From the President’s Desk
By Jen Arnswald, MSTA President

Resources for Implementing the Michigan Science Standards

Lately I have received numerous emails and questions regarding possible high school course sequences. If you are a high school teacher, you likely could share stories of heated discussions from your department meetings. There are lots of debate and many unanswered questions about what is best for students. Below you will find several links to resources that might help with the discussions that are taking place in your district. Next year’s freshman will be the first class that will take the revised M-STEP aligned to the new Michigan Science Standards in the spring of the 2019-2020 school year.

Michigan Model Course Mapping
A Resource Developed by the Michigan Science Standards Review Team to Support Options for Meeting Michigan Merit Curriculum Requirements and Scientific Literacy. This document provides several course options as well as the pros and cons of each pathway.

From The Desk of Your Executive Director
From Robby Cramer, MSTA Executive Director

Science Challenges = Advocacy Opportunities

In my high school typing class, one of the sentences I practiced typing to increase my proficiency was: “Now is the time for all good men to come to the aid of their country.” These words were brought to mind as I consider recent events such as the March for Science on Earth Day and then the Peoples Climate March a week later. Currently there are many issues that concern science educators. It really is time to use our voices in support of science.

Who are advocates for science? Science advocates are champions who dare to use their voice to support science ideas, causes or issues. I encourage you to find time to take a stand and share your thoughts about science ideas, issues and problems in local, state, and national contexts.

Many of you stepped forward as advocates for quality science education in our state in March as members of the MI House of Representatives were challenging our Michigan Science Standards. House Bill 4192 proposed discarding all current MI K-12 academic standards, and in their place, adopting the Massachusetts State Standards from 2001. In less than two days MSTA collected over 1200 signatures opposing this bill. In addition, many science educators attended House committee meetings to explain why they supported keeping the Michigan Science Standards. At this point, the bill appears to be stalled. Science advocates helped the representatives reconsider their position. Your voices were heard! Thank you so much for stepping forward and making a difference!

Of course, science advocacy extends beyond just the legislature. Educating parents about how science education in our state is changing is also vital. New resources from Achieve help explain the shifts in our new standards. You can even custom design your own parent brochures. See: https://www.nextgenscience.org/parentguides

In April, the MSTA Board of Directors met for the annual Strategic Planning

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Accelerated Model Course Pathways
In November 2015, Achieve released the Next Generation Science Standards (NGSS) Accelerated Model Course Pathways, a resource that offers guidance to schools and districts seeking to organize NGSS performance expectations into a compressed time frame. The NGSS Accelerated Model Course Pathways are designed for high-achieving students who want or need to pursue advanced level science courses earlier in middle or high school at a more rapid pace.

NGSS Appendix K: Model Course Mapping
To use these model course maps effectively, it is absolutely essential to understand the thought processes that were involved in building them. Please remember to read through the introduction materials to learn about the linking that was used to create the pathways.

California Science Framework Chapters
The curriculum framework was adopted by the State Board of Education on November 3, 2016. It provides guidance for educators implementing the NGSS.

NGSS Evidence Statements
NGSS Evidence Statements provide educators with additional detail on what students should know and be able to do. These Evidence Statements describe a detailed look at the NGSS performance expectations by breaking them into smaller chunks.

NGSS Bundles
What is bundling? “Bundles” are groups of standards arranged together to create the endpoints for units of instruction. Bundling is just one step in a curriculum development process; many other steps are required to create instructional materials designed for the NGSS. Why bundle? Bundling is helpful step in implementing standards because it helps students see connections between concepts and can allow more efficient use of instructional time.

From the Executive Director
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Retreat in Lansing. We spent the majority of the time analyzing our MSTA state conference. We will be making several changes based upon your recommendations. Thank you for your specific suggestions!

The MSTA Retreat was planned for the same day as the March for Science. However, we adjusted our schedule so that Board members could participate in the March.

We had posters printed that members could purchase and many people made their own signs!

Remember: Science challenges = advocacy opportunities. Make your voice heard.

The mission of the MSTA is to stimulate, support and provide leadership for the improvement of science education throughout Michigan.
A New Paradigm for Science Teaching and Learning
Andrew J. Frisch, Mathematics and Science Teacher, Farwell High School

“When am I ever going to use this? I’m never going to need to know this information!” As teachers, we have all heard our students make these comments and have probably given some version of this answer: “You don’t know what you are going to need later in life.” While that may be true, their question about relevance is an important one.

For too long, we as teachers have been providing information we think students will need in their future coursework or daily life. We cram in as much as possible in hopes that students will discover when and where to use it. In many cases though, the students are correct, they may never use most of the information that we are teaching them.

The new Michigan Science Standards require a paradigm shift for teachers. Rather than providing new information every day and, when time permits, culminating the unit with a real-world application, we need to flip that model. Students should be investigating natural phenomena and solving real-world problems every day. NGSS defines phenomena as “observable events that occur in the universe and that we can use our science knowledge to explain or predict” (Achieve, 2016). As students investigate phenomena, we as teachers will provide important information. However, information is provided in the service of helping students figure out phenomena and solve problems, rather than as an end in and of itself.

Through asking their own questions and collecting evidence to develop answers, students will undoubtedly still learn a lot of information, but more importantly, they will learn to be curious, creative, problem solvers. This is what our students really need—critical thinking skills to solve problems that exist now and in the future.

Making the switch to this new paradigm centered around explaining phenomena and solving problems is much easier said than done though! Students are more accustomed to memorizing facts and following directions to get the “correct” results in lab activities. Engaging in the messy process of science for themselves is much more challenging, and students may at first balk at the higher expectations. However, they quickly realize that actually doing science is much more fun than just hearing about it!

Of course, the new standards present a formidable change for teachers too. We are used to defining terms and providing answers, rather than helping students to ask their own questions and to figure out the answers for themselves. But, that is what the new Michigan Science Standards are all about! Meeting them requires students to observe, investigate, and create with the goal of deep conceptual learning and the ability to solve problems that do not yet have solutions.

The new Michigan Science Standards are more than a new way to package the same old learning objectives. They require us to think about teaching in a completely different way. Rather than focusing on transmitting information to students, we are helping them to ask good questions, collect evidence, and draw sound conclusions. This requires new curricula and teaching strategies and more opportunities for students to talk and engage with their peers.

Changing our paradigm for teaching will be a challenging and often frustrating process, but it is what is best for our students, so as teachers, we must rise to the challenge. We are all in this together—the more we can share and collaborate the smoother the transition will be. Luckily teachers all over the country are implementing these same changes. The Next Generation Science Standards website is a great place to start to find helpful resources. I highly recommend the following:

- Using phenomena to teach science https://nextgenscience.org/resources/phenomena
- Example storylines for coherent instruction https://nextgenscience.org/resources/example-storylines-ngss-topic
- Guide to implementing the NGSS https://nextgenscience.org/implementation

References
What I’ve Learned About the New Michigan Science Standards

By Brandon McDole

This year’s MSTA conference focused on the new Michigan Science Standards. The next few years will certainly be an exciting time for science education as we better understand how to effectively implement these standards. Whether you missed the conference or just want to hear about some of the talks you could not make it to, I thought it would be useful to share some of what I learned about the new standards at this year’s conference.

1. Engaging in the three dimensions requires explaining phenomena

The performance expectations integrate three dimensions of science learning—science & engineering practices, crosscutting concepts, and disciplinary core ideas. Students engage in these three dimensions as they investigate and explain natural phenomena. Phenomena are things that occur in the natural world that we can explain with science. It is our job to identify relevant and engaging phenomena that students can explore in order to develop the knowledge and skills described by the performance expectations.

A helpful session that I attended was called “Question and Phenomenon Pairs – Starting Storylines.” During this session James Emmerling described how phenomena can be effectively leveraged for learning. These storylines start with an engaging question about a phenomenon. For example, a high school biology storyline begins with the question, “Why don’t antibiotics work like they used to?” Throughout the unit, students investigate the phenomenon through a guided series of smaller questions. Along the way, they construct models and build a continually developing explanation of the phenomenon. Similar to problem based learning, the phenomenon gives a clear purpose for everything the students learn in a unit and creates a clear reason for students to construct their own science explanations.

2. The standards are not a checklist

Instead of a checklist of things our students should know, the new standards articulate what our students should be able to do. This means course content should be used as a tool to teach our students the skills of science and engineering. Darycy McMahon and Jennel Martin-Powell’s session “Three-Dimensional Science Performance Assessments” shared performance tasks developed by teachers. In these tasks, students construct explanations that demonstrate mastery of the standards. The performance task would either be placed at the end of a unit or broken up into smaller parts throughout the unit. They also described grouping the performance expectations together into “bundles,” meaning one performance task would measure proficiency for several standards.

