LINKS

LESSONS, INNOVATION & NEW KNOWLEDGE IN SCIENCE

FALL 2021

MICHIGAN SCIENCE TEACHERS ASSOCIATION

THE OFFICIAL MEMBER NEWSLETTER OF THE MICHIGAN SCIENCE TEACHERS ASSOCIATION

TABLE OF CONTENTS

A COVID Retrospective: Learning Can Happen, Even in a "Lost" Year

Marcia Goodrich, Lara Minnear and Darci Merillat | Mi-STAR

In March 2020, as a storm of classroom closures swept across Michigan, many predicted a lost year for students. But, two Mi-STAR teachers discovered remote learning has some surprising advantages, and even a COVID cumulonimbus can have a silver lining.

More Individual Attention

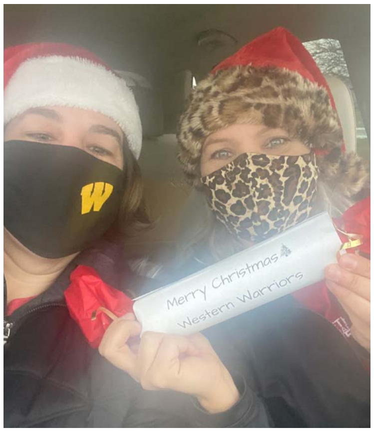
With students scattered throughout the school district, it's counterintuitive that remote learning could lead to more one-on-one instruction. But new technologies, such as Zoom and Google Classroom, provided a unique platform for individual attention.

Lara Minnear is a seventh grade science teacher at Creekside Middle School, in Zeeland. "Last year was tough," she said, but there were bright spots. Zoom breakout rooms in particular provided opportunities: "I could let students who could do their work alone fly, and I could meet anyone who was struggling in another breakout room and help them through it."

Students used the online program Classkick to record their notes, allowing Minnear to check their learning in real time. "I could see who needed help and make comments right away," she said.

Darci Merillat, who teaches sixth and seventh grade science at Bay City Western Middle School, in Auburn, had a similar experience. Zoom breakout rooms gave teams a good place to get together as a group. With most students working in those groups, Merillat was free to spend more time with individuals who were having trouble. "There isn't the time for that in a classroom that there is in Zoom," she said.

The individual attention extended beyond class hours. "Relationships with our students became beyond tight. We could call them, even drive to their homes," said Merillat. "I never have time for that in the regular school year."



Darci Merillat (right) and colleague delivering cookie dough while checking on disengaged students.

She and some of her fellow teachers began bringing cookie dough (baked cookies were out due to pandemic restrictions) to the homes of students who seemed disengaged from class, checking in with them and getting to know their families. This allowed the teachers to address any attendance problems and "charge them up about learning." Occasionally, families worried their students were having that "lost year," and the visits provided a chance to address their concerns. "I could tell parents their kids were soaring online," Merillat said.

Mastering New Technology

The sudden switch to remote learning meant abandoning the hands-on, discussion-based classroom model. The first step was to convert lessons to a format that could be delivered online. As a Noyce Fellow, Merillat was able to leverage support from Michigan Technological University's Robert Noyce Teacher Scholarship Program. She helped lead an all-out effort to convert many middle school science lessons, including much of the Mi-STAR curriculum, to a remote learning format using carefully designed slide guides that she and her Mi-STAR collaborators prepared and later shared with others via the Mi-STAR Learning Series.

Funded by the National Science Foundation, the Noyce program supports promising teachers interested in taking leadership roles in the STEM education community.

Adapting the Mi-STAR curriculum for remote learning was a big challenge, and the results justified the effort. Not only did teachers get the materials they needed, they also received training in online tools. "Wow, did we learn about programs, new ways of delivering lessons to kids, and reaching out to kids in ways I don't have time for in the classroom," Merillat said. "I've learned a whole lot of programs I can't live without now."

Minnear, who describes herself as, "not a tech person," struggled in the beginning. Then she found help, first from her district's intensive training program, then from Mi-STAR.

"They had so many resources and so many activities we could do remotely," she said. Plus Mi-STAR offered its ***Learning Series***, Zoom meetings that let teachers share ideas and ask questions. "I felt like I wasn't alone," said Minnear. "I could put a question out there, and I'd get an answer. I really appreciated that." The Mi-STAR Learning Series was created during the pandemic to provide a new way for Mi-STAR teachers—and others—to collaborate and support one another. Funding provided by the Michigan Department of Education, through the MISTEM Advisory Council grant process, helped to make the Learning Series possible.

Lara Minnear, a seventh grade science teacher at Creekside Middle School, uses a variety of technologies to connect with students, even when teaching face to face.

As the pandemic progressed, students gained a suite of new skills, quickly becoming proficient with workplace technologies like slides and Zoom—sometimes more proficient than their teachers. "My colleagues would come up to me and say they hadn't known how to do something online, but a kid from my class had taken over and shown their whole class how to do it," Merillat said.

Cooperation and Camaraderie

As natural disasters draw communities together, coping with COVID seemed to bring out the best in some students. Merillat selected a small number to serve on her co-gen group, a focus group that provided advice on the remote curriculum. "They were so good about giving feedback," she said. "They'd say, 'That was good' or 'That was boring, maybe we could do this instead.'" Kids she'd never thought of as leaders showed pride in serving, and they ended up participating more and volunteering in class. The student advisors were so enthusiastic they kept meeting after classroom-based learning resumed and threw a year-end celebration for the entire school.

