CIRCLS | Center for Integrative Research in Computing and Learning Sciences

AI Institute for Engaged Learning

James Lester, North Carolina State University, shares more about his NSF AI Institute for Engaged Learning: EngageAI (#2112635).

Team: James Lester (Principal Investigator), Gautam Biswas (Co-Principal Investigator), Jeremy Roschelle (Co-Principal Investigator), Cindy Hmelo-Silver (Co-Principal Investigator), Mohit Bansal (Co-Principal Investigator)

Driven by a vision in which AI supports and extends the intelligence of teachers and learners, the NSF AI Institute for Engaged Learning is designing, developing, and investigating AI-driven narrative-centered learning environments that create engaging story-based, collaborative problem-solving experiences.

What is the big idea of your project?

The AI Institute for Engaged Learning emerged from a recognition of the significant potential of interactive narrative to support learning. There's this well-known phenomenon that story plays a prominent role in human cognition, and that it thus plays a prominent role in human learning. Story is known to be deeply engaging, an effect we know from multiple media types that utilize stories: we know it from film, we know it from drama, we know it from literature, and we know it from games. There's this real opportunity to leverage the power of story to create learning experiences that are engaging, hence the name "engage" in the AI Institute. Of course, we want students to learn, but we also want them to become so engaged in the learning that they become better learners, and story offers a very promising vehicle for creating engagement.

Recent developments in AI have introduced the opportunity to create incredibly powerful learning technologies, which was really unimaginable twenty years ago, and it was just barely imaginable five years ago. We now have systems that can dynamically create experiences that are story-based problem-solving episodes. We're working in STEM education for K-12, and doing so in a way that's highly customized for learners. We're looking at what it means to tailor story-based learning experiences for both individual learners

and also groups of learners working collaboratively, and investigating how these technologies can be deployed in classrooms at scale. There are advances in natural language processing, advances in machine learning, and advances in computer vision that are foundational technologies. The Institute has core AI specialists in each of these areas, and together with our education researchers, they're driving forward research in three different dimensions that interact in really interesting ways: interactive narratives, embodied conversational agents, and multimodal learning analytics.

Tell me a little bit about your partnerships.

Educator and Student Partnerships

The Engage AI Institute has a dual focus on formal and informal learning contexts. Our main school partnerships are in North Carolina, Indiana, and Tennessee, which are significantly extended by the phenomenal networks of schools that Digital Promise brings. We also have museum and afterschool partners. For example, we've been working for many years with the North Carolina Museum of Natural Sciences in Raleigh. They're our main partner for museum-based work within the Institute. We also work with Boys and Girls Clubs.

One of the differences that we've found over the years working with museums is that it provides a fun design challenge. The visit times that you have in a museum are at the opposite end of the spectrum from what you have in a classroom. In a classroom, you might work with students and teachers for weeks on end, whereas in a museum, a visit time of five minutes would be considered very long. If you manage to have an exhibit that engages learners for ten minutes, that would be off-the-charts fantastic. This time difference means designing for fundamentally different kinds of story-based learning experiences.

I think the most important thing to know about partnerships like these is that they are fully based on relationships, and relationships developed over a long period of time. It's important to make a good impression when you're working with teachers and students and administrators early on so you might be fortunate enough to get to work with them again. It's far easier to keep a current partner than it is to recruit a new partner.

Engage AI Partnerships

One thing that I think is really interesting about the NSF AI Institutes, especially those that are in education, is the amazing interdisciplinary nature of the teams that make the work happen. I'll just mention three categories of people we have, each in itself very diverse. We have core AI people, and this ranges all the way from machine learning and computer vision to natural language processing, including understanding language and language generation. Then we have our AI and education folks – I'm one of those – who are people that are

right in between education and AI. The third category has some exceptionally strong folks in education across the learning sciences, including those who study embodied learning.

We're bringing together all three of these groups to re-envision what education can be like. The AI Institute is very much being driven by this shared vision from people with incredibly different backgrounds, which not only makes for delightful projects and interactions, but also moves the field forward in ways that are often unexpected.

What impacts do you hope to see from this project?

The main objective driving the Institute is creating a whole new generation of learning technologies that can support interactive narrative-based learning experiences in both formal and informal learning environments and to deliver those learning experiences at scale. Imagine what it would be like for a middle school student in three years to be able to learn any unit of science in the classroom and do so in a way that is driven by an engaging interactive, immersive story, and doing this through deeply collaborative, inquiry-based learning. Then imagine doing this all over the country. That's what we're aiming for.