3. Science & engineering are not linear

The linear model of hypothesis, procedure, conclusion does not accurately reflect how science or engineering are actually done. An integral part of these processes that has been missing in classrooms is using results to refine explanations. Many sessions at the conference emphasized that students’ explanations should be refined and expanded throughout a unit. Rich Bacolor’s and Jan Douglas’ session, “Making Thinking Public: Multiple Options for Recording Student Thinking,” showed how teachers can use KLEWS charts (fig. 1) to make thinking visible in the classroom. The KLEWS charts are posted in the classroom throughout a unit and added to and revised as necessary (Hershberger & Zembal-Saul, 2015). This is a great way to make the process of refining explanations explicit and public in the classroom. This process of refinement is included in multiple performance expectations, and the KLEWS chart is a great way to help facilitate it in the classroom.

Figure 1: KLEWS chart for making student thinking visible and refining explanations.

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What I’ve Learned About the New Michigan Science Standards  continued from page 5

Whether you just began digging into the new standards or have been working with them for some time, I hope these resources will give you some new ways to support your students. Links and references for all the resources I mentioned are included below.

Resources:
Three-Dimensional Science Performance Assessments: http://3dsciassessment.weebly.com/
Performance Task Examples: https://drive.google.com/drive/folders/0BzdCq-jvD2x-RjNPc38sYXNCc1k
Next Generation Storylines: http://www.nextgenstorylines.org/
KLEWS Chart: https://padlet.com/richbacolor/MMSCN2017

References

Learn about Michigan’s diverse natural resources, discover trends in their management, and experience activities that bring that knowledge to the classroom by attending this engaging professional development opportunity.

- Includes 15 meals, 5 night’s lodging and materials for only $395 ($295 with scholarship)
- Approximately 35 SCECH available from Michigan Department of Education
- One to Three credits offered by Ferris State University (additional tuition rates apply)

For more information, go to www.michigan.gov/anr

Centrally located at the MacMullan Conference Center on the north shore of Higgins Lake.
Reflections on the 2017 Annual Conference from Scholarship Winners

Heather DePoorter, 7th Grade Science Teacher, Chippewa Valley Schools
I had the pleasure of attending the MEECS Ecosystems and Biodiversity session at MSTA. I was thrilled that we each walked away with a unit put together in a well-organized binder as well as a kit of posters, Food Chain cards and many other items. I particularly liked how they also gave us the CD with the documents from the binder as well as PowerPoints and other resources to utilize in the classroom.

Jessica Wagenmaker was the presenter and she walked us through many activities as students. It was great to experience consensus circles and be the student. It was awkward at first, but once people started conversing, it became easier and easier. I can definitely see how this will add to my science talk in my classroom. A trick that she showed us was that she leaves the circle and is an observer to the class's science talk. The students completely run it on their own, with little teacher interjection.

The binder is well organized and I can see many uses for it in my classroom, particularly the lessons on photosynthesis, which I am currently teaching. They have labs that I cannot wait to try with my seventh grade students in the upcoming weeks. The binder also includes a list of supplies that are in the kit and supplies that teachers need to obtain for each lesson. This is extremely helpful to teachers to be able to look ahead and become organized quickly as well as order supplies in advance without legwork.

I cannot wait to continue to implement these lessons into my classroom. This session was worthwhile and I felt that I learned a ton in an hour and forty-five minutes. I also make some connections with other science teachers and an aquatic advisor from Bell Isle. I am extremely glad that I chose this session and if it is offered at MSTA in the future, I recommend it for anyone that teaches the science standards that accompany MEECS Biodiversity and Ecosystems.

Jean Crunkleton, Bothwell Middle School, Marquette Area Public Schools
I attended my first MSTA conference this spring in Novi, Michigan. I wasn’t sure what to expect and was hoping that it would be worth the seven hour travel time. Well, if you haven’t had a chance to attend this science teacher’s conference, I would highly recommend it. The two full packed days not only left me with a reenergized enthusiasm to teach, but a wealth of resources based on data, experience, and the new Michigan Science Standards.

One of my favorite sessions that I attended was titled “Trophic Cascades: Bottom Up and Top Down Controls in Ecosystems.” This was a HHMI BioInteractive session which was jam packed full of applicable and engaging lessons and resources, all of which are FREE!! Throughout the session the presenter provided a snippet into the variety of resources to help teach food chains, food webs, keystone species and trophic cascades. As session attendees we participated in several hands-on activities in which discussion guides and materials were provided including a ’click and learn’ tutorial, online animations, pieces of a short film linked to the teaching concept. The session ended with a quick preview of HHMI’s website, https://www.hhmi.org/biointeractive, highlighting the endless materials available to teachers.

Another session that was overflowing with free phenomenal resources was the “Michigan Environmental Education Curriculum Support - Climate Change.” I am amazed at how thorough and involved this curriculum...
Reflections on the 2017 Annual Conference from Scholarship Winners continued from page 6

is. In the Climate Change Unit there are 14 lessons that teach what climate science is and also the impact of climate change. The lessons can be taught as a unit or you can just pick and choose what fits into your classroom. Every lesson provides background information for the teacher, clear and easy to follow instructions, assessment options, and bonus extensions and enhancements. Throughout the two-hour session we acted as students and participated in many of the activities, all of which are applicable for a middle school setting or could easily be adjusted to fit your own needs. This MEECS unit is a great resource to teach about an extremely important science concept with connections specific to Michigan and the Great Lakes.

I am thankful to have had the opportunity to participate in the 2017 MSTA Conference. Living in the Upper Peninsula, you don’t get the opportunity to connect with many other middle schools as you do in a more populated area. By attending this conference I was able bring back these great resources and many others, to not only the teachers within my science department, but in the Marquette area as well.

Nick Brouwer, Jenison Public Schools
I had the opportunity to attend the NGSX training with my colleagues this winter, where we spent 5 days discovering how to create models with our students. We also were introduced to the KLEWS chart at this training. I was excited to see that Mary Starr would be hosting a session at the MSTA Conference titled “Developing Storylines using KLEWS charts.” During this session, I was able to better understand how these charts can be implemented in my classroom. My students have been able to better reflect upon what we have covered throughout a unit and how everything ties together using the KLEWS chart.

I also learned about phenomena during my NGSX training, but had questions about what constitutes a phenomenon. James Emmerling’s and Michelle Neelands’ session “Question and Phenomenon Pairs - Starting Storylines” provided more insight about teaching with phenomena that students can observe, investigate, and explain. The cards that were provided at this session have been very helpful as I develop phenomena with my department.

Lance Fowler, undergraduate at Central Michigan University
It is always exciting participating in something new for the first time. The first time you enter your science classroom back in middle school, the first time you introduce yourself to students as their science teacher, and the first time you go to the MSTA Conference. I had no idea how impactful this conference would be until attending for the first time. Being a student teacher planning for your own classroom in the future can be intimidating, but talking with current teachers and hearing their story made me so excited to learn more strategies to apply in my future classroom. Some of the main things I gained from this conference was going from letter grades to standards-based grading, how to do more student-centered and student-designed labs, and making the lab reports more fun and come alive.

First off, I didn’t know how much I would love the idea of standards-based grading until I joined Brian Langley’s session on “Make Grading More Meaningful.” His main reason for moving away from letter grades is that it never showed the students what areas they were struggling with and what concepts they had mastered. He had the idea that should students be graded on what they know and understand rather than just whether they turn in all their homework. He believed that grades should reflect understanding of the content and being able to apply the material to real world issues. Once students understand the material, they can evaluate the information and create different projects and experiments.

Another session I found insightful was the one Mike Sinclair presented entitled “Making Lab Reports Come Alive!” The main objective of his was showing different ways to have students write lab reports and allow the students to be creative with it. Some of my favorite examples he showed were the fan fiction, the advertisement, graphic novel/comic book strip, and the tweet. I love this idea because my students will not only give me the information on their findings and data, but also show me how imaginative they can get with a lab report. I believe that with this type of assessment, not only will students demonstrate their skills, but you will also learn more them as people. As a teacher, it is important to build those connections and show students how enjoyable a subject can be. As a future middle school teacher, I have to make sure that they fall in love with science or they will think this is the worst subject of their life. With this strategy, I know they will fall in love with science and possibly pursue a career in a science field.