When Merillat began the 2020–21 school year, she made a promise to herself: "I'm not going to have a year where people say, 'Your kids lost a year of school.'" By the end of the spring term, she had kept that promise. "It was a good year; it pushed me personally. Yes, there were some who didn't attend, but that was two out of 150. Overall, my kids had huge gains."

Finally, one of the best things to come out of the "lost year" has been that students actually want to be in school. At one point after regular classroom instruction resumed at Minnear's school, heavy snow was predicted. "Every single class said they didn't want a snow day; they wanted to be in school," said Minnear. "I've never had that happen before. They realize this is a good place to be."

Looking Forward: Remote Learning Reveals New Tools for F2F

Some of the new techniques and technologies adopted during the pandemic worked so well that these two Michigan science teachers are adding them to their face-to-face teaching toolbox. Lara Minnear is a seventh-grade science teacher at Creekside Middle School, in Zeeland. Darci Merillat teaches sixth and seventh grade science at Bay City Western Middle School, in Auburn.

Absences Solved with Google Classroom, Pear Deck

Courses built in Google Classroom have virtually everything a student needs to catch up with the rest of the class, said Merillat. With Pear Deck, students can also delve into discussions. Plus, parents can see what's going on in class. "I wouldn't be without those pieces again," she said.

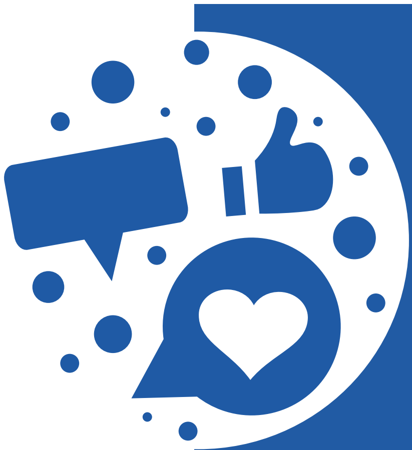
Remote Learning Plans: Perfect for Subs
Mi-STAR's remote learning plans can double as lesson plans for substitute teachers, said Minnear, adding, "We can also give them to kids who will be gone for a week."

Classkick
"I always swore I wouldn't give up my notebooks," Minnear said. "But I did." The app, which lets teachers track student work in real time, lends itself equally well to F2F classroom instruction.

Virtual Tools
Not every home is equipped with basic tools found in a science class. Merillat discovered a virtual ruler app, as well as other surprises. "You can use your smartphone to measure how far you throw something," she said. Mi-STAR's online simulations prompted her to look for more. "I'm putting these tools and simulations in a folder in Google Classroom so everyone can access them."

Zoom
Even with classrooms open, Zoom remains a great tool for connecting with students who can't be at school, with an added bonus. "I can meet with a parent on Zoom and walk them through our class," said Merillat. Last year, she held a Zoom version of Curriculum Night, when families are introduced to their students' classes for the upcoming year. "I had parents say they wouldn't have had time to attend otherwise," she said. "I'd like to use Zoom for this moving forward." Not everything worked; Minnear and Merillat both reported that Zoom breakout rooms did not transfer well to the classroom environment.

Building Relationships and Community
Merillat is keeping her co-gen group of student advisors as a regular part of her classes and is thinking about continuing her cookie-dough diplomacy (see "COVID Retrospective") to connect with students and families on their home turf. Minnear will continue leading an after-school Zoom cooking class that proved popular with her students—and also their families, who were thrilled to have dinner ready when they came home from work.



Driving the Learning Process Through Inquiry

Jamie MacPherson | Van Andel Institute for Education

"There is a time, much greater in amount than commonly allowed, which should be devoted to free and unguided exploratory work (call it play if you wish; I call it work)." – David Hawkins

When most of us hear, "inquiry-based learning" we tend to think it requires a complete overhaul of the work we are currently doing. But what if this isn't the case? What if by making a few adjustments in the daily work we're already doing, big changes in student learning suddenly become possible?

Think about the first time you created something from your own imagination. Perhaps it was a robot constructed from assorted Legos or spare parts. A miniature car or jet that sent you racing through the house amid an imaginary adventure. What about a time you tried your hand at the culinary arts? Mixing lemonade to sell on the sidewalk or baking brownies for a charitable event. Do you remember the shaking, the measuring, the tasting and stirring which formed the backbone of that experience?

So much of our childhood is spent learning through play. Then at some point, we put away the "toys" and pull out the textbooks. But...why? The pursuit of knowledge is often indistinguishable from messing about. Through unstructured pursuits, students build an apperceptive understanding for a subject, and have opportunities for surprise and discovery. More importantly, it opens the door to further exploration and growth. Simply by asking, "What do you wonder?" we can create a foundation for inquiry-driven learning.

Four Small Ideas to Consider

1. **Students don't know the "answer" they are supposed to get.**

Curiosity is a powerful catalyst for learning. When we can pose a question that is open-ended and allows for multiple "right" answers, determined solely by the direction each student or group chooses to take, that's powerful and meaningful learning. So, ask big questions and give minimal direction. See what happens. It involves a bit of risk for you and your students. But by taking the leap, the opportunities are endless as to where they may land.

2. **Students play a driving role in determining their process for learning.**

Learning is all about engagement. When we release authority and hand the reins over to our students, engagement is inevitable. Why? Because now they feel their learning is powerful and purposeful. Once the question or problem is posed, leave it up to the students to navigate their process for learning. This takes a fair amount of modeling, answering questions like, "Where can I go to find information about ___?" and "What do I do once I find the information I am looking for?" along with many others. But think about the high levels of inquiry that will ensue when students feel like they have agency over their process for learning.

