right learning conditions can make, creating learning experiences that couldn't be possible without it. Even so, my initial reaction to artificial intelligence (AI) in education was somewhere between skeptical and antagonistic. Like many teachers I've talked with, I'm concerned that using AI might weaken the human connection that's so important for a healthy school environment. I'm concerned about equity and access issues around technology. I also have serious questions about my students' privacy. While I remain concerned about these issues, as I started digging into what AI actually is (and isn't), I'm also learning about the powerful new learning experiences that AI can create that aren't possible without it. As AI continues to gain funding and attention, we teachers need to keep learning about it so we can offer our voices to the communities developing the tools they want us to use.

One particular paper has influenced me to keep participating in the conversation: Intelligence Unleashed: An argument for AI in education. Consider this:

> teachers – alongside learners and parents – should be central to the design of AIEd tools, and the ways in which they are used. This participatory design methodology will ensure that the messiness of real classrooms is taken into account and that the tools deliver the support that educators need – not the support that technologists or designers think they need. Teachers who take part in these processes will gain increased technological literacy, new design skills, and a greater understanding of what AIEd systems can offer.

Luckin and colleagues also talk about the many other expertises involved in educational AIs such as anthropology, biology, computer science, linguistics, philosophy, psychology, neuroscience, sociology, and education. To her list, I would explicitly add the branches of social justice and ethics. For AI in education to be done well, we have to proceed with expert voices from each of these fields. It's time for a serious risk/benefit conversation about the intended and unintended consequences. I can't speak to the computer science or psychology aspects of an AI tool, but I have almost 15 years of practical experience with what does and doesn't work in the classroom that I would like to contribute. For example, I've seen educational technology designers with good intentions offload too many pedagogical decisions to algorithms. When you haven't been trained or had experience teaching, you may not fully understand which of those decisions are consequential for students. On the other hand, I've seen technologies developing in collaboration with teachers that improve the learning experience for students and teachers alike. Because specific AIs (like the ones currently being developed for classrooms) can be so powerful, the outcomes will certainly be high impact. It's crucial that those impacts are positive for our students.

Read more of my thoughts on AI in education:

- Harnessing Educational Data: Discussing Dr. Safiya Noble's Keynote from Cyberlearning 2019
- Three Visionary Projects Using AI in Education
- Introduction to Artificial Intelligence in Education
- My Students are Deep, Complex, and Beautiful. Assessments Should Be, Too.
- Formative Assessment
- AI and Formative Assessment
- ASSISTments: A Forward-thinking Formative Assessment AI Ready to Use in Your Classroom Today

Diane W. Doersch
Director of Technology, Verizon Innovative Learning Schools at Digital Promise
Twitter: @DoerDi

Diane W. Doersch is the Director of Technology, Verizon Innovative Learning Schools at Digital Promise. Prior to serving at Digital Promise, she was a middle school classroom teacher, Director of Technology, then a Chief Technology and Information Officer for a large Wisconsin School district. With over 34 years in the field of education, Diane holds a BS in Elementary Education and a Masters Degree in Educational Technology. She serves as a CoSN (Consortium of School Networking) Board member and is CETL (Certified Educational Technology Leader) certified. She joined Digital Promise and the Verizon Innovative Learning Schools program to assist in closing the Digital Divide. All opinions expressed are her own and do not represent the stances of the organizations she serves.

Diane's Statement on AI:

The addition of artificial intelligence (AI) into today's society may have made our lives easier. Tasks that had previously taken a lot of time and human power to do have become increasingly easier and "just happen" with the addition of behind-the-scenes intelligence of AI. While I appreciate what AI has brought to our personal lives, as an EdTech leader, I continue to be cautious about how we incorporate artificial intelligence into what we do in our classrooms. School district decision-makers from the central office to the classroom level have a responsibility to become AI literate so they can ask discerning questions. We need to ask tough questions and explore topics surrounding student data privacy and security, ethics, and machine learning bias when it comes to AI. Thirty years in the future, I do not want a person to be held back by data that was collected and added to their profile as a student today. We need to ensure that we understand the implications of what we are doing at a societal level, before we implement technologies that may affect the futures of our students. I think the largest question we need to ask is, "If AI is the solution, what is the problem we are trying to solve?"

Favorite EdTech Organizations and their resources on AI:

CoSN (Consortium of School Networking) – Guidance on AI in the Classroom

Future of Privacy Forum – AI & Machine Learning

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Educators, Artificial Intelligence, and the Future of Learning Webinar Series

By Pati Ruiz and Kip Glazer

Watch the recording.

On Tuesday, March 23rd we (Pati and Kip) participated in the Educators, Artificial Intelligence, and the Future of Learning webinar facilitated by Tamara Sumner. The webinar was designed to help practitioners, AI researchers, and developers learn more about each other. The panelists included:

- Debra Russell, Head of Engagement, TeachFX
- Sherice Clarke, Assistant Professor, UCSD
- Pati Ruiz, Researcher & Former School Administrator, Digital Promise
- Kip Glazer, Principal, San Marcos High School, Santa Barbara, CA
- Kelly Thomas, Teacher, Carver Elementary School, Newport News, VA

You can read their bios and review AI resources here. The topic of the webinar was, how AI can enhance teacher support?

The webinar started with Tamara Sumner, discussing the current gap between research and practice and also the current situation with COVID. Then each panelist shared their AI system or perspective on AI, teacher support, and the future of education. Two important topics came up in the webinar and we would like to discuss them a little bit more here. The first is the ethical implications of AI in the larger ecosystem of schools and classrooms. The other is our dreams for where AI can really support educators.

We acknowledge the immense benefit of AI when it comes to analyzing a large quantity of data efficiently to provide real-time feedback for a classroom teacher. Kelly Thomas, a Special Educator who is working with 3rd through 5th graders, shared her positive experiences of using TeachFX with her students. She expressed her appreciation of TeachFX, which has allowed her to quickly compare the amount of teacher-talk versus student-talk. She particularly loved being able to quickly and easily determine what types of questions generated the most student engagement, something TeachFX can easily provide with the use of AI. Sherice Clarke shared the way that her research, ClassInSight, allows color-coded visualization of science teaching and learning to expose the underlying pedagogy at play in the classroom. ClassInSight's AI-generated visuals allow both

classroom teachers and researchers to pinpoint where the most effective instructional practices exist during a class. (See Poster 9 in this document for more information about ClassInSight.)

Both ClassInSight and TeachFX have strict privacy policies to safeguard student and teacher privacy. This is something that all educators should be asking companies for. During the webinar, both of us raised concerns as to who has access to what data. In particular, we are concerned about how student and family data is being treated as a commodity and being sold to AI companies who are using these data for surveillance purposes. We were also concerned about such a technology being "weaponized" against teachers rather than assisting and guiding teachers to improve their instructional practices. Even without AI, student achievement data devoid of important context such as students' socioeconomic status or previous trauma in the community has been used by some school leaders and policy makers to deride a group of teachers and contribute to the negative narrative against the teaching profession. Because AI makes it much simpler and easier to collect and analyze data, we must take care to create a clear understanding among all who are involved in the collection of such information.

When privacy policies are not in place (or not enforced), student data being collected can potentially be used to create additional knowledge gaps among our learners and perpetuate inequities among our students who have been traditionally minoritized due to the existing digital divide. We also believe that school leaders and policy makers must act to protect student privacy by creating additional safeguards as to who has access to the data, how long they can keep it, and for what purpose it can be used. Not only does this information need to be clear and disclosed upfront, but there also needs to be accountability and oversight into how companies are maintaining and using this information.

Because we are passionate about AI and its future, we want to ensure that the product developers who are able to gain entrance to our classrooms are following a set of ethical guidelines that ensure that our children's futures are not unscrupulously commercialized and monetized. We believe that we can only create a world where that is possible by involving teachers and administrators from start to finish as AI-enabled tools are developed. Such involvement of all stakeholders will help demystify the technology that teachers are bringing into their classrooms and make it easier to evaluate the true effectiveness of all AI-enabled tools being used in the classroom.

Thank you to Erin Walker for reviewing this post. We appreciate your work in AI and your work to bring educators and researchers together on this topic.

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Artificial Intelligence & Learning + Out of School Time Learning

by Merijke Coenraad

Tenth graders collaborate on an engineering project. Photo by Allison Shelley/The Verbatim Agency for EDUimages

Welcome
back to our blog series on Ambitious Mashups!
Today, we are going to focus on the use of Artificial Intelligence in Learning and mash it up with Learning in Out-of-school-time.

Artificial Intelligence and Learning. The most common technologies used within projects were (a) Intelligent tutoring systems, (b) machine learning, (c) speech, vision, and natural interactions, and (d) social robotics and avatars. While these were the most common technologies, many projects used a mashup of technologies and focused on how the technology could be used in new ways within the classroom to support learning. If you want to read more about the types of AI, we recommend the AI4K12 project and this poster thinking about 5 big ideas in AI as a starting point.

Need an example of what this looks like? Check out the Inq-Blotter project. It provides teachers with real-time tools that alert them to students' science needs as they are learning. Students use the Inq-ITS platform that provides them inquiry science learning experiences through labs and simulations. In addition to providing the experiences, Inq-ITS is an intelligent tutoring system and is able to assess students in real-time. Inq-Blotter builds on these capabilities to send teachers messages relating to how students are doing so they are able to provide just-in-time support. Inq-Blotter provides teachers with the opportunity to gather formative assessment data and support quality inquiry learning. This ambitious project took multiple years of research and mashed up data science, assessment, science learning, and intelligent tutoring tools.

If you are interested in intelligent tutors that help you understand what your students know, you can also check out our post on ASSISTments, an intelligent tutor for math learning. You can also see our webinar that discusses both ASSISTments and Inq-ITS.

So, what does this mean for your classroom? Think about:
What technologies might lie ahead and how do you want to use them? What would an intelligent tutoring system or social robot look like in your classroom?
Are you interested in using an intelligent tutor like Inq-ITS or ASSISTments in your classroom now? What are the implications of using these technologies for your teaching and practices within the classroom?
How could these emerging technologies affect your classroom practices and pedagogy? How will you continue to promote equitable learning opportunities when using them?

Out-of-school-time Learning. While we discussed technology in a formal setting during the school day, Some of the projects also investigated learning with educational technology in out-of-school environments.

Mash-it! Let's look at a project that ambitiously mashes using AI in out-of-school learning!

The Virtual STEM Buddies for Personalized Learning Experiences in Free Choice Informal Learning Settings project brings together museum learning with intelligent agent buddies to support students' STEM learning at a children's museum. The computerized character interacts with the child as they move through the museum and acts as both a meteor and a peer. The AI agent, aka the buddy, is able to give instructions based on teachable moments and help children to find exhibits that aren't crowded. AI in this out-of-school setting can provide youth with plenty of opportunities to learn and make the most of their museum experience. This ambitious project brought together team members from multiple universities and the Children's Museum of Atlanta to mash up intelligent tutors, STEM, and informal learning.

What do you think of the possibilities with AI? Tweet us @EducatorCIRCLS and tell us about your innovative technology use and stay tuned for future blogs in this series about CIRCL Ambitious Mashups.

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Reflections on Coded Bias

“Algorithmic justice—making sure there’s oversight in the age of automation—is one of the largest civil rights concerns we have.”Joy Buolamwini

On May 3rd, 2021 Educator CIRCLS hosted a watch party for the film Coded Bias which highlights the incredible work being done by organizations, data scientists, and activists on an international scale. The film challenged our unconscious biases and encouraged us to listen to one another as we consider the ways that we interact with artificial intelligence (AI) on a daily basis. To begin with, the film made very clear the wide societal impacts, both positive and negative, of AI as well as the fact that AI algorithms can perpetuate biases. Given this, we believe it is essential to become more knowledgeable about AI so that we, as educators, can make informed decisions about AI. As we watched this film we considered and discussed the ethical implications that need to be fully investigated before new AI tools are adopted in our classrooms. This film also helped us see that we also need to investigate the people designing the AI and helped us arrive at some important questions that we need to be asking about AI.

Here are some questions:

- How was the AI system designed, for classroom use or other situations? At what point are teachers brought in to make decisions about their students?
- What data was used when the system was trained?
    - What groups of people were included during the testing process?
- What data will be collected by the system and what will happen to that data if the tool is sold? Will it only be used for only the purpose specified? Are there any potential dangers to the students? Are there any potential dangers to the teachers who use the systems with their students?
    - Can students be identified from this data?
    - Can teachers be identified from this data?

    - Can this data be used to evaluate teachers' performance (something that may not be specified by the system)?
- How does the system interact with students, and can I give feedback to the system or override the decisions?

Another very important question but a difficult one to answer is: When this AI tool fails, how does it fail, and what are the consequences? While EdTech designers might not be able to accurately answer this question, you might be able to use it to start a conversation about the pitfalls of this particular piece of technology. It will also challenge EdTech designers to think about these difficult questions and engage the design process to adjust their product if needed. After all, starting these conversations about the ethics of AI and where its faults lie is our duty.

Sign up for the CIRCLS newsletter to stay updated on emerging technologies for teaching and learning and let us know what you think by tweeting @EducatorCIRCLS

Exploring the 2021 STEM For All Video Showcase

Featuring 287 short videos of federally funded projects aimed at improving STEM and Computer Science education, the 2021 STEM For All Video Showcase highlighted strategies to engage students and address educational inequities. The array of 3-minute videos showed the depth of work going on in the field to think about equity and social justice in the wake of COVID-19. Below are some favorites of our CIRCLS team that we hope you enjoy as well!

Co-Creating Equitable STEM Research Led by Communities

Contributed by Leah Friedman

This video features a project partnership between the Cornell Lab of Ornithology and community organizations around the country that are historically excluded from science research. Centering community wisdom and leadership, the group investigates the impact of noise pollution on public health in order to co-create appropriate solutions. This project is an amazing model of upending typical hierarchies of knowledge creation or control in STEM research, provides a really concrete framework for conducting research with community members, and exemplifies 'broadening' in every sense of the word.

Interest Stereotypes Cause Gender Gaps in STEM Motivation

Contributed by Judi Fusco

Thinking about stereotypical gendered messages that young children, older children, teens, and even adults receive about whether they belong somewhere is so important. These messages may be subtle, nuanced, and not intended, but they happen; we need to make sure we aren't excluding anyone, especially without realizing it.

Activity for Stories of Algebra for the Workplace

Contributed by Jeremy Roschelle

What if every student could tell a story of how they'll use math in the future career? Although this is just a beginning, it seems to me the technology for personalized AI-driven STEM storytelling will arise soon enough — and could help students create their own STEM identity.

You Deserve A Seat at The Table: The Data Economy Workforce

Contributed by Jonathan Pittman

This video features a project at Bethune Cookman University that uses an immersive game learning experience to help students gain 21st century digital workforce skills. Using gamified immersion is an excellent approach to build workforce skills and learn about the future of work.

Big Data from Small Groups: Learning Analytics and Adaptive Support in Game-based Collaborative Learning

Contributed by Dalila Dragnić-Cindrić

In this project, groups of up to four students work together in a 3D game-based environment called Crystal Island to solve complex eco-problems. A research team from Indiana University and North Carolina State University is investigating how students in small groups communicate and coordinate with each other when problem solving. Researchers used learning analytics to drive adaptive support.

The lead presenter is one of our Emerging Scholars, Asmalina Saleh. PIs are James Lester and Cindy Hmelo-Silver. CoPI is Krista Glasewski.

Activity for "WHIMC: Using Minecraft to Trigger Interest in STEM"

Contributed by Wendy Martin

If you are a fan of Minecraft or alternative histories you should check out H. Chad Lane's video about his project: What-If Hypothetical Implementation in Minecraft (WHIMC). I enjoyed learning about how those researchers were encouraging students to create alternate worlds to help them better understand the phenomena that shape our own world.

To explore videos from past video showcases, visit the STEM For All Multiplex.

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Learning from Gaming

by Sarah Hampton

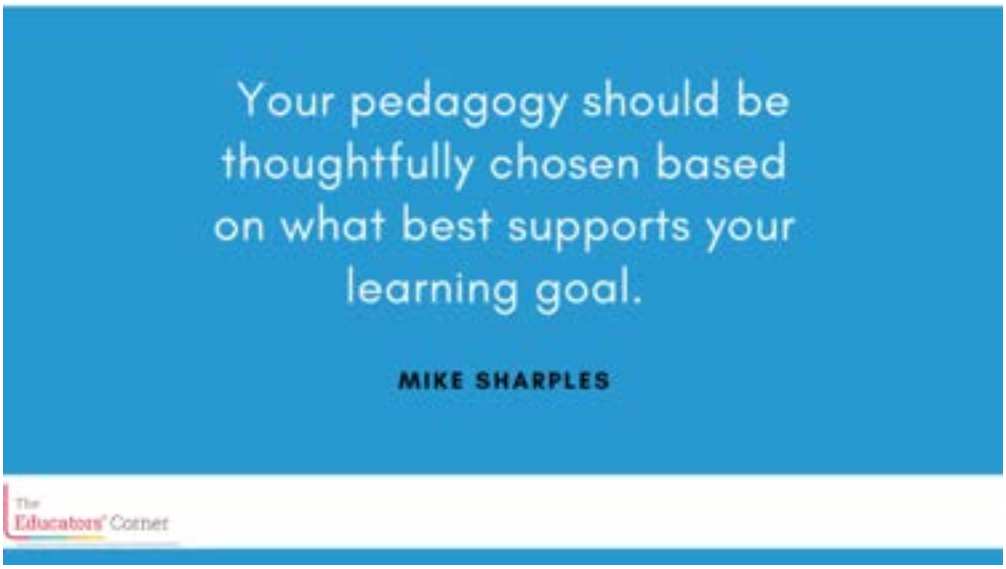
In the previous post of this series, we explored why pedagogy really matters.

The more pedagogies we know → the more we can choose from → the more targeted we can make the approach to hit the learning goals → the better our students can learn

In this post, let's see how pedagogy comes into play when incorporating educational games.

Consider two different game-based approaches I have used for a middle school physical science unit on chemical reactions. One year, I created a quiz show toward the end of the unit complete with teams and buzzers. The questions for the game came from the unit's notes and textbook. Another year, I used a design competition in the middle of the unit in which students created the best reptile egg incubator by chemically engineering a heat pack with optimal amounts of calcium chloride, baking soda, and water. Which do you think was more effective?

That was actually a trick question. The answer should have been–more effective for what? If my learning goal was to promote low level recall of multiple concepts, then my quiz show was the better choice. If my learning goal was to promote collaboration, problem solving, and deep learning of fewer concepts, then the design competition was the hands down winner.



Your pedagogy should be thoughtfully chosen based on what best supports your learning goal. That was my number one takeaway from our book study on P[ractical Pedagogy 40 New Ways to Teach and Learn](). This applies to game-based learning like any other kind of learning. I like how author Mike Sharples [explained it in our conversation]() with him last January.

The idea that pedagogy underpins effective games is also discussed in [Motivating Children to Learn Effectively: Exploring the Value of Intrinsic Integration in Educational Games](). The paper describes two different kinds of games. One type of game tacks fun onto learning like “chocolate covered broccoli.” (My quiz show is an example of this kind of gamification.) In contrast, intrinsically integrated games (like the incubator design competition):

1. deliver learning material through the parts of the game that are the most fun to play, riding on the back of the flow experience produced by the game, and not interrupting or diminishing its impact and;
2. embody the learning material within the structure of the gaming world and the player’s interactions with it, providing an external representation of the learning content that is explored through the core mechanics of the gameplay.

My students love learning through gaming. I bet yours do, too! Just remember–simply incorporating a game doesn’t mean your students will reach the learning goal. That depends on the underlying pedagogy. Evaluate potential games to see if the fun elements are sugar coating to make your learning goals more palatable or if the learning goals are intrinsically linked to the fun of the game.

You can find examples of games we like below. Do you already use effective games in your classes? Share them with us [@EducatorCIRCLS]()!

Intrinsically Integrated Educational Games

Crystal Island (middle school microbiology)

Geniverse (middle school/high school genetics)

Graspable Math (several different algebraic ideas)

eRebuild (middle school ratios and proportions)

Euclid the Game (geometry constructions)

Human Resource Machine (computational thinking)

Zoombinis (computational thinking)

Game Builder Garage (computational thinking Switch game)

Robot Turtles (computational thinking board game)

Lemonade Stand (entrepreneurship)

Institute of Play (multiple subjects and grade levels)

Absolute Blast (multiplayer math board game for grades 6-8)

Socratic Smackdown (discussion-based humanities game to practice argumentation)

Self on the Stand (middle school ELA)

Conditionals with Cards (elementary computer science)

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Explainable Artificial Intelligence for Responsible Artificial Intelligence

by Pati Ruiz

> "For algorithms that have the potential to ruin people's lives, or sharply reduce their options with regard to their liberty, their livelihood, their finances, we need an 'FDA for algorithms' that says, 'show me evidence that it's going to work, not just to make you money, but for society.'"- Cathy O'Neil, an academic and the author of Weapons of Math Destruction

The film Coded Bias included the quote above by Cathy O'Neil. In this post, I consider this statement in the context of teaching and learning.

We know that education has significant impacts on people's lives, from how they learn to what they learn, career trajectories, and beyond. With this power, comes the responsibility to develop data ethics. The field of explainable artificial intelligence (XAI), which has grown rapidly these past few years, includes a set of processes and methods that allow humans to better understand the results and outputs of machine learning algorithms. This helps developers of AI-mediated tools understand how the systems they design work and can help them ensure that they work correctly and are meeting requirements and regulatory standards. This also paves the path for accountability and transparency in Artificial Intelligence (AI).

There are several advantages to understanding how AI-enabled systems arrive at specific outputs. For example, XAI can help developers make sure the system is fair and working as expected. In classrooms, this might mean making sure that appropriate student identifiers are used to match students up for group work, that they are clear to the teacher, and that the teacher has the ability to override and train the AI. This plays an important role in allowing those affected by the decisions or results of an AI-enabled system to understand those outcomes and make changes.

Why does Explainable AI matter?

As a recent IBM report explains, “It is crucial for an organization to have a full understanding of the AI decision-making processes with model monitoring and accountability of AI and not to trust them blindly.” They go on to describe explainable AI as one of the key requirements of responsible AI. This means that AI needs to be developed in ways that are fair and auditable so that the designers of AI can be accountable for the algorithms and networks they build.

In schools, this means ensuring that things like teacher evaluations are clear and transparent. The film Coded Bias includes a vignette about a teacher whose contract was not renewed due to an algorithm that was not explainable. That algorithm was not transparent and the teacher did not understand why he had been terminated. Explainable AI would have allowed school administrators to point to exactly what factors contributed to the recommendation to terminate this teacher and in addition, they could then override the AI recommendation if they disagreed.

Regulation

While it is still controversial whether or not AI needs to be explainable, I think that XAI and the goal of fair and correct AI are essential pieces of the puzzle as explaining decisions made by algorithms can answer the public call of accountability in AI as well as legal “rights to explanation” of artificial intelligence required by policies including the European Union’s General Data Protection Regulation (GDPR).

As a former teacher myself, I wonder about the possibility of bias negatively affecting students’ learning. I seek to learn more and find answers. A more transparent AI system could help ensure student privacy and allow me to trust the system is there to support my teaching rather than harm it.

What considerations are important at your school? Please let us know by tweeting @EducatorCIRCLS and sign up for the CIRCLS newsletter to stay updated on emerging technologies for teaching and learning.

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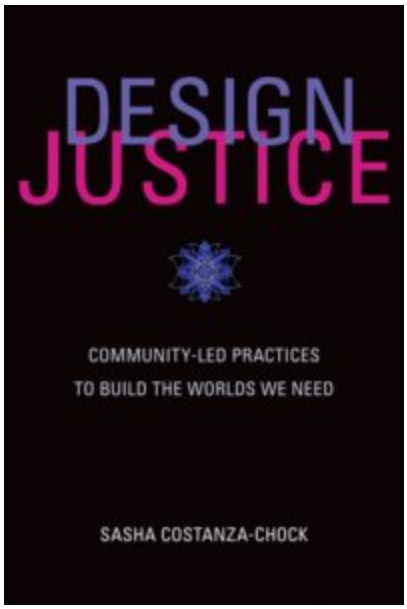
Book Review: Design Justice: Community-Led Practices to Build the Worlds We Need

by Pati Ruiz



> Critical pedagogy seeks to transform consciousness, to provide students with ways of knowing that enable them to know themselves better and live in the world more fully.
> —bell hooks, *Teaching to Transgress*

Written by Sasha Costanza-Chock, *Design Justice: Community-Led Practices to Build the Worlds We Need*, explores the relationships among design, power, and social justice. I was drawn to this book because it centers those who are intersectionally disadvantaged, this refers to individuals that might have multiple minoritized identities and originally refered to the oppression of African American women. It also shares the work done by Design Justice Network (DJN) to "build a better world, a world where many worlds fit." The Design Justice Network is "an international community of people and organizations who are committed to rethinking design processes so that they center people who are too often marginalized by design." This network is a community of practice that is guided by a set of 10 principles; I am a DJN signatory. I hope this short post prompts you to read the whole book that was made available for free on PubPub (the open-source, privacy-respecting, all-in-one collaborative publishing platform) or sign up for the Design Justice Network newsletter to learn more. This book has really inspired me to think differently about design and what it takes to truly make design accessible.

What is Design Justice?

The book begins with a definition, or "tentative description" of design justice:

> Design justice is a framework for analysis of how the design of technologies, tools, and learning environments (to name a few) distributes benefits and burdens between various groups of people. Design justice focuses explicitly on the ways that design reproduces and/or challenges the matrix of

> domination (white supremacy, heteropatriarchy, capitalism, ableism, settler colonialism, and other forms of structural inequality). Design justice is also a growing community of practice that aims to ensure a more equitable distribution of design's benefits and burdens; meaningful participation in design decisions; and recognition of community-based, Indigenous, and diaspora design traditions, knowledge, and practices (p. 23).

After a comprehensive overview of the values, practices, narratives, and site/locations of design, the book turns to the pedagogies of design in Chapter 5. In this chapter, the author focuses on answering the question: How do we teach and learn about design justice?

Costanza-Chock responds to this question by writing "I don't believe there is only one way to answer this question, which is why I use "pedagogies" in the plural form." Among the pedagogies described in the chapter are:

- Paulo Freire's educación popular or popular education (pop ed)
- critical community technology pedagogy
- participatory action design
- data feminism
- constructionism, and
- digital media literacy

Exploring Design Justice Pedagogies

In our previous work, as CIRCL Educators, we wrote about constructionism. This pedagogy is one that teachers often turn to and as Costanza-Chock notes, it is not one that is "explicit about race, class, gender, or disability politics." However, it should center the social and cultural aspects of learning, the construction of knowledge in the learner, and the learner's contexts (e.g.a student's racial/ethnic background, social class, and other social identities). Furthermore, Costanza-Chock writes that "in a constructionist pedagogy of design justice, learners should make knowledge about design justice for themselves and do so through working on meaningful projects. Ideally, these should be developed together with, rather than for, communities that are too often excluded from design processes."

Hand in hand with the pedagogies described in this chapter is the decolonization of design practices, which refers to deconstructing Western privilege of thoughts and approaches. Those involved in the decolonizing design movement advocate for a global approach to design that rethink historical narratives and seek to center design practices erased or ignored in Eurocentric design practices. As Costanza-Chock describes "design justice pedagogies must support students to actively develop their own critical analysis of design, power, and liberation, in ways that connect with their own lived experience." As teachers and educators, our

role is to figure out a way to overcome existing design challenges so that our students can implement just design principles.

