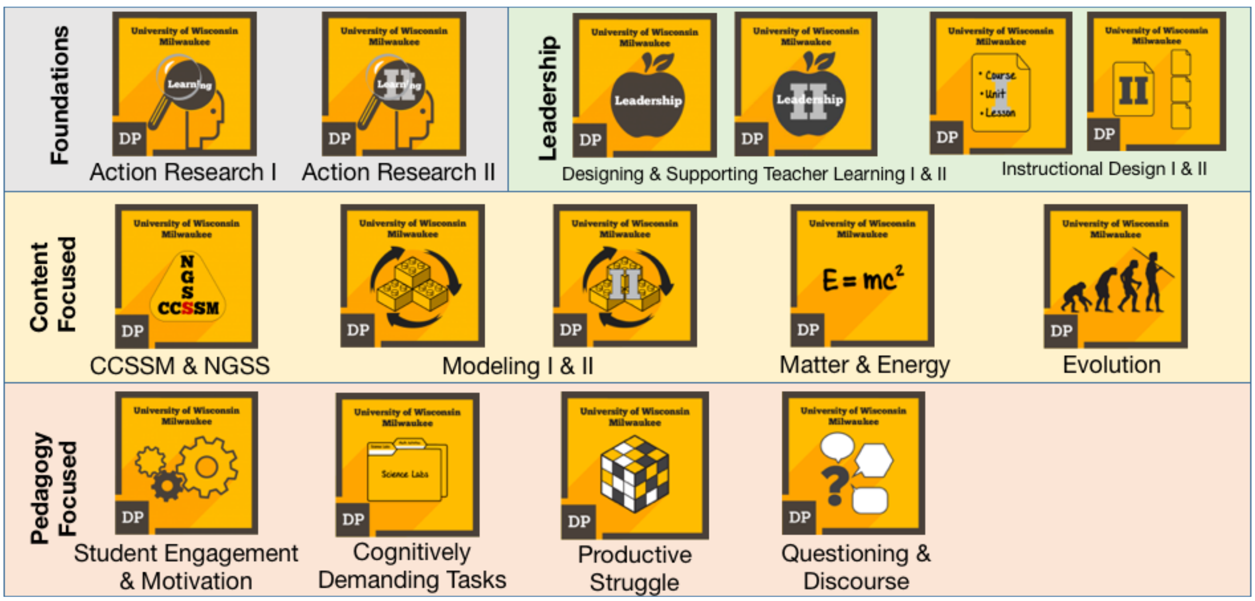
The Milwaukee Master Teacher Partnership:
Enhancing Teacher Practice in Secondary Math & Science

NSTA STEM Expo • Philadelphia PA • 13 July 2018

National Science Foundation Noyce Track 3 Master Teacher Fellows Project

- 24 high school mathematics and science teachers with Masters degrees
- Teachers complete four action research-based microcredentials per year on the Digital Promise platform
- Anticipate changes in teachers' content knowledge for teaching
  (content knowledge, pedagogical knowledge, pedagogical content knowledge)

Sample Microcredentials



Multiple Microcredential Levels

- Conduct action research in your own class
- Engage other teachers in your building or across buildings in action research
- Design and conduct teacher professional development on research topic

More information about the project at http://uwm.edu/mmtp

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Models and Modeling (Mathematics)

Method Components

Components and Implementation of Models and Modeling

- Examine your own personal model of teacher decision-making used for planning, teaching, and reflection of lessons
- Use the model of teacher decision-making from Clough, Berg, Olson to write a reflection of a recent lesson.
- Discuss the distinctions between models, modeling, modeling with mathematics, and mathematical modeling in the context of the Common Core State Standards for Mathematics.
- Identify critical features of modeling tasks in mathematics and the progressions related to modeling in high school mathematics.
- Explore pedagogical aspects of modeling, including the reasons for teaching modeling and pedagogical practices that support successful student engagement in modeling.
- Plan and teach a modeling-focused lesson that supports student learning opportunities related to other mathematics content standards.
- Choose or create a measurement tool (rubric, standards-based grading criteria) that capture student performance related to the standards.
- Analyze student performance related to the standards after students engage in the target lessons.
- Write a reflection of the planning, implementation and assessment of the modeling lesson.

Learning Opportunities

Session 1 (Face to Face)

1. **Math and Science Together** – Examine a model to guide thinking about planning for instruction, while teaching, and reflecting on your teaching.
    a. Your current model – create a diagram that represents a model of the decisions you make as a teacher when planning for lessons, teaching lessons, and then reflecting on your success regarding the impact you have on the learner.
    b. Introduce the Teacher Decision-making article with a focus on the diagram on page 8
        i. The model – diagram on page 8
        ii. Take home and read Promoting Effective Science Teacher Education and Science Teaching: A Framework for teacher decision-making.
            1. Respond to the following questions
                a. How does the model on page 8 compare with your initial model you drew? What are the strengths and limitations of the model? How would having a more sophisticated and complex model affect the utilitarian usage of the model when it comes to understanding your teaching, or explaining the act of instruction to someone else such as a peer, administrator, or parent?
                b. Reflect on a recent lesson using the diagram on page 8.