3. **Teachers and students construct meaning together.**

As a teacher of inquiry-based learning, it is essential to provide our students with the tools in which students can formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment. And, of course, give them clear guidance on how to use them. One of the most powerful ways to construct meaning is through journaling. This gives students a place to record the thought processes they are engaging in and document what they have discovered. It is a great tool to use for formative assessment and provides a wealth of opportunities for the teacher and the student to interact with information together.

4. **Students are working as hard as the teacher.**

Ready for some straight talk? Stop being the expert. As teachers, we fall into this trap oftentimes where we feel we must be the information provider. There is a time and place for this type of instruction but seek out opportunities where you can turn this work over to your students. When they have a question, it's okay (in fact, powerful!) to say, "That is a good question. How could we find the answer?" and open up a time and space to fulfill their curiosities. But ultimately, let them do the heavy lifting. This is one of the best ways to ensure that we are developing problem-solvers and life-long learners.

Jamie MacPherson has thirteen years teaching elementary students and currently works as a Learning Solution Specialist at Van Andel Institute for Education. VAI is an education nonprofit which seeks to empower teachers and build classrooms where curiosity, creativity, and critical thinking thrive. To learn more about Jamie's work, visit VAI.org.

MICHIGAN SCIENCE TEACHERS ASSOCIATION
PARTNERSHIP PROGRAM

Michigan Science Teachers Association Partnership Program Gains Momentum

Brendan Dwyer | Michigan Science Teachers Association

The MSTA is pleased to announce its newly re-imagined Partnership Program is beginning to gain traction, welcoming numerous members over the programs opening weeks. The Program, which began at the end of August 2021, significantly builds upon the previous member opportunities available to state science centers, zoos and natural areas to better unify Michigan's science attractions with our state's science educators.

For an annual fee of just $50, state science related attractions may now share their unique event programming, scientific findings, special group offers and more on the MSTA website, our digital communications pieces and at our annual conference. Specific offerings of the partnership include the ability for individuals at state science attractions to submit articles to the monthly eNewsletter and LINKS publication, opportunities to attend and exhibit at the MSTA Annual Conference and much more.

This new partnership is an invitation to science attractions across the state to establish their organization as a science education destination for school-groups, establish their staff as experts in the industry and as a forum to share thoughts, successful programs and innovative experiments in MSTA print and digital communications pieces. The clear and distinct benefit to Michigan Science Teachers is the influx of new science information, experiments, classroom activities, field trip ideas as well as potential personal connections and new relationships within the science community.

Do you know of a Michigan science attraction that could benefit from the MSTA Partnership Program? Take the initiative to invite them to share our vision for the advancement of science education in Michigan by joining the MSTA Partnership Program today!

For more information reach out to us directly by calling 734-973-0433 or email ***office@msta-mich.org***.

Engagement Profiles as Framework for Thinking About and Supporting Student Engagement in Science

Matthew J. Schell, Vicky Phun, Jennifer A. Schmidt | Michigan State University

Nearly all educators agree that highly engaged students are essential to quality learning. Indeed, some researchers have called engagement, "the holy grail of learning," (Sinatra et al., 2015), and engagement is an important anticipated outcome of NGSS instruction. What does it mean for a student to engage in learning? Definitions of engagement are often broad and varied; yet most scholars agree engagement is best described as having multiple subtypes, or dimensions, including: affective (what students are feeling), behavioral (what students are doing), and cognitive (what learners are thinking, Fredricks et al., 2004). Each of these dimensions can be high, moderate, or low, in various combinations, depending on the learning situation. We refer to these various combinations as engagement profiles. For example, a student might be enjoying an activity (high affective engagement) and working hard at it (high behavioral engagement), but may not see the activity as important or valuable to them (low cognitive engagement): We call this particular profile recreational engagement (see Figure 1 for the engagement profiles we identified in our classroom research).

Our research in science classrooms involving diverse students in grades seven through twelve indicates that having high engagement in all three dimensions (full engagement) is the most advantageous pattern of engagement. Students who are more often fully engaged in this way earn higher science grades, are more likely to consider pursuing a STEM career after high school graduation, and aspire to pursue higher levels of education (Figure 2). Recognizing engagement as a complex and multidimensional phenomenon enables teachers to target their efforts towards those dimensions that need support.

For instance, students who recognize their science learning is important, but are not working hard or enjoying their learning activities need different engagement supports compared with students who are working hard, enjoying their learning activities, but see them as having little importance.

One question teachers often ask us is, "How can I more fully engage my students across all dimensions?" Our research in science classrooms demonstrates that students are most likely to be fully engaged when their teachers do the following three things: 1) emphasize the **relevance** of what they are teaching; 2) give students the opportunity to **apply their knowledge** in practical ways; and 3) express their **enthusiasm** for the content (Figure 3). In the classrooms we studied, certain activities like independent seatwork tended to elicit the low engagement profile among students, with low engagement across the affective, cognitive, and behavioral domains. However, our results also suggest that how a teacher facilitates an activity (in terms of enthusiasm, relevance, application, etc.) may be more important in determining students' engagement than specific activities per se: In other words, seatwork (and indeed many other classroom activities) can be structured in a way that is more (or less) supportive of full engagement.

To learn more about this multidimensional framework for science engagement, please check out our website at ***https://www.engage-students.com/***. We offer a series of videos describing the different patterns of engagement, provide resources for teachers to reflect on their students' engagement, and describe strategies that support student engagement across multiple dimensions in science.