Tags: Adaptive/Personalized learning and intelligent tutors, Multimodal data analysis, Pedagogical agents

← iSAT AI Institute

This material is based upon work supported by the National Science Foundation under grant 2021159. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

CIRCLS | Center for Integrative Research in Computing and Learning Sciences

iSAT AI Institute

Sidney D'Mello, University of Colorado at Boulder, shares more about his NSF AI Institute for Student-AI Teaming (#2019805).

Team: Sidney D'Mello (Principal Investigator), Martha Palmer (Co-Principal Investigator), Tamara Sumner (Co-Principal Investigator), Sadhana Puntambekar (Co-Principal Investigator), Peter Foltz (Executive Director)

The AI Institute for Student-AI Teaming (iSAT) will develop, deploy, and study AI Partners that interact naturally with students and teachers through speech, gesture, gaze, and facial expression in real-world classrooms. These AI Partners will observe, participate in, and support small groups of students to engage in learning conversations while assisting teachers in orchestrating effective collaborative learning experiences. The AI technology aims to support students to develop STEM competencies and 21st-century skills of collaborative problem-solving and critical thinking. The focal content domain of the AI-enabled curricula will be AI literacy, and how to support teachers in integrating AI education within existing STEM and literacy standards. Critically, iSAT engages diverse stakeholders—researchers, students, parents, and community leaders—in the co-design of ethical and equitable AI technologies.

What inspired this institute?

The AI in education (Ed) communities and computer-supported collaborative learning (CSCL) communities have similar aims but different foci. In contrast to the collaborative learning model, the AI in Ed community has mostly followed the intelligent tutoring model and the model of personalization. We also noticed that many excellent technologies in the AI in Ed space weren't making it through to the collaborative learning work and that advanced AI wasn't currently being fully leveraged within the collaborative learning space. Therefore, when thinking through our institute, we asked ourselves what we can do to reimagine AI in education within the collaborative learning space.

Another inspiration for the Institute was understanding how people communicate and interact. We wanted to shift our focus from one-on-one and unimodal interactions to studying multimodal, multi-party, multi-curriculum interactions by leveraging research on how people coordinate in small groups. When thinking about our vision of AI in Ed, we wanted to go beyond a one-on-one silent and mundane human-computer interaction focused on enhancing domain knowledge only. Instead, we were excited by a vision of a classroom as being an amazingly interactive and engaging space where people are communicating with each other and experiencing the comradery of collaborative learning. But, it's hard to do that with a single teacher since they can't be omnipresent to orchestrate effective collaborative learning. This led us to think about how AI can support teachers, and ultimately to our Institute's idea of an AI Partner that listens in to, facilitates, and participates in these small group conversations to help students: 1) have more productive discussions, 2) collaboratively solve problems together, and 3) actually have fun and be engaged in the learning experience. To do that you need to be able to support multimodal (much of speech is grounded in gesture), multi-party (multiple people talking), and multi-curricula collaborative discourse. To do this in a noisy classroom environment with multiparty chatter, people moving around, technology considerations, etc, poses both technological challenges and opportunities.

How will your institute impact students?

Collaboration is a critical skill for the future workforce. Like other skills, collaboration must be learned and developed. Therefore, one focus of the Institute is on how to get teams to work together and how to intentionally help students develop collaborative skills, and more specifically, collaborative problem-solving. The Institute is supporting the use of collaboration not only as a means to achieve learning outcomes but actually helping to develop collaborative skills, which is widely recognized as a critical 21st-century skill.

This project will have a direct impact through its AI pathways for students. AI is all around us, and this project will provide students with deep AI literacy and an understanding of the power and risks of AI, as well as students' own sense of power through knowledge. This will also make them better equipped to thrive in the future AI-driven workforce. To achieve this, the project uses a pipeline model, where they start engaging students in highly diverse districts starting in middle school through the co-design of curricula and AI technology, immersive learning experiences, and research internships.

Lastly, the Institute is intentionally developing low-cost curricular materials and technology and will make anything developed through the Institute widely available to students nationwide. All our technology is open-source for non-commercial use.

Tell us a little bit about your partnerships.

iSAT Team

Interdisciplinarity and deep expertise at the intersections of foundational AI, learning sciences, and team science are necessary for achieving the Institute's goals and developing the AI partner. There are nine

universities working on this Institute that span 15 research areas, ranging from work on computational linguistics and distributed cognition to curriculum development in the classroom. When we formed our team, we asked ourselves who we worked with in the past that we loved working with. Core project team members then brought in collaborators that they were familiar with. It was helpful for the team to have this familiarity, especially during COVID when work was completely remote.

One of the most exciting things has been examining how you get these folks to talk together and even have the same value systems. How do you get somebody who primarily works with curated datasets to work with humans in the field? We're experimenting with a variety of mechanisms such as design sprints, data jams, and conjecture mapping workshops as concrete ways for people to do this together. Additionally, bringing everyone together in person to work collaboratively has been critical to designing and developing the curriculum and technology.