With the help of the MSTA Conference, I am gaining the confidence I need and learning new ideas to make sure my first classroom is a wonderful experience for my students.

Jacinda Bowman, The James and Grace Lee Boggs School, Detroit, MI
As a first year teacher in Detroit, I probably would not have made it to the MSTA conference without the scholarship and membership that was provided for me by MSTA and the Meemic Foundation. During my first year of teaching, developing professionally has often been pushed to the backburner because I have been operating in survival mode. I’m just trying to stay caught up and make the small adjustments that help me get through the day. The two days at the MSTA conference gave me

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a valuable space in which I could take a breath, reflect on my practice, and learn from the wealth of skills and knowledge in our MSTA community.

The most valuable sessions for me were the MEECS curriculum trainings with materials provided by Michigan’s DEQ. I am currently teaching at a school that emphasizes place-based education but is still in the process of developing a science and social studies curriculum. I was thrilled to be trained by enthusiastic professionals that use (and in some cases, helped to develop) the lessons with their own students. Being provided with materials that I can bring back to my school and share in the process of our own curriculum development is powerful. Looking through the curriculum and practicing the activities with other science teachers boosted my confidence and sense of efficacy. I am looking forward to using all four units with my own students next year.

Being a part of this year’s MSTA conference helped me learn that, as a community, we are all always developing and improving, and we are all always surviving, too. So, it is important to take time to learn and reflect as we go.

Lorelei Barlow, Middle School Science Teacher, Linden Charter Academy

My favorite session at the MSTA Conference was “Think Tubes Phenomenon/Modeling” presented by Conni Crittenden. Trying to create a think tube with another teacher was really fun. I also really liked visiting the vendors and won some cool items including a water test kit and a candy color separator. The MESTA Rock Shop was awesome as well, and I bought several rocks to bring back to my classroom. Thank you MSTA and MEEMIC for the scholarship to attend the conference!

Jumping Into Professionalism: A Preservice Teacher Presenting at the Annual Conference

By Emily Siriano, undergraduate at Grand Valley State University

I was the youngest one in the room, and there I was leading the way, presenting at the MSTA 64th Annual Conference alongside my professor from Grand Valley State University, Dr. Steve Mattox. He gave me the support I needed, but kept me in the spotlight with the material I created. I had just gotten comfortable leading 6th graders in my student teaching placement at Allendale Middle School, but there I was leading a group of master teachers in a session sharing earth science activities aligned to the new Michigan Science Standards. The room was full—people even had to pull chairs from another room to join our session.

Realizing they were all here to learn from me, an inexperienced student teacher, matured me right there in the moment. I gave it my all, and told myself to just naturally show my character because these are adults that are here to learn new ways to engage their students. I realized that we were all there for the same reason—to help mold kids into successful young adults who are good collaborators, communicators, and critical thinkers. It is encouraging to know that there are so many teachers that are working to give their students meaningful science experiences.

As I walked through the vendor area, I was repeatedly asked what grade and subject I taught. At first I had a hard time admitting that I was not yet a certified teacher. But, when I told people that I was an undergraduate student in the College of Education at Grand Valley State University, they lit up with excitement. I couldn’t believe the amount of appreciation and celebration I received. They seemed as excited as I am about graduation!

The teachers that I met during my experience at the conference were incredibly supportive of my career choice. This was empowering for me as I apply to jobs and seek to establish myself as a professional. Having the chance to present at a MSTA conference boosted my confidence and connected me with enthusiastic teachers willing to help me learn and grow as an educator. Teaching is more than a job or even a career—it is a lifestyle that I can’t wait to begin!

I am grateful and appreciative for opportunity to attend the conference to grow professionally. As a preservice teacher, I jump at any chance to learn from other experienced educators. MSTA’s annual conference is a great place for this to occur! It is a chance to jump right into professionalism by presenting and receiving great feedback from teachers who have a vision of how your ideas might be applied in the classroom. The networking opportunities are boundless when it comes to who you might meet and what connections can be made. I highly encourage all pre-service teachers to not only attend professional conferences, but present whenever possible!
Figuring out Conservation of Mass

By Lynn Thomas, Region 14 Director

An important but abstract concept for students to learn is that atoms (and therefore mass) are conserved during a chemical reaction. The new Michigan Science Standards emphasize that effective instruction must engage students in investigating observable phenomena to develop scientific knowledge and skills. The activity below can be used to address the following performance expectations:

Michigan Science Standards and Science and Engineering Practices:
Developing and Using Models: Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

In this activity students mix baking soda and vinegar to observe the following reaction:

\[
\text{NaHCO}_3 + \text{HC}_2\text{H}_3\text{O}_2 \rightarrow \text{NaC}_2\text{H}_3\text{O}_2 + \text{H}_2\text{O} + \text{CO}_2
\]

In addition to learning about conservation of mass during chemical reactions, students must apply their knowledge of forces to explain the third scenario.

1. Mix vinegar with sodium bicarbonate in an open beaker. Students weigh the solution before and after and see that the weight decreases. Students should discuss and develop explanations using a whiteboard. Through this process, most students develop a model that accounts for the loss of mass due to the release of a gas (carbon dioxide).

2. Mix vinegar with sodium bicarbonate inside a sealed bottle. Students weigh the bottle before and after and find that the weight remains constant. Students develop models that demonstrate constant mass because of the gas trapped inside the sealed bottle.

3. Mix vinegar with sodium bicarbonate inside a sealed ziplock-style bag. Students observe that the bag inflates when the reaction occurs and the weight decreases. This is where students struggle with their particulate models and where the most instructive discussion occurs. This observation doesn’t fit with the model they have developed from the first two phenomena. They expect an open container to lose mass and a closed container to conserve mass. Students now need to decide if they need to revise their model based on new evidence and how to explain the unexpected results.

The following guiding questions can help guide students in figuring out why the inflated bag appears to lose weight on the scale:

- What happened to the bag when the reaction occurred? The mass and weight stayed the same, but the volume of the bag increased which caused it to displace more air than the uninflated bag. The additional displaced air increases the upward buoyant force on the bag.

<table>
<thead>
<tr>
<th>Forces on the Ziploc bag</th>
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<tbody>
<tr>
<td><strong>Before</strong></td>
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<td><strong>After</strong></td>
</tr>
<tr>
<td>Mass does not change</td>
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<tr>
<td>Weight does not change</td>
</tr>
<tr>
<td>Buoyant force increases</td>
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<tr>
<td>Upward force exerted by pan (what the scale measures) decreases</td>
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• What does the scale actually measure? Although we think of a scale as measuring weight (the force of gravity on the mass of the bag), what it actually measures is the net force that the bag exerts on the scale. The net force is a combination of weight and buoyancy (the upward force exerted by the air on the bag, equal to the weight of the displaced air). So when the bag expands, its mass and weight stay the same, but the upward buoyant force increases which causes a lighter reading on the scale. The diagram on page 9 shows the forces acting on the bag before and after the reaction.

Students may not use the term buoyancy, but should understand that the inflated bag displaces more air than the uninflated bag and that the more air (or other fluid) that an object displaces, the greater the upward force will be.

Instead of giving our students answers, we need to help them ask good questions and support them in figuring out the answers. Our goal is to present phenomena that students are motivated to explain. This is what the new science standards are all about! NGSS supporting documents state that, “By centering science education on phenomena that students are motivated to explain, the focus of learning shifts from learning about a topic to figuring out why or how something happens” (Achieve, 2016).

References:
Achieve, Inc. 2016. Using Phenomena in NGSS-Designed Lesson and Units. 

Central Michigan University
across Michigan and Online
→ global.cmich.edu/OnlineEd
Mi-STAR Units Allow Middle School Students to Figure Out Science Concepts for Themselves

By Jayme Swanson, sixth grade teacher, Northeast Middle School, Midland

Five or six years ago, my science department decided we needed to redo our curriculum. We created a lot of good hands-on lessons, and when I tell other teachers that I haven’t used textbooks for four or five years, some of them practically fall out of their chairs.

When I had a chance to field test a Mi-STAR unit last year, I felt that I was reasonably well prepared. As it turned out, it was more work than I’d imagined. But after I saw the genius behind what Mi-STAR was doing, I wanted more.

So this year, I introduced my sixth graders to the unit Water on the Move. Since it was a pilot, I knew some things would go wrong, and that some things would change, so I leveled with my kids. I told them that this unit was brand new, and they could tell me what they liked and what they didn’t. More often than not, they liked it. In fact, sometimes I’d think a lab was not going to be very engaging, but then my students would love it.