Principles of Design Justice

What are practical examples of what teaching about design justice looks like? Based on the author's experiences in her own courses, 10 principlesillustrate what this movement envisions:

> Principle 1: We use design to sustain, heal, and empower our communities, as well as to seek liberation from exploitative and oppressive systems.
> Principle 2: We center the voices of those who are directly impacted by the outcomes of the design process.
> Principle 3: We prioritize design's impact on the community over the intentions of the designer.
> Principle 4: We view change as emergent from an accountable, accessible, and collaborative process, rather than as a point at the end of a process.
> Principle 5: We see the role of the designer as a facilitator rather than an expert.
> Principle 6: We believe that everyone is an expert based on their own lived experience, and that we all have unique and brilliant contributions to bring to a design process.
> Principle 7: We share design knowledge and tools with our communities.
> Principle 8: We work towards sustainable, community-led and -controlled outcomes.
> Principle 9: We work towards non-exploitative solutions that reconnect us to the earth and to each other.
> Principle 10: Before seeking new design solutions, we look for what is already working at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices.

At Educator CIRCLS we are at the beginning of our conversation around AI in Education. These design justice principles will be front of mind as we continue to consider and discuss the variety of ways AI technologies are currently being developed and employed. Please let us know your thoughts by tweeting @EducatorCIRCLS and sign up for the CIRCLS newsletter to stay updated on emerging technologies for teaching and learning.

Starting a Conversation between Practitioners and Researchers: A Practitioner's Point of View

by Kip Glazer

This is the first of four posts from a practitioner's perspective that were inspired by the theme of the CIRCLS'21 convening of remaking "broadening." Educator CIRCLS aims to bridge research with classroom practice and broaden the community of people involved in CIRCLS. Learn more about the upcoming convening and register (starting August 13, 2021).

When I was a classroom teacher, I attended a number of professional development (PD) workshops and conferences on teaching and learning. If you are a practitioner (a.k.a. a classroom teacher) in the field of education, you know that there are some PD sessions that try to share research findings and implications for the classroom that are simply awful. I am sad to say that I have attended my fair share of those over the past two decades.

One PD session in particular started me questioning. I was a teacher working with students who were learning to speak English. I attended a session on second language learning and the presenter had a Ph.D. in language development from a prestigious university and was supposed to be an expert in supporting language learners. I am a second language learner myself, having moved from South Korea to the United States at the age of 23. I was so excited to attend the workshop. I was thrilled to be given the responsibility of helping my students

who needed help in gaining language skills. I attentively listened to her presentation, trying to gain any information that I could use to help my students.

While listening to her presentation, however, I realized that her research primarily focused on Spanish-speaking students. So I raised my hand and asked, “What if a student doesn’t speak Spanish? What strategies would you suggest we use? Do we need to modify anything? For example, what if they spoke Tagalog or Ilocano? How about Hmong? What about Mandarin?”

Soon I found myself debating with an “expert” in the field whose research seemed less than useful for the teachers who were sitting in the PD session. You see, I was teaching a group of students who spoke Hmong, Mandarin, and Russian. A few of them also spoke Spanish, but my Instructional Assistant spoke Spanish so they were getting support from another adult in the room. What I really needed were the strategies that I could use for all my students, not just the Spanish-speaking students, which was implied in the title of the workshop that said, “Proven Strategies that Support English Language Learners.” When I told the presenter that the strategies that she shared may not work for my students, she replied, “Teachers who have not had much exposure to good research may never learn to appreciate the true value of good research. Perhaps you should consider reading about things and learning more.”

I must say that I was young and a bit hot-headed at the time. I did question her expertise openly and vociferously in a group setting. Come to think of it, I might have sounded rather rude and even confrontational towards the presenter. So I believe that I probably deserved that chastisement from that particular presenter. But over the years, similar treatment of being dismissed as a professional in my field propelled me to eventually getting my doctorate in Learning Technologies so that no one could easily dismiss the expertise that I know I possess as an educator.

If you are an educator, how many times have you attended a workshop that didn’t address your specific needs or concerns? For that workshop I described earlier, I found out later that many of my colleagues had similar questions too, but they did not ask the questions like I did. They told me that they learned to just listen and nod since many researchers never seem to understand the challenges of teaching real students in real life. Some said that they didn’t want to get shut down like I was. Few advised me never to ask questions like that, especially in front of an administrator for fear of being labeled as a “rebellious” teacher. They shared that they felt some researchers do not make the best presenters because they don’t seem to value practitioners’ lived experiences. Many of these teachers were highly-skilled, highly-educated professionals who accepted their fate of being treated as interlopers in the very profession that they devoted their lives to.

One difference between educators and researchers may be because of how we have been socialized, or it could be our personalities. I’ll give an example. As a principal who often evaluates and supports teachers, I am often flabbergasted and saddened by the attitude of my fellow educators who look at their professional

expertise from a “less-than” perspective. In the State of California, one needs a Master’s Degree to become a teacher. Yet many teachers are often reluctant to declare themselves to be the experts as classroom teachers. Contrast this to higher educational institutions who will hire a Ph.D. who has never even been a classroom teacher to train other teachers and call them an expert.

I know a 28-year old Ph.D. with research focused on gaming. She was hired as a professor in a teacher training program where she is in charge of training junior high and high school teachers. She has expertise in gaming that is valuable in the field of education, but I wonder about the depth of pedagogical or curricular strategies she could share with the teacher candidates. She has read about the issues, but can not know them from an authentic lived perspective since she hasn’t been in the classroom. What if she has to train future school administrators? What then? Can she anticipate and support how a state testing requirement, a board policy, public perception, student attitudes, or even limited wifi-access might derail a teacher’s good intention to fully use any game in the classroom to improve literacy and numeracy? Are we really setting her and her students (aka future teachers) up for success in doing the important job of educating our students?

As we come together to think about ***remaking broadening***, I would like us to consider our differences and to value those differences as important. As an educator and now a school leader, I have seen so much promising research that could be useful for our students that does not yield any positive benefits for real students in real classrooms because researchers don’t connect the importance of the work in a way that makes sense to practitioners.

What an expert dreams up, no matter how good, will not make any impact unless the practitioners embrace it and use it for their students. In my opinion, the journey to making a true and relevant impact in the lives of our students begins with more connections between researchers and practitioners. In the next post, I’ll share more about how practitioners think about their students and discuss why practitioners’ voices matter in research on emerging technologies for teaching and learning.

Why practitioners' voices matter in research on emerging technologies for teaching and learning

by Kip Glazer

This is the second of four posts from a practitioner's perspective that were

inspired by the theme of the CIRCLS'21 convening of remaking "broadening." Educator CIRCLS aims to bridge research with classroom practice and broaden the community of people involved in CIRCLS. Learn more about the upcoming convening and register (starting August 13, 2021).

In my previous post, I gave a background on some experiences I have had as a practitioner. I also began to share some differences I see between researchers and practitioners. I called upon my educator colleagues to recognize the fact that we are professionals who have expertise to contribute to the field of education. I start this post with questions that educators constantly ask ourselves as we look at any materials or tools. Educators are constantly thinking about how curriculum, materials, and technologies will work with our students. Many practitioners are very good representatives of different communities because we care deeply about the success of our students. (Of course, we do hope you'll also talk to students, but if you can't, we are often excellent advocates and understand them well.) Here are a few questions:

- How would this look in my classroom with my students?
- What would this do for my students?
- How would this be beneficial for my community that I serve, value, and love?

- What resources will I need to be able to fully implement this?
- How would I know this is actually working for my students?
- Based on the profile of my students and community, what modifications and alterations could/should I make?
- If any modification or alteration happens, what am I giving up? What will I gain? How will that impact the effectiveness?

Because these are the questions we educators constantly ask as we look at any materials or tools that we are thinking about using with our students, we are good at answering these questions to devise solutions every single day for our students. When a researcher is developing something for a classroom, they too should be able to answer these questions, but they can't because they don't know our students. In addition, there are more questions that practitioners would ask depending on the situation. For instance, they might ask how a tool can serve students with disabilities or how long it will take someone to become proficient at using that tool.

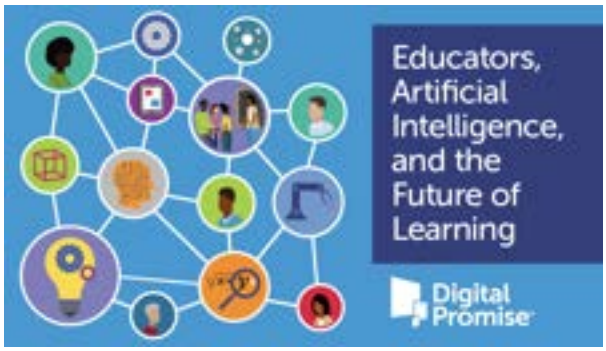
Let me be clear. I am not arguing that a researcher must have answers to the above questions. I am saying they should have educators actively participating in the process every step of the way as they develop future technologies for teaching and learning because ultimately we educators are the interpreters, translators, and the ones who have to implement the 30,000-foot level theories. Discussing these questions could be a starting point to create better partnerships with practitioners who can make research come to life in a meaningful way.

The theme of this conference is to remake "broadening" in research on emerging technologies for teaching and learning. It is no surprise that the word broadening is in quotes given what has happened in recent years regarding critical issues around gender and racial divisions in this country. As an Asian-American female immigrant who has had a few personal and professional experiences on this, few extremely painful, I would whole-heartedly support our collective effort on addressing such issues whenever possible in all situations. However, I would caution that we don't use the term "broadening" to imply that the field is occupied by one group that needs to allow the others to join in because our teaching and learning community already belongs to all of us!

Having said that, I am thrilled to see the preceding verb remake. Because the time to look at teaching and learning beyond the narrow perspective of division such as researcher versus practitioner is now. I challenge all of us to think about what it means to remake such a notion as we convene. After all, if a bird sings in the forest, and no one is there to hear it, did it really sing? If a great piece of technology is developed, but no one receives any benefit from it because the user experience was so horrible, did it really work? If an amazing research finding on teaching and learning never sees the light of day because it failed to fit practitioners' needs or work in classrooms broadly, did the research really matter?

Reflections on the AI and Learning Environments Webinar: Things to Consider When Making Purchasing and/or Adoption Decisions for AI Tools

By Sarah Hampton



On April 21, I was able to participate in something really exciting! I joined some amazing researchers and former teachers in the Educators, Artificial Intelligence, and the Future of Learning webinar on Learning Environments facilitated by James Lester. The webinar was designed to help practitioners, AI researchers, and developers share their perspectives on how artificial intelligence can be used in the classroom. As you may know, I am a middle and secondary math teacher. My fellow panelists included:

- Diane W. Doersch, Technical Project Director, Digital Promise
- Cindy Hmelo Silver, Learning and Technology Researcher, Indiana University
- Kylie Peppler and Emily Schindler, Learning and Technology Researchers, University of California, Irvine

The webinar focused on how AI can enhance learning environments. It started with James who discussed the advancements in educational AIs during his 25 years of work in the field, the significant benefit they can provide, and the current demand for AI in educational settings. In other words, this is a **hot topic** in education right now!

Next, Diane Doersch shared her thoughts on AI in education, drawing from her experiences as a former classroom teacher, a Director of Technology for a large school district, and Chief Technology and Information Officer. She called for **optimism yet caution** and **thoughtful vetting processes** before incorporating AI in classrooms. She also stressed **how important it is for school decision makers to know and understand what artificial intelligence is and the impacts that it has in order to properly vet products**.

In this initial post, I want to camp out on Diane's thoughts; we'll discuss Cindy Hmelo-Silver and Kylie Peppler and Emily Schindler's work in later posts. At Educator CIRCLS, we've really been digging into artificial intelligence so we can participate in the important conversation happening right now around how AI can be

used in classrooms, and, perhaps more importantly, when AI should and shouldn't be used in classrooms. We want to offer our educator perspectives to the communities developing, researching, and creating policy around AI in education. Furthermore, we want you to understand artificial intelligence so you can offer your unique perspectives and advocate for your students, too. Our friends at Digital Promise recently posted Artificial Intelligence 101: Covering the Basics for Educators. It's a great introduction to AI and has points to ponder for veteran AI folks, too.

I've spent a lot of time reflecting since the webinar. I've specifically been thinking about things to consider when making purchasing and/or adoption decisions for AI products. Diane and I offered some suggestions during the webinar (timestamp 39:55), and I have added more below. You will notice some common themes from AI 101 and from this school procurement guide by Edtech Equity. I hope these can be useful resources for you and your school decision makers as you're sure to see more and more AI products coming your way!

Is it safe? Is it secure? Is it ethical?

- How is the company funded? Do they sell the data they collected? How is the data safeguarded?
- What was the training data for the AI like? Was it sufficient in volume and diversity? Has it had adversarial training?
- What was the fitness model like when training the AI? What was the goal and how was fitness measured?
- What are the consequences if the AI fails? How does it fail?

Does it align with the mission of the district/school?

- Does it promote the kind of district/school culture you want?
- Does it create a significantly better learning experience that you couldn't gain otherwise? Will it lead to substantial time saving or learning gains or meaningful learning experiences? Is it more than a wow factor?
- Does it promote the kind of assessments and standards you want to grow toward, or does it increase performance on your current assessments and standards?

Is it classroom/teacher friendly?

- Was it developed in collaboration with teachers? If not, it might work really well in the lab but may not extend to the complexity of a real classroom.
- Has it been tested in a classroom context similar to your own?
- Can the teacher override the AI if necessary?
- Does the tool free up the teacher to do what the teacher does best? You don't want to offload what humans do best onto a machine. You want to maximize what machines do best and what people do

best.

- Does the tool have a thoughtful approach to classroom management?
- Does the tool have a simple but thoughtful teacher dashboard?
- Will implementing the tool require teachers to change their pedagogy? If so, what supports, training, and time will be offered to make that shift successful?
- Does it promote the kind of classroom culture/activities you want? For example, does it help with collaboration, critical thinking, engaging all students, etc.?

What do you think? Did I leave something out? Feel free to tweet us @EducatorCIRCLS with any comments or suggestions! Stay tuned for future posts unpacking important topics from the webinar and sign up for the CIRCLS newsletter to stay updated on emerging technologies for teaching and learning. I'll leave you with a question Diane posed, "If AI is the solution, then what's the problem we're trying to solve?"

Related

We also have resources from the other webinars in this series and additional posts on AI.

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Educator Spotlight: Marni Landry

Who is Marni Landry?

Some of us at Educator CIRCLS recently had the pleasure of talking to educator Marni Landry. Marni has been the K-12 STEM Outreach Manager at Grand Canyon University for about three and half years where she spends her time coordinating STEM professional development for teachers and amazing summer camps like GenCyber cybersecurity, with partner Cori Araza for students and teachers. Before coming to GCU, Marni taught high school science for 16 years. She wrote the STEM Integrated curriculum for, and taught in the Center for Research, Engineering, Science, and Technology program on the Paradise Valley High School campus.

Outside the classroom, Marni has been a leader in the teaching community. She served on the Paradise Valley Technology Committee, designing and delivering technology PD to staff and delivering biotechnology PD as a BioRad fellow. She has also presented STEM PD for the National and Arizona Science Teachers Association (ASTA) and has served as their committee chair. In addition, she partners with MESA (Math Engineering Science Achievement), HOSA-Future Health Professionals, and the Society of Women Engineers (SWE).

Marni's passion for teaching and learning was evident throughout our conversation, so it was no surprise to learn that her passion and impact have been widely recognized by various organizations. Marni is a recipient of the Presidential Award for Excellence in Science and Math Teaching, a Nobel Top 10 Teacher of the Year, AZ High School Science Teacher of the Year, Arizona Tech Council Teacher of the Year, IEEE Pre-College Teacher of the Year, Arizona Bioindustry Association Educator of the Year, and a Fellow of the Fulbright Teachers for Global Classrooms.

What's one thing you really care about getting right as an educator?

Even though she's been out of the classroom for a few years, Marni definitely maintains the heart of a teacher and still works through that lens. When asked what she really cares about getting right as an educator, she

said, “Getting people to love learning and getting people who say ‘I can’t’ to say ‘I will.’ Learning is not a task. It’s an adventure! I want them to say, ‘Yeah, this is hard, but that’s the fun part!’”

What are you most proud of in your career?
When asked what she’s most proud of in her career, Marni first pointed to her students’ successes. She said that she has been fortunate to build relationships with so many students and to still be part of many of their lives. “Seeing their success is what I’m most proud of. Other people may not always have seen what I saw in them, but I fought tooth and nail for them. So to see them succeed is what makes me most proud.”

Marni also pointed to a proud personal moment–winning the Presidential Award for Excellence in Math and Science Teaching. She took away something profound from that experience in addition to the recognition. “I didn’t think I was PAEMST material, but my mentor was convinced that I was. I didn’t even think I could go through the application process, but my mentor said I could do it and that she would help.” Marni realized her mentor’s investment in her had a trickle down effect on her students. “They might not think they’re the right material, but I believe they are. They might not think they can accomplish certain things, but I think they can and I can help.”

What are some of your favorite educational technologies?
You can tell Marni frequently uses tech tools because she had several favorites in her back pocket. Here are a few she mentioned:

- Data Nuggets
- Labxchange
- Jamboard
- Whiteboard.chat (this was a new one to us and it looks great!)
- Classroomscreen
- Poll Everywhere
- Slido
- Mentimeter

You can check out Marni’s Tech Tools Wakelet and GCU’s “Educator Tip of the Day” YouTube channel for more tech tools, tech tips, and general professional development, too!

What is your ideal vision for how the learning sciences and/or educational technologies could shape teaching and learning in the future?
Marni had some great thoughts surrounding the ideal partnership between the learning sciences, technologies, and education. She pointed out that teachers have to overcome several obstacles before they can meaningfully incorporate technology and research into their teaching practices. For one, she said teachers

don’t have time to try out several new technologies and get comfortable with them. “Before teachers can use technologies wisely, they have to have time and permission to use them messily. With the demands teachers face, there’s no chance for trying; there’s no chance for messy.” She also talked about the challenges of using educational research to create standardized policies. “The perfect research-based method, strategy, tool, etc. isn’t going to work for everybody. In an ideal world, educators would be valued and given the freedom to motivate their students in the way their students need to be motivated–and that might look different from classroom to classroom. We need the system to come to terms with that.”

Takeaway

We have several great takeaways from our conversation with Marni. One thing we appreciate most is that she highly values the quantitative aspects of the STEM fields she champions, and she equally values the qualitative aspects of being human and of teaching as a human endeavor. While she respects data, her students are more than numbers to her. They are names and faces and personalities and individuals. As the 2021-2022 school year starts, I hope we’re all inspired to be an educator like that.

Contact Info

You can connect with Marni via email at marni.landry@gcu.edu, through GCU’s Outreach program at CayonPD.com, or on social media @marni_landry

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Reflections on the AI and Learning Environments Webinar: Classroom Orchestration

by Sarah Hampton

In the previous post of this series, I shared some initial reflections on the AI and Learning Environments Webinar. I focused on one of the webinar's important themes–what to consider when making purchasing or adoption decisions of AI tools. In this post, I want to highlight another important theme–classroom orchestration, and how AI can enhance it.

What is Classroom Orchestration?

As practitioners, we understand how complex good teaching is. At any given moment, we're facilitating routines, reading our students' body language, adjusting instruction, distributing materials, setting up hardware, opening software, taking attendance, making judgement calls, managing distractions, monitoring progress, preserving classroom culture, and so much more! In other words, we coordinate multiple processes and activities simultaneously to promote a productive learning environment. That's classroom orchestration in a nutshell.

Cindy Hmelo Silver on Classroom Orchestration

One of my fellow panelists in the webinar, researcher Cindy Hmelo Silver, gets the complexity of good teaching, too. She shared her perspective as someone focusing on "ambitious learning practices" such as problem-based learning and inquiry learning. Cindy described classroom orchestration as "how teachers can productively coordinate interventions across multiple learning activities with multiple resources and different kinds of collaborative interactions." (See the webinar recording and learn more.)
Cindy is the director for the Center of Research on Learning and Technology at Indiana University. Her work often includes how technology supports ambitious learning practices. One problem she sees is that it becomes increasingly more difficult to facilitate activities that support ambitious learning practices as class sizes increase. She suggests that one potential solution for this is to allow AI technologies to help bear the burden of classroom orchestration.

Directly Helping Students through AI-Assisted Classroom Orchestration

One way AI can help with classroom orchestration is by helping students directly while they're engaged in activities. This could be through an intelligent tutoring system (ITS) that uses a virtual tutor agent to interact with students. These kinds of social agents are able to deliver individualized feedback and instruction to each student in a classroom simultaneously which frees up the teacher to facilitate groups, work one-on-one with students if they need a human teacher, etc. Intelligent tutoring systems are probably the most popular kinds of AI tools in schools today. Some but not all ITSs include virtual tutor agents–some still look like problems with hints or have text based ways for students to ask questions.

Helping Teachers Help Students through AI-Assisted Classroom Orchestration

Another way AI can help with classroom orchestration is by helping teachers coordinate the learning environment. Cindy discussed how much goes on in a classroom when students are engaged in authentic problem-based learning. Each group's approach to solving the problem will be unique and therefore their progress and activities will be as well. Some students might be engaged in computer-based modeling or simulations. Others might be reading or watching a video to learn about the phenomena they're studying. Others could be running experiments to test their hypotheses. The challenge of coordinating and facilitating these activities while ensuring all students are reaching their learning goals can prevent teachers from using PBL–even though students who learn from PBL approaches are better able to apply their knowledge to novel problems as well as utilize more effective self-directed learning strategies than students who learn from traditional curricula. (See one of Cindy's papers on PBL for more). AI-based classroom assistants could offer supports such as monitoring how dialogue or participation is distributed between group members, monitoring group progress on the overall project goal, identifying students or groups who are struggling on learning checkpoints, etc. and then generating a detailed report for teachers so they can make the best use of their time and human interventions. In contrast to virtual tutors, most of these kinds of assistants are still being developed.

I like the way classroom orchestration and AI assistants are envisioned in the AI and the Future of Learning Expert Panel Report beginning on page 10. Check it out to learn more about what researchers imagine AI assistants could do to support teachers in 5-10 years. What do you hope AI Assistants will be able to do? What types of supports would you need to facilitate more ambitious learning practices in your classroom? Let us know, tweet @EducatorCIRCLS and/or use #AIandEdu and help us imagine the future of education.

Ambitious Mashups in Out of School Learning with Asset-based Approaches

by Merijke Coenraad

Opportunities for students to learn are all around them. Our students are continuously learning at home and in their communities. As we continue to explore Ambitious Mashups, take a look at projects that have focused on how to provide valuable learning experiences and celebrate the knowledge students gain in out-of-school time. These projects have mainly focused on making, citizen science, and interactive/mobile exhibits. Keep reading to learn about a few ambitious mashups bringing highlighting learning in out-of-school time!

In the Learning in the Making: Leveraging Technologies for Impact project, researchers focused on promoting learning for middle and high school students using maker spaces. Their research found that successful making experiences for students happen at the intersection of the arts, engineering, and entrepreneurship, particularly when students have access to all three disciplines simultaneously. This **ambitious** project worked with 100-200 maker spaces to **mash up** informal learning and maker spaces in order to better understand how to support student learning in designing and making activities.

Paper Mechatronics is another making project, this time focusing on using inexpensive materials for students to learn a **mashup** of topics including programming, electronics, and mechanical design. This project uses making tools like computational devices, craft materials, and fabrication tools in a way that allows kids to build on their knowledge of paper crafts, be creative, and express themselves. See the **ambitious** projects you could take on at papermech.net.

A third out-of-school learning project, Mobile City Science, **mashed up** out-of-school learning with asset-based approaches to create a learning experience that celebrated students' community knowledge while helping them to build technological skills. Students collected data about and mapped their communities using mobile technologies. They identified assets for learning (e.g., libraries), deficits to learning (e.g., no safe routes

to school), and learning opportunities (e.g., places to build a community garden). These maps not only provide students with rich learning opportunities, but also can help educators to identify community-based and data-driven learning opportunities for students.

In previous blog posts we have focused on Culturally Sustaining Pedagogies and interviewed researchers focused on asset-based learning and ways to celebrate the assets that students bring to the classroom. Partnering with their communities and celebrating the knowledge that students bring from learning in these spaces is a great start to making your teaching more culturally responsive and sustaining.What does it look like to mash-up all of this up? Well, it is ambitious, but it is definitely doable!

While this making occurred outside of school, there are still many connections that can be made to your classroom. Not all students have opportunities to participate in out-of-school learning programs, particularly ones that are further from their homes or have a registration cost. Bringing these opportunities into the classroom expands the number of students who get to participate. Even if your students don't have access to making using the same tools available in makerspaces, how could more simple projects like paper crafts or a physical (rather than technological) mapping project connect to students' lives outside of school? Where do arts, engineering, and entrepreneurship intersect with your curriculum?

Learning from the CIRCL researchers who engaged in out-of-school time projects, think about:

- What learning is supported by making, citizen science, and interactive exhibit technologies? How can that learning be brought into the classroom through novel activities that all of our students can participate in?
- Are there maker-spaces near your school? How could you collaborate with them to provide new STEM learning experiences for your students?
- Citizen science represents a community of learners of all ages worldwide (and students can participate in many projects at no cost!). How could your students participate and collect science data inside and outside of school? How can what is learned through citizen science projects be capitalized on in your classroom? Check out Zooniverse for projects you can do in your classroom or find local projects on SciStarter or iNaturalist. Need some help getting started? iNaturalist has a teacher guide and a version of the app just for young students!
- Many students learn outside of school from their families and communities in addition to organized programs. How can you highlight the learning your students do outside of school, especially for students who are not typically the "focus" in the classroom.
- If you become aware of out-of-school opportunities, particularly ones that create low-cost or free opportunities for students, how can you share some out-of-school learning opportunities with all families?

How can you transform these opportunities within your classroom? Tweet us @EducatorCIRCLS and tell us about your innovative technology use and stay tuned for future blogs in this series about CIRCL Ambitious Mashups.

CIRCLS meet NEXUS! Exploring Learning Analytics, AIED, and Remaking Broadening

Image by RhondaK on Unsplash

By Judi Fusco

Let's think about our research of the future so we can be more inclusive. Who do we involve, where do we do it, what do we research, why do we do this research, and how do we do it?

A nexus is a collection of interconnected ideas, the NEXUS blog from the Society for Learning Analytics Research (SoLAR) shares practical developments in Learning Analytics with a broad audience. In this first post in a three-part shared series between NEXUS and the Center for Integrative Research in Computing and Learning Sciences or CIRCLS, we will consider ways the two communities can synergize. This post is cross posted at both SoLar Nexus on Medium and SoLAR Research.

Who We Are and What We Do

CIRCLS is a National Science Foundation funded hub that works to bring together a community of researchers, practitioners in K12 and informal settings, higher education faculty, technology developers, and graduate students, who are researching, developing, or working with emerging technologies for teaching and learning. Learning Analytics has played and continues to play a prominent and important role in projects with these future oriented technologies.

CIRCLS works to bring researchers together to address common needs, plan for the future, and create broader impact as they work to support personal-, community-, and context-centered needs with emerging technologies for learning. In our work, advancing equity is a core goal. In addition, CIRCLS helps to amplify work on emerging technologies for teaching and learning to policymakers, practitioners, and interested stakeholders. We've included a link to a 3-minute video to share more about how CIRCLS works to Build Community to Shape Emerging Technologies.