Educator and Student Partnerships

We were able to utilize existing research-practice partnerships (RPPs) with Denver Public Schools (DPS) and a new partnership with St. Vrain Valley School District (SVVSD). These relationships have been nurtured and cultivated by team members through other current and prior NSF awards. We also strategically partnered with the inquiryHub, which is a project that helps develop curriculum that promotes inquiry and computational thinking. We weren't able to collect data in schools during our first year (2020) due to COVID, but due to our strategic partnership, we were able to leverage an existing curriculum unit called sensor immersion that was being implemented by DPS teachers and impacted over 1000 students. Fortunately, in 2021, we worked with teachers over the summer to co-design a new curriculum unit on AI in games and conducted professional learning sessions around the implementation of a version of Sensor Immersion enhanced for collaborative learning. This work was completed during the ongoing pandemic and we owe our success to these valiant efforts.

The Institute also works with and collects input from teachers on the design of the AI technology through our Teacher Advisory Board and on our AI-enabled curriculum through intensive week-long co-design sessions, which also include students.

Critically, student voice plays a central role in our work through the Learning Futures Workshops where youth are engaged to adopt an expansive vision for AI in classrooms both within and beyond the grammar of schooling. A few key things we've learned from youth in these workshops include: 1) youth have a need and a desire to have affirming interactions with AI; 2) they prefer that AI help them form strong relationships with their peers rather than serve as a learning guide; 3) in terms of data privacy, they would like the ability to turn the AI off and negotiate what information is shared with the teacher; 4) they're willing to trade-off what information they're willing to share for features they value. This information is being used to inform the design of the AI partners resulting in novel designs including a Community Builder (CoBi) which helps students and teachers

develop and adhere to mutually-agreed collaborative agreements (e.g. respect, equity, advancing learning), a collaborative co-pilot which supports individual student groups, and an augmenter which aggregates and distills information from the groups to support teacher orchestration. We're planning on having prototypes of these technologies tested in the 2022/2023 school year.

Tags: AI education, bias and equity in AI, Collaborative and/or participatory learning, Natural language processing and speech technologies

← Collaborative Research: Learning Linkages: Integrating Data Streams of Multiple Modalities and Timescales: 1417997

EAGER: Cultivating Scientific Mindsets in the Machine Learning Era: 2225227 →

This material is based upon work supported by the National Science Foundation under grant 2021159. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

CIRCLS | Center for Integrative Research in Computing and Learning Sciences

The NSF AI Institute for Adult Learning and Online Education (AI-ALOE)

AI-ALOE INSTITUTE

We spoke to Chris Dede, AI-ALOE Co-Principal Investigator and Senior Research Fellow at Harvard Graduate School of Education, and summarize our conversation with him about the vision for the recently funded NSF AI Institute for Adult Learning and Online Education (ALOE) (NSF Award #2112532).

PI Team: Myk Garn, Principal Investigator, University System of Georgia; Ashok Goel, Director and Co-Principal Investigator, Georgia Institute of Technology; Scott Crossley, Co-Principal Investigator, Georgia State University; and Alexander Endert, Co-Principal Investigator, Georgia Institute of Technology, and Chris Dede, Co-Principal Investigator, Harvard Graduate School of Education

What is the big idea of your project?

The NSF AI Institute for Adult Learning and Online Education (AI-ALOE) aims to advance the workforce through higher and continuing education and adult education programs. Central to our work to create personalized learning technology is research and data collection in order to explore new AI theories, techniques and models of lifelong learning while we evaluate effectiveness, track results and study outcomes. No two adult learners (age 24 and up) process information the same way and may find different learning techniques or styles useful. Which is why the work of AI-ALOE is crucial. Our work will create AI teaching assistants to support adult learners.

Personally, I (Dede) have been long interested in adaptive learning, not just like an intelligent Tutoring System, but personalized so learners have voice and choice and that choice can include learning alone or learning in a social setting with other learners and teachers. Voice and choice can be very broad and we need to leverage learning analytics to really personalize online learning. As mentioned before, the institute is thinking about teaching assistants, and since we're in the adult learning space, where self-directed learning occurs, in those situations, it could be that a teaching assistant becomes an assistant to the self-directed learner.

Another component of the Institute being explored is mutual theory of mind by the Georgia Tech Design & Intelligence Lab. Humans have the ability to develop a model of what another person might be thinking given what they know about the person. A person might adjust their interactions with another to help make a

situation work more smoothly, but how does an AI system know how to work with people? Increased understanding in this area is fundamental to creating the specific tools the institute wants to develop.

Tell us a little bit about your partnerships.