The glory of Mi-STAR is the Unit Challenge, a big problem students are called upon to solve before the end of the unit. At the beginning of the unit, I wondered, “How are they supposed to do that? They are 11 years old.” But ultimately, they did. Everything in the unit spirals back to that challenge, that one goal. Every lesson gives them a little piece of the puzzle, keeping them focused on the big prize. The Unit Challenge is what makes the Mi-STAR units so powerful.

To introduce the Unit Challenge in the Water on the Move unit, I told my kids that development had come to this little town in the Western U.P. and had messed it all up. Their nice little river was flooding in the spring and drying up in the summer, and they were tasked with developing a plan to restore it to health. We happen to live in an area that floods in the spring, so my students totally got into the problem.

That brings us to another aspect of Mi-STAR: everything is centered on Michigan, and that’s huge. I remember once telling my class about a lake in California, and you could practically see their eyes glaze over. But my students have been swimming and fishing around here all their lives. They know that water is an enormous part of Michigan; they know the streams, lakes, and rivers. When you can connect their science lessons to something that’s happening in their world, you are getting somewhere.

Outside our classroom is the track and football field. Early in the unit, one of the kids noticed that water always pools up on the far side of the track. They wondered why it always got so mucky and yucky. My old way of responding would have been just to tell them, but this time, I said, “We’ll get back to that.” Later on, they determined on their own that the water was collecting in a low spot due to gravity. That never would have happened before Mi-STAR.

This leads to the third thing that makes this way of learning so great. The students are learning to figure things out for themselves. In this day and age, when every kid has a smartphone, they can’t just Google Mi-STAR questions and get an answer. They have to think. I tell them, “Don’t let the computer be your idiot box. Use your brain and talk to each other. That’s what critical thinkers do.”

The obvious result is the amazing work they do as they come to the Unit Challenge’s culminating project. There are several ways to get to an answer that works, and not only were they finding those solutions, they were explaining them, drawing them, doing math.

Our school has been pilot testing Mi-STAR units for the past two years, and we are already seeing results. For one thing, Mi-STAR is getting cross-curricular. I teach language arts as well as science, and my language arts students are starting to use the terminology they learned in Mi-STAR units, like “criteria” and “constraints.” They are also beginning to figure things out for themselves, to be independent learners. For me, that’s the most important lesson we can teach.
Fun Ideas for Teaching Measurement Skills

By Lu Anne Clark, Biology Professor at Lansing Community College

I have taught over 20 different courses in my almost 39 years of teaching—mostly biology courses, but also physical and earth science and nutrition. In all of these courses, measurement is an important skill that students must learn. My colleagues and I decided to combine measurement with real life scenarios to get the students out of their seats and actively engaged. The activities encourage students to think critically and relate metric units they are familiar with (such as 5 or 10K races, 2 liter bottles of pop, etc.) to English units.

In one activity, we have students measure the room. It is fun to see them crawling around on the floor or begging meter sticks from other groups so they can lay them end to end. In a different activity students measure the elevator. Later in the course they have to figure out how high a flight of stairs is for a speed and power activity. I love watching the various ways they do this ranging from measuring the height of one step and multiplying to trying to pass the meter stick up from below. They are quite creative!

To relate metric units more to real life, we have had students look at food and beverage containers. Some do not realize that the metric units are printed on the container as they are busily weighing or filling the containers with water. Others see that the units are there and how they compare to the more familiar English units. I have also had students research real world examples where not making good measurements had a disastrous or at least negative results. One example of this was the original foot bridge in Lansing leading to the Potter Park zoo. It wasn’t until the ceremony to install the bridge that they discovered it was too small.

In another activity, we have students measure stair heights on campus and determine whether or not they meet the ADA code. They enjoy getting out of the classroom and answering a real-world problem. Another class favorite is when we give students 10 beans and they have to figure out how many are in a larger jar based on the mass of the 10. For fun in biology, students have to measure their hand in metric units and then measure several objects using their hand instead of a meter stick.

We also create fun problems for our students to solve. In the example below, students have to measure the elevator to see if Martians could get a meteorite to our 4th floor classroom.

```
Background: Four large Martians want to move a meteorite from the first floor to our lab. Each Martian masses 95 Kg (gravity is different on Mars). They are 3 meters tall. The meteorite’s mass is 2000 kg. The meteorite is round and measures 3.5 meters in diameter.

Additional data - how much weight can be lifted by the A&S elevators?

What else would be important or useful to know?

Question: While they be able to deliver the asteroid to our class for our learning pleasure? Show your work.
```

These activities are engaging for students and help them to develop important critical-thinking and measurement skills that they can apply in their daily lives.
Teaching Chemical Equilibrium
By Larry Kolopajlo, Eastern Michigan University, lkolopajl@emich.edu

In this short article, I will share some of the strategies that I use in teaching chemical equilibrium. First, I probe student prior knowledge associated with the term equilibrium, including everyday meanings and memory associations. Students often discuss equilibrium as a psychological balance, or as a picture or clock hanging on a wall (static equilibrium in physics). I then explain that chemical equilibrium is a completely different concept that refers to a non-static or dynamic state, and that it is unbalanced with respect to reactant and product concentrations.

Definition: Chemical Equilibrium
A chemical reaction equilibrium is a reversible process in which:
(a) the concentrations of reactants and products do not change over time.
(b) the rate of the forward process is equal to the rate of the reverse process.

Student misconceptions regarding chemical equilibria have been reported to be resistant to instruction (Gussarsky & Gorodetsky, 1990), but that isn’t news to any practicing teacher. Many students cling to the false notion that a chemical equilibrium is like an algebraic equation expressing equivalence of reactant and product concentrations. In effect, students confuse the meaning of the symbols “=” and “⇌”. It is important to be explicit that:

\[ A \rightleftharpoons B \text{ does not mean } [A] = [B] \]

The following graphical representations help students to understand that a chemical equilibrium is a steady state that is unbalanced with respect to product or reactant concentrations.

Comparing Completion to Equilibrium

<table>
<thead>
<tr>
<th>Completion Reactions</th>
<th>Equilibrium Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \rightarrow )</td>
<td>( \rightleftharpoons )</td>
</tr>
<tr>
<td>One way</td>
<td>Reversible (two way)</td>
</tr>
<tr>
<td>Reactants convert to products and then the reaction stops.</td>
<td>Dynamic (the reaction never stops). Reactants perpetually convert to products and products back-convert to reactants.</td>
</tr>
<tr>
<td>After some time ( t ), no reactants remain if stoichiometric amounts of reactants were used.</td>
<td>The reaction mixture always contains the same ratio of both reactants and products at any time. Products or reactants can dominate the reaction mixture.</td>
</tr>
</tbody>
</table>

In: \( A + B \rightarrow C \), if \( B \) is the limiting reactant, then increasing excess reactant \( A \) causes no change in \( C \) as illustrated by the mole table below:

<table>
<thead>
<tr>
<th>Run</th>
<th>( A + B \rightarrow C )</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>1   1        1</td>
</tr>
<tr>
<td>(2)</td>
<td>2   1        1</td>
</tr>
</tbody>
</table>

Have no equilibrium constant \( K \)

In: \( A + B \rightleftharpoons C \), if \( B \) is the limiting reactant, then increasing excess reactant \( A \) will cause an increase in \( C \):

<table>
<thead>
<tr>
<th>Run</th>
<th>( A + B \rightleftharpoons C )</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>1   1      ( x )</td>
</tr>
<tr>
<td>(2)</td>
<td>2   1      ( &gt; x )</td>
</tr>
</tbody>
</table>

Have a equilibrium constant \( K \)
Teaching Chemical Equilibrium  continued from page 13

Demonstration
In this demonstration, you can control the color of a nickel amine complex by adding acid or base. The amine complex of almost any transition metal such as copper or nickel may be used. I like to use NiINTA-, nitrilotriacetate nickel(II) in water (about 0.05 M). This coordination complex has a deep blue color, but upon the addition of acid, the amine and carboxyl groups protonate, causing the ligand to unwrap from the metal complex. It’s actually a step by step unwrapping, but to conserve space, I show it as a two-step process below:

\[
\text{NiNTA}^- + \text{H}^+ \overset{\text{(aq)}}{\leftrightarrow} \text{Ni}^{2+} + \text{H}_4\text{NTA}^+ \\
\text{deep blue} \quad \text{light green} \quad \text{colorless}
\]

Adding base will deprotonate the ligand, allowing it to coordinate to nickel(II) ion to form the blue complex. I repeat acid and base additions to bring home the point of reversibility. The figure below illustrates the unwrapping of NTA from NiNTA- upon the addition of acid, and the reverse wrapping upon addition base.
Teaching Chemical Equilibrium  continued from page 14

Le Chatelier’s Principle
The last section of my unit on chemical equilibrium addresses Le Chatelier’s principle. I use the cartoon below to introduce the concept, with the students having studied reaction quotient.

