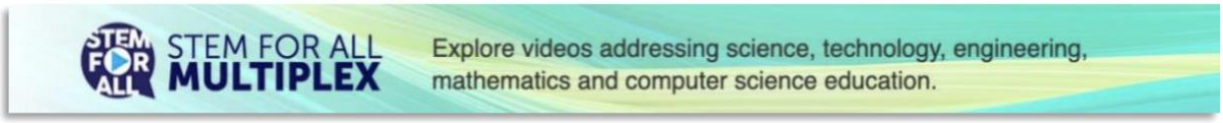

STEM for all Multiplex and STEMTLnet
February 2021 Theme of the Month
Integrating emerging technologies into teaching practice
Synthesis

The topic of this month's Theme on integrating emerging technologies could include a vast range of material. The moderators, Tom Moher, Emeritus Professor of the Learning Sciences at the University of Illinois and Wendy Martin, a Senior Researcher at EDC, usefully focused attention by choosing three bodies of work, which are exploring collaborative inquiry. The panel included three researchers: Noel Enyedy of Vanderbilt University, Emma Mercier, of the University of Illinois at Urbana-Champaign, and Jim Slotta, of the University of Toronto. The panel was completed by lead teachers Noelani Morris, Demonstration Teacher at the University of California Los Angeles Lab School. and Johanna Thompson of the Bernard Zell Anshe Emet Day School in Chicago. Researchers and practitioners shared their perspectives on both the design and implementation of new technologies within the classroom.

The integration of technology in education has always been an exciting frontier for pedagogy and learning science research. Generalized and highly optimistic claims about the value of technology for learning have also attracted empirical and philosophical critique. The moderators and expert panelists framed their presentations with two important criteria which eliminate many of the concerns that are raised about "educational technology" as a universal panacea.

The first is to focus less on particular innovative technologies and more on the processes of learning and teaching that may be supported by a learning environment that includes a particular tool as moderator Tom Moher said:

> ...the real issue isn't so much about the sort of inevitable adoption of a particular adult technology, but about the design and revision of new classroom activity structures, new ways of learning to leverage technologies....to me *that*'s what's emergent, it's not the technology. What's emergent is the way that they're used in context, the way that they create new learning activities and how they come to be.

The second criterion is to examine technologies that enable students to immerse themselves in the phenomena they are learning about, and to do it in a social setting.

> All of our projects today involve learning activities that try to leverage the physical space of classrooms and use technologies that are not owned by individuals, not personal sorts of technologies but are shared with classmates.

With both these criteria satisfied, the role of the teacher as innovator is salient. It is a commonplace by now that "educational innovation" fundamentally is implemented and interpreted by the teacher. Indeed, the teacher in many cases is the one who explores what the educational possibilities of a new technology actually are. While the long-standing challenge of connecting educational research to practice was mentioned more than once, the panelists shared an understanding that critical research is conducted *in* classroom practice — hence the Theme of the Month:" Integrating emerging technologies into classroom practice."
As was evident in some comments in the chat accompanying the webinar, teachers bring their own criteria and critique to their evaluation of new technologies. One teacher wrote,

I need the technology to provide a learning experience that can't be replicated without it. That might be a depth of comprehension or a degree of engagement that leads to a long-lasting desire to continue to think about the concept.

Noel Enyedy elaborated on this comment from his own work with teachers:

> ..emerging technologies often provide multiple entry points for students with different strengths. Kids who were not always successful in but-in-chairs lessons really could shine in these spaces, but kids who were good at 'typical' school also could find ways to be successful here.

Example 1: Kids become the phenomenon

Noel Enyedy told us about BeeSim, "a world where kids become bees to study pollination." The children take on roles of honey-bees and flowers. The children are equipped with sensors that report their position and motions and display the activity on a large digital display. At an age-appropriate level, the children can explore both the role of flowers as attracting resources, and the bees as foragers, pollinators, and collaborators with the other bees in their "hive."