This research initiative involves a cross-sector and cross-disciplinary collaboration in order to represent the many different types of adult learners and types of learning they have to do. Currently, our team is actively engaging with learners and instructors at Georgia Tech, Georgia State University, and Technical College System of Georgia.

The institute has a powerful partnership with the Technical College System of Georgia, an advanced vocational technical institution to help us not only understand who adult learners are but their needs. They have so many students in our target population, many who have been marginalized over the years, and we can learn what they need to do, and how new tools can work or help what they need and want to learn. Our partners are taking existing courses and applying AI tools to the current content of their curriculum.

Furthermore, these academic institutions are not only the homes of researchers involved but also sites where evaluation of the work can take place. Additionally, our industry partners will also be test beds. IBM and Boeing employ adult learners and publishing companies like Wiley design products to help adult learners. We look forward to learning from and collaborating with our current and future partners. Through our collaborative partnerships, we aspire to avoid reinventing the wheel and address the different facets of motivation and learning platforms available for adults.

We would also encourage the other NSF AI institutes, the AI in Education community, other related research groups and potential partners to learn more about using AI in different situations. Making connections between the work we are all doing with AI systems will help it grow.

List of partners:

Non-profit organizations

- Georgia Research Alliance
- 1EdTech

Academic

- Georgia Technology
- Georgia State University
- Technical College System of Georgia

- Harvard University
- University of North Carolina at Greensboro
- Arizona State University
- Vanderbilt

Industrial

- Boeing
- IBM
- Wiley

*Accenture, a multinational consulting company, has partnered with the NSF to fund the Institute.

What do you envision is the impact your project will have on teaching and learning with AI?

The institute is not only focused on improving AI in education but also doing things better, such as emphasizing guided learning by doing with less emphasis on teaching by telling — we need to empower self-directed learning. We're learning a great deal from Dr. Ruth Kanfer's work on how adult learners change through life and what is lost but also what is gained as one gets older. We also believe instead of teaching adults a skill they need "tomorrow," give them learning that will be continuous throughout their entire career and life. We want to give the adult learner an understanding of what they bring to a partnership with AI, and how important they are to humanizing decision-making in machine learning. In this way, the institute is hoping to shift the discourse from "AI taking over" to one of judgment, to one that humans are doing the work. There's a lot of potential for AI to empower and augment human abilities and that would have a huge impact on the future of teaching and learning. We are committed to an Ethics Plan that ensures all AI technologies developed by the ALOE Institute will be designed in a way that takes the well-being of users, unintended users, and stakeholders into account.

Lastly, the core of our work does not solely come from our partnerships, research, data and programs but participatory design. This helps us design better systems. Privacy, security, and bias, are all potential weaknesses of AI and so our thinking is that one way to mitigate those risks is very rich interaction with people who will be giving consent for their data.

Thank you Chris Dede for speaking with CIRCLS and we look forward to hearing more from you and your colleagues as the Institute progresses.

Exploring Artificial Intelligence-enhanced Electronic Design Process Logs: Empowering High School Engineering Teachers

Roxanne Moore shares more on her newly funded NSF RETTL project, Exploring Artificial Intelligence-enhanced Electronic Design Process Logs: Empowering High School Engineering Teachers (#2119135).

Team: Mark Riedl, Roxanne Moore, Jeff Rosen, Meltem Alemdar, Jessica Roberts, Gennie Mansi, Yasmine Belghith

The Engineering Design Process (EDP) is a framework commonly used in Engineering and Computer Science (CS) courses. The framework is typically drawn as a linear process from questioning to designing to implementation and testing, when in actuality, the design process is non-linear and involves multiple iterations of problem identification, user interviews, and solution ideation. However, these critical stages of the design process are often overlooked in classrooms, with students going straight to prototype development. Principal Investigator Mark Riedl and his Co-PIs, Roxanne Moore, Jeff Rosen, and Meltem Alemdar, are working to pilot an AI system that can assist high school teachers in guiding students through the design process, provide real-time feedback, and promote documentation of each stage of the process.

What inspired you to start this project?
Large class sizes, asynchronous group work, and the stigmatization of requesting feedback and failure, has made it challenging for teachers to provide real time feedback and assessment of students' engineering projects prior to their completion. Without structured guidance, students are less likely to document stages of their design process or thoroughly vet the problem they are trying to solve. This can result in pedagogical misalignment between the projects and prototypes that students are expected to produce. In addition, when assessing these projects, standard rubrics and final products, such as reports, that only focus on the final product make it difficult for instructors to gauge how well their students actually utilized the EDP during development.