LeChatelier’s Principle
Consider this simple equilibrium: \[ A \rightleftharpoons B \quad K_C = 2.0 \]
We wish to investigate what happens when a reaction vessel of exactly 1 liter volume initially contains 3 mol A and none of B. Initially:

\[
\begin{align*}
V &= 1 \text{ L} \\
\text{A} &\quad \text{B} \\
\text{A} &\quad \text{A} \\
\text{A} &\quad \text{None} \\
\text{Let } A &= 1 \text{ mol A} \\
\text{Let } B &= 1 \text{ mol B}
\end{align*}
\]

Let’s compute the reaction quotient \( Q \) for this initial situation:

\[
\begin{align*}
Q &= \frac{[B]}{[A]} = \frac{0}{3 \text{ M}} = 0 \\
\end{align*}
\]

Because no B exists, the reaction shifts right to make B until \( K = 2 \).
Teaching Chemical Equilibrium  

Let’s convert 2 A’s to make product B. We get:

\[
\begin{array}{c}
A & \rightarrow & B \\
A & A & B & B
\end{array}
\]

Find Q:

\[
Q = \frac{[B]}{[A]} = \frac{2 \text{ M}}{1 \text{ M}} = 2
\]

Now \( Q = K = 2 \) and the reaction is at equilibrium.

Now let’s consider what happens when 3 B’s are added to the previous mixture containing 1 A and 2 B’s:

\[
\begin{array}{c}
A & \rightarrow & B \\
A & A & B & B & B & B
\end{array}
\]

Find Q again:

\[
Q = \frac{[B]}{[A]} = \frac{5 \text{ M}}{1 \text{ M}} = 5
\]

Now \( Q = 5 > K = 2 \) and the reaction is not at equilibrium.

What happens? Too much product means that the reaction shifts left. Let’s convert 1 B to reactant A. We get:

\[
\begin{array}{c}
A & \rightarrow & B \\
A & A & B & B & B & B
\end{array}
\]

Find Q again:

\[
Q = \frac{[B]}{[A]} = \frac{4 \text{ M}}{2 \text{ M}} = 2
\]

Now \( Q = K = 2 \) and the reaction is at equilibrium.
Teaching Chemical Equilibrium  continued from page 16

Le Chatelier’s Principle

If a change is made to a system at equilibrium, the equilibrium will shift in a direction to undo the change.

The above statement is true because the equilibrium constant K never changes.

The change is called a stress.

References
A Fun Way to Learn About the Solar System
by Pamela Opolsky, Jefferson International Academy

I like to use song and music to help my students learn information. None of my first graders knew the planets in order, so I decided to create a model along with a song to help them. I put up a part of a large sun in the corner of the room. I found a cheap solar system model on EBay, and hung the planets in order from the sun.

The next time they came in the room, they noticed the model right away. We discussed how large the sun was, too large for the whole thing to be in the corner, and also compared it to the size of the planets. We talked about how the planets were grouped—small ones close to the sun, and the larger far away, and one of the lights separated the groups. This light we called the Asteroid Belt.

I then taught them my song (I devised my own tune):

In the center of the solar system is the sun, the sun.
Then comes Mercury, Venus, Earth, Mars.
Asteroid Belt, Asteroid Belt
Jupiter, Saturn, Uranus, Neptune.

Once they got the hang of the song, we moved under the hanging planets and pointed at them. I then taught them the corresponding movements. For the first line, they would create a large circle with their arms swinging, and when it came to “the sun”, they would shoot out an arm and a leg on the opposite side. For the second line, they would make with their fingers, the first letter of the planet they sang about, but in a sassy way with one hand on their hip. “Asteroid Belt” is their favorite part, as they move as if they have a huge imaginary hula hoop around their middle and making motions with their hands of a very large belt. The last line was again motions with fingers (a big “S” in the air for Saturn).

I continued to use our ceiling model as we read about the inner and outer planets and other celestial objects. We added three more lines to the end of the song:

Kuiper Belt, Kuiper Belt
Where the comets come from
Swish, swish, swish

Of course for “Kuiper Belt” we do our little hula hoop movement. For the next line we jab out our fingers, and then end with our arms crossed and our bodies slanted.

They seem to really enjoy the song. I hear them singing it in the hall sometimes! My second graders even remember it from last year. When I did an assessment on my older students before starting a unit on space, I was surprised that many of the fifth graders did not know the planets, so I tried the song and movements with them. I think they enjoyed doing it more than the first graders! I hope you borrow my idea and have fun with your students, too.
Learning about Air Pressure by Figuring Out Phenomena

By Colleen Polydoras, Northville Public Schools

As we shift our instruction to meet the new Michigan Science Standards (MSS), it is crucial that we design three-dimensional learning experiences that allow students to explain observable phenomena. My colleagues and I end the year focusing on Earth’s Systems and the Earth and Human Activity MSS standards, and we thought that using phenomena involving air pressure would be a good way to get the students to use models to explain their thinking.

Air pressure relates to many Disciplinary Core Ideas, and can be applied to understanding natural disasters caused by severe weather. My colleagues and I decided to perform the water balloon in the flask demo using boiling water as the source that changed the pressure inside the flask. Students were posed with the demo and asked to think about it independently by writing in their interactive science notebooks. Students then discussed in their small table groups why the water balloon was drawn into the flask when hot water was added. The table groups then used butcher paper to make their thinking visible. The groups had to agree on ideas and concepts to put on the poster and used the poster to participate in an accountable talk large group discussion. The poster had to have a diagram, labels and explanations.

During the accountable talk session the following guidelines were given to students:

- Listen patiently and rephrase and repeat what you heard.
- Avoid interrupting others
- Agree or disagree with an idea or concept, not a person, and make sure to EXPLAIN why
- Share a new idea or concept
- Add on to other students’ ideas
- Explain what someone else means
- Provide examples to explain thoughts further

After two class sessions of discussion around this phenomenon, I made the concepts and ideas students agreed upon visible using the Promethean Board and posed two other quick demonstrations to help students figure out that a difference in air pressure caused the balloon to enter the flask. I had the students use syringes and marshmallows to see air pressure in action, and I shared another demonstration that used a water balloon, bottle, and a burning sticky note as the source to change the air pressure inside the jar.

This lesson brought out students misconceptions and challenged students to think about what they already knew scientifically about the properties of gases.

Helpful links:
Water balloon with match:
https://mail.google.com/mail/u/0/#search/colleen/15b9f62a91c8581f7projector=1
Marshmallow in syringe:
http://sites.jmu.edu/chemdemo/2011/09/09/marshmallow-magic/

Please feel free to contact me at polydoco@northvilleschools.org with any questions about the lesson.
Innovative science programs at Lawrence Tech for students and teachers!

Forensic Science Summer Workshop for Educators
For more information or to register, call 248.204.3516 or email msedir@ltu.edu

eXtreme Science Saturdays for high school students
To register, visit www.ltu.edu/extremescience
For more information, call 248.204.2227 or email extremescience@ltu.edu

Biotech Summer Camps for high school sophomores, juniors, and seniors
For more information or to register, visit www.ltu.edu/summercamps
An Event You Will Not Want to Miss: Solar Eclipse August 21, 2017

By Robert Victor

On Monday, August 21 a solar eclipse will be visible throughout North America. Those lucky enough to be within a narrow track across the U.S. from Oregon to South Carolina will experience a total solar eclipse. The last time a total eclipse crossed the United States from sea to sea was June 8, 1918. Whether you travel to a location within the path of totality or stay at home to see the partial eclipse, the following web resources will help you prepare to observe the eclipse safely.