History and Mission

CIRCLS is a new center with a long history that is grounded with the work done in the Center for Innovative Research on Cyberlearning, which started in 2013. CIRCL supported the Cyberlearning program area at NSF, which preceded the Research on Emerging Technologies for Teaching and Learning (RETTL) program. CIRCLS is the new center supporting the RETTL program. First CIRCL, and now CIRCLS, shares reports about work that influenced the field. The projects involve ambitious designs for more equitable learning experiences with emerging technology.

Another characteristic of the projects is how they work to develop learning theories and technologies that are likely to become important to the field within 5-10 years. We see how CIRCLS projects often overlap with the research being done in SOLAR and that there are many members who are active in both communities. Artificial Intelligence (AI) is a growing area and Learning Analytics is integral when thinking about AI and how it could augment learning.

In our work to bridge the gap between research and classroom practice, we involve practitioners through Educator CIRCLS and also think about policy needs for emerging technologies, specifically AI. We also have special programming for graduate students and new scholars in our Emerging Scholars expertise exchange. If interested in any of these communities, SoLAR members are welcome to visit our website, read more, and join.

Remaking "Broadening"

When you hear the term "broadening," (or for our non-US readers from SoLAR, perhaps "inclusion" is more familiar) what do you think? Our upcoming virtual convening will focus on building an understanding of how the field can make stronger progress by examining and remaking "broad." How can this familiar word become more meaningful and specific, leading to greater intellectual merit and impacts? How can broadening address who we involve in research, where we conduct research, what we research, why we do the research, and how we do research?

The theme "Remake Broadening" challenges our community to learn and engage in innovative ways to make positive changes in education.Through roundtable discussions, breakout sessions, plenaries, and more, we will reflect and consider next steps and recommendations for the field. Our keynote speakers, Nicki Washington and Craig Watkins will offer insights as to how we can further our work to nurture inclusive communities and how we must move forward to "broaden" multiple aspects of the field. Some of the topics the community will explore include:

- Learning Analytics and Data Visualization: Broadening our View
- AI and Education Policy
- Equity and Ethics Considerations for Teaching and Learning with AI

- Using the Learning Sciences and Computational Approaches to develop Assessments and Intelligent Tutoring Systems
- Towards Equity, Accessibility, & Inclusion

Cynthia D'Angelo, Chad Dorsey,, and Tiffany Barnes, the facilitators for the Learning Analytics and Data Visualization: Broadening our View session, describe what they will discuss in their session:

> For example, as we think about learning analytics and broadening our view, the production and application of learning analytics has extensive implications for education choices both now and in the future. While learning analytics can be used in many ways to improve learning, we must be aware of the more subtle consequences of its use in order to ensure that they are oriented toward the most positive ends possible. We make many choices and assumptions (sometimes implicitly) at many stages of research, including question selection, data collection, data processing, analysis, and presentation. These choices frequently have equity implications, often in subtle ways.

If this sounds interesting, we hope you'll register for CIRCLS'21 and join us in thinking about these and other issues.

In our second post, we'll share more about the sessions focused on bringing learning sciences and computer sciences together as we think about broadening in research on emerging technologies for teaching and learning.

Humanizing AI Research in Education by Broadening Community Engagement

Author: Aditi Mallavarapu

Learning Sciences and Technology
Postdoctoral Researcher at CIRCLS. Her research projects all have the shared goal of collaborating with practitioners to design and build computational and analytical methods and tools to support and improve exploration-based learning. She has worked professionally as a technical consultant where she developed software solutions for healthcare and financial organizations. As an instructor she is involved with underserved communities to pique their interests in Computer Science.

*This blog is the second of the three-part shared series, between **NEXUS** and the Center for Integrative Research in Computing and Learning Sciences or **CIRCLS**. The **first post** described the synergy between the two communities, and introduced the CIRCLS priority around broadening/inclusion in Learning Analytics/AI in education. In this post, we highlight the concerns and the importance of "broadening" participation in research of AI in education, equally raised by both the communities.*

Photo by Zainul Yasni (@zainulyasni6118)

The "Fate" of AI education research

Education, like many other fields, has been revolutionized in this era of datafication. The omni-present machines, with the so-called "intelligence," are being used to improve the way we learn and teach through devices and technologies, and connect learners, teachers, and even families across ecologies (classrooms, museums, homes) to manage learning. Some innovations have started to dominate the way we learn and remember, sometimes even remembering for us. The imaginative artificial technologies enacted in *Star Trek* with communicators, talking virtual assistants, and video chats have become our reality. But this reality has not been equitably rolled out across individuals, schools, or communities.

As AI technologies become intertwined with our daily lives, there are justifiable concerns in society around algorithmic fairness, accountability, trustworthiness and ethics ("FATE"). Research is developing rapidly to ask how can we, as a community, rethink AI-based technological progress to address this inequity? How can we address the concerns around privacy, trust, and bias, that have become prevalent due to the prolific use of data and recording devices in these AI technologies? Progress in defining the nature of the challenges, and ways forward, is being made in both the Learning Analytics and AIED communities, but there remains much to do.

Researchers have suggested addressing these issues, in part, by **broadening community engagement**. With the recent transition to online learning due to the COVID-19 pandemic, the need to address these issues has become more urgent.

Addressing the issues by broadening engagement

For over a decade, researchers have been working synergistically across disciplines to address issues around equity, privacy, trust and bias. Some researchers have highlighted, humanizing the issues by engaging all stakeholders, learners, educators, caregivers and domain experts, in contributing to the design of the AI systems. One goal of broadening engagement is to consider the complex dynamics that result from multiple perspectives of the different stakeholders involved in a learning process, while designing the AI system. To fully achieve this, the design process should provide the stakeholders an active and respected role, which is non-trivial. The black box-like opaqueness that many of these AI technologies possess makes it difficult for practitioners to contribute. This should not be an excuse.

One way of providing everyone a platform to voice their opinions is to reduce the opaqueness through enacting and visualizing scenarios, making the design process about the humans involved in conceiving and using the system. Taking such a human-centered approach engages practitioners in conversations around what should be measured, and how that measurement could be used in decisions, with a hopeful view of mitigating at least some unwarranted applications and effects that a researcher alone might not be able to anticipate from where they sit.

Come be a part of the conversation!

We at CIRCLS, have planned the CIRCLS'21 convening for the community with the theme of "Remake Broadening." Broadening participation for emergent technologies, like AI design, is an important aspect of this initiative. The keynote speakers have vested interests in broadening participation in Computer Science and AI education across different age groups and communities using emergent AI technologies. They have planned to engage the attendees in thinking about "designing for broadening" through "broadening participation in design."

The community will also be hearing from the researchers at the AI institutes, iSat, AI-ALOE and AIEngage.org (part of the 11 institutes that won the recent NSF "AI institute" competition). This session will highlight how the community of both researchers and practitioners can contribute to and participate in AI research.

We invite SoLAR members to the conversation. Our Expertise Connections sessions (September 13, 4pm Eastern: Equity and Ethics Considerations for AI) and our Strategy sessions (September 14, 3pm Eastern: Remake Broadening) will allow researchers and practitioners alike to survey the emerging landscape and think strategically about how we could remake the envisioned broadening. We've designed these sessions to engage participants with the most pressing topics in small group activities — a "low floor and high ceiling" setting for both practitioners and researchers, that encourages the understanding of each others' perspectives.

We hope this plan will give all attendees the chance to shape the broadening process. Our vision for this convening is a first step to “remake broadening”. With more engagements to follow, we hope to keep the conversation going even after the convening. We hope you’ll join us. You can see details about all the sessions when you register and explore Swapcard for CIRCLS’21.

CIRCLS | Center for Integrative Research in Computing and Learning Sciences

Learning with and from Artificial Intelligence-Driven Analytics

How is the evolving field of Artificial Intelligence shaping educational contexts? Let's explore both the benefits and challenges of innovative AI-Driven analytics…

by Rachel Dickler

Rachel Dickler is a Postdoctoral Research Associate at the NSF AI Institute for Student-AI Teaming (iSAT) at the University of Colorado Boulder. Her research spans across many fields including Human Computer Interaction, Artificial intelligence, Learning Sciences, and Education. Specifically, she is exploring the development of innovative technological tools (e.g., AI pedagogical agents, teacher dashboards) that can be used to promote collaborative learning in middle school and high school classrooms.

The phrase "Artificial Intelligence" (AI) is often associated with ideas of humanoid robots, self-driving cars, or virtual assistants like Alexa and Siri. Rarely do we think of classrooms as primary examples of AI, but interdisciplinary innovations across fields such as Computer Science and the Learning Sciences are using AI to reshape how we measure learning in educational settings. So what does this mean for the future of education? How can we design AI that is safe, equitable, and effective in both assessing and promoting learning? The answers to these questions can be found in research at the intersection of AI and learning analytics.

What is AI?

AI can take on many forms but generally involves machines that are able to make decisions and adapt in similar ways to people. People interact with their environments based on different experiences over time and "learning" from the outcomes of those experiences (e.g., when we drive to work we first try to take a direct route and eventually discover that some roads have significant traffic during rush hour). We then use this information that we have learned to inform our future decisions (e.g., we may decide to take a longer, less direct route in order to avoid traffic), but sometimes these decisions are far from perfect depending on the

context and unexpected obstacles (e.g., there happens to be construction the day that we take the less direct route and so we are still late to work).

Just like humans, machines can be trained to make decisions by providing them with experiences (i.e., in the form of data) and the corresponding outcomes associated with the experiences to create a model (i.e., representing relationships between certain features of the data and outcomes). The machine then applies the model to make decisions and predictions about outcomes of new experiences based on the features of the new data. These AI models can be applied to help accomplish complicated tasks across contexts, including in classrooms. Specifically, AI is often used to make decisions and predictions about student learning outcomes in educational settings by informing learning analytics.

AI-Driven Learning Analytics

One reason that AI is particularly useful in educational settings is because it can drive the assessment of complex student competencies that would otherwise be challenging and time-consuming to measure. For example, it takes hours to manually grade middle school students' argumentative essays, particularly because there is not just one "correct" answer or way of organizing the essays. Researchers, however, have created AI-driven models that can automatically score students' essays for complicated areas such as students' use of evidence to support claims in their writing as well as the organization of the ideas within the essay.

AI analytics can also be used to inform individualized support to students and displays of student performance to teachers. For instance, if multiple middle school students are completing a scientific lab experiment simultaneously, it can be difficult to monitor each students' progress and provide personalized support to students at the appropriate time. AI analytics within virtual lab environments provide an opportunity to automatically score student progress and correspondingly provide personalized support to students in real-time through an AI tutoring agent. The AI analytics can also be used to keep teachers informed of student progress through a dashboard that provides real-time alerts on student difficulties as well as other essential visualizations and data on student progress.

These are just a few examples of the cutting-edge innovations emerging at the intersection of AI and Learning Analytics. It has been exciting to see the potential of these tools to support instruction and learning in classroom settings, but, just like people driving to work, AI technologies are not perfect. Let's think through some of the challenges that come with implementing AI innovations in educational settings.

Challenges with AI in Education

It is critical to keep in mind that all initial stages of AI technologies are created by humans, which means that these tools are susceptible to human biases and error. Correspondingly, some of the greatest challenges with creating AI for educational contexts are that people must decide: the sample of which people's experiences or data are used to train the AI model, the types of data to include in the model, the approach that is used

to model the data, and how to define outcomes (i.e., decide what is a “correct” versus “incorrect” student answer). All of these decisions (and more) impact the way that AI analytics evaluate student learning, which can have a substantial impact on critical educational outcomes for students. Many AI researchers have emphasized the importance of keeping humans involved in final decision making to help mediate some of these issues.

Another core challenge with AI analytics in classrooms is privacy concerns. While using different types of data (e.g., voice data, eye movements, facial expressions, etc.) can help to make AI models more powerful in certain cases, these types of data are also extremely personal. Therefore trust is needed in terms of how data is collected, used, and stored. Establishing standards for data use and implementation of AI technologies requires cross-disciplinary efforts.

Interdisciplinary Collaboration is Essential

There have been efforts across fields and institutions to promote interdisciplinary collaboration that is addressing the challenges faced around AI in education. The National Science Foundation has recently funded several institutes including the NSF AI Institute for Student-AI Teaming (iSAT), NSF AI Institute for Engaged Learning (AIEngage.org), and AI Institute for Adult Learning & Online Education (AI-ALOE) which all have a focus on creating ethical and equitable AI learning environments.

Additionally, communities such as the Center for Integrative Research in Computing and Learning Sciences (CIRCLS) provide opportunities for these important conversations through events such as their recent virtual convening with multiple sessions that brought together stakeholders across fields. For example, there was an expertise exchange led by Dr. Diane Litman, Dr. Janice Gobert, and Aditi Mallavarapu on “Using the Learning Sciences and Computational Approaches to develop Assessments and Intelligent Tutoring Systems” that addressed many of the ideas and questions presented in this blog through discussions with practitioners in K12 and informal settings, higher education faculty, technology developers, researchers, and graduate students.

Through conversations across disciplines and with diverse stakeholders, we can take action to address core challenges with AI in education while also providing opportunities for learning analytics to shape educational settings in valuable ways.

Supporting Computationally Rich Communication During Remote Learning: Lessons Learned

By Colin Hennessy Elliott & the SchoolWide Labs Team

This post was written by a member of the SchoolWide Labs research team, about their experience during the pandemic and what they learned from middle school science and STEM teachers as part of a larger Research-Practice Partnership between a university and a large school district in the United States. The post was reviewed by practicing Educator CIRCLS members. The purpose of the blog is to help open the door between the worlds of research and practice a bit wider so that we can see the differing perspectives and start a dialogue. We are always looking for more practitioners and researchers who want to join us in this work.

The COVID-19 pandemic pushed many school communities online last school year in the US. Teachers were charged with accommodating so many needs while holding levels of care and compassion for students and their families. As a multi-year research project aimed at supporting teachers in integrating computational thinking in science and STEM learning, we worked with renewed senses of compassion, creativity, and struggle. We witnessed how students and teachers innovatively developed computationally rich communication using the technologies from our project while teaching and learning remotely. Below we share a few moments from the 2020-21 school year that have helped us learn what it takes to engage middle school students in computational practices (i.e. collaborating on programming a physical system, interpreting data from a sensor) that are personally relevant and community-based. These moments offer lessons on how collaboration and communication are key to learning, regardless of whether the learning takes place in person or remotely.

Who we are

The SchoolWide Labs research team, housed at the University of Colorado Boulder with collaborators at Utah State University, has partnered with Denver Public Schools (DPS) for over five years. We work with middle school science and STEM teachers to co-develop models for teacher learning that support the integration of computational thinking into science and STEM classrooms. The team selected, assembled, and refined a programmable sensor technology with input from teachers on what would be feasible in their classrooms and in collaboration with a local electronics retailer (SparkFun Electronics). This collaboration focused particularly on programmable sensors because they offer opportunities for students to develop deeper relationships with

scientific data, as producers rather than just data collectors.[1] This aligns with modern scientific practice where scientists often tinker with computational tools to produce the data they need to answer specific questions.

The Data Sensor Hub (DaSH) is a low cost physical computing system used in the curriculum and professional learning workshops developed by the SchoolWide Labs team. Ensuring the DaSH would be low cost was a priority of the team as an issue of access and equity. The DaSH consists of the BBC Micro:bit, a connection expander called the gator:bit, and an array of sensors that can be attached to the micro:bit and gator:bit with alligator clips (see Figure 1). Students can easily assemble the DaSH themselves to experience the physical connections and hard wiring. Students and teachers can write programs for the DaSH using MakeCode, a block-based programming environment that can be accessed via a web browser, making it easy to use with various computer setups. For students with more programming experience, MakeCode has the option to use python or javascript to program the micro:bits.

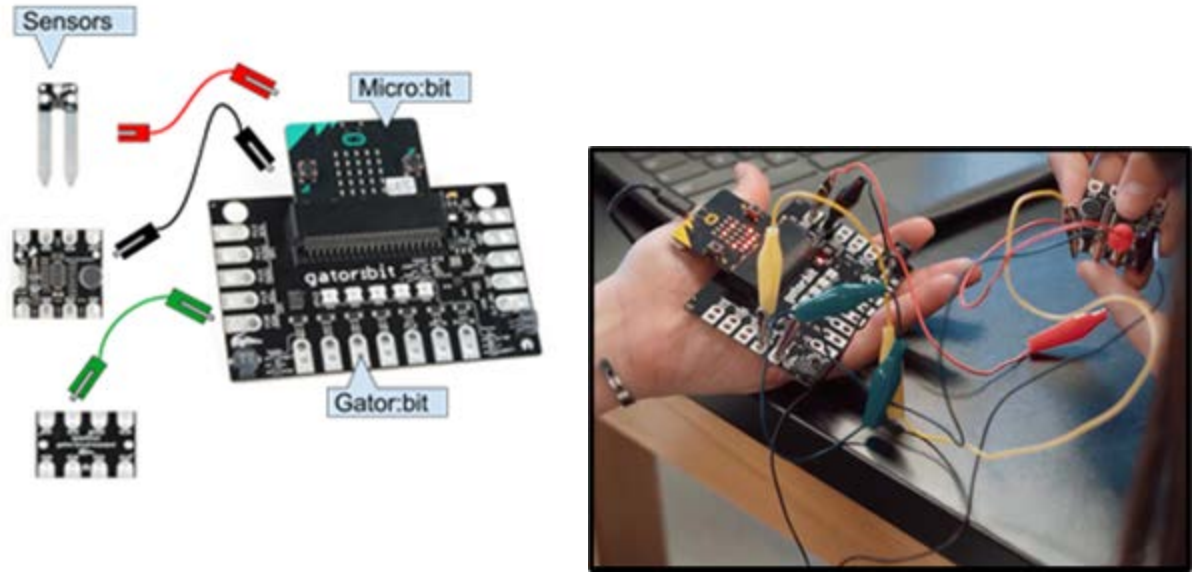

Figure 1.The Data Sensor Hub (DaSH). The picture on the left depicts the components of the DaSH used with the Sensor Immersion Unit including the micro:bit, Gator:bit and three sensors (top to bottom: soil moisture sensor, microphone sensor, environmental sensor). The picture on the right shows a teacher and student interacting with the DaSH set up just for the microphone sensor.

Before the COVID-19 pandemic, our research team co-designed curricular units with teachers interested in using the DaSH to engage middle school students in scientific inquiry. Currently there are four units available on our website, three that use the DaSH and one that uses a 3-D printer. The Sensor Immersion Unit – the only unit teachers implemented remotely in the 2020-21 school year – has students explore the DaSH in use via a classroom data display, learn basic programming, and create their own displays that collect environmental data (sound, temperature, carbon dioxide levels, or soil moisture) to address a question of their choice. For example, one group of students decided to investigate climate change by measuring atmospheric carbon

dioxide levels in their neighborhoods and exploring the impact of plants and trees. The goal is for students to develop ownership of the DaSH as a data collection tool by wiring the hardware and programming the software. In the process, they engage in computational thinking and computationally rich communication when they discuss their use of the DaSH with peers and the teacher.

In the 2020-21 school year most middle schools in Denver Public Schools were remote. Several STEM teachers, with more curricular flexibility, decided to provide DaSHs to students who wanted the responsibility of having them for a period of time. Having the DaSHs in students' homes offered opportunities to make the barriers between home and school less visible, as students conducted place-based investigations and emergently took on the role of data producers. For example, some students shared temperature data and carbon dioxide levels in and around their homes with the class. In these moments, students emergently took on the role of data producers. Below, we share two examples from observing student and teacher interactions in virtual mediums which helped our research team learn about what is possible using the DaSH. We also developed new supports to help teachers facilitate extended student collaboration and communication when using the DaSH.

Lesson Learned 1: Increasing student collaboration in virtual settings

One middle school STEM teacher, Lauren (a pseudonym), had the opportunity to teach different cohorts of eighth graders in the first two quarters of the 2020-21 school year. A new SchoolWide Labs participant, she was enthusiastic about implementing the Sensor Immersion Unit with her first cohort in the first quarter. She navigated the logistical challenges of getting DaSHs to over half her students along with the pedagogical challenges of adapting the curriculum to a remote setting. After her first implementation, she shared that she was disappointed that her students rarely collaborated or shared their thinking with each other when they were online. We heard from other teachers that they had similar struggles. Before Lauren's second implementation, we facilitated several professional learning sessions with the aim of supporting teachers to elicit more student collaboration in remote settings. Through our work together, we identified the importance of establishing collaboration norms for students, offering continued opportunities to meet in small groups virtually, and modeling how to make their work visible to each other. In Lauren's second implementation with new students during next quarter, she intentionally discussed norms and roles for group work in "breakout rooms," or separate video calls for each group (her school was not using a software that had the breakout room functionality). One of the resulting virtual rooms with three eighth graders during the Sensor Immersion Unit was especially encouraging for both Lauren and our research team. Without their cameras on at any point, the three boys shared their screens (swapping depending on who needed help or wanted to show the others) and coordinated their developing programs (on different screens) in relation to the DaSHs that two students had at home. Their collaboration included checking in to make sure everyone was ready to move on ("Everyone ok?") and the opportunity to ask for further explanation from others at any point ("hold on, why does my [DaSH]…"). With their visual joint attention on the shared screen, the three successfully navigated an early program

Book Review: You Look Like a Thing and I Love You

This post was originally published on CIRCLEducators.org in October, 2020.

by Judi Fusco

During CIRCL Educators' Summer of Artificial Intelligence (AI), I read the book *You Look Like a Thing and I Love You: How AI Works and Why It's Making the World a Weirder Place*[1], by Dr. Janelle Shane. I got the recommendation for it from fellow CIRCL Educator, Angie Kalthoff.

I found the book helpful even though it is not about AI in education. I read and enjoyed the e-book and the audio version. As I started writing this review, I was driving somewhere with one of my teenagers and I asked if we could listen to the book. She rolled her eyes but was soon laughing out loud as we listened. I think that's a great testament to how accessible the book is.

Teaching an AI

Many of us use AI products like Siri or Alexa, on a regular basis. But how did they get "smart?" In the book, Dr. Shane writes about the process of training machine learning[2], systems to be "intelligent". She tells us how they certainly don't start smart. Reading about the foibles, flailings, and failings that she has witnessed in her work helped me understand why it is so important to get the training part right and helped me understand some of what needs to be considered as new products are developed.

Dr. Shane starts out comparing machine learning and rule-based AI systems, which are two very different types of AI systems. Briefly, a rule-based system uses rules written by human programmers as it works with data to make decisions. By contrast, a machine learning algorithm[3] is not given rules. Instead, humans pick an algorithm, give a goal (maybe to make a prediction or decision), give example data that helps the algorithm learn[4], and then the algorithm has to figure out how to achieve that goal. Depending on the algorithm, they will discover their own rules (for some this means adjusting weights on connections between what is input and what they output). From the example data given to the algorithm, it "learns" or rather the algorithm improves what it produces through its experience with that data. *It's important to note that the algorithm is doing the*

work to improve and not a human programmer. In the book, Dr. Shane explains that after she sets up the algorithm with a goal and gives it training data she goes to get coffee and lets it work.

Strengths and Weaknesses

There are strengths and weaknesses in the machine learning approach. A strength is that as the algorithm tries to reach its goal, it can detect relationships and features of details that the programmer may not have thought would be important, or that the programmer may not even have been aware of. This can either be good or bad.

One way it can be good or positive is that sometimes an AI tries a novel solution because it isn't bogged down with knowledge constraints of rules in the world. However, not knowing about constraints in the world can simultaneously be bad and lead to impossible ideas. For example, in the book, Dr. Shane discusses how in simulated worlds, an AI will try things that won't work in our world because it doesn't understand the laws of physics. To help the AI, a human programmer needs to specify what is impossible or not. Also, an AI will take shortcuts that may lead to the goal, but may not be fair. One time, an AI created a solution that took advantage of a situation. While it was playing a game, the AI discovered there wasn't enough RAM in the computer of its opponent for a specific move. The AI would make that move and cause the other computer to run out of RAM and then crash. The AI would then win every time. Dr. Shane discusses many other instances where an AI exploits a weakness to look like it's smart.

In addition, one other problem we have learned from machine learning work, is that it highlights and exacerbates problems that it learns from training data. For example, much training data comes from the internet. Much of the data on the internet is full of bias. When biased data are used to train an AI, the biases and problems in the data become what guide the AI toward its goal. Because of this, our biases, found on the internet, become perpetuated in the decisions the machine learning algorithms make. (Read about some of the unfair and biased decisions that have occurred when AI was used to make decisions about defendants in the justice system.)

Bias

People often think that machines are "fair and unbiased" but this can be a dangerous perspective. Machines are only as unbiased as the human who creates them and the data that trains them. (Note: we all have biases! Also, our data reflect the biases in the world.)

In the book, Dr. Shane says, machine learning occurs in the AI algorithms by "copying humans" — the algorithms don't find the "best solution" or an unbiased one, they are seeking a way to do "what the humans would have done" (p 24) in the past because of the data they use for training. What do you think would happen

if an AI were screening job candidates based on how companies typically hired in the past? (Spoiler alert: hiring practices do not become less discriminatory and the algorithms perpetuate and extend biased hiring.)

A related problem comes about because machine learning AIs make their own rules. These rules are not explicitly stated in some machine learning algorithms so we (humans aka the creators and the users) don't always know what an AI is doing. There are calls for machine learning to write out the rules it creates so that humans can understand them, but this is a very hard problem and it won't be easy to fix. (In addition, some algorithms are proprietary and companies won't let us know what is happening.)

Integrating AIs into our lives

It feels necessary to know how a machine is making decisions when it is tasked with making decisions about people's lives (e.g., prison release, hiring, and job performance). We should not blindly trust how AIs make decisions. AIs have no idea of the consequences of its decisions. We can still use them to help us with our work, but we should be very cautious about the types of problems we automate. We also need to ensure that the AI makes it clear what they are doing so that humans can review the automation, how humans can override decisions, and the consequences of an incorrect decision by an AI. Dr. Shane reminds us that an **"AI can't be bribed but it also can't raise moral objections to anything it's asked to do"** (p. 4).

In addition, we need to ensure the data we use for training are as representative as possible to avoid bias, make sure that the system can't take shortcuts to meet its goal, and we need to make sure the systems work with a lot of different types of populations (e.g., gender, racial, people with learning differences). Also, an AI is not as smart as a human, in fact, Dr. Shane shares that most AI systems using machine learning (in 2019) have the approximate brainpower of a worm. Machine learning can help us automate tasks, but we still have a lot of work to do to ensure that AIs don't harm or damage people.

What are your thoughts or questions on machine learning or other types of AI in education? Tweet to @CIRCLEducators and be part of the conversation.

Thank you to James Lester for reviewing this post. We appreciate your work in AI and your work to bring educators and researchers together on this topic.

See a recent TED Talk by author Janelle Shane.

Notes:

1. Read the book to find out what the title means!
2. Machine learning is one of several AI approaches.

3. Machine Learning is a general term that also includes neural networks and the more specialized neural network class of Deep Learning. Note also, a famous class of ML algorithms that use rules are decision-tree algorithms.
4. Some algorithms “learn” with labeled examples and some without, but that’s a discussion beyond the scope of this post.