References

Conner, J. O., & Pope, D. C. (2013). Not just robo-students: Why full engagement matters and how schools can promote it. *Journal of Youth and Adolescence*, 42(9), 1426–1442. https://doi.org/10.1007/s10964-013-9948-y

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*, 59–109. http://doi.org/10.3102/00346543074001059

Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The Challenges of Defining and Measuring Student Engagement in Science. *Educational Psychologist, 50(1).* https://doi.org/10.1080/00461520.2014.1002924

Acknowledgment

This work was funded by a grant from the National Science Foundation, DRL #1661064. Any opinions, findings, conclusions, or recommendations expressed in this manuscript are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Figure 1. Engagement Profiles Identified in Our Research

Profile name	ENGAGEMENT DIMENSIONS		
	Affective (interest and enjoyment)	Behavioral (concentrating effort and working hard)	Cognitive (important to self and future)
Full	↑	↑	↑
Purposeful	↓	↑	↑
Recreational	↑	↑	↓
Busy	↓	—	↓
Rational	↓	↓	↑
Moderate	—	—	—
Detached	—	—	↓
Universally Low	↓	↓	↓

Note: Several of the profile names used here were originally proposed by Connor & Pope (2013)

↑ High — Moderate ↓ Low/absent

Figure 2. Educational Outcomes Associated with Different Engagement Profiles

Note: Several of the profile names used here were originally proposed by Connor & Pope (2013)

Profile name	Learners who spend more time in profile are likely to ...		
	Earn high science grades	Consider STEM career	Set higher education as a goal
Full	✓	✓	✓
Purposeful	✓	✓	
Recreational	✓	✓	
Busy	✓		
Rational		✓	
Moderate	✓	✓	
Detached	✓		
Universally Low			

Figure 3. Student Engagement in Different Instructional Practices/ Activities

Note: Several of the profile names used here were originally proposed by Connor & Pope (2013)

Profile name	Learners are more likely to be in profile when educators ...				
	Emphasize relevance	Give opportunities to apply knowledge	Express enthusiasm	Assign a test	Assign independent work
Full	✓	✓	✓		
Purposeful				✓	✓
Recreational		✓	✓		
Busy					✓
Rational		✓			
Moderate	✓	✓			
Detached			✓		
Universally Low					✓

Pandemic Prof: What I Learned as a New Adjunct During COVID-19

Jordan D. Smith, M.A. Sci. Ed. | Teacher of Natural Sciences, St. Patrick Catholic School, Portland, MI & Affiliate Professor, Spring Arbor University, Spring Arbor, MI

Making the Jump from High School to Higher Ed
After 10 years of teaching science to high schoolers at a college-prep Catholic school, I went into my first experience teaching undergraduates with what I thought was a good idea of how to do the whole professor thing. I needed to be tough, and authoritative, right? How hard could teaching meteorology and planetary science to pre-service teachers be? As it turned out I had a lot to learn too.

I finished my master's degree in fall 2019 with the aspiration of taking on teaching part time at a community college. Thankfully, my hopes didn't come to fruition right away. When March 2020 rolled around, I, like teachers across the country, found myself suddenly learning to teach completely online. As it would turn out, that trial under fire experience would be invaluable as I got my shot teaching undergrads for the first time the following semester and not at a community college, but at my alma mater, which was even better than I had hoped for. That semester was fall 2020, the pandemic semester. This is what I learned.

Be Intentional About Putting Students First
Making small talk with students has never been my strong suit. However, this year I made a concerted effort to really do so. With my college students, this was really important as we navigated the various learning challenges the pandemic threw our way. As a result of learning about student's lives outside the classroom, I was able to help student athletes balance competition and class. I was able to support a non-traditional age student expecting a baby and another recovering from surgery. I also was able to help a student with learning disabilities find a way to succeed in a class they thought certain to fail. After considering the tough authoritative tack, I quickly realized honesty and authenticity was a better tactic. Afterall, as I was teaching pre-service teachers I wanted to not only teach them the science they needed to know, but also model how to be a teacher. Part of that I've found requires being a bit vulnerable and open with students when you don't know or are confused. Sharing honestly that I was new at teaching college helped create a "we are all in this together" mentality for the class, which made a big difference.

Students learn best from teachers who they know care about them. It sounds like a cliche, but it is true. Amid a once in a lifetime (hopefully!) global pandemic, supporting students emotionally has never been more important. Knowing student's life situations allows you to put students first. Although my class met in person, from the beginning I had a few students who were in quarantine and needed to attend via Zoom. Having had experience with Google Meet I saw no problem with this.

I was surprised when I heard that some professors fought allowing attending via Zoom and really insisted that only students specifically ordered to quarantine could attend class remotely. This struck me as strange to choose that hill to die on. Whether it is a student athlete, a student with health concerns, or non-traditional students with difficult work schedules, if students want to attend class and we have the technology to make that possible in a way that accommodates their life situations, we should.

I also realized that my strict adherence to deadlines was not in the student's best interest. The policy I had with my high school students of accepting late work no more than 24 hours late for partial credit very quickly went out the window. In dealing with students navigating quarantine and distance learning offering flexibility in due dates made a big difference in students being successful. Some students struggled to get work in with the absence of hard deadlines, but ultimately the experience of working with flexible deadlines that requires prioritization and planning is something that will serve my students well in the future. This flexibility also helped build a feeling of trust I found resulted in students more freely reaching out for help. Instead of racing through material that had to be covered and rigidly adhering to due dates, I relaxed and let the students work in a way that recognized the fact they have lives and other responsibilities. I don't think I'll ever go back to doing that the old way, even post pandemic.