Solar Eclipse information and Resources

https://eclipse2017.nasa.gov/
https://eclipse.aas.org/
https://www.astrosociety.org/education/2017-solar-eclipse-information-resources/

https://www.greatamericaneclipse.com/
ASK AN EXPERT!
An MSTA Mini-Grant Provides New Opportunities for Young Fives Students
By Becky Durling, Young Fives Teacher, Discovery Elementary, Williamston Community Schools

What do you do with a $1000 in a Young Fives? You call in the experts! This past fall I was awarded a mini-grant from MSTA, and quickly put the money to work to enhance the science curriculum in our two Young Fives’ classrooms by creating engaging and meaningful experiences for our students with experts from around our area.

In January we were excited to welcome Potter Park Zoo Outreach to our school. This is an amazing experience and if your school is anywhere near Potter Park Zoo in Lansing, you need to give them a call! At the time, we were finishing up a unit on the five senses. Potter Park Zoo Outreach put together a theme-specific visit to engage our students in how animals use their five senses. Forty-seven students were able to get up and close and personal with many different animals including a hedgehog, an armadillo, a skink, and a beautiful owl. The docents were incredible with the kids, taking time to explain each animal’s unique senses and answer all kinds of questions. Our kids truly enjoyed this experience!

A large part of our grant went toward a field trip to the University of Michigan’s Natural History Museum to visit the Owosso Mastodon. The Owosso Mastodon is the most complete mastodon skeleton found in Michigan. She was discovered on my grandpa’s farm near Henderson, Michigan in the 1940’s. Beginning in January our began researching Ice Age mammals and dinosaurs and learning about their habitats and characteristics. During our project the fine arts were infused into science by partnering with our Visual Arts and Music teachers, as well as visiting artists. The kids sculpted dinosaurs and mastodons with local Williamston artist Liz Wylegala, created Ice Age mammal and dinosaur masks, illustrated a habitat with Michigan author and illustrator Tom Woodruff, and participated in a performance about these creatures. Our visit to the Natural History Museum was the icing on the cake. Here the kids were able to participate in a hands-on, developmentally appropriate museum program titled “Dancing with the Dinosaurs!” During the program they were able to share with the docents what they had learned during the past three months. Our kids also had the opportunity to explore the floors of this great museum visiting our Owosso Mastodon, other Ice Age animals including the Bristle Mammoth, dinosaurs and other native Michigan animals!
Ask an Expert!  continued from page 23

This May, our MSTA mini-grant, in combination with a grant from the Spirit of Alexandria Foundation, will bring to our school the Howell Nature Bus! During this visit our kids, along with our 4th grade buddy class, will have the chance to experience a live bird show, participate in many hands-on nature based activities in the mobile classroom, and play educational games. The visit will be facilitated by two naturalists from the Howell Nature Center. This experience will be a great way to wrap up classroom research and activities on birds we have been involved in all year. From November to April we participated in Project FeederWatch through Cornell University Lab of Ornithology, we created our own bird books based on the visitors to our feeders, participated in hands on activities from Growing Up Wild!, and much, much more.

Finally, we will also be using a portion of our MSTA grant money for our school gardens. Currently, we have eight raised beds on our school grounds. We have plans to do some landscaping around the beds, as well as plant our gardens for the spring and summer. Each season we work closely with MSU Master Gardeners in our area from the planning, to the planting, to the harvesting.

Our MSTA mini-grant was put to great use this school year! We were excited to enhance our science curriculum with area experts, trips, and more. Thank-you, MSTA!

Bending pipes for a mini hoop house for our garden beds with our 4th grade buddy class.

Cleaning out our garden beds with our 4th grade buddy class.

Follow MSTA on

MI Teacher Participates in Research in Antarctica

Eric Thuma, a physics teacher at Stoney Creek High School in Rochester Hills, always wanted to assist in world class scientific research. He lived his lifelong dream by joining Jim Madsen from the University of Wisconsin River Falls in Antarctica for 3 weeks doing equipment upgrades on the COSRAY Neutron Detectors at McMurdo Station. The neutron monitors are designed to study cosmic radiation and solar activity.

Eric was deployed to McMurdo Station in Antarctica from Dec. 30, 2016 to Jan 24, 2017. While in Antarctica, Eric assisted with the repair of the COSRAY Neutron Detectors. He also aided in the transfer of the detectors from McMurdo Station to a Jang Bogo Station, which is a South Korean facility. His students were able to participate in his research experience through online communication and a number of live webcasts.

Eric is one many teachers selected through a nationwide search to participate in PolarTREC, an educational research experience in which K-12 teachers participate in polar research, working closely with scientists as a pathway to improving science education. Through PolarTREC, teachers have the rare opportunity to spend two to six weeks working with a research team in the Arctic or Antarctic. While on field expeditions, teachers and researchers share their experiences with scientists, educators, communities, and students of all ages through the use of Internet tools such as online teacher and researcher journals, message boards, photo albums, podcasts, PolarConnect real-time presentations from the field, and online learning resources. After the field experience, teachers and researchers continue to share their experiences with the public and create instructional activities to transfer scientific data, methodologies, and technology to classrooms.

PolarTREC is managed by the Arctic Research Consortium of the U.S. (ARCUS) and funded by the National Science Foundation and additional partnerships. For more information and to participate, see the PolarTREC website at: http://www.polartrec.com or contact the ARCUS Project Managers, Janet Warburton and Sarah Bartholow at info@polartrec.com or call 907-474-1600.

The Arctic Research Consortium of the United States (ARCUS) is based in Fairbanks, Alaska and was formed in 1988 to provide leadership in advancing knowledge and understanding of the Arctic. ARCUS is a member consortium of educational and scientific institutions. Further information is available at: http://www.arcus.org.
Dinosaurs Hook Students on Science

Hooking students on the sciences early in their education is one of the keys to filling the severe gap anticipated in U.S. science, technology, engineering and math (STEM) fields in the coming years. According to the President’s Council of Advisors on Science Technology (PCAST), “Economic projections point to a need for approximately 1 million more STEM professionals than the U.S. will produce at the current rate over the next decade if the country is to retain its historical preeminence in science and technology.” Beyond the lack of proficiency, and perhaps most important, according to PCAST there is a significant lack of interest in STEM among youths.

Educators can attest to the challenge of getting their students interested and excited about the wonders of science. Imagination Station, Toledo’s Science Center, understands that challenge, as well as the importance of STEM education and strives to present exhibitions and programming that will immerse students and “hook” them into the world of science through a fun and interactive experience. The latest of these experiences is a temporary exhibition opening May 27 and running through the end of the year: Dinosaurs Around the World: Passport to Pangea.

Using advanced animatronics as well as authentic casts, a real fossil, cutting-edge research and immersive design elements, this engaging, interactive trip back in time to the Mesozoic Era will equally thrill and educate visitors, while its multi-layered narrative brings the world of Pangea to life like never before. Nine galleries in Dinosaurs Around the World highlight the characteristics of dinosaurs on each of today’s seven continents.

New Generation Science Standards

When educators bring their students to the exhibition, they are reinforcing and bringing to life Next Generation Science Standards. Each of the seven Cross-Cutting Concepts present at all levels of science—patterns; cause and effect; scale, proportion and quantity; systems and system models; energy and matter; structure and function; and stability and change—is clearly reflected within Dinosaurs Around the World. Designed in collaboration with award-winning paleontologist Gregory M. Erikson, the exhibition includes detailed instruction on geologic time scale, geology, evolution, ecology, geography, and climatology. An Educator Guide offers fun activities and lesson plans for all levels of learners and can be modified based on students’ needs and interests.

Dinosaurs Are Entry to Sciences

Dinosaurs don’t only offer a wealth of valuable information, they are also an excellent gateway for kids to begin engaging with the sciences. Dinosaurs are cool. Kids of all ages love them. And when students’ interests are peaked, they are more likely to want to dive deeper into the subject which might, over time, encourage them forward into STEM careers or at least help them gain a deeper appreciation for the impact of science on their lives. The mission of Imagination Station is to serve the community by providing informal science education and fun in order to spark a passion for the sciences by combining interactive exhibits and educational programming. It is the science center’s hope that this exhibition will spark the fire of interest in students’ minds and they will leave with a desire to know more about these fascinating creatures and the impact they continue to have on our understanding of the world.

Experiences like Dinosaurs Around the World could not happen without the support of generous sponsors like Comfort Line, this exhibits sponsor. For more information about Dinosaurs Around the World: Passport to Pangea visit imaginationstationtoledo.org/Dinosaurs.
The Junior Science & Humanities Symposium: A Showcase for High School Students Engaged in Significant Scientific Research

By Dr. Sandra Yarema, Wayne State University

This April, I had the privilege as regional program director, of accompanying four high school students from Michigan to the National Junior Science & Humanities Symposium (NJSHS), held in San Diego, California. We joined more than 300 high school students who qualified for attendance by submitting and presenting original scientific research papers in regional symposia held at universities nationwide. Approximately 150 adult leaders including high school teachers, university faculty, ranking military guests, and professional research scientists also attended the national symposium to encourage this future generation of scientists and engineers and to celebrate student achievement in the sciences.