> This is really the key point of the talk about the pedagogy is kids are... are investigating this phenomenon by becoming the phenomenon that they're interested in. It's based for me, strongly on the idea about embodied play, of running around in a physical space and taking on particular roles. And why that's important to me is, is play for me is not necessarily defined best by a type of activity that you do, but an orientation you take towards your own activity.

Dewey in *Democracy and Education* points out that "persons who play are not just doing something (pure physical movement); they are trying to do or effect something, an attitude that involves anticipatory forecasts which stimulate their present responses." Such play when it is engaged with interesting phenomena, stimulates reflection and inquiry. In BeeSim, children are enabled by the technology both to enact their "embodied simulation" as bees and flowers, but they can also see the whole dynamic web on the public display. This dual view enriches the learning possibilities. As Enyedy observed,

> One amazing thing that happened was that the teachers and the students just took our project as a spark for further inquiry and for action—they spent months after we left building pollination gardens to save the bees.

Finally, he pointed out that this deeply interactive activity stimulates affective engagement:

> It begins and ends with emotion... the type of science that we need kids to engage in can no longer be this cold disembodied type of science, but it needs to be a warm and emotional science.

Noelani Morris, a teacher-collaborator with Enyedy, described how the BeeSim environment was rich enough that it could support sustained, valuable learning that often followed unexpected paths, reflecting the children's interests and questions. As the experience unfolded, other disciplinary content — art, for example — took a natural part in the students' activity.

Example #2: Supporting collaboration and the teacher's role

Emma Mercier contributed observations drawn from projects with middle-school students and with undergraduate engineering students, and with graduate students. The common thread consisted of shared displays used to support and facilitation collaboration. With the 10- and 11-year-olds, individual or small-group work was aggregated onto a large screen or dashboard "driven" by the teacher. Middle school students were happy to use a shared, projected display of their work, for group discussion, but the system did not translate well to the post-secondary classroom: "There was a sort of weirdness about publicly displaying your work at

that scale that seemed to be problematic." These students worked better with linked tablets that enabled all the students in a group to see a common display, but in a less public environment.

Such results led her team to an exploration of "device ecology" which includes both the actual hardware/software tools and their deployment, and the specific needs or preferences of different users in the system. This includes the ways that the environment supports or encourages student discourse about tasks, methodology, and data, but they have paid increasing attention as well to the teacher's role and needs.

This led to investigations of teachers' pedagogical repertoires and preferences, not only with regard to monitoring and moderating the flow of a lesson, but also with regard to the acquisition and display of data analytics. What data do teachers want, and how can it be made available in usable form to support teachers' instructional decision-making?

> This is the framework that we use a lot of the time thinking about how do these pieces fit together in a classroom: The teams, the teachers, the technology and the tasks. Putting the four things together is essential and a lot of the times changing one piece changes everything else.

Example #3: Designing curriculum so students work as a learning community

Jim Slotta introduced his segment with a reflection on the core question in his research:

> How can we design curriculum so students work as a learning community? Can this approach help students learn more than just content, engaging them in authentic practices, discourse, and epistemic positions? How can the learning environment, both physical and technological, actively scaffold student and teacher interactions? What's the role of the teacher in guiding these activities and how can these new forms of media help?

Such a community is characterized by the students being "a primary resource for the curriculum," producing the knowledge with which they will work to investigate authentic questions, developing a shared discourse both about the content that is the focus of their study, and about their epistemological methods and values. In the approach that Jim and his colleagues are exploring, which can be called "embedded phenomena," the researchers and teachers create an immersive environment that is rich enough in digital and other phenomena to support sustained investigation. An example he gave (and showed video of) is this:

> Imagine that you told the kids that there's insects living and thriving in these various habitats around the classroom, behind the walls you cannot see them, but they're in there. And if you put a special computer monitor on the wall it's like an x-ray vision into the wall. And there's different kinds of habitats in there like hot water pipes and cold water pipes and brick and plaster, and the walls might vary in their temperature. And the kids don't know anything about these ecosystems or these habitats or the creatures and the creatures might have life cycles but they're going to try to find out and the teacher's going to try to help them find out. They're going to work as a community to gather information about who's eating who and where do certain species thrive?