Be Strategic with Technology and Time
As the class I taught was set up as a hybrid course, I knew right away I would have to be very intentional about using the online portion of the course to make sure it was useful for students to advance their learning. After meeting two hours in person one evening a week, students would have about two hours of online instruction asynchronous throughout the remainder of the week. This format was new for not only me, but also my class.

To make the best use of our in-person class time, I thought about what I could do most effectively in person that couldn't be done as well online asynchronously. I decided the one thing that needed to be prioritized was lecture time in person. After recording video lessons for my high school students during the spring of 2020, I realized this format doesn't allow for the informal give and take you get when standing in front of a class teaching. You can't see student expressions and see if they are "getting it" and adjust on the fly to keep students engaged. You can't share that off-the-cuff anecdote or take those wonderful rabbit trails after a student question. In other words, recorded lectures lose much of the best of what is the art of teaching.

With in-person class time dedicated for lecture, I decided the asynchronous online portion was best used for taking what we learned beyond the classroom walls. So I had students doing things like reading science in the news, exploring the societal implications of what we were learning on discussion boards, and making observations of the weather outside the dorm window. Those learning activities didn't need to be done synchronously. Using this format also had some surprising results. For instance, I found for many students who were quieter in class, they really opened up in discussion online!

Since most weeks I had at least some students attending via Zoom, recording the Zoom feed became a normal class routine. This had the added benefit of allowing me to share that recording on Blackboard for students who missed class and for one reason or another, couldn't attend via Zoom either. I later learned I had some students who would go back and revisit the recorded lecture to help review, which was

an unexpected benefit of that technology that I didn't plan for. As a part time faculty member, only on campus once a week I found that Zoom also allowed me to have more availability to meet for office hours than I would have otherwise. For many students, this format also was a bit more accessible. It's something I plan to continue even when I am on campus more in the future.

Be Inventive in Making Learning Engaging
Keeping students learning and engaged despite the stress and uncertainty of living during a pandemic required some serious creativity. On the upside I found the new format of a hybrid course and the regular pace of shifting health guidance surrounding attending college during a pandemic made a lot of students more receptive to trying new things in general. This also meant if something didn't work out there was less pressure; I could easily admit failure and try something new.

One thing I found especially important is to get students outside and off screen. For instance, I had students record and analyze weather observations outside their dorm. At another point in the semester, students tracked and sketched the gradual changes of the moon phases from night to night. Perhaps the most challenging outside assignment I gave students was a scavenger hunt to photograph and identify as many different types of clouds as they could over the course of a two-week period.

Tying in student interests and pop culture, I had students analyze a science fiction movie or tv show for it's accurate (or not) depiction of space exploration. I also found that giving students choice in how to demonstrate their learning is just as important for undergraduates as it is for younger students. For instance in learning about severe weather some students made public service announcements about how to stay safe in a weather emergency of their choice. As most of the students in my class were preservice teachers, some wrote emergency preparedness plans for the severe weather most likely to impact a school.

Conclusion
Looking back on my first experience teaching college students I realize now it wasn't what I expected. It was challenging, but incredibly rewarding to help prepare students, especially pre-service teachers. Over the course of the semester, I think I learned as much as my students did. I learned to be flexible and prioritize student relationships. I learned to put the most important things first in in-person learning and to strategically use online class time. I learned to flex my creative muscles to keep students engaged and learning despite disruptions. Since then, I have been promoted to Affiliate Professor and am teaching several more classes this fall so I must not have screwed up too bad. And, while I wouldn't have chosen to have my first college teaching experience during a global pandemic, I learned to be a "pandemic prof" and I know I can handle whatever comes next.

Programs & Science Education

Waste Management Update on Recycling

Susan Robinson and Kathleen Klein

WM indicates outlook for recycling is strong as the company invests in technology due to growth in domestic demand.

WM is the largest recycler of post-consumer materials in North America, handling over 15 million tons per year at approximately 150 processing facilities (including recycling and organics), thus the company finds a recycling or beneficial use market for 42,000 tons of material every single day of the year.

Recycling is the most important service WM provides to help its customers reduce their own environmental impact. The company continues to make investments to increase services for all materials with viable end markets. For the fourth year, WM will invest over $100 million per year in recycling infrastructure – in 2021 this number will exceed $150 million. In addition, the company has added five new materials recycling facilities (MRFs) in the last two years and is upgrading 20 MRFs today. By 2023, roughly 90 percent of WM's tons per year will be recycled at MRFs with the latest technology.

Recycling has evolved over the years with some significant challenges over the past few years. However, because of these challenges, the recycling industry is in a better place in 2021 than in 2011. Recycling has once again proven its resilience, adapting to changes in global market conditions. As a result, the industry also began to make serious investments in technology to improve quality to support end markets and increase efficiency, which was especially important with the impacts of COVID as well as labor shortages the industry was facing.

End markets for recyclables play a critical role in the sustainability of recycling programs. Since China's retreat from the import market in 2018, domestic markets have slowly come online – particularly for paper and plastic. New and expanded paper mills in the U.S. are using more curbside mixed paper and cardboard, while the growing economy in the U.S. and the growth of e-commerce further bolsters fiber markets.

At the same time, pressure on the plastic industry has increased demand for most plastic bottles. In fact, HDPE (#2 - natural colored milk jugs) is the highest value item in the recycling bin today. Manufacturers that have made commitments to using post-consumer content in bottles to reduce GHG emissions and marine debris are stepping up to purchase more post-consumer plastic.