The southeastern Michigan region’s 53rd annual JSHS was held at Wayne State University on March 10, 2017. Sixteen students from seven schools across Michigan submitted applications to participate in the regional symposium. All of these applicants presented their research papers to a panel of judges, comprised of professors, and researchers at Wayne State University in the fields of bio-medicine, biochemistry, math/computer science, and engineering. Ten of the twenty-five judges were from the U.S. Army Tank-Automotive Research, Development, and Engineering Center (TARDEC) in Warren.

All the participants also had the opportunity to showcase their work in a poster session, and were treated to a formal dinner banquet, as well as a guided tour of the campus at Wayne State University, specifically including the iBio- Integrative Biology Research Center. The Academy of Applied Sciences will distribute $4,500 in academic scholarships to the top three regional finalists: $2,000 to first place, $1,500 to second place; and $1,000 to third place.

The top four finalists from the SE MI JSHS were invited to participate in the National JSHS, all expenses paid: 1st place, Richard Yang, from Troy High School presented Optimization of Electro Pulsing on Yttria- Stabilized Tetragonal Polycrystalline Zirconia (3Y-TZP) Ceramic Water Filter Sintering, and 2nd Place, Michelle Zhang from the Battle Creek Area Math/Science Center presented Quorum Sensing Regulation of the Violacein Biosynthetic Gene Cluster. The 3rd and 4th place participants participated in the poster session; Lily Kitagawa, from Kalamazoo Area Math/Science Center, presented Efficient k-mer Counting in DNA Sequencing, and Astha Dalal, from Troy High School, Noninvasive Measure of cancer Stem Cells CD44 vs TIFP.

Our national symposium experience began with a welcome banquet on Wednesday evening. Every meal was enhanced by a keynote presentation by STEM professionals, including Nobel laureate, Dr. William Phillips, National Institute of Standards. Thursday’s schedule included STEM seminar sessions presented by various researchers sponsored by the U.S. Department of Defense, followed by tours to various research facilities such as the Scripps Institute of Oceanography, the National Marine Mammal Foundation, the Naval Health Research Center, and the USS AMERICA. On Friday, the top two delegates from each region competed for military-sponsored scholarships by presenting their research in oral sessions held throughout the day.
The Junior Science & Humanities Symposium continued from page 26

Sessions were organized by disciplines that were designated by the students’ research topics during the registration process. These included medicine, environmental science, biology, chemistry, engineering, mathematics, computer applications, and physics. Our 3rd and 4th regional delegates presented research in a poster session held on Friday evening, with a judging session on Saturday morning. Shuttle tours to Birch Aquarium, and La Jolla cove and beach were arranged for Saturday afternoon. A gala banquet and awards ceremony was held poolside on Saturday evening. Tri-service sponsored awards for excellence were presented to the top three students who presented their research, in each category, in poster presentations: 1st place $1,000; 2nd place $800 and 3rd place $600. Tri-service sponsored undergraduate tuition scholarships were also presented to a total 24 students who presented their research in oral paper competition. 1st, 2nd, and 3rd place student winners were named in each of eight categories of competition. 3rd place winners were each awarded a $4,000 scholarship, 2nd place winners were each awarded an $8,000 scholarship, and 1st place winners were each awarded a $12,000 scholarship. Astha Dalal received a peer-recognition honorable mention for her poster presentation. Although Michigan’s delegates were not awarded any of the top scholarship prizes, they each brought home new experiences and opportunities to promote science, and made friends and contacts that will benefit each of them.

For more information about participating in the JSHS, visit http://coe.wayne.edu/ted/science/jshs/

*Dr. Sandra Yarema is the Coordinator of the Science Education Program, [http://coe.wayne.edu/ted/science/](http://coe.wayne.edu/ted/science/) and Director of the SE MI Junior Science and Humanities Symposium, [http://coe.wayne.edu/ted/science/jshs/](http://coe.wayne.edu/ted/science/jshs/)*
Educating Students about Invasive Species

Jeffrey L. Ram, Wayne State University

Educating students about invasive species can serve the dual purpose of addressing the Michigan Science Standards and protecting the Great Lakes from new invasive species. A new state-wide project co-led by Wayne State University, Michigan Technological University, and the Belle Isle Conservancy will provide teacher workshops (http://sun.science.wayne.edu/~jram/MiISGPworkshopRegistration.html) and internet-based activities (http://detroitaquarium.weebly.com/kids-corner.html) for incorporating invasive species education into STEM curricula.

“While many invasive species in the Great Lakes arrived by ballast water which the public can’t directly do much about, educating students and their families can greatly impact the introduction of non-native organisms and diseases through pet and other commercial routes and potentially reduce or prevent the spread of invasive species that are already here,” observes Jeff Ram, Wayne State University Professor.

New invasions that damage our environment are so intertwined with science, economics, history, and geography that they form the perfect nexus for cross-curricular teaching. Amy Emmert, the director of field trips and other educational activities at the Belle Isle Aquarium, thinks that “map-making, artwork, adaptation, food webs, reproduction, and writing can all be part of understanding invasive species. While stories like the ‘turtle smuggler’ (yes, your students will ask: why would anyone put turtles in their pants!) are great center points for discussion, personal responsibility also becomes the theme when the topic is ‘why should we care about new organisms in our environment?’”

The professional development workshops, aimed at elementary and middle school teachers (grades 3 - 8) are entitled Achieving Michigan Science Standards using Invasive Species Lessons in Your Classroom and will take place throughout the state in October and November 2017. Participation of teachers in the workshops is supported by generous stipends for attending and for creating lesson plans and presentations following the workshops.

Organization of the teacher workshops is headed by Joan Chadde, well-known throughout Michigan as the Director of the Michigan Tech Center for Science & Environmental Outreach (MTCSEO), which has run numerous teacher workshops in both upper and lower peninsulas of Michigan. Besides planning conferences for this project in Marquette, Saginaw, Grand Rapids, and Detroit, she has also applied to present this program as a workshop and breakout at the Michigan Alliance for Environmental and Outdoor Education (MAEOE) conference scheduled for October 6th. Thus, the project will provide many opportunities statewide for teachers to obtain the materials and exchange ideas about educating students with an invasive species focus.

The project will also create online materials for educators and students everywhere to use. Numerous invasive species related activities are available in the “Kid’s Corner” section of the website, cited above.

The newest game is a multilevel “matching/memory” game called “Catch Invaders!” in which students have to match names of invasive species with descriptions of the havoc they’ve caused, their biology, how they got here, and so on. Currently a two level game, the creators have several more challenging levels and many other species to add to the game. The icon that starts the game is shown on this page. The “Kid’s Corner” page also has links to games from elsewhere on the internet (“Invaders!” by Plum Landing is especially fun and memorable). At workshops and in follow-up activities new lesson plans for teachers will be created and posted on the Belle Isle Aquarium website’s “Educators” section during the 2017-2018 school year.

For more information about the professional development workshops, contact Joan Chadde at jchadde@mtu.edu. Ideas and suggestions for more invasive species games can be shared with Jeff Ram at jeffram@gmail.com. To find out more about field trips at the Belle Isle Aquarium, contact Amy Emmert, emmerta@belleisleconservancy.org. This project is funded in part with funds from the Michigan Invasive Species Grant Program through the Departments of Natural Resources, Environmental Quality, and Agriculture and Rural Development.
Jupiter and Saturn frolic in summer’s evening sky, while Venus shines at dawn

By Robert C. Victor, Twilight sky maps by Robert D. Miller, Graphs of planet rising and setting times by Jeffrey L. Hunt

Mid-June finds bright Jupiter high in SSW at dusk, and Saturn low in SE, some 70° apart. At dawn, Venus gleams in the east, while Saturn is low in SW. On selected dates, the Moon forms attractive pairings with one or another of these planets, or with one of the five bright zodiacal stars.

In June’s evening twilight (see http://tinyurl.com/JuneEveningTwilightChart for sky chart) bright Jupiter stands high in S to SW at dusk, with Spica nearby, to its lower left. As Jupiter ends retrograde motion against background stars in early June, it reaches a maximum distance of just over 11° WNW of Spica. Keep watch this summer, until Jupiter passes just 3° north of Spica on Sept. 11. By then, they'll be very low in the WSW at dusk. After that, the next time Jupiter passes Spica will be during their triple conjunction in 2028-2029.