Several members of the project team have spent significant time developing, teaching, and observing engineering courses. While teachers and students would say that they use and understand the EDP, our experience is that the logistics and execution of key steps in the design process and their documentation remain challenging across many environments. Deep understanding of the problem is often viewed as an

impediment to prototyping and testing, which is considered the most “engaging” part of engineering. However, this focus makes engineering more about the tools and less about the people and the process of creating something that betters society.

The proposed AI system aims to help improve the engineering curriculum, assist in the assessment of the design processes, and destigmatize failure by empowering teachers to create task models that can offer both real time guidance and identify pathways students may take during the engineering design process. The system will also help students adapt these task models to teachers’ project specifications.

Tell me about your partnerships.
This project is a collaboration between Georgia Tech’s College of Computing (GT CoC), researchers at Georgia Tech’s Center for Education Integrating Science, Mathematics and Computing (CEISMC), and the George W. Woodruff School of Mechanical Engineering. CEISMC hires both researchers and former educators to stay in touch with educator and learner needs and inform their research and development processes. In fact, Co-PI Jeff Rosen is a former classroom teacher and is well connected to other teachers and leadership administrators in the counties and states where they partner. To ensure that their research is grounded in educational practice, CEISMC typically conducts research-practice discussions through educator focus groups regarding curriculum implementation. These focus groups will include educators who have used the EDP framework previously and educators who have never used it.

What would a classroom utilizing your technology look like?
This project does not propose to replace teachers with AI; rather, the project will explore a novel approach in which AI systems assist teachers in the creation of instructional modules that adhere to EDP best practices. The system could act as a “virtual teacher’s aid,” reducing teachers’ workload and supporting students in overcoming frustrations and misunderstandings without stigma. In this way, we hope our tool could ultimately result in students who are self-motivated to use the EDP to design solutions for many types of problems.

A classroom using our technology would still retain many of the characteristics of typical engineering courses —collaborative design projects, asynchronous work, use of technology, and tools for prototyping—however, we hope that students would also use technology not just for Computer-Aided Design and internet research, but as means to continuously document and reflect on their design process. We hope that this will be a modernized engineering notebook or inventor’s journal that, rather than being static, is actually helpful in guiding the students during their design journey. However, this requires cultural changes with regard to how students spend their time in engineering class.

What do you foresee being your biggest barrier to meeting this goal?
There has been a long history of engineering curricula at the middle and high school levels that focus on a linear process of design, fabrication, or prototyping. This is a frequent limitation of the curriculum, and often

the scoping of design problems, which can result in the EDP not feeling relevant to many engineering design problems. We are aware that our tool will not solve this problem singularly; rather, it will require a multi-pronged approach. We will need to ensure that our technological innovation lends itself well to this type of process and doesn't reinforce stereotypes that students already have about engineering (e.g. engineers don't do "creative" work, engineers are men, engineering has a "right" answer, engineering is not human-centered).

← Transformative Computational Models of Narrative to Support Teaching Indigenous Perspectives in K-12 Classrooms

The NSF AI Institute for Adult Learning and Online Education (AI-ALOE) →

This material is based upon work supported by the National Science Foundation under grant 2021159. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

CIRCLS | Center for Integrative Research in Computing and Learning Sciences

Transformative Computational Models of Narrative to Support Teaching Indigenous Perspectives in K-12 Classrooms

Melissa Tehee and Breanne K. Litts at Utah State University, and Rogelio E. Cardona-Rivera at the University of Utah share more on their most recent NSF-funded RETTL project, Transformative Computational Models of Narrative to Support Teaching Indigenous Perspectives in K-12 Classrooms (#2119573).

What is the big idea of your project?

This project aims to address the lack of representation of Indigenous culture, history, and stories in the classroom. It uses a community-driven process and is working to develop emerging narrative technologies from an Indigenous perspective to support teachers and classroom learning. Specifically, the project is trying to determine, at the computational level, how to create representations of Indigenous narratives that support an Indigenous knowledge system rather than a Western knowledge system. The project is also working to provide a VR experience or game that can be used by K-12 teachers who are less familiar with Indigenous history so that they are well equipped to implement the curriculum in a way that's respectful and appropriate. The project staff is working in partnership with the Northwestern Band of the Shoshone Nation (NWBSN) in Utah, and hopes to expand this work in partnership with many Tribal Nations over time. They are approaching this work at a "deep human level," and are building on their previous work that examined biases that exist in the technologies that we use today.

What is unique about your project team's composition?