For the first time ever, the value of plastic exceeds the value of aluminum. Plastic water and soda bottles (#1 PET), HDPE and Polypropylene bottles and tubs (#5 PP) make up 30 percent of the commodity value of materials sold at WM MRFs.

Other types of packaging are under pressure, driving demand for metals and glass, and WM is continuing to encourage recycling for all its customers.

Highlights for 2021 Recycling at WM

- **The domestic recycling industry has adapted and grown stronger** as a result of the global market reset of 2018-2020 – and it is now growing as the economy reopens.
- **National and state climate goals are increasing the pressure to reduce GHG emissions.** Recycling will play an important role in achieving U.S. climate goals.
- **Environmental impacts are increasingly being considered**, in addition to recycling rates.
- **Domestic markets have adapted**, and MRFs are investing in technology to ensure high quality recyclables are sold to discerning end markets.
- **State and local governments are adjusting programs based on market realities.**
- **Most residential plastics are being processed in North America.** None of the plastic from residential programs processed at WM's single stream MRFs is exported.
- **Post-consumer content matters.** Brand commitments have helped push post-consumer plastic values to record high levels.
- **New technologies will play an important role in solving for hard-to-recycle materials,** but solutions are years off from being commercialized/available at the scale needed in the U.S.

<u>Here's what you can do:</u>

1. Shop for products made of recycled content and support the remanufacturing processes/services.
2. Buy items with less packaging
3. Buy refillable, reusable containers
4. Bring reusable cloth or canvas bags to the grocery store
5. Buy only what you need or what you know you will use – to reduce waste, this applies to food as well, 40% of the food we use resources to grow gets wasted.
6. Tie plastic bags in knots before placing them in the trash, this keeps them from filling with wind and blowing into the natural environment and remember - do NOT put them in your recycle bin
7. Ask to be removed from paper junk mail and catalogue mailing lists
8. Repurpose, reuse or repair items
9. For unwanted used electronics, try upgrading the device to continue using it, otherwise, donate or recycle it at an e-waste recycler
10. Print on both sides of paper and remember - buy recycled paper
11. Compost your food scraps and yard waste
12. DON'T BE A WISHCYCLER! RECYCLE OFTEN BUT RECYCLE RIGHT! MAKE A DIFFERENCE TODAY!

If we all take small steps every day to reduce the amount of waste we produce, we can help protect the planet for generations to come.

For more information, ***EGLE - Recycling (michigan.gov)*** and ***www.epa.gov/recycle*** .

Students Bring Their Science Ideas to Life with Seesaw

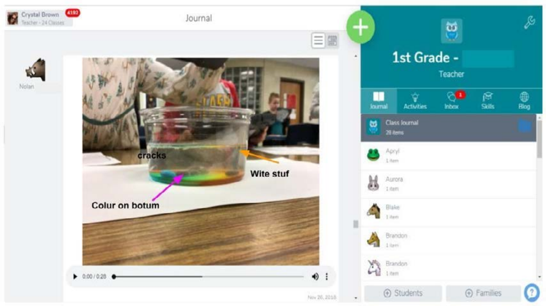
Crystal Brown | Elementary STEM Teacher, Gibraltar School District & MSTA Regional Director

As a busy classroom teacher of almost 30 years, I hardly ever had time to sit with a student as they explained their thinking about their electrical circuit model. Who has time for that when you have reading assessments and math inventories to do for all of them multiple times a year!? With so many assessments to give and not enough time to give them, teachers often let go of one on one time during Science time in the elementary school. Unfortunately, this individual time is when we hear student explanations of phenomena, their reasoning about their evidence, or the workings of their model.

When I started using Seesaw, it gave my students the freedom to share their work on their own time, while I was able to hear their ideas on my own time! I started using Seesaw in math to capture a student's math work in action. After a few days, I quickly saw it as an incredible formative assessment tool!

If you're not familiar with Seesaw... do a quick search and watch an informational video. Students can post a photo, drawing, video, file, or text. Students can add a text caption, draw on a photo, record a voice caption, and add You'll be hooked. You'll be obsessed. Your teaching life will be changed. All of a sudden, Science Journaling has a very vivid digitized life. All of a sudden, our students' thoughts and ideas not only become visible, they become audible and accessible to peers and families for immediate feedback.

In first grade, we work at asking questions about phenomena. Curiosity drives exploration and provides the opportunity for modeling instruction. Just recently I was inspired to give students a warm bowl of water and have them drop in a few M&M's and just watch. Because students have been using Seesaw as a student journal, they were easily able to take a before picture and comment with their predictions. As soon as they dropped the M&M's in, they grabbed their iPads and took many more pictures as the phenomena occurred. Throughout the activity, I was able to record students talking and interacting as they giggled and talked about what they could see. This video is easily posted as a teacher to Seesaw so parents have a context for the images they are about to see. When the M&Ms were done, students were brought up front for a first grade modeling mini-lesson. Following their lesson, students were able to use their iPads, post a picture of the M&Ms, adding arrows and labels about what they could see, and a voice caption with their questions about what happened.



With my phone plugged in to my speakers after school, I'm able to quickly see images and hear the thoughts of my first graders about their experiences. The possibilities of Seesaw as a Digital Science Journal are endless!

Follow **@Seesaw** on Twitter, join free PD in Pajamas webinars. You'll be amazed at how many ways Seesaw can be applied to elementary science. As always, contact me if you have any questions or would like to hear more about Elementary Science/STEM implementation!