Also in June, we find Saturn rising in SE, to lower left of Antares. Saturn is at opposition to the Sun on the night of June 14-15 and is visible all night. In 2017, Saturn’s rings are tipped 27° edge-on, the greatest angle possible, with their northern face in view.

This year, these inspiring showpiece planets Jupiter with its cloud belts and four bright satellites discovered by Galileo and Saturn with its spectacular rings and bright moon Titan in a 16-day orbit-are conveniently visible at dusk from mid-June through mid-September. Provide opportunities for your students to catch telescopic views of both planets in a single session! In coming years, as these planets’ opposition dates shift later, the beginning of the “window” of dates to see both planets in early evening slips about 12 days later each year, while the close of the window shifts about one month later annually. By 2020, both giant planets will be seen together in early evening skies from mid-July through December. The autumn of 2020 will be a fascinating time to watch these planets gradually close the gap between them until they’re just 0.1 degree apart on December 21, their closest pairing since 1623, during Galileo’s time. So, mark 12/21/2020 on your calendar! A conjunction of Jupiter and Saturn, the slowest of the naked-eye planets, occurs only once every 20 years, just a few times in a lifetime! They will meet again in conjunction in 2040 and 2060, but the next one closer than 2020’s will happen 6 decades later, in 2080.

In early June, you’ll need binoculars--and very clear skies--for final glimpses of faint Mars sinking into the NWV evening twilight glow. Look for it to the lower right of the “Twin” stars of Gemini, Pollux and Castor. In the eastern sky, watch for Altair rising to lower right of Vega and Deneb, completing the Summer Triangle, while Arcturus passes through its high point south of overhead. Summer begins on June 21 at 12:24 a.m. EDT, when the Sun is directly overhead at the Tropic of Cancer. On June 20 and 21, Michigan residents observe the year’s highest Sun, passing within 20° south of overhead at midday from southern parts of our state, midway between the times of sunrise and sunset. The appropriately named Summer Triangle is up all night from late June through early August. Whenever the Summer Triangle is high in a dark sky, the Milky Way will be in fine view, with one of its brightest star clouds inside the Triangle, along the axis of the Northern Cross, or neck of Cygnus, the Swan. Binoculars will readily resolve that misty patch of light into multitudes of stars.

In June’s evening twilight (see http://tinyurl.com/JuneEveningTwilightChart for sky chart) Venus and Mercury will be in fine view, while Saturn is low in SW. On selected dates, the Moon forms attractive pairings with one or another of these planets, or with one of the five bright zodiacal stars.

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On the evening of June 3, the waxing gibbous Moon passes closely N of Jupiter, and on the following evening, more widely N of Spica. The Moon passes the apogee of its orbit on the afternoon of June 8. That evening, it appears widely N of Antares, and on the next morning, the most distant Full Moon of 2017 appears several degrees lower right of Saturn, in SW. On the evening of June 9 through dawn on June 10, the Moon, just past Full, remains in close company with Saturn all night. Saturn is itself at opposition five nights later, on the night of June 14-15. By then the Moon rises just before midnight, so shift your viewing time to predawn to follow the rest of the Moon’s cycle of phases. The Last Quarter (morning half moon) occurs on June 17. On June 20, the waning crescent Moon is a few degrees upper right of Venus. On the next morning, June 21, the Moon appears several degrees lower left of Venus, and lower right of the Pleiades star cluster. On June 22, the Moon’s final morning, look for the 4-percent crescent rising in ENE just over an hour before sunrise. Can you spot Aldebaran, eye of Taurus, closely lower left of the Moon? Less than 42 hours remain until New Moon, at 10:31 p.m. EDT on June 23.

continued on page 30
Jupiter and Saturn frolic in summer’s evening sky  continued from page 29

The graph of planets’ morning rising times (see http://tinyurl.com/planetsrising) is useful for observers in southern Michigan as well as for Chicago. Note the dates along lower edge of chart, and time interval ahead of sunrise along the left margin. The chart’s lower, zero baseline represents the time of sunrise. The chart shows times of moonrise plotted as open circles. These “dots” show that the Moon rises in a dark sky more than 4 hours before sunup on June 17, and closer to the time of sunrise on each successive morning. On June 19, Moon rises just over 3 hours before sunrise, and on June 20, the Moon rises just ahead of Venus. On June 21, Moon rises after Venus, and in deep twilight within 2 hours before sunrise. On June 22, the last easy chance to see Moon in the morning, Moon rises in brighter twilight a little more than an hour before sunup, just before the star Aldebaran rises. The curve labeled “Venus” shows that planet rising ever farther ahead of the Sun until early in August. Also shown is Venus-Regulus rising together on Sept. 20; Venus-Mars on Oct. 5; and Venus-Jupiter on Nov. 13; all possibly resulting in close pairings of those objects in the morning sky.

On June 24, the Moon sets after the Sun, but by barely half an hour. Although the Moon is 23 hours old (past New), it is very low in bright twilight, and won’t be seen from Michigan. This year, a sighting of the first crescent after the June 23 New Moon ends the month of Ramadan and begins the next, Shawwal in the Islamic calendar. On the evening of Sunday, June 25, spotting the nearly 2-day-old Moon will be easy: At the end of civil twilight, when the Sun is 6° below the horizon (about 35 minutes after sunset in southern Michigan), the Moon is still 8° up in WNW and 6 percent illuminated. The Moon will set more than 1¼ hours after sunset.

On the evening of June 27, there will be a close pairing of the Moon and Regulus. The Moon occults (covers) the star in the early afternoon from Hawaii, and in early evening from Ecuador and Peru. From Michigan, the crescent slips south of the star in late afternoon, and appears to the left of the star at dusk. By sunset on Fri. June 30, the Moon has just passed First Quarter phase and appears half full. That evening, bright Jupiter appears a few degrees SE of the Moon, and Spica several degrees SE of Jupiter. An ideal evening for telescopic views of the Moon and Jupiter, and of the 3rd-magnitude star Gamma of Virgo very close to the Moon! At 100-power or greater, the star splits into a very tight, matching pair of stars, with a period of revolution of 169 years. (The pair will change noticeably during a lifetime, as it slowly widens and revolves away from its present north-south orientation.) From Michigan on Fri. June 30, the leading dark edge of the Moon will occult this star, at 10:38 p.m. EDT as seen from East Lansing. Correction can be made to calculate approximate times of disappearance for other locations in Michigan: Subtract 2 minutes for every degree of latitude you are farther north of East Lansing, and subtract one minute for every degree of longitude you are farther west. If you’re south or east of East Lansing, the corrections must be added.

Now, have a look at the graph of evening planet setting times (see http://tinyurl.com/EveningPlanets). This chart is also useful for sky watchers in southern Michigan. Again, dates are plotted along the lower edge of the chart, but this time, the left edge shows the time interval after sunset, and the zero baseline of the chart represents the time of sunset. The “dots” show the Moon setting barely half an hour after sunset on June 24. The chart shows the Moon setting successively later each evening June 25-30: In a darkened sky near the end of twilight on June 25; about the same time Regulus sets, nearly 3 hours after sunset on the night of June 27; and over 4 hours after sunset, about as Jupiter and Spica set, on the night of June 30. The same chart shows Regulus will set in evening twilight by late in July, while Spica and Jupiter start setting in twilight in late August/early September. Antares sets before the end of twilight by October, and Saturn, in 2017, sinks into twilight in late November.

Many of the events described in this article are illustrated in the June 2017 Sky Calendar from Abrams Planetarium. Each monthly issue includes a map of the evening sky. For a sample issue and to subscribe, visit www.pa.msu.edu/abrams/skycalendar/

Robert C. Victor, formerly Staff Astronomer at Abrams Planetarium, Michigan State University, is now retired and enjoys providing sky watching opportunities for school children in and around Palm Springs.

Robert D. Miller did graduate work in Planetarium Science and later astronomy and computer science at Michigan State University, and remains active in research and public outreach in astronomy.

Dr. Jeffrey L. Hunt, a retired planetarium director now living in the Chicago area, has taught astronomy and sky watching to all ages. He studied astronomy education at Abrams Planetarium at Michigan State University. Jeff writes an astronomy blog at jeffreyhunt.wordpress.com and can be followed on Twitter at @jeff_hunt.
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