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I'm a Teacher, Will Artificial Intelligence Help Me?

by Judi Fusco and Pati Ruiz

Artificial Intelligence (AI) systems are becoming more prevalent everywhere including education. Educators often seem to wonder, "What is it?" and, "What can it do?" Let's address these questions and then discuss why and how YOU should be involved!

What is it and what can it do for teachers?

Artificial intelligence (AI) is a field of computer science that lets machines make decisions and predictions. The goal of AI is to create machines that can mimic human capabilities. To do this, AI systems use many different techniques. You are probably using AI systems every day because they are embedded in our mobile phones and cars and include things like face recognition to unlock your phone, digital voice assistants, and mapping/route recommendations. We're not going to go into the details of how AI works in this post, but you can read a prior post on AI and check out this glossary of AI terms that might be helpful if you want more background on the topic. In this post, we will focus on examples of AI systems that can help teachers.

Teachers have to do countless tasks, such as lesson planning, teaching, grading mentoring, classroom management, keeping up with technology in the classroom and new pedagogical practices, monitoring progress, and administrative work, all while keeping students' social and emotional needs in mind. While AI has come a long way since the 1950s when the term was coined and work on Intelligent Tutoring Systems began, it cannot replace a teacher in the classroom. We will share examples of how existing AI systems have successfully helped teachers and reduced their load.

Example: Personalized online math learning software for middle and high school students

Mathia provides coaching to students as they solve math problems and gives teachers a detailed picture of where each student is, as well as suggestions for conversation starters to talk about each student's understanding. This support allows teachers to spend more time with students focused on learning, while also directly giving the students additional, useful feedback as they solve math problems.

Example: A platform that provides immediate feedback to students and assessment data to teachers

Another AI system that supports both teachers and students is ASSISTments. It is also currently focused on math. For students, it gives assistance in the form of hints and instant feedback while they do math homework. For teachers, it gives information about which homework problems were difficult and what the most common wrong answers were. This can prompt teachers to spend time discussing the problems that students need the most help on, and teachers can be sure to re-teach concepts based on common wrong answers.

In addition to teaching content, when you think about all the things a teacher does in managing their classroom and all the "plates" they must juggle to keep 25, 30, or more students on task, engaged, and learning, you can imagine they could use some support. These next three systems described primarily support teachers.

Example: A digital assistant for teachers

One AI system that helps with classroom management tasks is a multimodal digital assistant specifically developed for teachers with privacy in mind, called Merlyn. Merlyn looks like a small speaker, but does so much more. It allows teachers to use voice and a remote control to control content from a distance. For example, with Merlyn teachers can set timers and switch displays between their laptop, document camera, and interactive whiteboard. Teachers can control a web browser on their laptop and do things like share a presentation, go to a specific point in a video, show a website, or search. This frees them up to walk around the classroom and interact with students more easily.

Other ways AI systems can support teaching and learning

The examples above show three categories of how AI systems have helped teachers and their students. Three more examples include, an AI system that can analyze the conversation from a classroom session and identify the amount that a teacher talked versus a student (i.e. TeachFX). This tool also identifies whether teachers let students build on each other's thoughts leading to discussions. With the help of this AI system, teachers can work to engage their students in discussions and reflect on their practice.

Grading is another task that is very important but very time consuming. Gradescope, for example, supports instructors in grading their existing paper-based and digital assignments in less time than it normally takes them. It does this by scanning text and sorting similar responses together for the teacher to grade some of each type, the system then "learns" from the teacher, automatically grades the rest, and sends the grading to the teacher for review.

Finally, AI systems that are specialized within a subject matter can allow teachers to set up content-specific learning experiences. For example in the domain of science, Inq-ITS, allows teachers to select digital labs for their middle school students. When completing the assigned digital labs, students learn by doing. Inq-ITS autoscores the labs in real-time and shows the teacher performance updates for each student. A teacher can use the reports to provide the appropriate support to students who need additional help. Inq-ITS also supports students with hints while performing the labs.

Educators Must be Involved in the Design of AI Systems

The AI systems described above, support or augment, but never replace a teacher. We believe that AI systems can help by doing things that machines are good at while having teachers do the things that humans do best.

The AI systems above are also designed by teams that have made education and learning environments the main audience for their systems. They have also included teachers in their design process. There are other AI tools that exist and even more that are being developed to support teachers and students on other activities and tasks, but some don't have the same focus on education. We think that it's important that in the design of AI systems for classrooms, educators – the end-users – need to be involved in the design.

Some of the teams that design AI systems for education haven't been in a classroom recently and when they were they probably weren't the teacher. To make a technology that works in classrooms requires classroom experts (the main users) to be part of the design process and not an afterthought. When teachers give feedback, they help ensure 1) that systems work in ways that make sense for classrooms in general, and 2) that systems would work well in their specific classroom situations. (We'll discuss why this is the case in another future blog post.)

A final, yet very important reason for educators to be involved, is that while AI systems can bring opportunities to support teaching and learning, there are also privacy, ethics, equity, and bias issues to be aware of. We don't want to add anything to your already full plate, but as technologies come into your classroom, you should ask questions about how the system supports students, if the systems were designed for students like your students, what the privacy policies are, and any implications that might affect your students.

We understand that most teachers don't have a single extra minute but it is crucial to have current teachers in the design process. If you want to learn and think about AI systems, as they become more prevalent, you will become an even more invaluable teacher or technology leader in your school/district. Your voice is important and getting more educators involved makes a more powerful collective voice.

Looking ahead

If you're still reading this blog, you probably have an interest in AI systems; below we suggest a few places to connect. Teachers are critical to the design of effective AI technologies for schools and classrooms. We hope this post has given you some insights into how AI systems might support you and your students. If you are interested in getting involved, we have some links for you below. Consider this blog post an invitation to you to connect with us and join the conversation; we hope you'll join us in thinking about the future of AI in Education.

In our next post we will discuss how AI systems informed by learning science principles may help solve problems in learning environments.

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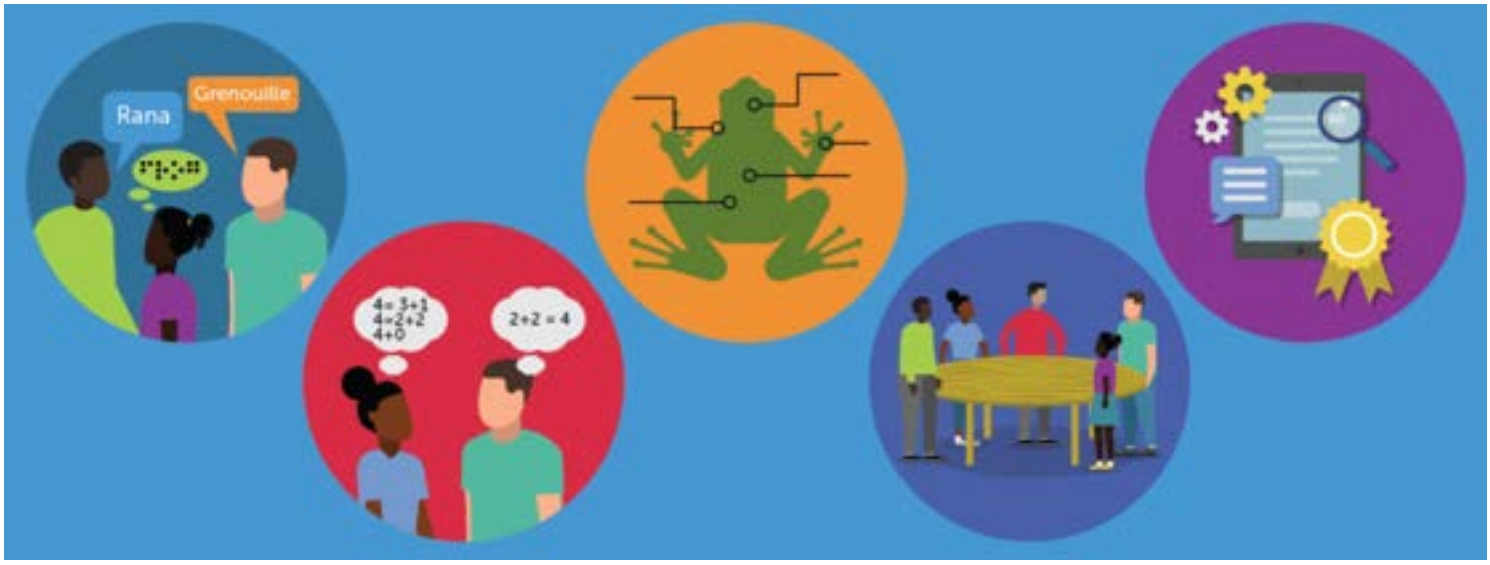
How Can AI Systems Support Teachers: 5 Big Ideas from the Learning Sciences

This post was originally published on the Digital Promise website.



By Pati Ruiz and Judi Fusco

The learning sciences study the design and implementation of effective learning environments by drawing on a variety of perspectives across a range of physical, social, and technological spaces[1]. Learning sciences focuses on human learning and helps individuals achieve their fullest potential and attain 21st-century skills. Because of this focus, the learning sciences should be foundational in the design and development of emerging technologies for teaching and learning. AI systems are an emerging technology that are starting to play a significant role in the redesign of learning environments. To increase our chances of creating successful AI systems for learning, they should be grounded in the learning sciences. We'll discuss five big ideas from the learning sciences in relation to the design of AI systems: *Representation and Supports; Collaboration; How Students Think; Building on Students' Cultural and Linguistic Assets; Assessment and Feedback*. We propose that these big ideas are important as a starting point in the design of better AI systems.

Big Idea 1: Representation and Supports

The learning sciences have found that enabling students to make connections across multiple representations (for example, graphs, writing, images, maps, blocks, etc.) contributes to knowledge construction. Different forms of representation give them a way to make sense of concepts in the best way that helps them construct their knowledge. How can this big idea be used in designing an AI system?

In a classroom where a teacher is fielding questions from students about a specific species of frog, an AI system can support the teacher by quickly searching for and projecting a set of visual representations of the frog that are appropriate for the students and have high-quality information for the teacher and students. When teaching about a metabolic function, an animation might help, and the AI system could share the animation and also point to text or other representations that may help students make connections to understand the process. By giving students and teachers just-in-time support like a relevant animation or engaging follow-up questions, AI systems can support teachers to orchestrate learning experiences by automating tasks (as described above) so teachers can spend more time focused on students. Beyond those types of just-in-time supports, AI systems can further support the engagement of all students in sustained creative work—something that has been a challenging problem in the design of learning environments.

Big Idea 2: Collaboration

The learning sciences have found that learning environments should be designed to foster collaboration and help learners work together to share and make sense of challenging problems. Research points us toward more social and collaborative learning environments.

AI systems could support this big idea by making recommendations for how teachers group students or by giving students themselves prompts that may lead to shared understanding when working in groups without the teacher. Emerging AI technologies might help teachers ask different groups the right guiding questions as the AI system "listens" to what each group is discussing. An AI system that asks questions might also be able to assess the answers to those questions, help students arrive at the same conceptual understanding, and determine when the group is ready for a new task.

Big Idea 3: How Students Think

The learning sciences have found that learning environments should be not only collaborative, but also foster adaptive or personalized learning because there is not a single way to learn and individuals have unique needs when it comes to learning environment designs.

AI systems might support teachers in facilitating this big idea by finding instances of student reasoning for teachers to review based on the analysis of video, audio, or student work. AI systems can also quickly provide insights to teachers about what learning path a student is taking and analytics could help teachers understand how each of their students tends to learn a concept based on their writing, speaking, or movements. A teacher might take the feedback given by an AI system and follow-up with students about their individual learning process and make decisions with them about what to do next. By helping students keep track of how they are practicing and providing scaffolds when they are needed and removing them when a student is ready, an AI system can support students' unique learning needs.

Big Idea 4: Building on Students' Cultural and Linguistic Assets

The learning sciences have found that learning and teaching are cultural processes and that we best support learning when we include students' cultural and linguistic backgrounds as pedagogical assets. This big idea means that AI systems need to support learning environments that enable teachers and learners to address the multiple elements of learning, including identity and culture. To do this, developers need to restructure the assumptions that are made about learners and what they know by keeping both teachers and learners in the loop. For example, AI systems can help personalize the materials for Spanish-speaking students and their parents by translating sections of text, or by providing just-in-time translations so that they can more fully participate in learning experiences. Another personalization could be an AI system where the agent speaks to students and engages them using speech patterns similar to those of the student.

Big Idea 5: Assessment and Feedback

There's been a lot of discussion around how AI systems can support teachers and students with new types of assessment, such as more stealth assessment, or formative assessment. Formative assessment provides specific information to a teacher about students' strengths and challenges to help a teacher adapt their instruction to meet students' needs. Students' needs vary and they can also be challenging to anticipate—this is where AI systems can support teachers and readers. We won't get into assessment and feedback more here, but check out this Educator CIRCLS webinar on Assessment or read this post on AI and Formative Assessment to learn more about this big idea.

Looking ahead

These big ideas from the learning sciences should be incorporated into AI systems to create better, user-centered products. In addition, educators need to be involved in the process because they have valuable

insights about what is working and not working in ways that complement researchers' expertise. Merlyn Mind Practitioner Advisory Board member, Grace Magley reminds us that teachers "have to see real benefits, not just new tech" and "they need to be shown how it would work in a classroom full of diverse learners. They need to see benefits for the teacher as well as the learners."

This blog post is an invitation to you to connect with us and join the conversation on the future of AI in Education. If you are interested in getting involved, please visit:

Educator CIRCLS

AI CIRCLS

[1]Sawyer, R. (Ed.). (2014). The Cambridge Handbook of the Learning Sciences (2nd ed., Cambridge Handbooks in Psychology). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139519526

← I'm a Teacher, Will Artificial Intelligence Help Me?

Apprentice Learner: Artificial Intelligence (AI) in the Classroom →

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Apprentice Learner: Artificial Intelligence (AI) in the Classroom

by Sarah Hampton

One of my favorite things about CIRCLS is the opportunity to collaborate with education researchers and technology developers. Our goal as a community is to innovate education using technology and the learning sciences to give more learners engaging educational experiences to help them gain deep understanding. To reach that goal, we need expertise from many areas: researchers who study how we learn best, teachers who understand how new technologies can be integrated, and developers who turn ideas into hardware or software.

Recently I've been reminded of an opportunity when Judi, Pati, and I meet with Daniel Weitekemp in June of 2020. Daniel, a PhD student at Carnegie Mellon University at the time, was developing an AI tool for teachers called Apprentice Learner.

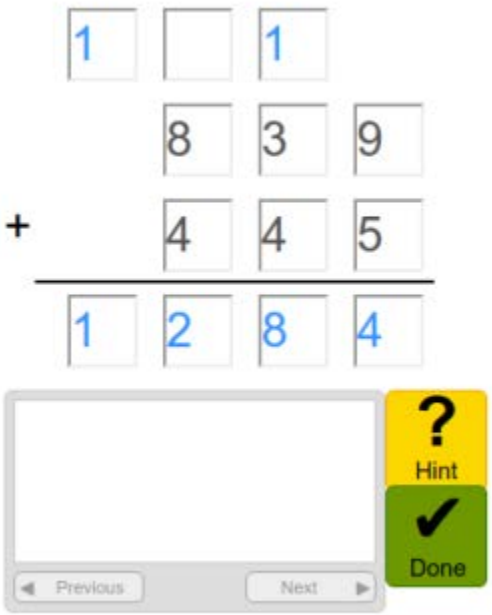


Figure 1. Apprentice Learner Interface that students use when interacting with Apprentice Learner. The user can request a hint or

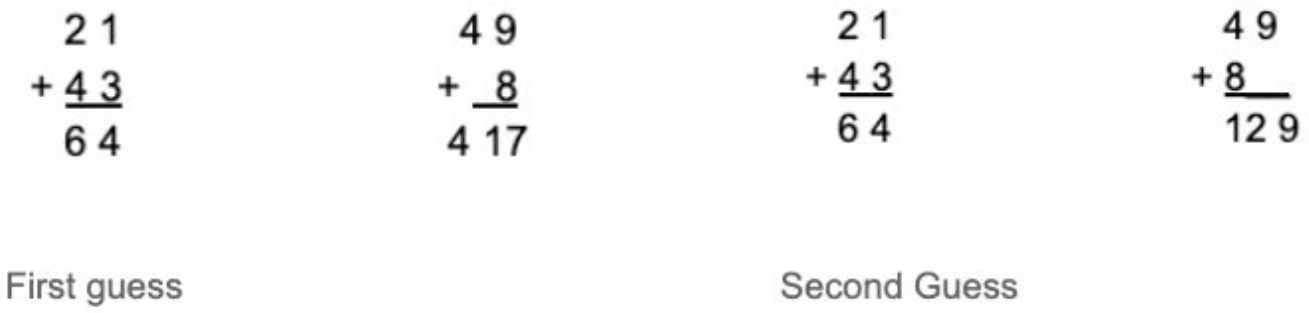
Apprentice Learner looks a bit like a calculator at first glance, so an onlooker might be tempted to say, "What's so cutting edge about this? We've been able to do basic math on calculators for years." But we need to understand the difference between traditional software and software using artificial intelligence (AI) to appreciate the new benefits this kind of tool can bring to the education table.

In a basic calculator, there's an unchanging program that tells the screen to display "1284" when you type in "839+445." There's no explanation given for how and why the programming behind a calculator works. Yet, for each math problem someone could type in a calculator, there is an answer that has been explicitly programmed to be displayed on the screen.

type in their answer and then hit done.

Contrast a calculator to Apprentice Learner, which uses machine learning (a type of artificial intelligence). No one tells Apprentice Learner to display "1284" when it sees 839+445." Instead, it has some basic explicit instructions and is given lots of examples of correctly solved problems adding 2 or more columns of numbers. Then it has to figure out how to answer new questions. The examples it is given are called training data. In this case, Apprentice Learner was given explicit instructions about adding single digit numbers and then lots of training data–multidigit addition problems with their answers–maybe problems like "21+43=64," "49+8=57," and "234+1767=2001." Then, it starts guessing at ways to arrive at the answers given from the training data.

The first guess might be to stack the numbers and add each column from left to right. That works perfectly for "21+43," but gives an incorrect answer of "129" for "49+8."



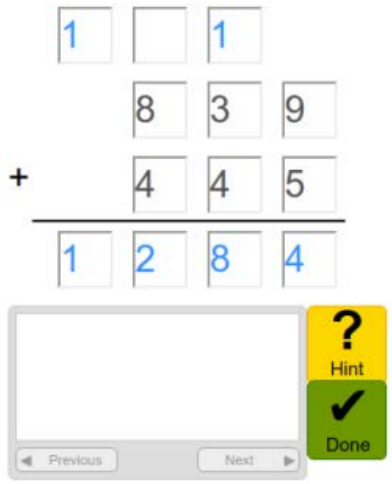
The second guess might be to stack the numbers and add each column from right to left. Again, that works perfectly for "21+43." Unfortunately, that would give an answer of "417" for "49+8."

The software continues finding patterns and trying out models until it finds one that fits the training data best. You can see below that, eventually, Apprentice Learner "figured out" how to regroup (aka carry) so it could arrive at the correct answer.

So what are the implications for something like this in education? Here are a few of my thoughts:

Apprentice Learner models inductive learning which can help pre-service teachers.

Induction is the process of establishing a general law by observing multiple specific examples. It's the basic principle machine learning uses. In addition, inductive reasoning tasks such as identifying similarities and differences, pattern recognition, generalization, and hypothesis generation play important roles when learning mathematics. (See Haverty, Koedinger, Klahr, Alibali). Multiple studies have shown that greater learning



occurs when students induce mathematical principles themselves first rather than having the principles directly explained at the onset. (See Zhu and Simon, Klauer, and Koedinger and Anderson)

However, instructional strategies that promote students to reason inductively prior to direct instruction can be difficult for math teachers to implement if they haven't experienced learning math this way themselves. Based on conversations with multiple math teacher colleagues throughout the years, most of us learned math in more direct manners i.e., the teacher shows and explains the procedure first and then the learner imitates it with practice problems. (Note: even this language communicates that there is "one right way" to do math unlike induction in which all procedures are evaluated for usefulness. This could be a post in its own right.)

Apprentice Learner could provide a low-stakes experience to encourage early-career teachers to think through math solutions inductively. Helping teachers recognize and honor multiple student pathways to a solution empowers students, helps foster critical thinking, and increases long-term retention. (See Atta, Ayaz, and Nawaz and Pokharel) This could also help teachers preempt student misconceptions (like column misalignment caused by a misunderstanding of place values and digits) and be ready with counterexamples to show why those misconceptions won't work for every instance, much like I demonstrated above with Apprentice Learner's possible first and second guess at how multi-digit addition works. Ken Koedinger, professor of human-computer interaction and psychology at CMU put it like this, "The machine learning system often stumbles in the same places that students do. As you're teaching the computer, we can imagine a teacher may get new insights about what's hard to learn because the machine has trouble learning it."

The right training data is crucial.

What would have happened if there were only some types of problems in the training data? What if they were all two digit numbers? Then it wouldn't have mattered if you stacked them left to right or right to left. What if none required regrouping/carrying? Then adding right to left is a perfectly acceptable way to add in every instance. But when all the edge cases are included, the model is more accurate and robust.

Making sure the training data has enough data and a wide array of data to cover all the edge cases is crucial to the success of any AI model. Consider what has already happened when insufficient training data was used for facial recognition software. "A growing body of research exposes divergent error rates across demographic groups, with the poorest accuracy consistently found in subjects who are female, Black, and 18-30 years old." Some of the most historically excluded people were most at risk for negative consequences of

the AI failing. What's important for us as educators? We need to ask questions about things like training data before using AI tools, and do our best to protect all students from negative consequences of software.

Feedback is incredibly advantageous.

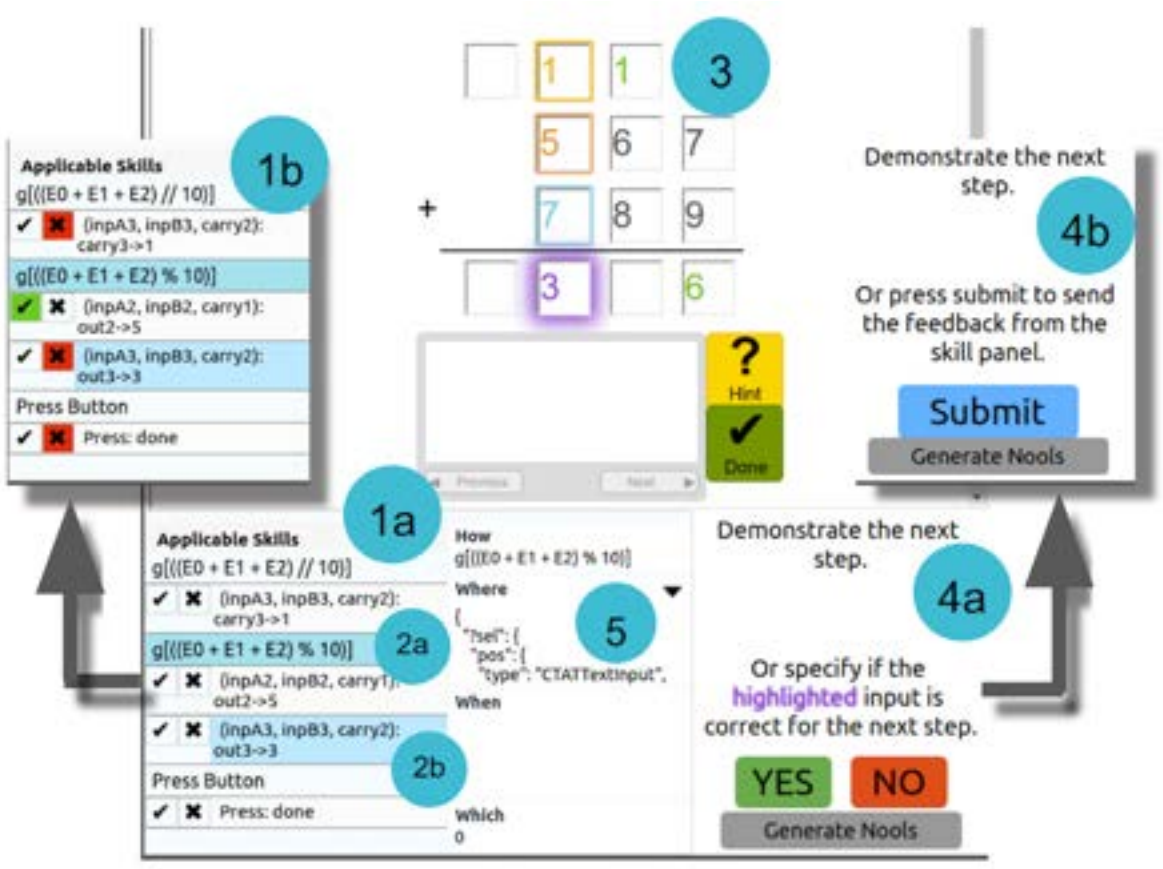


Figure 2. Diagram of how it works to give feedback to the Apprentice Learner system.

One of the most interesting things about Apprentice Learner is how it incorporates human feedback while it develops models. Instead of letting the AI run its course after the initial programming, it's designed for human interaction throughout the process. The developers' novel approach allows Apprentice Learner to be up and running in about a fourth of the time compared to similar systems. That's a significant difference! (You can read about their approach in the Association for Computing Machinery's Digital Library.)

It's no surprise that feedback helps the system learn, in fact, there's a parallel between helping the software learn and helping students learn. Feedback is one of the most effective instructional strategies in our teacher toolkit. As I highlighted in a former post, feedback had an average effect size of 0.79 standard deviation – an effect greater than students' prior cognitive ability, socioeconomic background, and reduced class size on students' performance. I've seen firsthand how quickly students can learn when they're given clear individualized feedback exactly when they need it. I wasn't surprised to see that human intervention could do the same for the software.

I really enjoyed our conversation with Daniel. It was interesting to hear our different perspectives around the same tool. (Judi is a research scientist, Pati is a former teacher and current research scientist, Daniel is a developer, and I am a classroom teacher.) I could see how this type of collaboration during the research and development of tools could amplify their impacts in classrooms. We always want to hear from more classroom teachers! Tweet @EducatorCIRCLS and be part of the conversation.

Thank you for your time in talking and reviewing this post, Daniel Weitekamp, PhD Candidate, Carnegie Mellon University.

Learn More about Apprentice Learner:

- New AI Enables Teachers to Rapidly Develop Intelligent Tutoring Systems (cmu.edu)
- Apprentice Learner Architecture — Apprentice documentation (al-core.readthedocs.io)
- Daniel Weitekamp III, Erik Harpstead, and Kenneth R Koedinger. 2020. An Interaction Design for Machine Teaching to Develop AI Tutors. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems – CHI '20,. https://doi.org/10.1145/3313831.3376226
- Christopher J MacLellan, Erik Harpstead, Rony Patel, and Kenneth R Koedinger. 2016. The Apprentice Learner Architecture: Closing the loop between learning theory and educational data. In Proceedings of the 9th International Conference on Educational Data Mining – EDM '16, 151–158. Retrieved from http://www.educationaldatamining.org/EDM2016/proceedings/paper_118.pdf

Learn More about Math Teaching and Learning:

- Common Errors and Misconceptions in Column Addition and Subtraction
- Comparative Study of Inductive & Deductive Methods of Teaching Mathematics at Elementary Level
- The Effective Role of Inductive Method in Teaching, Learning Mathematics in Secondary School Level

Enhancing Learning Performance With Microlearning

image by Arthur Lambillotte via Unsplash

by Courtney Teague, Rita Fennelly-Atkinson, and Jillian Doggett

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What is microlearning?