Producing Ferrofluids in the Lab, Easier Than One Might Think

Kayley Ulbrik, Brent Schwesinger, Brooke Mastronardi, Juliana Jakubczak, Omar Ammoun and Mark Benvenuto | University of Detroit Mercy, Department of Chemistry & Biochemistry

Introduction
Creating ferrofluids is an experiment or demonstration that is educational and can be both fun and dramatic. Additionally, we found the required fluids for the experiment to be remarkably inexpensive materials to produce, and have found them to have some relevant, interesting connections to the new Michigan Science Standards.

Curiously, the idea of any ferrofluid has its origin in a problem NASA was trying to solve in the 1960's: how to make a fluid flow in some desired direction in zero gravity. The idea of adding iron to a liquid is credited to Steve Papell of NASA, but its spread to a wider audience of scientists appears to have taken some time. Today ferrofluids are generally considered those which have some magnetic iron dispersed in a liquid, although a more precise definition would indicate that the iron is nano-particle-sized iron suspended in some liquid. Using particles larger than this is defined as a magnetorheological fluid. For our purposes in the classroom, we term all mixtures of iron particles and a viscous fluid as a ferrofluid.

Our aim was not simply to make a ferrofluid, but rather to determine if a particular concentration or particle size of iron was optimal for creating one. Also, we sought to determine if one particular oil worked better than others in creating a fluid that responded to a magnet. Changing these two variables allowed us to examine a wide range of viscosities, and to expand a single experiment into a project.

Experimental
The materials needed for this experiment are very simple. They are:

1. Iron powder – any particle size is acceptable, available through Flinn Scientific and other science supply houses
2. Vegetable oil – available at any grocery store
3. Motor oil – available at any auto supply store or filling station
4. Magnet – available at most hardware stores

A known mass of iron is added to a known volume of oil and the two are mixed. Masses of iron from 0.1 g to 15.0 g were used. The amount of oil was kept constant at 10.0 mL. The mixing does not require more than five minutes. Then, a magnet is touched to the outside of whatever glass container holds the fluid. Photos 1 and 2 show smaller and larger particle sizes of iron in motor oil. Photos 3 and 4 show the different particle sizes of iron in vegetable oil.

Results
We have found that making ferrofluids from either vegetable oil or from motor oil, and from two different sizes of iron powder, made little difference in the end results of whether or not the iron and the total fluid respond to a magnet in a visible way. In all cases, a magnet can be moved slowly up the side of a beaker or other glass container, and the iron particles come together and move with it. In mixtures using smaller concentrations of iron, more oil is left behind at the bottom of the container. Our extremes were a mixture of 0.1 g of iron powder in 10 mL of oil for the lowest concentration, and 15.0 g of iron powder in 10 mL of oil as the highest concentration.

Perhaps obviously, the largest differences are seen between high concentrations of iron in an oil, and extremely low concentrations. Higher concentrations have what may be considered a more exciting and visible effect, as all the iron responds to the magnet applied to the glassware, making patterns of points or spikes. Lower concentrations still do however appear to move a significant amount of oil, and to produce such spikes of iron particles.

We also found all the mixtures of iron in oil we made remained stable for weeks (and we believe much longer). This makes it convenient for the person who wishes to make only one fluid but use it repeatedly in different classes at different times.

Michigan Science Standards Connections
There are at least three of the Michigan Science Standards which have strong connections to making any of the ferrofluids we have mentioned. There are also some basic concepts from a chemistry class that are applicable here.

1. HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

   This MSS is well connected to the idea and the plan of producing ferrofluids with different types of oils, and their differing viscosities. The bulk materials respond to a magnetic field and do so visibly.
2. HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

   Using powdered iron in any experiment allows the student or teacher to learn about and discuss magnetism. It also can serve as a starting point for a discussion about how the new material – the ferrofluid – acts differently from the two starting components.
3. HS-PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

   The fluids made here definitely interact with the magnet applied to the outside of a beaker or other piece of glassware. This is a straightforward example that shows how forces act between two materials, meaning the external magnet and the ferrofluid.
4. Weight percent and molarity

   We produced a series of ferrofluids using nothing more complex than a known mass of iron powder and a known mass and volume of some oil. Mass of iron divided by mass of oil, then multiplied by 100 gives the weight percent of iron in the fluid.

It may be a stretch away from the common definition of molarity to claim that the mass of iron can be converted to moles of iron, then divided by liters of solution, simply because the iron does not dissolve in the oil. Rather, it is mixed with the oil but remains undissolved in it. However, mathematically, a molarity can still be calculated. This can actually lead to a deeper understanding of molarity and how solutes (iron) and solvents (oil) interact.

Conclusions
Ferrofluids are simple and straightforward to produce. The materials needed to do so are quite inexpensive. The results are readily observed and can be exciting for students working with them. Additionally, there are several connections to the Michigan Science Standards and to basic chemical principles that can be made using such fluids.

References:

1. US Patent 3215572A. Solomon Steven Papell. 1963. Low viscosity magnetic fluid obtained by the colloidal suspension of magnetic particles.
2. Michigan Science Standards. Found at: Michigan.gov/documents/mde/K-12_Science_Performance_Expectations_v5_496901_7.pdf

Photo 1

Photo 2

Photo 3

Photo 4

The K-5 Corner

Crystal Brown | Elementary STEM Teacher, Gibraltar School District & MSTA Regional Director

Teaching elementary science and STEM can be challenging in today's educational culture… check out the elementary corner for helpful tips and inspiring stories.