Johanna Thompson commented:

> I think the kids...want to be inspired just like we do. They want to know that the reason they came to school today matters, and that we're not going to waste their time. ...When I think about like the things that students need, both like for their hearts and their joy of learning, and as well as the idea of technology, those collaboration spaces are great. I think we can never go back to a world where video isn't a part of the way we collaborate or the students wanted video this year.

In reflecting on teachers' and researchers' emerging lessons from these emergent technologies, she added

you could manipulate an environment and you could make a choice with certain predictions for an outcome, and then find out if you were right or not, and then decide what that means as a group, and then realize that someone else did the same experiment. And they came up with a completely different reason for what that meant, that's the kind of magic that I would see with my students when they would argue over, "No, they don't eat. That doesn't eat that because look at this evidence, and this does

Jim Slotta added:

I don't think any of us really understood the new sort of timbre of learning the new discourse patterns, the new epistemic commitments, the new ways of being in the classroom that we were... We knew these were there, but we just didn't know what they were.

The presentations by the expert panel used examples from their work in design and implementation to argue for a fresh learner-centered approach to education technology integration. This approach focuses less on what the tools afford to learners, than on what becomes possible in the classroom ecology when the tools are present. Environments that immerse the students in rich phenomena, and indeed sometimes blur the lines between learner and phenomenon, can engage students affectively and imaginatively with "worlds" and representations that naturally lead to questions, and are rich enough to explore for answers. The additional design commitment to foster the growth of learning communities enables authentic discourse about the content, but also about the inquiry process as it unfolds, and the meaning that is being made. Finally, all three examples see teachers, and researchers themselves, as part of the learning community. The approach presented by the expert panel argues that it's not only the technology that is emergent.

After the main presentation, break-out groups enabled participants to discuss questions and insights stimulated by the presentation, and the recommendations below reflect the richness of the conversations that were reported.

Recommendations for teacher-leaders

The expert panelists encouraged teachers and schools to seek out collaborations with researchers who are investigating emergent technologies, and participate in the studies, taking advantage of the growing realization of the benefits that "practice" can render to "research."

In such collaborations, teacher-leaders can work with their colleagues to articulate the educational values they are seeking to address. In this way, they can look for innovations that fill a pedagogical need (as opposed to taking up a new technology, and trying to find out how it serves their intentions). This supports teachers' commitments to equity and community.

Recommendations for researchers

Design your research bearing in mind that, as Jim Slotta said, "The teachers are going to keep innovating beyond what we do. We're just kind of poking around with new forms of interaction and understanding things, but they're really on the ground doing the work in the classroom."

How can we look not just for growth in specific content areas or skills, but patterns of growth in student understanding, and in the development of community discourse about shared inquiry? What kind of data and analyses will allow researchers to probe such questions, and how can the technology serve the researcher in such investigations?

"What have we learned about learning and teaching and how can we actually move that out into the field?" Logistical issues with new technologies are real issues. When a new technology is showing promise in the research phase, issues of cost, access, equity, and scalability will shape whether or how the new environment can be available to teachers beyond the field test collaborators — allowing for them to add insights about the

nature of the innovation. Such logistical issues themselves can drive fruitful research about efficacy, robustness, teacher learning, and social equity.

Recommendations for policy-makers and administrators.

As with all pedagogical innovations, teachers taking a lead need support from their schools and systems — most often in flexibility to allow for different scheduling or classroom rhythms, as well as support needed for active collaboration with research partners.

Consider helping your teachers gain capacity as classroom researchers themselves (see background information, and this *Educational Researcher* article for an overview of the teacher-researcher movement).

Support teacher learning and teacher research in your system by ensuring regular times for teacher collaboration and conversation about research topics arising from their experimentation with emerging technologies. Such topics might include investigations of the science being taught, the impacts and uses of the technology, innovations in pedagogy, and benefits and challenges of the new tools for differing students and for teachers.

Written by:
Brian Drayton,
Co-Director for the Center for School Reform at TERC.