Microlearning is a teaching and learning approach that delivers educational content in short, focused bursts of information. Microlearning tends to focus on one objective, and the learning doesn't require more than 1-20 minutes of the learner's time. Schools and teachers can use microlearning to supplement traditional instruction or as a standalone learning tool. microlearning has been around for a long time–remember those flashcards at kindergarten that helped us learn numbers, the alphabet, and colors? However, schools were largely unaware of how powerful this learning strategy can be for a teacher.

Microlearning has several potential benefits for both learners and teachers. For learners, microlearning can provide a more engaging and interactive learning experience. This type of instruction can also help to reduce distractions for students who become disengaged with unnecessary learning information. For teachers, microlearning can be used to differentiate instruction and address the needs of all learners. Additionally, microlearning can save instructional time by allowing teachers to deliver targeted information in a concise format. Teachers can tailor microlearning content to focus on specific skills or knowledge gaps (Teague, 2021).

Microlearning is flexible and can be accessed anytime, anywhere. Learners can complete microlearning activities on their own time, at their own pace. Microlearning is like a seasoning for learning; it seasons and

heats up information to make the process of comprehending new knowledge easier. It has been part-and-parcel in many schools' instructional strategies since time immemorial, but only recently have we begun paying attention to how powerful this strategy really can be when used correctly.

What does microlearning look like?

Microlearning can come in many forms. Below is a list of 10 microlearning examples:

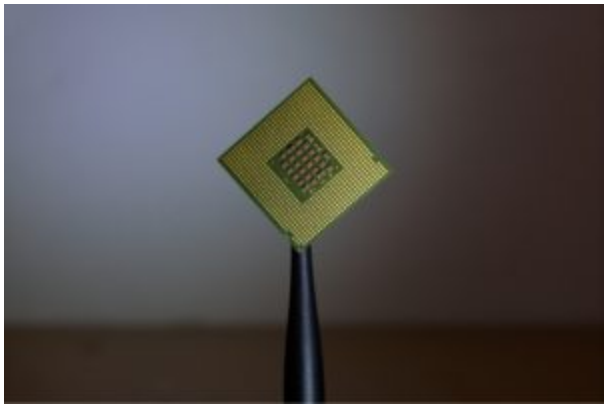

image by Brian Kostiuk via Unsplash

1. Short, Focused Videos
2. Infographics
3. Podcasts or Audio Recordings
4. Social Media Posts and Feeds
5. Interactive Multimedia
6. Animations
7. Flashcards
8. Virtual Simulations
9. Assessment Activities: Polls, Multiple-Choice Questions, Open Response Questions
10. Games

How can teachers use microlearning effectively to maximize content retention, personalize learning experiences, and bolster student engagement?

Use microlearning to Active Student Prior Knowledge and Generate Excitement for New Learning

Assign microlearning, such as a self-paced learning game, to assess and activate prior knowledge around a topic. Or place a few bite-sized learning opportunities about an upcoming lesson in your Learning Management System (LMS) for learners to preview beforehand to generate interest and excitement for new learning.

Use microlearning to Personalize Learning Experiences

Creating microlearning in various formats covering multiple topics gives learners the agency to make meaningful choices about their learning paths. For example, to learn a new concept or build new skills, learners can choose to engage with an interactive image, listen to a short audio guide, participate in a learning game, or watch an explainer video or animation. Additionally, learners who need remediation or want to extend their learning can quickly access content to review a topic again or complete additional microlearning lessons.

Use microlearning to Encourage Communication and Collaboration

Create different microlearning bites, each covering a specific objective or portion of a learning goal. Assign each student to engage with one microlearning bite and then use the Jigsaw method to have learners learn about a new topic in a cooperative style. Similarly, you can assign microlearning that includes thought-provoking, probing questions and have learners discuss on a discussion forum or by recording and responding to each other's short video or audio responses.

Use microlearning to Engage Families and Caretakers

Distribute microlearning to learners' families and caretakers to help them quickly learn content learners are learning in class to support them in taking an active role in their child's learning at home.

Use microlearning to Reduce Time Spent Grading

Create microgames and assessments using tools that automatically grade and provide learner analytics to reduce the time spent grading. For example, create an interactive video with embedded questions, a short quiz on your LMS, or a learning game that automatically grades learners' responses and provides you with learner analytics you can use right away to inform just-in-time teaching.

Use microlearning to Build Classroom Community

Have learners create microlearning lessons to teach each other about themselves, topics that interest them, or around specific learning objectives that they have mastered. Use these bite-sized pieces of learning to expand your microlearning repository, give learners ownership of their learning, and foster a sense of classroom community.

Use microlearning to Promote Learning Outside of School

Over time, create and curate a repository of microlearning assets, such as explainer videos, audio recordings, infographics, learning games, trivia quizzes, flashcards, etc., on your Learning Management System (LMS). Then, learners can easily access and continue their learning outside of school, cultivating a life-long learning mindset.

How to assess microlearning?

The flexibility of microlearning allows for an abundance of possibilities in how it is assessed. For example, if your goal is simply to educate people about a new process using a video, then you don't have to assess, you can simply measure the reach by the number of views and effectiveness by the level of adherence to the new process by a specific date. If your goal is to educate people about the available services, then your performance indicator might be the use of those services. In other words, you have a license to be creative and to assess learning effectiveness in many different ways.

More formally, the evaluation of learning can be categorized into two types: assessments and indicators (Fennelly-Atkinson & Dyer, 2021). Assessments include most formal and informal methods of evaluating learning, which include surveys, check-ins (i.e. verbal, data, progress, etc), completion rates, knowledge checks, skill demonstration observations, self-evaluations, and performance evaluations. Meanwhile, indicators include indirect measures such as performance, productivity, and success benchmarks. Which type you use is largely dependent on the learning context and need. The key questions to consider are the following:

- What measurable change is the microlearning impacting?
- Do you need individual, organizational, or both types of data?
- What is the ease of collecting and analyzing the data?
- Can existing evaluations or indicators be used to measure the impact of learning?

What are the drawbacks of microlearning & how to mitigate them?

Microlearning does have some potential drawbacks. For one thing, it can be easy for learners to become overwhelmed by the sheer volume of micro-lessons that they are expected to complete. Additionally, microlearning can sometimes result in a fragmented understanding of a topic, as learners are only exposed to small pieces of information at a time. Microlearning often does not provide an opportunity for learners to practice and apply what they have learned. However, these potential drawbacks can be avoided or mitigated when microlearning is designed into learning activities. Another potential drawback of microlearning is that it can be difficult to maintain a consistent level of quality control. With so much content being produced by so many different people, it can be hard to ensure that all of the material is accurate and up to date. This problem can be mitigated by careful selection of materials and regular quality checks. Because of this, microlearning can create a significant amount of work for teachers. In order to properly incorporate microlearning into their classrooms, teachers need to have a good understanding of the material and be able to effectively facilitate discussion and debate. While it may require some additional effort on the part of teachers to do microlearning, it feels worth it as it has the potential to significantly improve student engagement and learning outcomes.

Which tools can you use to create microlearning?

While microlearning does not necessarily require the use of digital tools, the reach and potential of these types of learning experiences is magnified by technology. Because microlearning is so short and usually discrete, there are many types of tools and methods of delivery that can be used. Formal authoring tools such as LMSs and Articulate can be used, but are not required. Any type of tool that can create a static or dynamic piece of content can be used. Further, any type of delivery system can be used to disseminate the learning. Making microlearning relevant and specific to the learning context, environment, and audience are key to selecting a content creation tool and delivery systems (Fennelly-Atkinson & Dyer, 2021).

Summary

To wrap it up, microlearning is breaking down and chunking learning into bite-sized pieces. Microlearning might be small but can have a big impact on powerful teaching and learning. It can take many different forms, which means that there are just as many content-creation tools and delivery platforms. Likewise, there are a variety of ways to assess microlearning depending on the goal and purpose for its use. There is no one correct way of creating microlearning. Microlearning can be as simple as listening to the pronunciation of words on an audible dictionary online application. Teachers can use this flexible method of microlearning to support research-based instructional practices and personalize learning experiences.

So how might you use this approach to meet the modern learner's needs? Tweet @EducatorCIRCLS and be part of the conversation.

References

Fennelly-Atkinson, R., & Dyer, R. (2021). Assessing the Learning in microlearning. *In Microlearning in the Digital Age* (pp. 95-107). Routledge.

Teague, C. (2021, January 11). It's All About microlearning. https://community.simplek12.com/webinar/5673

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Teachers Partnering with Artificial Intelligence: Augmentation and Automation

By Pati Ruiz and Judi Fusco

Artificial intelligence systems are increasingly being deployed in K-12 educational settings and we expect this trend to continue. Our starting point is that AI systems should support or augment, but never replace, a teacher. In order to ensure this, these systems should be developed with the input of teachers, students, and families.

So, what types of AI systems do teachers want to see developed? A group of teachers from the Merlyn Mind Practitioner Advisory Board shared ideas for how AI might help teachers better support their students. One scenario emerged around students who have Individualized Education Programs or Plans (IEPs)[1]. In this post we will describe how an AI system might support teachers and students by automating:

1. Planning and Supporting Preferences
2. Monitoring
3. Documentation

Planning and Supporting Preferences

First, a teacher could input student instructional plans into the system. Then, the system can review the plans, make recommendations, and send alerts to the teacher when something may not work for a student. In the alert, the system could provide suggestions of adaptations on lessons or assignments based on the needs of each student. For example, an AI system can scan what's coming up in an instructional unit and alert the teacher that the website they selected does not meet the accessibility standards required by the students in the classroom. A more advanced system could also suggest an alternative option, or even better, search for multiple resources that are appropriate and let the teacher decide what resources are best suited for their students' instructional needs. In all cases, the AI system is only helping and making suggestions that the teacher may act on.

An AI system can also allow for a broader range of inputs from students for assignments based on their needs. For example, if a student accommodation includes submitting assignments as recorded audio, but the teacher prefers written assignments, an AI system can convert the student's audio to text so the teacher can review or grade the text. The text-to-speech tool should also allow the teacher to hear the student's voice for a particular sentence or phrase, for example, if the translation was not successful. Alternatively, if a student needs to hear the teacher's comments on their assignments instead of reading them, the AI system can convert the text comments into spoken text for the student to hear. To additionally help the teacher, the system might suggest comments that they had written for another student so the teacher can reuse or repurpose them. The system might also remind the teacher of a student's preference for feedback and if the student prefers verbal feedback, the teacher could read and record the comments for that more personal touch.

Monitoring

To support teachers in providing adequate accommodations for their students, an AI system can monitor student IEP information and make automated recommendations for needed support. For example, the system could identify students who require extended time and either share a list with the teacher or make appropriate adjustments to due dates for individual students in a learning management system. Here, we point out the need for AI systems to be able to interact with other systems or be embedded within them. Additionally, the system must do this in a way that does not expose sensitive information about students to the whole class.

Related to the text-to-speech and speech-to-text ideas discussed above, an AI system can also provide individualized read-aloud capabilities for students who need that support. The system could also remind the teacher to provide tools, like headphones or closed captioning for students who need to listen to content. We firmly believe that AI systems can help by doing things that machines are good at, while continuing to enable teachers to focus on what humans do best—like developing interpersonal relationships and identifying nuanced needs. With these types of automated supports, it is important to ensure that teachers have the ability to make the final decisions about students' needs and that students have the agency to accept and decline supports as they go.

Documentation

Supporting a classroom with students who have varying needs—whether they are documented in an IEP or not—requires a significant amount of monitoring and reporting on the part of educators. An AI system could support teachers by not only monitoring the individual requirements of students, but also documenting the adjustments and accommodations that were made for each student. This documentation could then be shared with the students' families to provide a summary of the work that students have accomplished and how they have been supported in completing that work. Of course, a teacher would review and verify that the summary produced by the AI system is accurate and flag any issues with the write-ups that would need to be addressed by the AI design team.

By the end of the instructional unit, teachers would be able to review reports of student progress, identify what worked and what didn't, and ensure that all students are making meaningful progress. Automating, planning, tracking, and documentation can give a teacher more time to care for students; however, given the various risks AI systems bring, it is crucial that teachers also have the capability to override an AI system when needed.

Risks

The imagined AI system described helps teachers do what they do best by supporting them to ensure their students receive the accommodations they require and then documents those accommodations. Using such systems will come with risks, and AI systems that engage with student IEP data need to have the highest level of data privacy and oversight. As we discussed earlier, educators must be involved—for example, the teacher is in charge of giving feedback, but the system may make suggestions that help the teacher give better feedback. If educator experts are not in the loop, there could be harmful consequences for students. Educators must be diligent and not assume that every accommodation determined by an AI system is correct or the best decision. AI systems lack full context and the ability to make human decisions. Educators must have oversight and be able to verify and approve every decision made by the system.

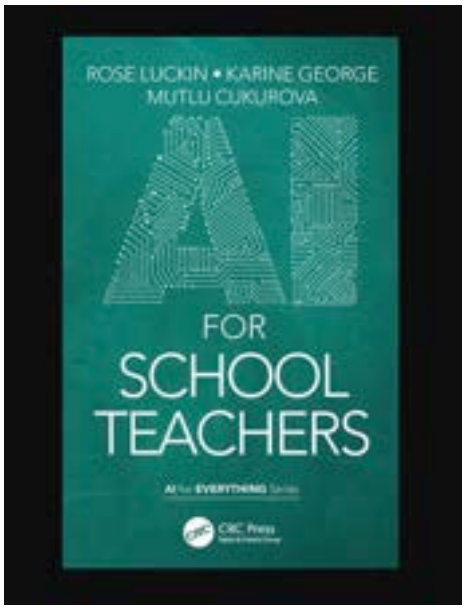
Educator Voices

This blog post presents an imagined AI system based on conversations with a group of practitioners from the Merlyn Mind Practitioner Advisory Board. We need more teachers and educators involved in these conversations, so please consider this blog post as an invitation to you to connect with us and join the conversation on the future of AI in Education. In addition to Merlyn Mind, if you are interested in getting involved, please visit the links below.

- Educator CIRCLS
- AI CIRCLS

[1] An IEP is a legal document in the United States that is developed for all public school children who need special education. It is created by district personnel with input from the child's guardians and is reviewed every year. For more information see https://www2.ed.gov/about/offices/list/ocr/docs/edlite-FAPE504.html

Book: AI for School Teachers



by Rose Luckin and Rowland Wells

This post was written by Professor Rose Luckin, Founder, and Rowland Wells, Director of Research Communication (non-academic) at EDUCATE Ventures Research. The purpose of the blog is to help open the door between the worlds of research and practice a bit wider so that we can see the differing perspectives and start a dialogue. We are always looking for more practitioners and researchers who want to join us in this work.

In the newly published '[AI for School Teachers]', by Professors Rose Luckin, Mutlu Cukurova, and Headteacher Karine George, a blueprint for working with AI in schools is laid out in precise and practical detail. It explains how classroom teachers can hack the AI conversation using a holistic methodology applied to any number of challenges faced in educational settings.

Such challenges could be:

- Trying to recruit, train or retain the best staff
- Analysing attainment gaps
- Concerns about bullying
- Trying to address the gender gap in maths
- Understanding learning analytics
- Worries about pupil attendance
- Uncertainty as to whether marking and feedback engages students or actually helps them learn

The methodology described in the book is called the [7-Step AI Readiness Framework], and it is rooted in ethics, and designed to educate and enthuse leadership and colleagues about AI. The book supports this process of learning about AI through helping readers understand what it could reveal from the data they have at their disposal, and how AI would go about processing that data to produce useful outcomes.

The premise in the book is that by contextualising AI for a reader's own experience, a better understanding of what AI can do and how it works at a non-technical level can be achieved. There is some terminology employed, such as 'Unsupervised Machine Learning', but the book uses everyday analogies, like cooking, to explain the processing of data that Unsupervised Machine Learning can achieve, and why this could lead to useful ways AI can help schools solve some of their toughest challenges.

It is recognised in the book that classroom teachers are frequently time-poor and operating at capacity. The authors remain convinced, however, that those educators working in schools, colleges, and universities are the ones best placed to conduct and lead on the process. The authors aim to show teachers and their leaders how AI can help them tackle some of the most pressing educational challenges they face and in so doing they hope that this will help teachers justify to themselves and their managers that spending time on getting to grips with AI is essential; likewise, that mangers and leaders will understand why they and their team must have time to get AI Ready.

The consequences of not getting AI Ready are that challenges that could be addressed more effectively with AI continue to remain unsolved, and that meagre educational budgets are wasted on AI products and services that are not the right ones for the purchaser's needs. The only winners in this situation are the companies making the money from the AI!

AI for School Teachers is there to help ensure teachers and learners are the winners when it comes to the benefits of AI, because there really are some significant benefits to be reaped.

None of the above can be achieved without the support of the school's headteacher or administrative infrastructure. The case must be made to colleagues and leadership that those in charge of timetabling create capacity for the tackling of challenges and learning about AI in the school, which is why the first step in the 7-Step AI Readiness Framework is about educating, enthusing, and exciting the people you work with!

7-Step AI Readiness Framework

STEP 1 what is AI and how can you and your colleagues develop an AI mindset?
Educate, Enthuse, Excite.
The Key learning objectives of this step include understanding why data is so important to machine learning AI along with the basic implications of AI for their role/position/life; and knowing that there are a range of activities that AI can achieve, such as speech recognition and that it can enable the creation of autonomous systems and what this means.

STEP 2 what challenges do you currently face in your work role or in your life? How can you decide which challenge to focus on when it comes to AI readiness?
Tailor and Hone.

The Key learning objectives of this step include understanding the criteria that can be used to decide which challenges are best suited to AI tools and methods and the basics about the types of task that AI is particularly good at completing and the types of task that are much better completed by humans (this is the foundation for later learning); and knowing that they already come into contact with many different types of data every day that can be collected, analysed and learnt from, using AI.

STEP 3 what is data and how its value can be identified – what data you can access to and how it can be collated?

Identify and Collate data.

The Key learning objectives of this step include understanding the sorts of sources of data that are relevant to their work/life and the differences between different data sources and the ethical implications that are relevant to collecting and collating data of the sort that AI uses; and knowing that data exists about a range of factors within their work or their individual learning including: the physical environment, the virtual environment, the curriculum, the pedagogy, the use of resources and the connections between these resources as well as between the resources and the people who use them

STEP 4 what new data do you need to address the challenge you identified in STEP 2 and what new data is available and how can you collect it?

Collect data

The Key learning objectives of this step include understanding how to collect some new data that is relevant to the challenge they have selected and that fills an important data gap and the potential biases that can occur in data collection and use and therefore in AI systems; and knowing that different data collection methods are suitable for different data sources and that some data is more credible than other data. If an AI system has been built with data that lacks credibility it will be at best ineffective and in the worst case downright dangerous.

STEP 5 – what are the AI techniques that it is appropriate to use with educational or training data?

Apply analysis and AI techniques to your data.

The Key learning objectives of this step include understanding what can be achieved by using AI as part of the data analysis process along with the ethical implications that are relevant to selecting and applying AI to data; and knowing that there are a range of AI techniques that can be applied, what they do and when to use them

STEP 6 – what is the data that has been analysed in STEP 5 telling them about their challenge?

Learn

The Key learning objectives of this step include understanding the of what AI can help them to learn from the data they have identified about their challenge; and knowing that there are no set answers to exactly what can be learnt from applying AI to data and that interpretation is important

STEP 7 How can ETHICS be embedded into the way we use AI? Am I/my organisation now AI ready – how do I know?

Iterate

The Key learning objectives of this step include understanding what evidence there is that they/their organisation is/are now AI ready and the ethical implications that are relevant to all steps in the AI readiness programme and how AI can be developed and applied; and knowing the criteria for making decisions about whether or not a further iteration through the AI readiness programme is needed

The above was a very brief summary of the 7-step AI Readiness Framework and how it could help tackle some of the challenges in your school. To find out more about how you can benefit from examining your institution through a 'data and AI lens', and leveraging the transformational power of AI to tackle your challenges, order your copy of AI for School Teachers, and take our newly launched AI Readiness Diagnostic, a set of quick and simple questions tied to the 7 steps of the AI Readiness Framework. With each of your answers, the diagnostic tool provides you with a visual map of your current expertise, and offers a wealth of recommendations and reading material appropriate to your stage of AI innovation, even if you're just taking your first step on an AI journey.

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Developing Sample Computational Thinking Lessons with ChatGPT

by Pati Ruiz, Merijke Coenraad, and Judi Fusco with contributions from
Julio Vazquez

What is ChatGPT?

Let's start with some definitions, ChatGPT is commonly classified as a natural language processing model, meaning it deals with language and human speech patterns, and "generative artificial intelligence", meaning that it is AI that creates new content — in this case, new text.

More specifically, ChatGPT is a chat-based generative pre-trained transformer. Meaning that the model: (1) can generate responses to questions (Generative); (2) was trained in advance on a large amount of the written material available on the web (Pre-trained); (3) and can process sentences differently than other types of models (Transformer). Basically, it's a chatbot that allows a user to ask a question in plain language and get a response in a way similar to how a human would reply.

What does this mean for education?

> "ChatGPT is a good prompt for conversation.
> I see this tool as a starting point for teachers and students."
> -Julio Vazquez, North Salem Central School District

Despite the precedent of banning access to ChatGPT set by New York City Public Schools in January 2023, not all school districts are following suit. Some educators believe that these AI systems and tools are out in the world and the best thing educators can do is to teach students to partner with AI tools so they can be better prepared for a technological world. For example, English teacher Cherie Shields was recently interviewed by the New York Times where she shared that she assigned students in one of her classes to use Chat GPT to create outlines for a recent essay assignment. She shared that the process helped deepen students' understanding of the stories while also teaching them to interact with an AI system by manipulating their

inputs to get the responses they were looking for. In this case, ChatGPT became a tool that can support learning when we thoughtfully include it in our lessons and also guide students in using it well.

Dr. Julio Vazquez, Director of Instruction and Human Resources, and his team are encouraging experimentation and access to ChatGPT for all faculty and staff and are thinking about how to provide students with access in a manner that will not conflict with student privacy laws. Staff members are rolling their sleeves up and starting to explore and learn about how they can use it with their students productively. In fact, they are exploring the use of ChatGPT to develop sample Computational Thinking (CT) lesson plans that the team uses as a jumping off point in their CT Pathways development process.

ChatGPT for Developing Sample Computational Thinking Lesson Plans

North Salem Central School District

In a recent conversation with Dr. Vazquez, we asked him more about how he and his teachers are incorporating ChatGPT in their computational thinking lesson planning process.

Dr. Vazquez and his colleague Cynthia Sandler, Library Media Specialist, started by entering prompts into ChatGPT and seeing what came out. The searches started with prompt terms that went something like "*generate a 5th grade lesson for computational thinking focusing on science.*"

As the team began to analyze the lesson plans that came out, they realized they needed to make adjustments. Julio shared that he and his team have become better at giving ChatGPT enough context so that the lessons that are developed are closer to what the team expects of a lesson plan and the content better aligns to both CT and content area standards. For example, a more recent lesson prompt terms included:

> "write a science lesson that integrates
> 9-12.CT.1
> Create a simple digital model that
> makes predictions of outcomes. and HS-PS1-5. Apply scientific principles and evidence to explain how the rate of a physical or chemical change is
> affected when conditions are varied."

The prompt terms and outputs were documented and provided a good starting point for sparking conversation. On first pass, the team collectively agreed that they liked the structure of the generated lesson plans. Beyond format and in terms of the content of computational thinking and subject area standards, the prompt terms entered into ChatGPT also included Habits of Mind, thinking dispositions which are implemented in North Salem, as well as the use of Visible Thinking Routines.

Dr. Vazquez and his team have worked with ChatGPT to develop sample computational thinking lessons across all subject areas K-12. These lessons are not meant to be implemented in the classroom "as is," but rather, these sample lessons are to be used as a first draft, a starting point for consideration and conversation in North Salem. Teachers will vet the lessons for accuracy and then iterate and improve them in order to meet the learning needs of their students. Given the need for high-quality, integrated computational thinking lessons we will continue to work with Dr. Vazquez and his team at North Salem to learn more about how they are integrating ChatGPT in their work and their vetting process. We look forward to sharing more! Until then, do you have questions for us? Are you integrating ChatGPT in your classroom, school, or district? Let us know @EducatorCIRCLS.

Artificial Intelligence in Education: A Reading Guide Focused on Promoting Equity and Accountability in AI

by Pati Ruiz

As a former Spanish and computer science teacher, I think a lot about emerging technologies and how they apply in learning contexts. Recently, I have been focused on artificial intelligence (AI) and how it affects students, their families, and communities. I am particularly interested in the consequences (intended and unanticipated) of these emerging AI technologies on students who experience exclusion, specifically Latinx, Black, Indigenous, and students with disabilities.

Working with the Center for Integrative Research on Computing and Learning Sciences (CIRCLS), I have seen work ranging from Intelligent Tutors and systems designed to adapt and personalize learning, including some that are developing pedagogical agents and robots. I've also seen work that seeks to minimize bias and promote equity in AI, projects using computer vision, natural language processing and speech technologies. Of all of these efforts, I consider the work to promote equity and accountability in AI to be the most important and I created this list to focus on those issues. You can also check out this glossary of AI terms written specifically for educators.

First published: March 2020. Last updated: March 2024

A Good Place to Start

- Unmasking AI By Joy Buolamwini
- Is ethical AI possible? The Gray Area Podcast with Sean Illing and guest Timnit Gebru. Transcript.
- Algorithms of Oppression: How Search Engines Reinforce Racism by Safiya Umoja Noble
- Viral Justice How We Grow the World We Want by Ruha Benjamin
- A People's Guide To AI by by Mimi Onuoha and Diana Nucera, with design and illustration by And Also Too (Open Access)
- Algorithmic Accountability: A Primer by Joan Donovan, Jeanna Matthews, Robyn Caplan, Lauren Hanson (Open Access)

- Artificial Unintelligence How Computers Misunderstand the World and More than a Glitch Confronting Race, Gender, and Ability Bias in Tech by Meredith Broussard
- Coded Bias a Shalini Kantayya film
- Off Task: EdTech Threats to Student Privacy and Equity in the Age of AI by Center for Democracy & Technology (CDT)
- The Cyclical Ethical Effects of Using Artificial Intelligence in Education by Edward Dieterle, Chris Dede, and Michael Walker

Power, Privilege, Ethics, and Justice in Artificial Intelligence (AI)

- Advancing Racial Equity Through Technology Policy by Julia Rhodes Davis, Eliza McCullough, Sarah Treuhaft, and Rachel Gichinga
- Datasheets for Datasets by Timnit Gebru, Jamie Morgenstern, Briana Vecchione, Jennifer Wortman Vaughan, Hanna Wallach, Hal Daumé III, Kate Crawford (Open Access)
- The Steep Cost of Capture by Meredith Whittaker
- Responsible Language in Artificial Intelligence & Machine Learning by Genevieve Smith, Ishita Rustagi, Alicia Sheares, and Julia Nee with support from Kellie McElhaney
- Algorithmic Bias in Education by Ryan S. Baker and Aaron Hawn
- Exploring the Ethics of AI (Website Resource)
- Algorithmic Fairness in Education by René F. Kizilcec and Hansol Lee (Open Access)
- Auditing Algorithms for Discrimination by Pauline Kim (Open Access)
- Facial Recognition Technologies: A Primer by Joy Buolamwini, Vicente Ordóñez, Jamie Morgenstern, and Erik Learned-Miller (Open Access)
- Facial Recognition Technologies in the Wild: A Call for a Federal Office by Erik Learned-Miller, Vicente Ordóñez, Jamie Morgenstern, and Joy Buolamwini (Open Access)
- The Whiteness of AI by Stephen Cave and Kanta Dihal (Open Access)
- AI and Accessibility By World Institute on Disability (Open Access)
- The Problems AI has Today Go Back Centuries by Karen Hao (Open Access)
- Atlas of AI – Power, Politics, and the Planetary Costs of Artificial Intelligence by Kate Crawford
- Hard Choices in Artificial Intelligence by Roel Dobbea, Thomas Krendl Gilbert, and Yonatan Mintz (Open Access)
- Algorithmic Injustice: A Relational Ethics Approach by Abeba Birhane (Open Access)
- Ethics and Computing Repository from EngageCSEdu originally developed by the National Center for Women & Information Technology (NCWIT) and now operated by the Association for Computing Machinery, EngageCSEdu publishes high-quality, engaging, classroom-tested Open Educational Resources (OER's) for computer science education with a focus on materials for introductory courses in computing.