Transform the Classics into Problem-Based, Elementary STEM

As a STEM teacher, my students bounce through the door eager to see what materials are sitting on the counter and anxious to hear what is next. The joy of making something, building something, and solving a problem is instinctual to our youngest students. My job, as an elementary STEM teacher, is to continuously remind them that scientists and engineers don't just question and build randomly… they question and build to solve problems.

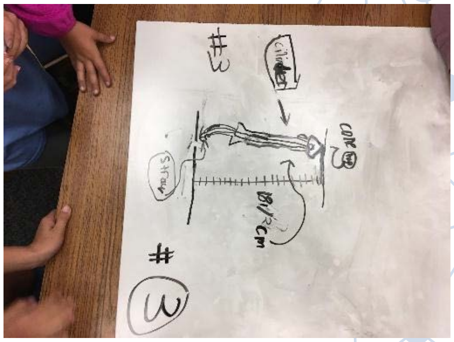
Instead of re-creating engaging, challenging, and fun building projects, I've taken some classics and applied a real life 'problem' to them. This allows students to dig more deeply into the science and math, transforming a simple challenge into a more meaningful STEM experience.

The Straw Rocket, 3rd-5th grade

As my third graders settle into their seats, they gaze upon a picture of fireworks up in the sky. Beautiful blooms of light sprinkled across the black night. We talk about what they are, how they got there, how fireworks work, etc… and then I show them the problem. The next image is a video of fireworks seen through trees. They are shocked they can't see the fireworks. They know there's always a story to present the problem, so they lean in, eager to hear. "I visited a town up north this past July and although you can see the fireworks inside of the park, the neighborhood just outside of the park can't see them! Why?"

Students discuss quickly and come up with the problem--it's not the trees that are unusual, it's the fireworks! They aren't going high enough! We begin our EDP and students generate questions about the area, the trees, all about fireworks. After answering questions about the area, and doing some basic video research about fireworks, we begin to imagine what kind of rocket would be able to go higher. We watch footage of NASA rockets so we can observe the shape and design of the rockets. What features do they use? How is the nose shaped? What shape is the body?

Students themselves make the plan for building model firework rockets to test in the classroom. They decide to hang a target on the ceiling so they can launch something high enough to go over the trees, but still make sure it goes straight up and does not hit the neighborhood. We use the basic straw rocket design found on NASA's educational website, but students add and change with features they've noticed.



After building and testing, deep discussions occur about problems and possible solutions. There's discussions about what is making it launch… air, not rocket fuel or explosive powder. But just like these things, the air must be trapped to create the push of the rocket off the ground. Discussions about force, gravity, pressure, and aerodynamics are common.

With a straw, a slip of paper, lots of scotch tape, and quite a bit of determination, students have a great time engineering a new fireworks rocket for the town up north.

Stacking Cups, Kindergarten - 2nd grade

We want our youngest students to build on their instincts, and their instincts of stacking are the easiest to access. How can stacking cups become a STEM project? With a little help from a good story. We start by looking at a picture of a road that has collapsed because the foundation has been washed out. As students look at the photograph I ask, "What is the problem here?" Students talk about how it fell, why it fell, and what used to be there. They eventually decide the dirt was 'washed away' and we apply the word 'erosion' to what they see. Then we look at other pictures of erosion-caused problems, noticing the same thing has happened. Some source of water or wind has caused erosion. We finally land on a photograph of a house teetering over the edge of a sandy hill, about to fall over.

Students agree that erosion is to blame, but this time I ask, "After we put the sand back, and fix the house, won't this happen again?" They all scream, YES! "What can we do?" And the 'Imagine' phase of the EDP begins. They brainstorm lots of solutions, but eventually someone suggests a wall to stop the water from reaching the sand and they all agree this solution will work.

From our youngest students, we practice that scientists and engineers build and test a model, not the real thing. 'It looks like the real thing, it acts like the real thing, but it's made of different materials and it's smaller.' We do some research together about a 'strong wall' we could build and decide on concrete bricks and mortar. Our model wall to build and test will be made of 3oz paper cups (the bricks) and index cards cut in half (the mortar.)

Students at this age are guided through the planning of the test. I show them how they will build a cup wall and I will use a board (with the word 'erosion' written on it) to try to blow down their wall using wind instead of water, since it's less messy. They are told the wall has to be 12 inches tall, and 12 inches wide (the dimensions of a ruler for ease of measurement.) They are given 50 cups and 30 index card squares.

Once they have their materials, they start stacking cups one on top of the other, which of course quickly fall. We all pause and meet on the carpet for a problem solving session. Students are encouraged to ask questions about a strong wall... what does it look like? What are some examples of strong walls? We do a quick image search of a strong wall and students begin to notice a pattern. No matter what material is used, the objects are not laid one on top of the other. They are laid in an offset pattern. Students go off to test this out and experience some success.

Ultimately, the cups still struggle to stand up until students think three dimensional and build two or three cups walls deep. One group accidentally discovers this and as it works, the others notice and begin to try this as well. We encourage sharing designs. No one is ever 'stealing' an idea. We feel proud when someone uses an idea we've tried. The strength of the interlocking design has been discovered using their instincts, questioning, experimenting, and guidance. Lots of fun has been had to stop the power of erosion and students end feeling successful and ready to remember what they've learned in future building challenges.

MICHIGAN
SCIENCE
TEACHERS
ASSOCIATION

www.msta-mich.org