A key component of this project is the truly interdisciplinary team that comprises it. The project team is composed of three principal investigators (PIs), Dr. Tehee, Dr. Litts, and Dr. Cardona-Rivera, and a Tribal Knowledge holder for the NWBSN, Darren Parry. This cross-disciplinary team has the potential to produce high-impact research that reduces bias in emerging technologies, expands representations of diverse knowledge, perspectives, and cultures in K-12 classrooms, and contributes to the field's knowledge of community-driven design practices that promote equity. Dr. Tehee is a psychologist and brings her expertise in narrative and storytelling as a healing process with Indigenous communities. She is also a citizen of the Cherokee Nation. Dr. Litts is a learning scientist and has been working with the NWBSN for four years, including on her NSF CAREER grant, and has both deep knowledge of and relationships with the community. She also brings her expertise in designing storytelling technologies for learning. Dr. Cardona-Rivera is a Puerto Rican computer scientist and has extensive expertise in narrative based computational modeling techniques,

which he has also been exploring through his NSF CAREER grant. Councilman Parry is on the Tribal Council for the NWBSN, and often works with K-12 teachers, integrating Indigenous perspectives and American Indian history into curricula. He visits hundreds of classrooms a year across Utah and Idaho to share knowledge.

What are the guiding theories of your project?
Identity development, ethnocultural empathy, and perspective taking are significant pieces of this project. Dr. Tehee has been working with undergrads, but sees the benefit of starting at a younger age, when students' identities and thinking isn't as shaped. Dr. Tehee explained that the histories that people learn in school really impact who they develop to be, stating that "it is difficult to value things you can't see." She elaborated that without perspective taking and learning about these things, we won't have a multicultural society that allows for other ways of knowing, thinking, or being. However, teachers often feel uncomfortable teaching a culture and history they don't fully understand, and that they themselves often weren't taught. Through this project, the team aims to address these pieces by making a sustainable emerging narrative technology for classrooms. They want Tribal Knowledge Holders to feel confident the technology accurately and appropriately represents their knowledge and teachers to feel comfortable using this technology so that Tribal Knowledge Holders, such as Parry, don't have the burden of visiting hundreds of classrooms a year. The project team is working in close partnership with both the NWBSN and K-12 teachers in order to achieve this.

The team also described the two main ideas in which the project is rooted: rhetorical and technological sovereignty. These ideas involve having power and self-determination over the rhetoric and stories being told about you, as well as the technologies being used to tell those stories. They explained that for the Indigenous communities they work with, having the power to tell their own stories shapes their cultural identity and allows for healing. Further, when students in elementary school feel like they have someone in the classroom who understands their stories and perspectives, it makes a difference in how they experience the education system.

What do you mean by computational models of narrative technologies?
Another goal of the project is to influence how we think about developing software technology in general, especially where the intent is to meet the needs of a given community. As Dr. Cardona-Rivera explained: "Software implicitly expresses a model of a given domain. For example, Microsoft Word models document processing through the metaphor of a typewriter, expecting the author to structure their writing linearly, and immediately see how their content will be presented." Other document processors (e.g., LaTeX) may follow a different metaphor. The challenge is that the computational models – the data and algorithms – that these software depend on are mostly invisible to the people that use the software.

As the team noted, in addition to being invisible, these models ultimately shape how a person engages with the software. Unfortunately, software technology is predominantly built around Western metaphors. This includes software narrative technology; applications that help people tell stories, like iMovie, Adobe Premier,

and Lightworks. For the kind of positive impact the PIs want, they must unpack where current software narrative technology falls short of affording Indigenous communities the software capabilities they would need and want in order to best tell the narratives they wish to share. As Dr. Cardona-Rivera concluded: “Imagine if we could re-think the basis that this kind of technology depends on. What new stories might we be able to tell? That’s what we’re trying to find out.”

How does your project build and center community partnerships?
The project is rooted in two important existing partnerships established through the team’s previous work with Indigenous communities and K-12 teachers. As mentioned above, the partnership with the NWBSN was developed over the course of almost four years. The project’s multi-year partnership with K-12 teachers formed with support from a Spencer Foundation grant co-developing a curriculum that centers culture in the classroom. Through intersections of these projects, some of the Tribal Knowledge Holders involved have previously worked with these teachers in their classrooms, and a goal of the work is to deepen those relationships.

Dr. Litts and Dr. Tehee explained that this work would not be possible without these strong pre-established relationships. The community’s needs are truly at the forefront in driving the development of this work. They noted that their community and teacher partners brought the issues the grant addresses to them; this is in contrast to research where community voice is often secondary to the research questions or ideas that PIs have. Dr. Tehee expanded on this point by stating, “I’m doing research I couldn’t have predicted because it is guided by what the needs are, not my trajectory.” Dr. Litts added, “This new funding will support the needs our partners have right now. Specifically, the technology we will build through this work will support the preservation and sharing of culture in ways Tribal Knowledge Holders are asking for and K-12 teachers are telling us they need. This work represents our shared journey.”