Design and Artificial Intelligence (AI)

- Design Justice: Community-Led Practices to Build the Worlds We Need by Sasha Costanza-Chock (Open Access)
- Co-Designing Checklists to Understand Organizational Challenges and Opportunities around Fairness in AI by Michael A. Madaio, Luke Stark, Jennifer Wortman Vaughan, and Hanna Wallach (Open Access)

(Dis)ability and Artificial Intelligence (AI)

- No, large language models aren't like disabled people (and it's problematic to argue that they are) by Emily M. Bender (Open Access)
- Disability, Bias, and AI from AI Now (Open Access)
- Unintended Machine Learning Biases as Social Barriers for Persons with Disabilities by Ben Hutchinson, Vinodkumar Prabhakaran, Emily Denton, Kellie Webster, Yu Zhong, and Stephen Denuyl (Open Access) ***Note on title:*** Please see the article (*The problems AI has today go back centuries*) about using ***unanticipated*** when talking about the consequences of AI.
  "*When people talk about unintended consequences, it sounds like they're saying the consequences couldn't have been predicted. But* ***AI's unintended consequences are in fact highly predictable*** *if you just look back at history.*" -Marie-Therese Png
- Toward Fairness in AI for People with Disabilities: A Research Roadmap by Anhong Guo, Ece Kamar, Jennifer Wortman Vaughan, Hanna Wallach, Meredith Ringel Morris (Open Access)

Artificial Intelligence (AI) Literacy and AI in PreK-12 Education Resources

- Towards social generative AI for education: theory, practices and ethics (Open Access) by Mike Sharples
- CrashCourse: Artificial Intelligence (Video Series: 21 Videos)
- Conceptualizing AI literacy: An exploratory review by Davy Tsz Kit Ng, Jac Ka Lok Leung, Samuel Kai Wah Chu, and Maggie ShenQiao (Open Access)
- Critically Conscious Computing: Methods for Secondary Education by Amy J. Ko, Anne Beitlers, Brett Wortzman, Matt Davidson, Alannah Oleson, Mara Kirdani-Ryan, Stefania Druga (Open Access)
- Curriculum: AI Plus Ethics for Middle School by Blakely Payne (Open Access Curriculum)
- AI4ALL Open Learning a program designed to equip educators and community members to empower high school students with relevant and approachable AI education.
- Artificial Intelligence (AI) for K-12 (AI4K12) an initiative that is developing (1) national guidelines for AI education for K-12, (2) an online, curated resource Directory to facilitate AI instruction, and (3) a

community of practitioners, researchers, resource and tool developers focused on the AI for K-12 audience.

History of Artificial Intelligence (AI)

- The History of AI the Stanford Encyclopedia of Philosophy (Open Access)
- The History of Artificial Intelligence by Rockwell Anyoha (Open Access)

Guidelines and Frameworks for Artificial Intelligence (AI)

- Emerging Technology Adoption Framework: For PK-12 Education by Pati Ruiz, Eleanor Richard, Carly Chillmon, Zohal Shah, Adam Kurth, Andy Fekete, Kip Glazer, Megan Pattenhouse, Judi Fusco, Rita Fennelly-Atkinson, Lin Lin Sheryl Arriola, David Lockett, Valerie Crawford-Meyer, Sana Karim, Sarah Hampton, Belinda Beckford
- K-12 Generative Artificial Intelligence (Gen AI) Readiness Checklist by CoSN and Council of the Great City Schools
- The Ethical Framework for AI in Education (Open Access)
- Universal Guidelines for Artificial Intelligence (Website Resource) by The Public Voice
- UNICEF Policy guidance on AI for children. Recommendations for building AI policies and systems that uphold child rights

Policy and Advocacy Groups

- Design Justice Network
- Algorithmic Justice League – Unmasking AI Harms and Biases
- Data 4 Black Lives
- The AI Now Institute

Critical Race Theory and Background Readings

- The Master's Tools Will Never Dismantle the Master's House by Audre Lorde (Open Access)
- The New Jim Crow: Mass incarceration in the age of colorblindness by Michelle Alexander
- Women of Color in Tech and/or Futures/Foresight Work
- Introduction: Race and/as Technology; or, How to Do Things to Race by Wendy Hui Kyong Chun (Open Access)
- Critical Race Theory (Third Edition): An Introduction by Richard Delgado, Jean Stefancic, Foreword By Angela Harris

Research Centers

- UCLA Center for Critical Internet Inquiry
- The Center for Critical Race and Digital Studies (CR+DS)
- The IDA B. WELLS Just Data Lab
- AI Now Institute at New York University

EducatorCIRCLS on Artificial Intelligence (AI)

- I'm a Teacher, Will Artificial Intelligence Help Me? by Judi Fusco and Pati Ruiz (Open Access)
- How Can AI Systems Support Teachers: 5 Big Ideas from the Learning Sciences by Pati Ruiz and Judi Fusco (Open Access)
- Reflections on the AI and Learning Environments Webinar: Classroom Orchestration by Sarah Hampton (Open Access)
- Three Visionary Projects Using AI in Education Return to Educator CIRCLS by Sarah Hampton (Open Access)
- AI and Formative Assessment by Sarah Hampton (Open Access)
- AI and the Future of Education by The Educator CIRCLS Team (Open Access)
- Introduction to Artificial Intelligence in Education By Sarah Hampton (Open Access)
- Harnessing Educational Data: Discussing Dr. Safiya Noble's Keynote from Cyberlearning 2019 By Pati Ruiz, Sarah Hampton, Judi Fusco, Amar Abbott, and Angie Kalthoff (Open Access)
- Humanizing AI Research in Education by Broadening Community Engagement by Aditi Mallavarapu (Open Access)
- Educators, Artificial Intelligence, and the Future of Learning Webinar Series By Pati Ruiz and Kip Glazer

Additional High-quality Reading Lists

- AI Ethicist
- All Tech Is Human
- AI Truth

Other Resources

- The Artificial Intelligence Incident Database The AI Incident Database is the only collection of AI deployment harms or near harms across all disciplines, geographies, and use cases. The incident database is managed in a participatory manner by persons and organizations contributing code, research, and broader impacts.

- Teaching: Human-AI Interaction Resources by Iris Howley
- Home – Race, Technology, and Justice – LibGuides at Portland State University by Anders Tobiason

Do you have reading recommendations? Let us know @EducatorCIRCLS.

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Artificial Intelligence and Education: What We're Up To

by Pati Ruiz

I was recently asked for an overview of the AI and Education landscape and how we are participating in it. In addition to promoting equity and accountability in AI, here is a summary of our recent writing and research including key ideas from our work. We believe that AI systems should support and augment, but never replace, a human. To ensure this, emerging technology systems and tools should be developed with the input of educators, learners, and families. As always, please share your thoughts with us @EducatorCIRCLS.

Writing and Presentations

AI and the Future of Teaching and Learning | **A blog series we partnered on with the U.S. Department of Education's Office of Educational Technology**

Key Ideas:

- Educational technology is evolving to include artificial intelligence.
- Artificial intelligence will bring "human-like" features and agency into future technologies.
- Policy will have an important role in guiding the uses of artificial intelligence in education to realize benefits while limiting risks.
- Artificial intelligence will enable students and teachers to interact with technology in human-like ways.
- Individuals will find it difficult to make choices that balance benefits and risks.
- Creating policies can strengthen how people make decisions about artificial intelligence in education.
- Educational applications of many types will be artificial intelligence-enabled, including teaching and learning, guiding and advising, and administration and resource planning applications.
- Use of artificial intelligence systems in school technology is presently light, allowing time for policy to have an impact on safety, equity, and effectiveness.

- Policies should encourage teacher engagement, including the development of teachers' trust, and their confidence to recommend not using untrustworthy artificial intelligence systems.
- Policies should incorporate experiences for educators to shape and support their own professional learning about how to utilize artificial intelligence systems in teaching and learning.
- Including and informing educators in design and development decisions will result in more useful and usable teacher supports.

AI or Intelligence Augmentation for Education? | **Communications of the ACM**

Key Ideas:

- We recommend a focus on intelligence augmentation (IA) in education that would put educators' professional judgment and learners' voice at the center of innovative designs and features.
- An IA system might save an educator administrative time (for example, in grading papers) and support their attention to their students' struggles and needs.
- An IA system might help educators notice when a student is participating less and suggest strategies for engagement, perhaps even based on what worked to engage the student in a related classroom situation.
- We hope that IA for education will focus attention on how human and computational intelligence could come together for the benefit of learners.

Artificial Intelligence 101: Covering the Basics for Educators | **Digital Promise Blog**

Key Ideas:

- AI lets machines make decisions and predictions.
- Teachers are essential to education, and AI should be used to better support them.
- Technology often comes with ethical implications and AI is no different, educators should ask questions and investigate AI tools and systems before they adopt them into a classroom.

Teachers Partnering with Artificial Intelligence: Augmentation and Automation | **Educator CIRCLS Blog**

Key Ideas:

- Artificial intelligence systems are increasingly being deployed in K-12 educational settings and we expect this trend to continue.
- AI systems should support or augment, but never replace, a teacher.
  These systems should be developed with the input of teachers, students, and families.

Artificial Intelligence and Adaptivity to Strengthen Equity in Student Learning | **Getting Smart**

Key Ideas:

- Educators, researchers, and developers prioritize adaptivity when it comes to emerging learning technologies.
- Incorporating AI tools requires specific and precise inputs to generate useful outputs.
- When practitioners, learners, researchers, and developers work together with shared values, more equitable learning is possible.

Ethical AI | **EngageAI Nexus Blog**

Key Ideas:

- Ethical considerations should be front and center throughout the development of any new AI innovation, and ethics should be central to our definition of success for AI.
- Policies and guidelines from the government, accreditation requirements in education, and standards of professional ethics are all needed to reinforce ethics in AI.
- Public education is also important so that end-users can make informed decisions based on a full understanding of key issues such as transparency and privacy.

Definitions | Glossary of Artificial Intelligence Terms for Educators: A glossary written for educators to reference when learning about and using artificial intelligence (AI).

Presentation | Insights on Artificial Intelligence and the Future of Teaching and Learning at the 2023 Consortium for School Network (CoSN) Conference.

Listening Sessions | AI and the Future of Learning: Listening Sessions | We supported the U.S. Department of Education's Office of Educational Technology listening sessions about Artificial Intelligence (AI). We connected with teachers, educational leaders, students, parents, technologists, researchers, and policymakers to gather input, ideas, and engage in conversations that will help the Department shape a vision for AI policy that is inclusive of emerging research and practices while also informed by the opportunities and risks.

Ongoing Research

Emerging technology adoption framework: For PK-12 education | **Educator CIRCLS Emerging Technology Advisory Board**

Key Ideas:

- A framework we co-developed with education community members to help ensure that educational leaders, technology specialists, teachers, students, and families are all part of the evaluation and adoption process for placing emerging technologies (including artificial intelligence and machine learning) in PK-12 classrooms.
- We are currently working with League member Willy Haug, Director of Technology and Innovation to modify this framework for adoption at Menlo Park City School District.

Study | ChatGPT/GPT-4 for Developing Sample Computational Thinking Lesson Plans at North Salem School District

- I am working with Dr. Julio Vazquez, Director of Instruction and Human Resources North Salem School District, who is working with his team to develop sample computational thinking lessons across all subject areas K-12 using ChatGPT. These lessons are not meant to be implemented in the classroom "as is," but rather, these sample lessons are to be used as a first draft, a starting point for consideration and conversation in North Salem. Teachers will vet the lessons for accuracy and then iterate and improve them in order to meet the learning needs of their students. Given the need for high-quality, integrated computational thinking lessons we will continue to work with Dr. Vazquez and his team at North Salem to learn more about how they are integrating ChatGPT in their work and their vetting process.

Artificial Intelligence Practitioner Advisory Board | A group that will explore the use of emerging technologies in classrooms, and how we might leverage technologies to better support educators and their students. We hope to foster a sense of community within the group where researchers and developers can learn along with you as we all go through the process of reviewing technologies and making recommendations on their use. This Practitioner Advisory Board is supported by two NSF projects:

- NSF Project: The Center for Integrative Research in Computing and Learning Sciences (CIRCLS)
- NSF Project: EngageAI Institute
  Related Event: The Inaugural EngageAI Institute Forum: A Reflective Discussion Among Researchers, Educators, and Practitioners

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Regulation of Learning: What is it, and why is it Important?

by Sarah Hampton and Dr. Dalila Dragnić-Cindrić

How many of us want our students to be highly motivated learners?
Proactive? Goal-directed? Strategic? Perseverant? Adaptive? We've heard teachers across subjects and grade bands say that these are difference-making characteristics that students need to be successful in and out of the classroom. In educational research terms, students who demonstrate these qualities are skilled at **regulating** their learning. Researchers have dedicated significant efforts to understanding self-regulated learning skills and the underlying processes. In a series of three blog posts, we take a closer look at regulation of learning, why it matters to students and teachers, and how educators might foster it in classroom settings.

As Timothy Cleary describes in The Self-Regulated Learning Guide (2018), self-regulated learners "want to perform well on some activity" and "purposefully and strategically figure out ways to achieve their goals… despite experiencing challenges, barriers, or struggles, [they] continuously find a way to learn" (pp. 9-10). Interestingly, they do this by repeating three fairly simple phases (Figure 1):

1. **Before the Learning (Preparation Phase)**–self-motivating and figuring out how to approach the task;
2. **During the Learning (Execution Phase)**–maintaining motivation, using strategies to complete the task, and self-monitoring thinking and actions during learning;
3. **After the Learning (Reflection Phase)**–determining how well the selected strategies helped accomplish the task and deciding how to improve next time.

Figure 1. Phases of self-regulated learning.

Note: This figure shows phases of self-regulated learning and steps students can take throughout this cyclical process. Adapted from the original figure The Cycle of Self-Regulated Learning by Karen Kirk from Develop Self-Regulated Learners: Choosing and Using the Best Strategies for the Task. Published under the Creative Commons license.

Self-regulated learning is cyclical and its phases are iterative and loosely sequenced; students might move from one phase to the next or revisit previous phases as needed. Thinking about strategies involves thinking about learning strategies (e.g., ignoring distractions, re-reading task instructions) as well as best content area strategies to use in a given task.

But what do we do when our students aren't particularly skilled in regulating their learning? Can regulation be *learned*? Can regulation be *taught*? *Should* it be taught?

Some learners figure out how to regulate their learning on their own and then go on to do it automatically without much thought. That can lead us to believe that some people just get it and some people don't. However, that kind of fixed mindset thinking isn't accurate. Regulation of learning can be learned and strengthened when people become aware of the principles and processes behind it and consciously reflect on how to do it better. In fact, when learners realize that the strategies they select are directly linked to how successful they are with tasks, they experience greater self-efficacy, motivation, and success on future tasks (Greene, 2018).

Likewise, regulation of learning can be taught when we explicitly talk about it with our students, model it for them, and prompt them to engage in it before, during, and after learning activities in our classes. For example,

a mathematics teacher might ask her students to fill out a task planning sheet before starting a task (Figure 2) to help them prepare for learning.

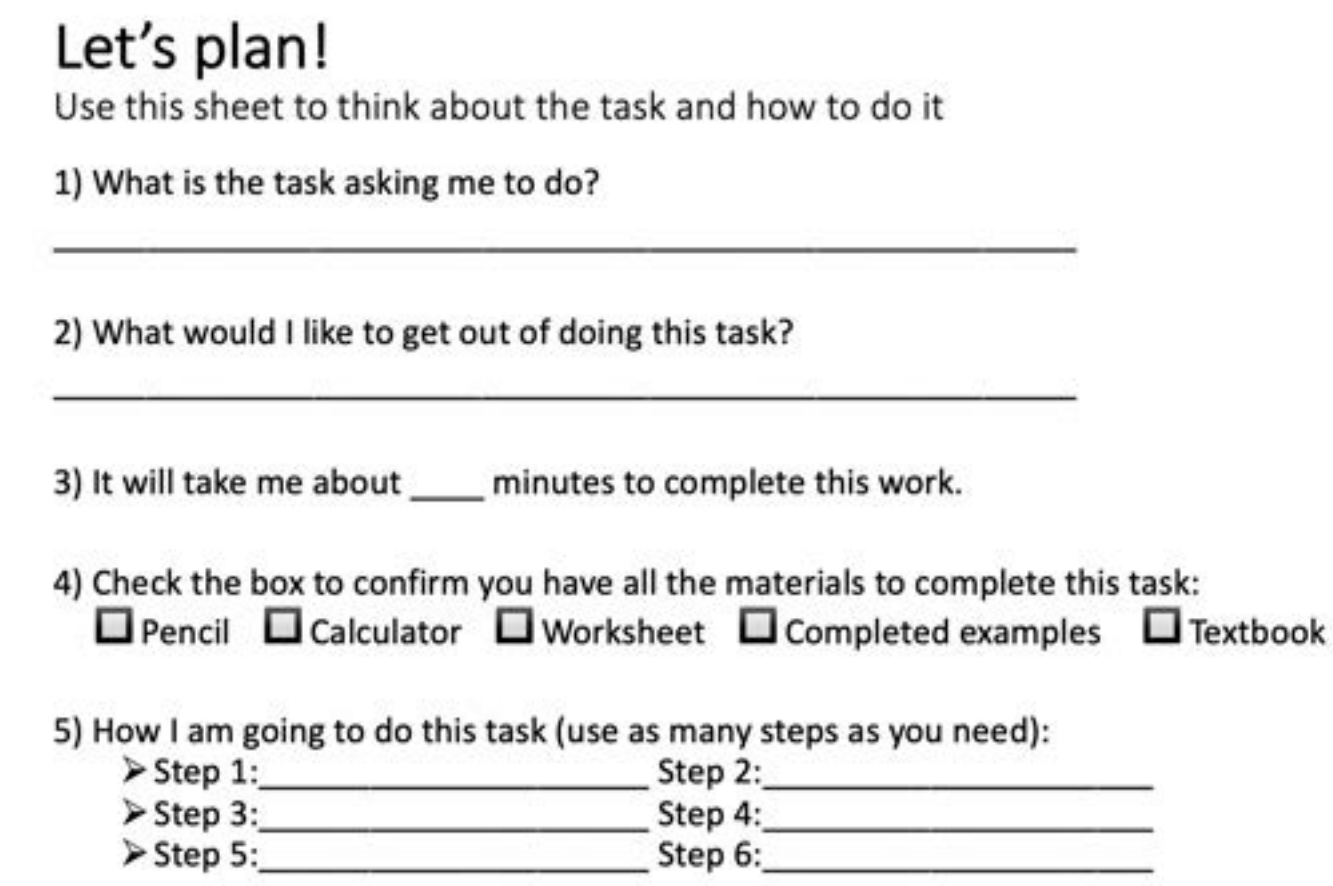

Figure 2. Student task planning sheet by D. Dragnić-Cindrić and S. Hampton

The purpose of engaging students in task planning is to get them to think about the task and their own goals for it, which might differ from the teacher's goals. It connects the doing of the task to the time the teacher allotted for it and the materials students will need to use to get it done. Lastly, it leads the students to think about and plan the steps needed to complete the task beforehand. Of course, this plan is a starting point and should remain flexible as students work through the task. The idea behind scaffolds like this planning sheet is that they help students internalize and learn how to engage in self-regulated learning, and over time, begin to do it on their own in other classes.

So regulation can be learned and taught, but should it? In our conversations on this topic, we relied on our combined expertise, Sarah, as a practitioner and teacher coach with 15 years of experience, and Dalila, as a learning scientist, who studies individual and group regulation of learning. During our conversation, we discussed current regulation of learning literature, Dalila's own research findings, and Sarah's deep knowledge of classroom contexts. We concluded that teaching regulation is so important because, immediately, it helps students see what they do in the classroom as something they do for themselves vs. something they do for

the teacher, parents, school, etc., and, ultimately, it prepares students for success in any career path. **The bottom line is that regulation empowers students and prepares them for life.**

> Everyone is going to encounter a difficult moment, an exceptional challenge, and regulation is critical in that moment. Regulation of learning strategies are for everyone. Even if you don't need them today, I promise you, a day will come when you'll need them. – Dalila Dragnić-Cindrić

In addition to the benefits for students, an upfront investment in teaching regulation of learning returns dividends for teachers, too. Imagine having a classroom full of students who are active and confident self-regulated learners rather than passive recipients of knowledge. Some of the time you currently spend motivating learners and managing your classroom could be repurposed for more personalized instruction as students begin diagnosing their own learning barriers and requesting specific kinds of help. Teaching regulation of learning alleviates teachers of the sole responsibility for ensuring students' progress, while equipping students to assume more ownership of their learning success.

Research supports what we intuitively know–helping students learn to be highly motivated, proactive, goal-directed, strategic, perseverant, adaptive learners is a game changer for them, and we can accomplish it by explicitly teaching and modeling regulation of learning skills. Because the benefits transcend subject areas and career paths, we would argue that teaching regulation is even more important than teaching subject specific content. Thankfully, teaching content and regulation of learning together is the best way to teach them both.

In the coming blog posts within this series, we'll explore some barriers and potential solutions for teaching regulation of learning in our classrooms. We'll also discuss regulation of learning in collaborative groups (i.e., social regulation of learning) and hear more from Dalila about her research on this topic and from Sarah about her experiences with managing collaborative groups in her math and science classrooms. Together we will offer insights and recommendations for educators.

Do you think it's important to explicitly teach regulation of learning? Why or why not? If you're already teaching it, let us know your favorite strategies by tweeting @EducatorCIRCLS!

Resources

Cleary, T. J. (2018). *The self-regulated learning guide: Teaching students to think in the language of strategies*. Routledge. https://doi.org/10.4324/9781315693378

Greene, J. A. (2018). *Self-regulation in education*. Routledge. https://doi.org/10.4324/9781315537450

Kirk, K. (n.d.) *The cycle of self-regulated learning*. [Figure]. The Supporting and Advancing Geoscience Education at Two-Year Colleges (SAGE 2YC) project website. Retrieved July 13, 2023, from https://serc.carleton.edu/sage2yc/self_regulated/index.html

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Social Regulation of Learning and Insights for Educators

by Sarah Hampton and Dr. Dalila Dragnić-Cindrić

In the first post of this series (Hampton & Dragnić-Cindrić, 2023), we focused primarily on individual student's self-regulated learning (SRL), explained the related key terms and ideas, and discussed why it is important to teach SRL alongside subject content. In this post, we will focus on regulation of learning in small, collaborative groups.

Social regulation of learning (SoRL) occurs when students in collaborative groups purposefully select, use, and, if necessary, adjust their collective actions and behaviors to achieve shared learning goals (Hadwin et al., 2018). Navigating group dynamics and collaborating well are skills all students need. SoRL is an essential prerequisite for successful collaboration (Dragnić-Cindrić & Greene, 2021).

Social regulation of learning (Figure 1) unfolds through the same three loose phases of learning as SRL (i.e., preparation, execution, reflection), and it has the added complexity of coordinating with others. Collaborative groups enact their SoRL by relying on one or more of the following modes of regulation: *self-regulated learning* (SRL), *coregulated learning* (CoRL), and *socially-shared regulation of learning* (SSRL).

These three modes of regulation vary in their focus:

- SRL focuses on what "I" do within the group related to my own learning;
- CoRL focuses on what "you" do and how I can temporarily help you with your regulation; and
- SSRL focuses on what "we" do together to propel joint learning.

CoRL occurs when one group member temporarily supports one or more others in the group, with the goal of eventually transitioning regulation of learning to the regulated student(s). For example, if a student is repeatedly distracted by looking at another group, a teammate might prompt them a few times to pay attention to their own group. After a few prompts, the "regulated" student might decide to switch seats to fully engage with the group and avoid further disruption.

SSRL is characterized by the equal and balanced participation of all group members in the group's regulation of learning. During SSRL, group members build on each other's actions and statements to create synergistic

outcomes.

Figure 1. Social regulation of learning infographic

Note: This graphic shows a three-person collaborative group engaging in social regulation of learning. The group first plans how to do the task. Then, they attempt to execute their plan and fail. They reflect on what went wrong and what they needed to change. Finally, they try again and achieve their goal.

When you consider all the ways learners must regulate during group work—self, others, and each other—it's not surprising that successful collaboration can be challenging. Importantly, students don't have to regulate their learning all the time. In fact, when students are satisfied with their learning progress, there is no need to regulate. Typically, regulation unfolds as a response to an encountered challenge. For example, some group members might lose their motivation for the task and want to quit. Other group members might need to actively encourage them and point out the progress the group made so far to get them to re-engage.

Most of what we've discussed so far has been about what students in the group are doing to regulate their own learning. It is also possible that someone outside the group—the teacher or even a student from another group—might need to help with the group's regulation of learning. This is called *external regulation of learning*. For example, a teacher may decide to step in if a group is engaging in excessive off-task behavior or if they are repeatedly trying an ineffective learning strategy.

Such an intervention involves trade-offs between the teacher's control over the group's learning and allowing adequate space and time for the students to learn how to socially regulate their own learning (Dragnić-Cindić et al., 2023). Think of it like this— when a child first learns to tie shoelaces, it's clumsy and time-consuming and requires multiple tries with some help. It would be much faster if a parent tied them instead. However, if the parent repeatedly makes the choice to step in and tie the child's shoelaces, then the child never has the opportunity to learn. Given enough space and time, the child eventually learns to tie them quickly, and the parent never has to intervene again. Similarly, the teacher's job is to discern when and how to offer the least assistance possible to help students grow in SRL, CoRL, and SSRL and recognize which mode of regulation is the most appropriate in a given situation.

The quality of a group's regulation of learning is closely connected to the *group climate* (Dragnić-Cindrić & Greene, 2021), a persistent pattern of group members' interactions, emotions, and behaviors that remains stable over time. Successful groups tend to have a positive group climate characterized by positive interactions. For example, group members praise each others' ideas, offer encouragement when mistakes are made, and joke and laugh together. It is important to establish a positive climate from the first collaborative session, and clear group norms and teacher modeling of desired interactions can help with that. Teachers should step in when off-task or negative behaviors hurt the group climate or even the classroom culture in ways that make growth unlikely.

In other words, rather than managing students directly, teachers should manage the classroom conditions that allow students to manage their own learning. We include research-based teachers' moves in the table below (Table 1).