To close, PIs explained that while this type of work can be challenging or uncomfortable at times, they are embracing the “mess” that comes along with the exciting possibilities that their project presents, noting that when working with humans, “we’re doing life as much as we’re doing research together.”

← Technology to Review Online Videos for Education (TROVE)

Exploring Artificial Intelligence-enhanced Electronic Design Process Logs: Empowering High School Engineering Teachers →

CIRCLS | Center for Integrative Research in Computing and Learning Sciences

Technology to Review Online Videos for Education (TROVE)

Claire Christensen, Senior Education Researcher at SRI International, shares more on her most recent NSF-funded project, EAGER: Technology to Review Online Videos for Education (TROVE) (#2139219).

Team: Anirban Roy, Sarah Gerard, Maddie Cincebeaux

Exposure to online videos through various digital media platforms has become increasingly prevalent among young children. In particular, YouTube has become one of the most popular video streaming platforms regularly consumed. Because there are so many online videos and they are released at such an astonishing rate, it is challenging to understand the specific content that children are exposed to. Together, Dr. Claire Christensen, an education researcher, and Co-PI Dr. Anirban Roy, a machine-learning (ML) researcher, have formed an interdisciplinary team to create a machine learning-based tool that can identify early mathematics content in YouTube videos.

What inspired your project?
With the portability of digital devices, it has become nearly impossible for adults, caregivers, or educators to monitor every video a child engages with on YouTube. This has made it challenging for adults to distinguish between educational and non-educational content consumption on the platform.

On average, approximately 500 hours of video content are released every minute on YouTube, and there are no existing automated approaches to classifying this content. Existing approaches rely on human reviews to identify video content, but it is difficult to keep up with coding a rapidly growing collection of YouTube content and apply those reviews to more broadly understand children's media consumption. To support children's healthy media use we need an efficient, accurate way to understand what they watch on YouTube. So we are working to develop TROVE, Technology to Review Online Videos for Education. It is a tool that will use ML algorithms to identify and better understand the mathematics content in online videos. In the future, researchers could use this tool to understand how exposure to different types of media content affects their development. And developers could use this tool to create or direct children to high-quality educational content online.

What are you most excited about or looking forward to accomplishing in the first year of your project and beyond?

Our prior internally funded research and development allowed us to work with parents and educators to pave the direction of the project. Now, in the first year of our NSF EAGER funding, the priority is to accurately train a ML algorithm to understand kindergarten- and preschool-level mathematics content in YouTube videos. Human annotators will use a rubric we developed to identify Common Core-aligned early mathematics content in YouTube videos. Then we will use their annotations to train a machine learning model and judge its accuracy. We will also have the support of an external advisory board that has expertise in children's media, learning sciences, and mathematics learning.

We envision several future applications for TROVE. For example, we have submitted a collaborative NIH/NICHD proposal around using TROVE as part to better measure children's media exposure and measure its longitudinal correlations with their academic, social-emotional, and physical development. Another potential future application is as a tool for parents, caregivers, or educators to get a more nuanced measure of their child's exposure than what they currently have access to (e.g., total screen time, name of videos, name of apps). Paired with research that looks at outcomes, TROVE could then be used to flag children's media use as a predictor of positive or negative outcomes and provide guidance to adults on interventions, if needed.

What do you foresee being your biggest obstacle to meeting this goal?

There may never be enough data to train the model, so we need to explore novel approaches to machine learning with small datasets. For ML researchers, education content is novel and nuanced in ways that other content topics are not. In education, you can teach a domain in a multitude of ways whereas more other machine learning tasks, like classifying objects, are more clear-cut. Human reviewers can identify the many myriad ways a video teaches a skill, but training an ML algorithm to be this flexible is challenging and requires a lot of data. And this challenge is part of why I love working on this project at SRI, with colleagues who are world-class ML researchers. Through this NSF grant we have opportunities to apply existing technologies developed in other fields to piece together the best possible approach to this problem. I can't wait to see what we learn!

Tags: Computer vision technologies, Machine learning, Math education, Media use

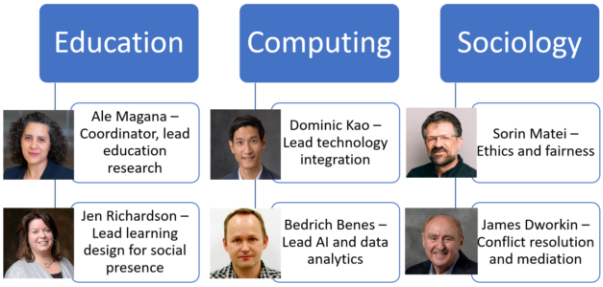
← Productive Engagement through Collaborative Action and Sociology (PECAS) Mediator

Transformative Computational Models of Narrative to Support Teaching Indigenous Perspectives in K-12 Classrooms →

Productive Engagement through Collaborative Action and Sociology (PECAS) Mediator

Alejandra J. Magana, Dominic Kao, Bedrich Benes, and Jennifer Richardson at Purdue University share more on their most recent NSF-funded project, Productive Online Teamwork Engagement Through Intelligent Mediation (#2113991).

The COVID-19 pandemic required a shift to virtual collaboration across professional and academic contexts. This shift inspired full time faculty members and researchers, Alejandra Magana, Dominic Kao, Bedrich Benes, and Jennifer Richardson, to develop tools that can help foster social presence, facilitate teamwork, and promote engagement in online learning within higher education settings.

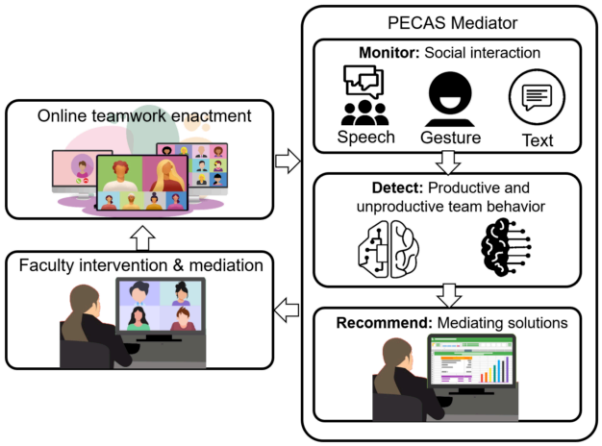


Team members, interdisciplinary expertise, and roles

What inspired your project?

The principal investigators (PIs) are faculty members with large class sizes ranging from 80 to 150 students. Being virtual, they experienced challenges in monitoring individual and team dynamics in their courses. Through these experiences they recognized a need for online learning environments that foster both effective teamwork and productive collaboration amongst students. Realizing this issue was a pervasive one institutionally led to the inception of their Research on Emerging Technologies for Teaching and Learning (RETTL) project: Productive Engagement through Collaborative Action and Sociology (PECAS) Mediator. This tool is currently under developmental stages to support course instructors and students in online learning environments through artificial intelligence (AI).

Currently, one of the few ways that instructors can assess overall teamwork and performance is by the quality of team project deliverables at the end of a course. However, these products do not provide information about the quality of the team's collaborative process. This lack of direct insight into the individual stages of a team project lifecycle makes it nearly impossible for instructors to intervene into and mediate team conflicts in a timely and an appropriate manner. Consequently, the inability to monitor collaboration across disparate virtual spaces makes it difficult for course instructors to guide student teams towards adopting practices that are tailored to their unique behavioral dynamics and ensure team success in collaboration and performance.



Project concept for PECAS Mediator to detect productive and unproductive team behaviors and recommend mediating solutions to faculty.

What insights do you want to share on your collaborations and partnerships?

After observing many instructors struggling with facilitating team building in unfamiliar remote learning environments, Dr. Magana leveraged her expertise in the teamwork literature in order to lead a conflict resolution training mid-semester to better support and facilitate collaboration among her students. With the creation of PECAS Mediator, course instructors will be provided real-time insights, through AI-enabled monitoring, into various forms of engagement that may contribute to overall team performance. This may include alerts on behaviors that may serve as potential flags of unproductive engagement within teams. These alerts allow instructors to provide timely and appropriate mediation and guidance to teams. It also offers an opportunity to further educate course instructors on appropriate ways to handle mediation for various behaviors amongst novice and expert learners within teams.

Actively teaching in higher education gives these researchers first-hand knowledge of students' experiences and feedback that can be incorporated in the project. However, they remain cautious about incorporating AI into their classes. Some of these concerns include: the potential for bias from or inaccuracy of algorithms, measuring outcomes based on engagement without feedback, and differing webcam quality and fidelity among students. These issues will be examined during the project. They also are concerned about their students' perceptions of using AI to detect issues during their collaboration. The PIs don't want students to be uncomfortable with the technology. The PIs emphasized that no personal data would be stored at any point; insights would always be captured at the group level and would never be linked to any individual.

What will be the impact of your project on teaching and learning?

This project provides an opportunity to contribute to the broader learning sciences community. Currently, there is extensive research on teamwork and collaboration, specifically in the context of pedagogical design, but there is limited literature on novice learner team behaviors within higher education settings. Further, the PECAS Mediator project will improve the learning experiences for students and course instructors by assisting faculty with monitoring and mediation, plus, the research will give insights about facilitation to increase productive engagement.

Tags: AI, Collaborative and/or participatory learning, Design-based research (DBR), Online learning