Table 1. Research-based recommendations for teachers

Research Finding	What It Means for Teachers	Teacher Moves
Groups' regulative skills improve over time.	If we want students to learn how to work well in groups and regulate their own learning, we have to give them **opportunities to practice**.	• Identify where collaborative learning activities work best in each unit and plan for multiple collaborative opportunities throughout the year. • Keep students in the same groups over several collaborative sessions so they can continue building on regulation of learning skills without starting over with new group dynamics each time. • Phase out support as the groups' regulation of learning improves.

Groups with a positive group climate tend to engage in more high-quality regulation of learning than groups with a negative climate.	Students don't automatically know how to work well in groups. We have to set and reinforce expectations for **positive interactions** as a part of our classroom cultures.	• Establish collaborative norms and nurture positive interactions from the first collaborative engagement. Set clear expectations for group work up front, such as:
		  • You're expected to become a more patient listener.
		  • You're expected to share the workload equitably.
		  • You're expected to run into challenges and manage frustrations productively.
		  • You're expected to reflect on how you did as a group and how you can improve next time.
		• Model specific words and actions group members can use to diffuse difficult interactions.
		• Occasionally prompt students to reflect on their group interactions using a rubric and brainstorm how to improve.

Group-level regulation of learning unfolds as a response to the challenges faced during collaborative sessions.	Our ability to recognize challenges that require group-level regulation of learning is key to providing a thoughtful and measured level of support **when** needed.	• When a challenge arises, if needed, prompt students to monitor and control their responses to it. • At the end of each collaborative session, prompt groups to engage in both individual and joint reflection on what did and did not go well for them during group work to help them learn and internalize effective SoRL skills.
The teacher's expectations and level of involvement influence how the group responds to the encountered challenges.	**Why, how, and how much** we intervene during group work influences how quickly groups learn to regulate their own learning. In general, we need to gradually release control to our students.	• Be explicit about the goals of the group work. Clearly state content learning objectives and regulation of learning objectives for the activity. • Teach and model SoRL knowledge, skills, and dispositions. For example, goal setting, progress monitoring, attention focusing, frustration management, teammate leveraging, etc. • Provide specific feedback on SoRL skills so students can improve more efficiently. This could be done verbally while visiting groups or more formally using a rubric. • During collaborative activities, intervene as often as needed but as little as possible. Model regulation but do not regulate learning for the group except in a just-in-time, as-needed manner.

In the final blog post of this series, we'll explore some barriers and potential solutions for teaching regulation of learning in our classrooms. Meanwhile, we would love to hear from you. Are you already incorporating some teacher moves that facilitate regulation of learning in your classroom? If so, which ones? If not, which moves could you implement easily? Let us know by engaging with us on social media @EducatorCIRCLS!

Suggested citation format: Hampton, S., & Dragnić-Cindrić, D. (2023). *Social Regulation of Learning and Insights for Educators.* Educator CIRCLS Blog. Retrieved from https://circls.org/educatorcircls/social-regulation-of-learning-and-insights-for-educators

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Resources

Dragnić-Cindrić, D., & Greene, J. A. (2021). *Social regulation of learning as a base for successful collaboration.* (Rapid Community Report Series). Digital Promise, International Society of the Learning Sciences, and the Center for Integrative Research in Computing and Learning Sciences. https://repository.isls.org//handle/1/6854

Dragnić-Cindrić, D., Lobczowski, N. G., Greene, J. A., & Murphy, P. K. (2023). Exploring the teacher's role in discourse and social regulation of learning: Insights from collaborative sessions in high-school physics classrooms. *Cognition and Instruction*, 1-32. https://doi.org/10.1080/07370008.2023.2266847

Hadwin, A. F., Järvelä, S., & Miller, M. (2018). Self-regulation, co-regulation, and shared regulation in collaborative learning environments. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 83–105). Routledge.

Hampton S., & Dragnić-Cindrić, D. (2023). Regulation of learning: What is it, and why is it important? *Center for Integrative Research in Computing and Learning Sciences.* https://circls.org/educatorcircls/regulation-of-learning-what-is-it-and-why-is-it-important

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Overcoming Barriers to Teaching Regulation of Learning

by Sarah Hampton and Dr. Dalila Dragnić-Cindrić

Photo by Allison Shelley for EDUimages

In our two previous blog posts, we talked about students' individual self-regulated learning (SRL), group-level, social regulation of learning (SoRL), and why it's important to explicitly teach both alongside our content (Hampton & Dragnić-Cindrić, 2023a, 2023b). The link between students' effective self-regulated learning and successful academic and life outcomes has been well documented (Dent & Koenka, 2016). If that's the case, and if we know the benefits, why don't more teachers focus on teaching it?

In this post, we will explore some of the barriers and possible solutions for teaching regulation of learning that we have seen in K-12 and higher education classrooms. Importantly, some of the barriers that surfaced during our conversations are within a teacher's control, and others are not (e.g., district or state policies). In the spirit of teacher empowerment, this post focuses on the barriers and solutions within teachers' control.

Barrier 1: Comprehensive instruction of SRL and or SoRL requires the teacher to give up control, an uncomfortable idea for many of us.

Suggested Solution: Gradually but steadily release control of learning to the students, making them responsible for their own learning.

Elaboration: If we want students to take more responsibility for their own learning, then we must give responsibility back to them. Doing so gradually but steadily can help teachers overcome their own discomfort with releasing control as well as ease students into new, more active roles in their own learning.

In a recent study conducted in high school physics classrooms, Dalila and colleagues showed that the level of teachers' control over collaborative groups' dialogues impacted groups' SoRL. Students in groups in which

the teacher controlled the conversation engaged in less conversation with each other and enacted less SoRL (Dragnić-Cindrić et al., 2023).

For Sarah, our conversation about this study led to a somewhat sobering realization. As a reflective practitioner, she said, “I realized that I had been robbing my students of taking more responsibility for their learning because I was holding onto so much of it. In an effort to maximize our learning minutes, head off classroom disruptions at the pass, and ensure successful learning outcomes, I have hoarded control of my students’ learning experiences.”

If we want students to take more ownership, we must shift more control over learning back to them. Gradual release of control means providing more support and guidance at the beginning, then fading the support as students demonstrate increased capability to manage their own learning. During our conversations on this topic, Sarah said her “aha” moment came when Dalila pointed out that regulation happens whether a teacher acknowledges it or not. “You’re modeling regulation whether you’re intentional about it or not. You’re either modeling good examples or bad examples. It’s about taking advantage of the opportunity to help students learn how to regulate their learning individually and with others.”

That leads us to the next barrier…

Barrier 2: Teachers may not be sure how to teach regulation of learning.

Suggested Solution: To teach regulation of learning, include both modeling and direct instruction of regulation of learning.

Elaboration: As teachers, we have made a career in education and are most likely effective at regulating our own learning. We have probably automated many regulation strategies and don’t even need to think about them, which can make it difficult to understand the perspective of students who find learning how to learn challenging. Because we haven’t had to explicitly think about regulation to navigate learning challenges in our own lives, we may not know how to model and explicitly articulate learning strategies to our students.

Additionally, most teacher preparation programs do not include courses on how to teach regulation of learning. We also recognize that teachers with many demands on their time don’t have the luxury of independently learning about best practices for teaching regulation and developing worksheets, prompts, reflections, etc., to help their students with regulation of learning. Still, there are some steps that can be taken to improve students’ regulation of learning through modeling and direct instruction (Paris & Paris, 2001).

1. Reflect on your own learning strategies and take time to model them for your students. Narrate your own thought processes and explain how you approach and solve problems. Learn more about regulation of learning and how to teach it. We gave a brief overview in the first post of the series, but we have included

more teacher-friendly resources in the Additional Resources section below. For a self-paced professional learning experience, you might like the “Self-regulation professional development module” by the Students at the Center Hub.

2. Explicitly teach students effective regulation of learning and learning strategies you’re already familiar with, such as:

- Modify your learning environment and structure study time: Studying is more effective if you eliminate distractions and study in short time intervals followed by brief breaks. Put your phone away and engage in a focused 15-minute study session followed by a 5-minute break (Yes, this is the time to check that phone!)
- Summarize text and tell someone about it: When studying new material, an effective approach is to read the text and then write a summary of the main points or tell someone else, a friend or a family member, about it. Go into details as much as you can. If there are things you cannot recall, that’s a sign you might want to read that part again. Many students rely exclusively on text highlighting and re-reading. These strategies are ineffective because they create “illusions of knowing,” a false sense that you have learned the material.
- Quiz yourself to memorize new words or concepts: In subjects where memorizing content is needed (e.g., studying vocabulary), quizzing works! Quiz yourself and ask others to quiz you.
- Seek help when you get stuck: It is okay to ask for help, and smart students do! If you are stuck, ask others to explain how they approach similar problems. Show your teacher your work and walk them through it — they will be happy to help you identify the rough spots and help you work through them.

We provide links to the additional learning strategy resources below.

Barrier 3: From a short-term perspective, teaching regulation of learning feels like a less valuable use of time than teaching content.

Suggested Solution: Embrace teaching regulation of learning as an inextricable part of teaching your content’s process standards. In other words, part of the standards we’re expected to teach requires students to engage in regulation of learning (see examples below).

Elaboration: Regulation of learning isn’t directly assessed, so when it comes to spending 10 minutes of class time, teachers are likely to choose learning content over learning how to learn. However, hyperfocusing on content standards over process standards is more short-sighted than short-term. The research suggests that teaching regulation will pay content learning dividends in a single school year (Dignath & Büttner, 2008). Beyond that, learning how to navigate challenges and find a way to learn alone and together will benefit learners their entire lives.

Many school districts are adopting big-picture mission statements and portraits of a graduate. Most have a line about creating self-sufficient lifelong learners. Teaching regulation of learning is a critically important way to spend your class time. Justify that time (to yourself and others!) using your existing state and national standards and school, district, and/or state mission statements. Here are some examples:

The National Council of Teachers of Mathematics (NCTM) problem-solving process standards call for teachers to:

- Allow students to apply and adapt a variety of appropriate strategies to solve problems
- Allow students to monitor and reflect on their own and others' strategies for solving problems

The National Council for Teachers of English calls for students to:

- Participate as knowledgeable, reflective, creative, and critical members of a variety of literacy communities.

The National Science Teaching Association (NSTA) emphasizes that:

- Learning is an active, constructive process, and not a receptive one;
- High quality science, engineering, mathematics, and technology education fosters students' 21st-century skills of collaboration, problem solving, communication, and creative thinking;

North Carolina Department of Public Instruction's "A Portrait of a Graduate" emphasizes that in addition to academic content, schools must be more intentional about fostering durable skills critical for students' success, including learner's mindset, personal responsibility, and collaboration.

These are a few of the challenges we have identified. What other barriers prevent you or your colleagues from teaching regulation of learning? How have you navigated these challenges in your classroom? We would love to hear your thoughts — tweet us at @EducatorCIRCLS!

References

Dent, A.L., & Koenka, A.C. (2016). The Relation Between Self-Regulated Learning and Academic Achievement Across Childhood and Adolescence: A Meta-Analysis. *Educational Psychology Review*, **28**, 425–474. https://doi.org/10.1007/s10648-015-9320-8

Dignath, C. & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning*, 3, 231–264. https://doi.org/10.1007/s11409-008-9029-x.

Dragnić-Cindrić, D., Lobczowski, N. G., Greene, J. A., & Murphy, P. K. (2023). Exploring the teacher's role in discourse and social regulation of learning: Insights from collaborative sessions in high-school physics classrooms. *Cognition and Instruction,* 1–32. https://doi.org/10.1080/07370008.2023.2266847

Hampton S., & Dragnić-Cindrić, D. (2023a). Regulation of learning: What is it, and why is it important? *Center for Integrative Research in Computing and Learning Sciences.* https://circls.org/educatorcircls/regulation-of-learning-what-is-it-and-why-is-it-important

Hampton S., & Dragnić-Cindrić, D. (2023b). Social Regulation of Learning and Insights for Educators. *Center for Integrative Research in Computing and Learning Sciences.* https://circls.org/educatorcircls/regulation-of-learning-what-is-it-and-why-is-it-important

North Carolina Department of Public Instruction. (n.d.). Portrait of a graduate. https://www.dpi.nc.gov/districts-schools/operation-polaris/portrait-graduate#Tab-DurableSkills-4800

Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist, 36*(2), 89–101. https://doi.org/10.1207/S15326985EP3602_4

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Additional Resources:

Elaboration | How Expanding On Ideas Increase Outcomes | Science of Learning Series
Interleaving | Mixed up Practice | Science of Learning Series
Self-regulated learning: The technique smart students use.
Spacing | Revisit Material To Boost Outcomes | Science of Learning Series
Teacher Support of Co- and Socially-Shared Regulation of Learning in Middle School Mathematics Classrooms

CRAFTing Better Learning Experiences: Infusing GenAI in Education Effectively and Ethically

CRAFT Framework by Andrew Fenstermaker, Drew Olsson and Sarah Hampton

by Andrew Fenstermaker, Drew Olsson, and Sarah Hampton

Introduction

Generative artificial intelligence (GenAI) stands to be a disruptive technology in education and all facets of our daily life. While this technology offers significant advantages for teaching and learning, it hinders the process when used without a full understanding of how the technology works and how to evaluate the content generated. The educator must remain the expert, advocate, arbiter, human in the loop identifying why and when the technology gets used, and the critical evaluator to uphold the best of our human ideals.

CRAFT Framework Overview

Using GenAI to augment the lesson design process can seem overwhelming. From composing and revising prompts to evaluating the outputs, integrating GenAI requires a new set of literacy skills. CRAFT was collaboratively designed by Andrew Fenstermaker, Drew Olsson, and Sarah Hampton and augmented using GenAI. The framework serves as a step-by-step roadmap that scaffolds the process of infusing GenAI with the learning sciences to improve learning experiences ethically.

1. Create

The first step in the framework is to *create* a lesson plan using GenAI prompting that is grounded in learning sciences based on a specific standard, age group or grade level, and time frame. Often, we start with a basic prompt providing no persona or context for GenAI to use in its algorithm as it generates the output. As you can see in this example of generating a lesson plan on the main idea, the chatbot makes inferences about the grade level being taught, length of time, and materials available. The chatbot is simply following its algorithm to predict the next word in its sequence of constructing a complete lesson plan.

Giving a chatbot a persona, such as an expert teacher, and providing more details up front can enhance its recommendations. Reviewing the output from the Detailed Prompt example, you will see that the targeted grade level, specific standard, and length of time are now tailored to our prompt. We can improve the outputs further by including a request for evidence-based best education practices from learning sciences research up front. Therefore, the goal of the create step in the CRAFT framework is to underpin a detailed prompt with learning sciences.

Basic Prompt	Detailed Prompt	Detailed + learning sciences + Chain-of-Thought Prompts
No persona assigned to chatbot.	Persona assigned to chatbot. *(ex. You are an expert third grade teacher.)*	Persona assigned to chatbot as well underpinning the lesson design in learning sciences. *(ex. You are an expert third grade teacher. Provide an evidence-based way grounded in learning sciences to teach…)*
Little context provided	Context provided including, but not limited to: - Standard - Age group - Time frame	Context provided including, but not limited to: - Standard - Age group - Time frame
	No chain-of-thought prompting used to refine output	Chain-of-thought prompting leveraged to further refine and enhance the learning experience.

In addition, the results from the prompt with learning sciences can be optimized using chain-of-thought prompting. Chain-of-thought prompting is a technique that allows us to take a complex task and decompose it into a series of logical steps to increase the performance of the large language model (chatbot). As you explore the Detailed Prompt + learning sciences + Chain-of-Thought prompts, you will see that a series of 11 chain-of-thought prompts were used to continually refine the output. Decomposition methods were used as we broke our complex task into smaller chunks, from identifying effect size and selecting an evidence-based learning strategy to incorporating elements aligned with student interests and crafting sentence starters to scaffold the process for students.

2. Review

Advancements in GenAI capabilities and detailed prompting strategies may lull the user in "falling asleep at the wheel." That is, over-relying on outputs without going through the process of refining its outputs for a given context with intentional consideration. The CARE framework is designed to critically evaluate each output for ***Clarity***, ***Accuracy***, ***Relevance***, and ***Ethics***.

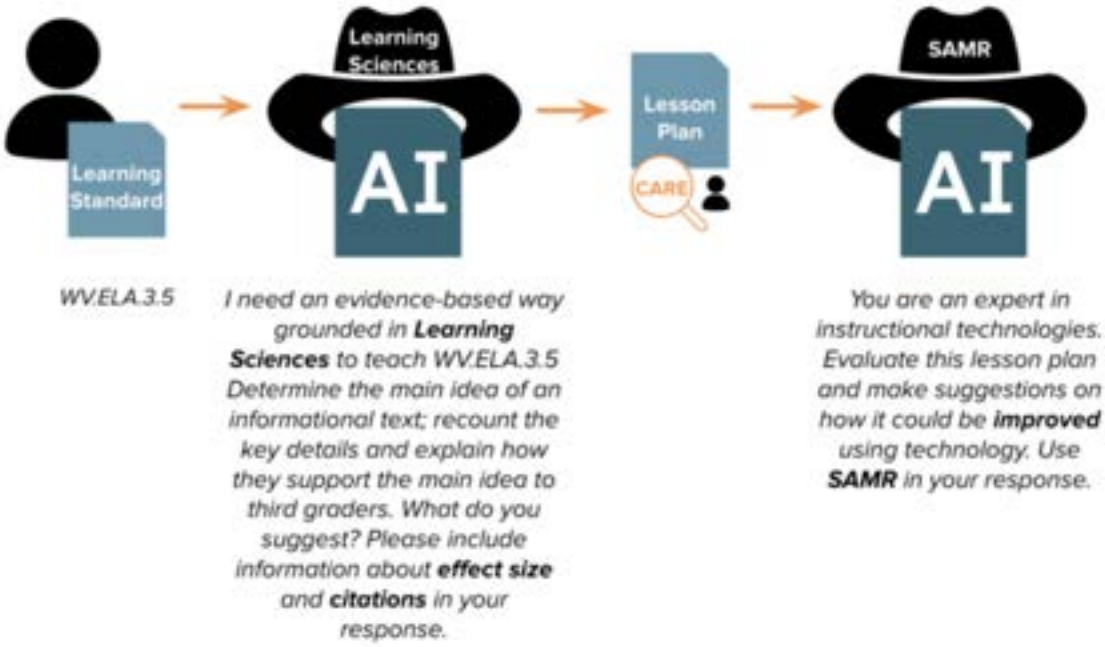
- ***Clarity***– A lack of clarity in GenAI output might mean the output is not appropriate for a given audience such as overly wordy sentences for a 5th grade class.
- ***Accuracy***– It is well known that AI makes things up, from citing studies that never existed to stating facts there are blatantly false. It is up to the user to fact check GenAI outputs so that misinformation is not shared in a classroom setting.

- ***Relevance***– Often, an AI's first output will not generate a response that matches the intent of the input given. Continue refining your prompts until the output fits your needs.
- ***Ethics***– GenAI is trained on biased data and can be racist. Inspecting outputs for possible stereotypical depictions or biased results is imperative to uphold integrity and respect for all.

3. Amplify

Once we have reviewed our lesson plan grounded in learning sciences using the CARE framework, we are ready for the Amplify stage of CRAFT. The recent National Ed Tech Plan highlights three different divides with instructional technology: Access, Design and Use. The COVID-19 pandemic sparked a rapid influx of instructional technology, decreasing the access divide but exposing prominent divides in how teachers were designing digital learning as well as how students were using the digital tools and resources.

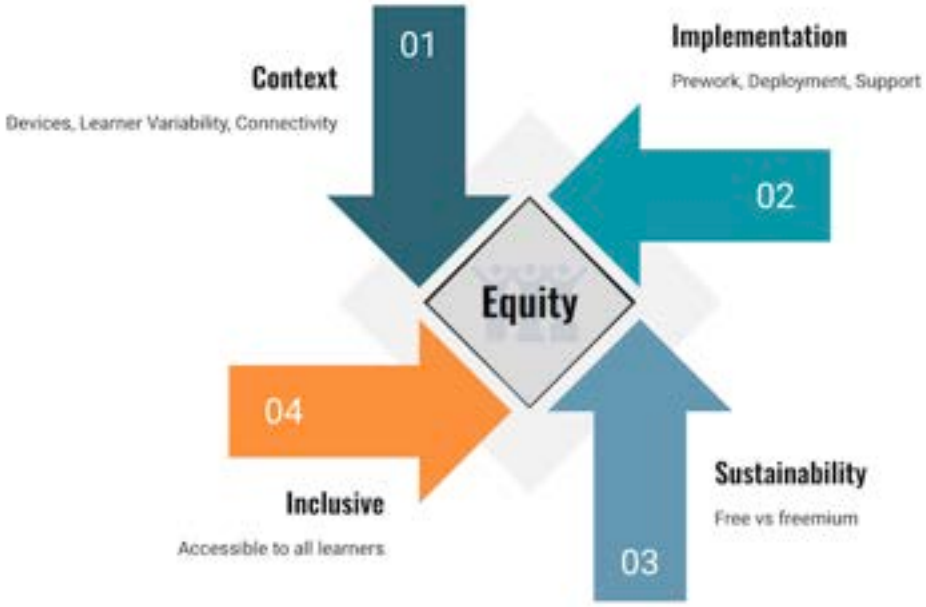
The *amplify* stage fosters opportunities for teachers to work towards minimizing the Design and Use divides by using GenAI prompts centered around the SAMR (substitution, augmentation, modification, redefinition) model. The graphic below illustrates the progression from beginning with a standard, using chain-of-thought prompting grounded in learning sciences, reviewing with the CARE framework, and concluding with instructional technology enhancements through the SAMR model.



As outlined before, we continue to use chain-of-thought prompting to further refine our outputs. Within our amplified SAMR lesson plan, you can see that the additional prompts help refocus the large language model (chatbot) when the algorithm deviates from our original vision and allow us to select the specific level(s) of SAMR we wish to incorporate within our final lesson. Just as we did before, we must leverage the review stage to critically evaluate the outputs using the CARE framework.

4. Fine-tune

Leveraging the *fine-tune* stage allows us to ensure that our lesson is both effective and equitable by carefully evaluating the integration of instructional technology. This includes considering the context of use, implementation strategies, sustainability factors, and inclusivity for all learners. By focusing on these key areas, we can enhance the technology's impact and ensure it aligns with our pedagogical goals.



5. Transform

The final stage of the CRAFT framework does not require additional prompting or reviewing of outputs. Instead, by implementing the filtered enhancements, teachers transform the learning experience, making it more engaging, interactive, and effective for their students.

Conclusion and Call to Action

As GenAI continues to evolve, it is essential for educators to remain the experts in their classrooms and use technology as a tool to enhance, not dictate, their practices. We encourage you to employ the CRAFT Framework to center students in the learning design process. It is through the intentional underpinning of learning sciences that we can remove barriers to create rich learning experiences for all students.

Resources

Link to PDF of CRAFT (two pager)

About the Authors

Andrew Fenstermaker is the Instructional Technology Coordinator for the Iowa City School District. A perpetual learner who infused emerging technologies into his own classroom for ten years now works to empower educators through dynamic professional development, one-on-one coaching, and innovative lesson design that centers students and removes barriers to success. He is a Google Certified Coach and Innovator, leading efforts locally and nationally on adopting and scaling computational thinking and AI in education while sharing key deliverables through presentations and publications.

Drew Olsson is the Technology Integration Coordinator for the Agua Fria High School District. An advocate for staff and student AI Integration, mindful EdTech implementation, and building tech literacy for all. He taught math and computer science for 9 years before moving into his current role where he services 5 comprehensive high schools and over 10,000 students. He is invested in providing powerful learning opportunities for all students so that they may thrive in an increasingly techno-centric world. Drew holds Master's Degrees in Secondary Education and Educational Leadership from Arizona State University.

Sarah Hampton is a Technology and Curriculum Specialist for the Greenbrier County School District specializing in secondary math education. Prior to her current role, she brought passion for evidence-based instructional strategies and thoughtful technology integration to her middle and high school math and science classrooms. A veteran educator of 15+ years, Sarah works to bring the benefits of education research to more students through embedded professional development in her district and through collaboration with researchers and educators at the Center for Integrative Research in Computing and Learning Sciences.

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Navigating Ethical AI: Empowering Educators with Tools, Frameworks, and Critical Perspectives

by Marlon Matilla

Photo of CRAFT Ethical Engine card game designed by Marlon Matilla

The Navigating Ethical AI: Interactive Lessons and Equitable Practices for Educators webinar serves as a microcosm of the broader challenges and opportunities that artificial intelligence (AI) presents in the educational landscape. The session brought together educators to explore the ethical implications of integrating AI into classrooms, highlighting the intersection between technological innovation and pedagogical responsibility.

The Ethical Imperative in AI Education

Central to the discussion was the need for educators to critically engage with AI, not just as a tool but as a complex system with far-reaching implications. Dr. Kip Glazer, principal at Mountain View High School, emphasized that understanding the technical distinctions between different types of AI—such as generative and supervised AI—is crucial for educators (see *Ethical Use of AI – Privileging measured and deliberate thinking*, for further thoughts from Dr. Glazer). This technical literacy forms the foundation for ethical decision-making, as educators must navigate the biases inherent in AI systems and their potential impact on students and teaching practices. The dialogue in the session reflects a growing recognition that AI's role in education is not neutral; it is laden with ethical considerations that educators must address proactively.

Practical Engagement with AI Ethics

Assistant professor Dr. Victoria Delaney introduced the Stanford Classroom-Ready Resources About AI for Teaching (CRAFT) project, which exemplifies how these ethical considerations can be translated into classroom practice. By developing adaptable AI literacy resources, the CRAFT initiative seeks to empower teachers to integrate AI education in a way that is both practical and responsive to the needs of diverse student populations. The project underscores the importance of flexibility and customization in educational resources, recognizing that teachers must be able to tailor AI lessons to their specific classroom contexts.

This approach is further exemplified by my CRAFT *Ethical Engine* card game, a tool I designed to foster critical thinking and ethical reasoning among students. This game moves beyond theoretical discussions, offering a hands-on way for students to grapple with the real-world implications of AI. Through scenarios like AI in law enforcement or AI-controlled military drones, the game prompts students to consider both the benefits and risks of AI technologies, thereby cultivating a more nuanced understanding of AI ethics.

Collective Responsibility and Advocacy

The session also highlighted the collective responsibility of educators to advocate for ethical AI practices. The Educator Bill of Rights, discussed by Dr. Kip Glazer, is a testament to this advocacy. It asserts the rights of educators to have a say in the AI tools introduced into their work environments and emphasizes the need for transparency and equity in AI implementation. This document not only empowers educators to protect their professional autonomy but also ensures that AI adoption in schools does not exacerbate existing inequalities or undermine educational goals.

The session's exploration of these themes reflects a broader narrative within education: the need for a critical, reflective approach to technology. As AI becomes increasingly integrated into classrooms, educators are not just passive recipients of these tools; they are active participants in shaping how AI is used and understood in educational settings. This requires a deep engagement with the ethical dimensions of AI, as well as a commitment to advocating for practices that are fair, transparent, and aligned with educational values.

Engaging Educators in Discussion

The CRAFT Ethical Engine card game resource presented in the session and the Educator Bill of Rights can serve as starting points for bringing educators and students into conversations about ethical issues. As the presenters emphasized in this webinar, it is important to empower educators to think critically about how to safeguard against the ethical pitfalls that these technologies can produce and bring awareness to students about potential issues.

A Unified Perspective on AI in Education

Synthesizing the insights from the session reveals a unified perspective on the role of AI in education: It is a powerful tool that holds both promise and peril. The session participants collectively underscore that the successful integration of AI into education hinges on the ability of educators to critically assess and ethically navigate these technologies. Furthermore, our conversations with educators illustrate the necessity of an ethical framework for AI in education, one that is informed by a deep understanding of the technology and a commitment to equity and fairness. It is my hope that this synthesis of ideas and the resources shared can provide guidance for educators who are navigating the complex landscape of AI. Educators need more

resources to ensure they are equipped to make informed, ethical decisions that benefit both their students and the broader educational community.

About the Author

Marlon Matilla is an educator dedicated to advancing data-driven and technology-focused learning in K-12 STEM education. Since 2015, he has taught mathematics, computer science, and cybersecurity with a strong emphasis on hands-on learning. As a CIRCLS Educator Fellow, he has contributed to AI education initiatives, including the co-design of ethical AI resources through Stanford's CRAFT Fellowship. His recent publication, *Optimizing Breakfast Choices: Leveraging Data Analytics in Packaged Foods for Informed Student Nutrition Decisions*, supported by the University of Arkansas' NSF-funded Data Analytics Teacher Alliance RET program, is published in the ASEE Professional Engineering Education Repository. Committed to merging research with practice, Marlon (aka Matt) aims to continue as a researcher-educator, fostering data literacy and ethical AI technology use in education.

Ethical Use of AI – Privileging measured and deliberate thinking

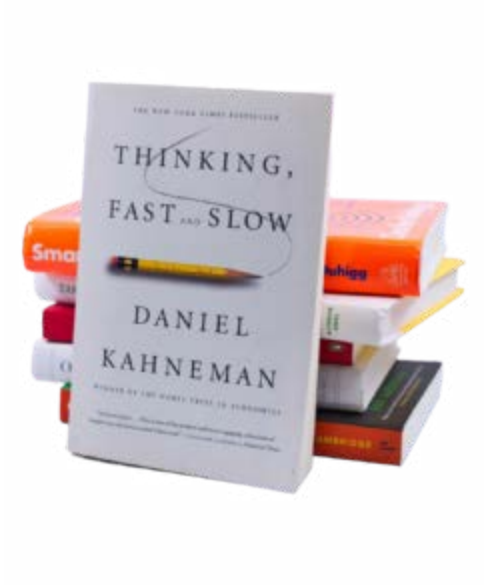

Photo by Ahmed Almakhzanji on Unsplash

by Kip Glazer

As a school leader and
educator, I am deeply committed to promoting the ethical use of artificial intelligence (AI), a responsibility that we all share as AI-embedded tools become increasingly prevalent in our school systems. I strongly advocate using interactive methods, such as leveraging games to engage learners and educators in these crucial discussions (featured in this blog post by Marlon Matilla). I believe that the active participation of both researchers and practitioners is essential, and I am proud to have contributed to this vital discussion by being a part of the Educator CIRCLS community over the years.

As I think about the ethical use of AI, I can't help but think about the design of the AI system and how it nudges the users to behave. In his book *Thinking Fast and Slow*, Daniel Kahneman argues that humans have System 1 thinking that reacts quickly and instinctively, while System 2 thinking reacts more slowly and deliberately. Unfortunately, our System 1 thinking (aka impulses) often overrides our System 2 thinking when making decisions, and many companies have used this to maximize profit at the expense of the consumers. As much as technology companies tout the usefulness of AI systems, I am concerned that the rapid spread of AI is amplifying the functions of System 1 thinking at the expense of System 2 thinking. Because AI prioritizes speed and volume (similar to System 1 thinking) over quality based on careful deliberation (which is the hallmark of System 2 thinking), I am concerned that we humans will not be able to avoid the temptation of choosing the quickest answers. If you believe that is not likely, I would encourage you to consider reading *Nudge: The Final Edition* by Thaler and Sunstein. Thaler and Sunstein argue how choice architecture influences human behaviors. They cite Kahnmen's work extensively to clarify that even the slightest nudge easily influences all humans and can have a significant impact.

Undoubtedly, we have made significant strides in acknowledging and discussing the potential harm of AI. Our *Navigating Ethical AI: Interactive Lessons and Equitable Practices for Educators* webinar is a testament to

how the learning sciences field is actively responding to the growing concerns about the ethical use of AI. It's important to note that the dangers and harm of AI often do not stem from any malicious intent by its creators. Instead, they result from our automatic thinking, reinforced by Generative AI's (GenAI) speed. However, our increased understanding and awareness can help us navigate these challenges and somewhat mitigate potential harm.

Still, I can't help but be concerned about the proliferation of GenAI as it seems to automate and propagate products that replicate the basest human instincts. Think about the deep fakes and their ability to go viral! Think about the students attempting to shortcut their learning. Think about the educators using GenAI tools to grade all their student work to save time. Such routine behaviors are not what we typically consider to be unethical AI use. It is our automatic thinking allowing the results generated by a biased-ridden system. Even if we are aware of the potential harm of blindly trusting GenAI's outcome, it will be difficult to eschew such influences based on simple nudges by our general environment. Most importantly, I am concerned that classroom teachers without basic AI literacy won't be able to guide their students in this new environment to recognize the potential harm done by GenAI because they can't compete against System 1 thinking.

To activate System 2 thinking safely and productively, teachers need support from knowledgeable leaders who can lead them. Because we recognized the importance of school leaders in implementing Systems 2 thinking, Sofía De Jesús and I wrote Framework for AI Implementation for Administrators and Leaders in K-12 Schools when we participated in the Computer Science Teachers Association's Equity Fellowship Program. We wanted to make it easier and more manageable for the many school leaders who feel overwhelmed by the number of currently available AI-enabled tools and the feverish sales pitches encouraging them not to leave their teachers and students behind! With the framework, we hope that they can access their System 2 thinking as they consider purchasing and implementing AI-enabled tools.

Educators need to stay vigilant against the urge to choose *automation* and *efficiency* over *ethical* and *deliberate* as further AI-embedded tools are being introduced to our school ecosystems. Now more than ever before, we must activate our Systems 2 thinking to ensure we are modeling and instilling equitable values with AI in education.

References:

Kahneman, D. (2011). Thinking, fast and slow. *Farrar, Straus and Giroux.*

Thaler, R. H., & Sunstein, C. R. (2021). *Nudge: The final edition*. Yale University Press.

About the Author

Kip Glazer, Ed.D. is the proud principal of Mountain View High School. A long-time practitioner participant for CIRCLS and Educator CIRCLS, she has been sharing her school leader's perspective on various learning technologies topics, including Artificial Intelligence implementation in schools. She has been an **Equity Fellow** for the Computer Science Teachers Association and a member of the EngageAI Practitioner Board.

The Convenience of Inconvenience: Exploring Connections with Researchers and Practitioners

Image by Steve Johnson on Unsplash

by Nneka McGee and Krystal Chatman

The goals of change are aspirational. In the artificial intelligence (AI) era, we see change as a catalyst that will bring about the true transformation in education many of us have sought for decades. We all agree that change is necessary, right? Therefore, it's only a matter of time before aspirations become concrete. Though we should continue to strive for the best ideas, there is one reality we must face: The difficulty of change is an inconvenient truth.

While change can be a challenge, particularly in education, hope is still a constant. Artificial intelligence and other emerging technologies have potential, but what are optimal ways to incorporate them into learning environments? Researchers have long explored the questions and possible answers of improving educational outcomes. Practitioners apply real-world experiences that significantly impact learners. The premise of bringing these disparate groups together offers a promising solution to understanding change.

In summer and fall of 2024, the Center for Integrative Research in Computing and Learning Sciences (CIRCLS) facilitated a convening of researchers and practitioners to explore AI problems of practice in PreK-12 education (for further details, see Educator CIRCLS '24 Summer Series). An innovative act in itself, as it is not often the explorers of educational theory (researchers) are provided with the opportunity to collaborate with the facilitators (teachers) of the suggested strategies. This convening offered an opportunity for both sides to engage at a deeper level, gaining insight into how the "other side" operates to improve their practice. Through discussions, researchers had the opportunity to convey how valuable the experiences of practitioners are to the work of advancing innovation in education. Practitioners shared their interest in research areas such as generative AI and expressed their concerns about helping students navigate the future of learning.

Problems of Practice

Dialogue was a primary focus of the convening. To bridge the distance between practice and research, CIRCLS facilitators divided attendees into groups with the goal of centering conversations on what practitioners experience within their educational ecosystems. Through in-depth discussions, researchers and practitioners identified areas of focus by posing questions such as:

- Do we need multiple literacies?
- How do we address accessibility issues?
- How do we use AI tools and what are the benefits?
- How do we include others across the spectrum to include more voices in developing AI tools?
- How can we use AI to support educator coaching?

AI literacy was a common thread among the groups. There was a collective acknowledgement of the limitations surrounding this emerging technology given the current state of training at educational institutions. Without the appropriate requisite foundations on how to use AI effectively, its potential to transform education is unclear. Additional conversations explored the limitations practitioners face with utilizing or implementing AI tools due to policies and how use of AI in learning spaces cannot swiftly progress until practitioner decision-makers gain more knowledge and confidence in AI use. Although researchers may be working on other areas, the conversations provided essential insights into the needs and wonderings of practitioners.

Research to Action

During a second round of grouping, researchers also sought input on their research topics and potential impact in today's classrooms. Recruiting research subjects has always been a challenge; therefore, informing practitioners of research topics opened avenues for feedback and questions related to applicability and feasibility. Several topics emerged from the group, including:

- Collaborative learning
- Student voice
- Systemic challenges
- AI scoring
- Policy development
- Navigating tensions
- Centering pedagogy

Just as in the prior group discussions, AI literacy was a popular talking point, often interwoven within the topics listed above.

When groups reconvened, all agreed that more conversation was necessary. More action was also on the minds of researchers and practitioners, but the realities of change were ever present. Several participants expressed concern about the trajectory of AI in education, particularly when considering access, bias, safety, security, and environmental impact. Despite misgivings, there was an overall sense of optimism about the future of research and the contributions of practitioners in propelling use of emerging technologies forward.

About the Authors

Nneka J. McGee, J..D., Ed.D. is an educational consultant and former Chief Academic Officer dedicated to ensuring students have access and opportunities to explore AI and emerging technologies. She completed her doctoral studies on AI and its implementation in K-12 classrooms. She is a frequent speaker on AI topics and serves as a member of several AI-focused advisory boards and committees.

Krystal Chatman is a seasoned educator and advocate with over 15 years of experience in integrating technology into teaching and promoting equitable computer science education. Currently serving as the Professional Learning & Community Manager for the Computer Science Teachers Association, she is also a co-founder of the Mississippi AI Collaborative, focused on AI upskilling across the Southern U.S. A dedicated leader in broadening participation in computer science and STEM, Krystal has facilitated panels on AI at the White House, spoken at the Brookings Institution, and developed Mississippi's first AI conference.

Translating Research on Emerging Technologies for Educators

Image by mcmurryjulie from Pixabay

by Cassandra Kelley

This blog post discusses the development of an Educator CIRCLS workshop aimed to "translate" or disseminate computer science education research findings to practitioners while promoting AI literacy.

Have you ever played the telephone game, where a sentence is whispered into someone's ear and passed from person to person, until the final person reveals the message aloud to see how closely it aligns with what was originally said? I am frequently reminded of this childhood game in my role as the Broader Impacts Project Coordinator at the University of Pittsburgh and CIRCLS, where I think about how we can "translate" research into practice for practitioners; however, the game has become much more challenging due to the technical terminology, academic jargon (e.g., research methodologies), and other contextual phrases that are often included within the message being communicated. Moreover, all of the players have individual "language barriers" (e.g., prior knowledge, experience, expertise, etc.) that add another layer of difficulty to ensure the mediated message is comprehensive for all.

My broader impacts position, inspired by the National Science Foundation (NSF) merit review criteria, was created as an avenue for broadly disseminating research on emerging technologies for teaching and learning—similar to programs such as Research Practice Partnerships (RPP) or Research Experiences for Teachers (RET). I was drawn to this opportunity because I feel it is critical not only for educators to learn about and understand education research, but also for researchers to consider the direct impact of their work on practice. I firmly believe in the importance of bridging the gap that currently exists between research and practice by promoting partnerships among all stakeholders, which can include further engagement in participatory research and involvement in co-design models.

As a former PreK-12 educator and higher education faculty member supporting pre-service teachers, my initial concern about this translation process was thinking about how students and teachers will benefit. From my own experience working in school systems, I have observed an institutional culture where research and policy are "thrown" at teachers through mandates and other recommendations. Educators' voices are often missing from the conversation and there is not an immediate focus on how to best support their practices, which truly should center on the needs of students. I have also witnessed researchers temporarily engaging with educators for the purpose of conducting a study and then disappearing, which I personally know can feel like a one-sided transaction.

These factors led me to consider novel strategies for research dissemination that could potentially build stronger connections between researchers and practitioners. Specifically, I wanted to explore the development of supplemental curricular resources to be shared with teachers during a workshop so they could have opportunities to: (1) interact with computer science (CS) education concepts and understand their relationship within research findings, (2) experience the role of a learner and researcher, (3) engage in discussion with other educators and researchers about the impact of specific research projects on practice—especially with regard to the integration of emerging technologies, and ultimately to (4) bring elements of their professional learning back into the classroom via guided activities that could be adapted for implementation with students.

It is important to note that these goals were shaped through many discussions with practitioners, especially after having the opportunity to speak directly with 20 educators about their experiences as participants in professional development programs for CS education. I sought their recommendations for how we might design and structure a workshop to disseminate research findings via our supplemental curricular resources (see Engaging Educators in Emerging Technology Research for further details about the facilitation of this workshop). Throughout these reflective conversations, it was frequently mentioned how most programs tend to be "technocentric" and focus more on "new shiny technology tools" rather than pedagogy for classroom integration or research-based practices and learning theories. Educators advocated for further rigor and inquiry-based activities that immerse them into the research literature, paired with opportunities for collaboration and the exchange of ideas or curricular resources; each of these elements would be intentionally incorporated into our workshop design.

Additionally, I connected with members of interdisciplinary research teams to better understand their different areas of expertise and the methodologies used across projects. I had to consider the application of CS terminology and concepts within each project (many of which were new to me) and pinpoint the key areas to focus on in the translation. Fortunately, I was introduced to a new undergraduate student in the lab who was double majoring in both CS and communication. She was eager to help and became a translator for me when I wore my "learner hat," similar to how a teacher's assistant or tutor might provide direct instruction to dive deeper into the content. Likewise, I would then put on my "teacher hat" and explain pedagogical concepts (e.g., scaffolding, asking different levels of questions, Universal Design for Learning- UDL strategies, etc.) or

learning theories (e.g., constructivism, sociocultural learning, project-based learning, etc.) while we discussed how we could take research findings and use them to develop supplemental curricula or guided activities for dissemination to educators.

A final consideration in the development of these guided activities was how to simulate the research procedures in an immersive way without the technology equipment. This was necessary because we wanted to acknowledge potential constraints of implementation in schools, such as access issues and the need for further technical support or training—not to mention how expensive these emerging technologies are. Therefore, we engaged in further conversations with the research teams about how we might develop user-friendly prototypes of simulations that educators could interact with on their own devices. Our discussions reminded us that there may be further barriers to research dissemination in the traditional schooling environment including challenges with existing curricula requirements and/or scheduling constraints. For this reason, we decided it might make more sense to frame our activities as supplemental or enrichment materials that can be adapted/remixed across a variety of settings (e.g., after school programs or summer camps).

In summary, these convenings with researchers and practitioners across what Wenger-Trayner and colleagues (2014) refer to as the "boundaries in landscapes of practice" helped us consider the institutional culture bounding each landscape. We found it extremely valuable learning from multiple perspectives and using these insights to help us identify existing boundaries and ways to collectively navigate them.

Key takeaways from the experience are:

- Acknowledge the systemic barriers with regard to education policy and practices in different community settings.

- Engage in learning partnerships by collaboratively negotiating and exploring the existing boundaries. This includes actively listening to all voices (e.g., researchers and practitioners) from different landscapes (e.g., PreK-12 education, higher education, and industry) to create a two-way dialogue of mutual reflection.

- Focus less on the technology and more on the diffusion of innovative ideas as well as the AI literacy needed by ALL stakeholders for advancement of these ideas.

- Develop immersive guided activities that promote further conversations about AI literacy while being grounded in research and learning theories. Be sure to clearly communicate these connections when translating back-and-forth and offer opportunities for reflective discussion.

- Seek feedback at every stage of the iterative process and prioritize the community partnerships across the landscapes of practice above all.

- Remember that the ultimate shared goal or vision is to positively impact the future of learning for students.

Since I personally identify as both a researcher and practitioner, I have learned firsthand the importance of negotiating my own experiences to build a bridge between my understanding of the teaching practice and students' needs, while also thinking critically about advancing the field of education research. In order to bring these landscapes together, researchers must consider ways to make their work more accessible so they can get the necessary buy-in from teachers that will propel institutional change and innovation in the future of schooling and education. Likewise, educators need to keep seeking opportunities to stay abreast of current research findings, especially to help lead this exploration of new pedagogical practices or emerging technologies that can support teaching and learning. One avenue to achieve this is establishing sustained partnerships between researchers and practitioners through co-design or participatory research. Moreover, the incorporation of "intermediaries" or "knowledge brokers," which Levin (2013) defines as "people or organizations that translate or transmit research," similar to my position as a Broader Impacts Project Coordinator, can "play a critical role in the process of diffusing ideas and practices in education" (p. 21). It is my hope that researchers will take into account how emerging scholars, such as school administrators, academic coaches, a subgroup of PreK-12 teachers, post-doctoral students, or graduate students, might be leveraged to help spearhead this essential translation of research into practice.

Thank you to **Sarina Saran**, **Deniz Sonmez Unal**, **Sarah Hampton**, **Dr. Erin Walker**, and **Dr. Judi Fusco** for their thinking and feedback on this post.

References:

Levin, B. (2013, February). To know is not enough: Research knowledge and its use. *Review of education*, 1(1), 2-31. DOI: 10.1002/rev3.3001

Wenger-Trayner, E., Fenton-O'Creevy, M., Hutchinson, S., Kubiak, C., & Wenger-Trayner, B. (Eds.). (2014). *Learning in landscapes of practice: Boundaries, identity, and knowledgeability in practice-based learning*. Routledge.

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Cassandra Kelley, Ed.D. has over fifteen years of experience in PreK-12 and teacher education. She earned her doctorate degree in Learning Technologies from Pepperdine University and is passionate about exploring

new tools that can improve teaching and learning. She currently serves as a *Broader Impacts Project Coordinator* at the University of Pittsburgh and supports CIRCLS with Expertise Exchanges in the AI CIRCLS and Educator CIRCLS sub communities. Cassandra also teaches graduate courses for National University in the Master of Science in Designing Instructional and Educational Technology (MSDIET) Program.

Engaging Educators in Emerging Technology Research

Image by Tung Lam from Pixabay

by Cassandra Kelley, Sarina Saran, Deniz Sonmez Unal, and Erin Walker

This blog post discusses the outcomes of an Educator CIRCLS workshop that disseminated computer science education research findings to practitioners while prompting broader discussions of AI in classrooms

This past summer and fall of 2024, Educator CIRCLS hosted a series of webinars, workshops, and convenings between researchers and practitioners focused on artificial intelligence (AI) literacy. Specifically, they were designed to engage participants in reflective conversations about ethics, equity, and other problems or possibilities of practice concerning the integration of AI (especially genAI) in PreK-12 education.

As part of this series, our team from the University of Pittsburgh piloted a novel strategy for research dissemination, in which we developed supplemental curricular resources or guided activities and shared them with educators in a workshop format. The goals behind these activities were twofold:

- To facilitate discussion among educators about current research on the integration of emerging technologies that incorporate AI (e.g., robots and intelligent tutoring systems) and how they might impact the future of learning in education settings, and

- To provide a mechanism for educators to think critically about ways to introduce elements of AI literacy to students via real world exercises that can simulate the work that researchers are doing (see Translating Research on Emerging Technologies for Educators for further background context about the design of this workshop).

During the planning stage of the workshop, we felt it was pertinent to get a better understanding of PreK-12 teachers' experiences with professional learning for computer science (CS) education. We wanted to speak

directly with them about the impact of these experiences on their practice and seek their recommendations for how these professional development programs are designed.

We interviewed 20 educators from 16 states, who taught across different grade levels and/or content areas. Most interviewees felt a disconnect with research dissemination as a form of professional learning and expressed their desire to better understand how emerging technologies connect with research-based practices and learning theories. They discussed how previous workshops they have attended either focus directly on the technology tools or on a mandated "turnkey curriculum" based on rote memorization and knowledge transfer (e.g., Advanced Placement CS course materials). Teachers expressed how they appreciated receiving curricular resources because such resources help them to stay current in this ever-evolving field. They would like to see less "direct instruction" lessons and more real-world approaches with project-based or problem-based learning (PBL) that promote inquiry—similar to what is expected in the industry. They also emphasized the need for further collaborative opportunities to ideate on promoting digital/AI literacy through their instruction.

Following our conversations with teachers, we intentionally designed a workshop with guided activities, based on research projects on emerging technologies, that could expose practitioners to existing literature and findings while potentially seeding new ideas for curricula. Our workshop design incorporated the following structure: (1) outline the theoretical framework and CS concepts, (2) have participants experience different roles (e.g., student, educator, and researcher) within inquiry-based activities, (3) share project research findings, (4) discuss implications for practice and ways to address AI literacy, and (5) reflect on the overall format of the workshop and considering how to improve the design of future workshops.

We featured two research projects:

- **Project 1:** The design of intelligent robots with social behaviors and their potential roles in learning settings

- **Project 2:** Utilizing neuroadaptive learning technologies to assess a learners' cognitive state with brain imaging

Our first session on teachable robots presented a research project that examined middle school students' interactions with Nao robots in mathematics instruction. Participants were asked to think about the design and implementation challenges in building a robotic dialogue system for learning from the perspective of a student, educator, and a researcher. They explored CS concepts related to Natural Language Processing (NLP) by: (1) determining keywords used in solving a math problem, (2) reviewing sample dialogue scripts and Artificial Intelligence Mark-up Language (AIML) that researchers used to program the Nao robot, and (3) interacting with prototype simulations created in Pandorabots that represented social and nonsocial versions of a chatbot. We

also shared further extensions that could potentially be remixed or adapted for use with students, such as revising the dialogue by adding more social elements, writing a new script for solving a different math problem in AIML, developing a chatbot to test the code, or experimenting with a program such as Scratch to create a dialogue between two sprites.

Our second session on neuroimaging and educational data-mining presented a research project that examined how students process information while interacting with intelligent tutoring systems. A major component of this study focused on the analysis of data collected by these systems to uncover patterns or trends that can inform and potentially improve teaching and learning practices. Additionally, neuroimaging brain data was collected as a proof of concept to explore how it might be analyzed to better understand how cognition, attention, and emotion affect learning (for further background on how this equipment works, see Neuroscience in Education). Similar to the first workshop, we presented guided activities to help participants think about the design of intelligent tutoring systems and the types of data collected ; participants created their own data visualizations from sample datasets for analysis using the free educational software, Common Online Data Analysis Platform (CODAP) and categorized example brain activation images based on the corresponding levels of task difficulty. Further extension activities were shared, such as outlining specific actions that an intelligent tutoring system might take to provide feedback (e.g., hints, prompting questions, or praise) in response to student behavior and debunking "neuro-myths" in education.

At the conclusion of each workshop, we asked educators their thoughts about the potential benefits and challenges of integrating these emerging technologies in PreK-12 classrooms and what they would like future research to explore. Our goal was to hear practitioner voices and gather input for researchers and developers to consider. This led to a focused discussion on the need to promote AI literacy in education, especially to address ethics and transparency.

Key takeaways from the experience are:

- Teachers appreciate the opportunity to learn more about innovative research projects, but they especially like the idea of being in dialogue with researchers and potentially playing a role in the work that's being done. Many volunteered to pilot future projects exploring the implementation of curricula and/or emerging technologies with their students if invited.

- Teachers expressed that the content in our guided activities, while rigorous, enabled them to be more reflective. They were engaged with the hands-on simulations of the research and discussed how "active learning helped to promote deeper thinking." As one participant mentioned, the activities allowed her to "think outside of the normal pedagogy box."

- Teachers had mixed feelings on the relevance of the workshop content and how to bring it into their schools or classrooms. Some thought it would be challenging to implement the activities with students due to external factors and other curricular mandates. As one participant stated, “one tension with cutting-edge research is that it’s difficult to be practical in the moment. I think you’re on the right track with scaling down the technology or bringing the insights to the classroom level…this [workshop] is way more effective than most formats, but I think you would have a difficult time getting educators to opt in.” Meanwhile another participant said, “in both workshops, the concepts and practice of the teachable bot and neuroimaging was beyond the ‘here and now’ of teaching and learning, but the examination of how our current concepts of pedagogy may change as we catch up to the technology.” Additionally, several teachers discussed how the workshop offered new ways for them to think about bringing in real-world data and student-led projects to promote further inquiry and AI literacy.

- Teachers valued the opportunity to collaborate with other educators and researchers. They liked exploring different lenses (e.g., student, teacher, and researcher) while engaging in reflective discussions about the impact of research on their practice. One teacher highlighted how it felt like a “safe space to troubleshoot uses of AI and educational data mining” and another expressed appreciation for “garnering others’ experiences to get further ideas for their own classroom.”

Based on overall positive feedback from our teacher participants, we believe this research dissemination workshop model is worth exploring with other projects, especially since educators felt they were able to take something meaningful away from the experience. As one participant stated, “I feel very fortunate to be involved in this work. I’m very happy that your team is working to push the boundaries of how we learn and teach.” This gives us hope that researchers will consider the importance of collaborating and co-designing with educators. Additionally, this work validates the need for further mediation between research and practice, which potentially can include creating new roles for “knowledge brokers” (Levin, 2013) to promote further dialogue across these boundaries in order to truly make a broader impact.

Thank you to **Sarah Hampton** and **Dr. Judi Fusco** for their thinking and feedback on this post.

References:

Levin, B. (2013, February). To know is not enough: Research knowledge and its use. *Review of education*, 1(1), 2-31. DOI: 10.1002/rev3.3001

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Sarina Saran is a third-year undergraduate student at the University of Pittsburgh pursuing a B.S. in Computer Science and a B.A. in Media and Professional Communications. She is curious about the intersection of technology and communication, and she has been able to develop a greater understanding of the challenges in this area as an Undergraduate Research Assistant in the Office of Broader Impacts.

Deniz Sonmez Unal is a Ph.D. candidate in Intelligent Systems at the University of Pittsburgh. Her research focuses on modeling student cognitive states using multimodal data, including interaction logs, verbal protocol data, and neural signals to enhance the diagnostic capabilities of intelligent tutoring systems.

Erin Walker, Ph.D. is a co-PI of CIRCLS and a tenured Associate Professor at the University of Pittsburgh, with joint appointments in Computer Science and the Learning Research and Development Center. She uses interdisciplinary methods to improve the design and implementation of educational technology, and then to understand when and why it is effective. Her current focus is to examine how artificial intelligence techniques can be applied to support social human- human and human agent learning interactions.