2. Modeling in the context of mathematics
    a. Considering the general concept of modeling
    b. Examples of successful modeling: The Cruise Ship Task
    c. Modeling in Mathematics

Session 2 (Online PLC)

- Read GAIMME Report, Chapters 1 and 3
- Read Chapters 1 and 16 of Hirsch and Roth McDuffie (2016)
- Read practitioner articles Meyer (2015), Anhalt & Cortez (2015), and Wendt & Murphy (2016)
- Be prepared to discuss how the readings help to clarify the nature of a good mathematical modeling task and how we might plan for lessons that use those tasks

Session 3 (Face to Face)

3. Debrief the readings: What did you take away from each of the three types of readings (GAIMME report, APME research-based reports, practitioner articles)? What are you still wondering about related to mathematical modeling?
    a. Why use modeling? What are the affordances for student learning
    b. Unpacking the modeling cycle: discussing characteristics of modeling tasks based on GAIMME & a closer read of CCSSM, progression
    c. Distinction between mathematical modeling & modeling with mathematics
4. Enact a three-act task/101qs task together and discuss how it connects to the characteristics
5. Discuss mathematics teaching practices that support modeling
6. Connecting modeling across mathematics and science
    Mixed Small Groups – Math and Science
    a. What are common points between modeling between math and science in terms of student learning? How does it help the learner?
    b. What are similarities and differences between modeling in math and science?
    c. What are the similarities and differences between our assessing strategies?

Session 4 (Online PLC)

- Produce a written summary of modeling in mathematics key points from Session 3 small-group discussions
- Read the CCSSM Progression document in Modeling and reflect
- Read GAIMME Appendix B on assessment
- Plan and teach a lesson on modeling, including a rigorous data collection component (check in with lesson plan and data collection instrument prior to teaching)

Session 5 (Face-to-Face)

7. Work session focused on data analysis from taught lesson(s)

Session 6 (Online PLC)

- Write up documentation of lesson and evidence; prepare for public presentation

Session 7 (Face-to-Face)

8. Poster session: Results of Teaching a Modeling lesson
    a. Final Reflection and Critique
        1. What type of model did you use? What Modeling strategy did you use?
        2. How did you integrate it into the lesson?
        3. What specifically did you want students to be doing during this lesson that told you it was successful?
        4. What was some feedback from students and artifacts
        5. What would you change?

The effect of using computational vs. non-computational models to understand natural selection

The process

Students in two different classes were given the same videos to watch at home outlining the four "steps" of natural selection:

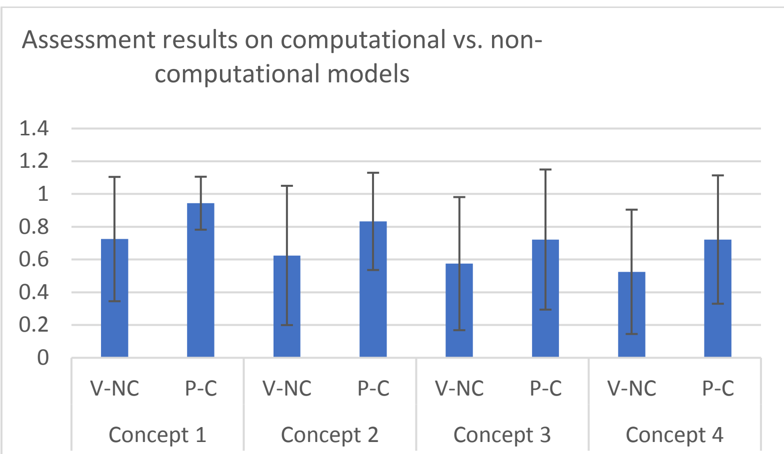
1. Individuals within a population vary in their traits
2. More offspring are produced than can survive due to conditions in the environment.
3. Those individuals with variations that increase their survivability will survive.
4. Individuals that survive will pass these beneficial traits to their offspring during reproduction.

In each class, after a review of the ideas they watched at home, the students were assigned a task in which they modelled these ideas of natural selection.

The first class used a virtual model in which they designed three species of birds on an island and ran the simulation which introduced random mutations which led to traits that may or may-not have increased survivability.

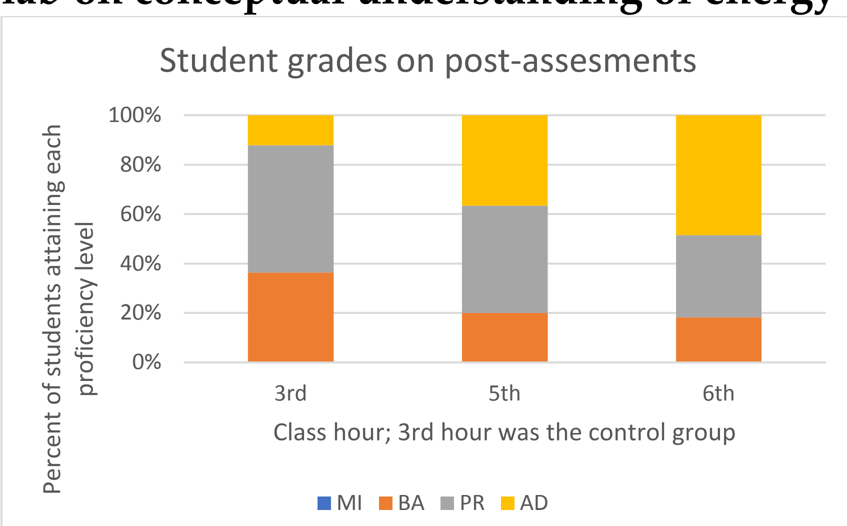
The second class did an activity in which they measured the zones of inhibition around circles of paper soaked in antibiotics and related these ideas to natural selection.

Both classes then conducted an assessment in which they were given information recorded about a population of finches in the Galapagos islands and were asked to interpret the information and apply it to the "steps" of natural selection.



Using a t-test to compare understanding on each concept	
Concept	Results (p-values)
1	0.026065
2	0.036629
3	0.016735
4	0.016273

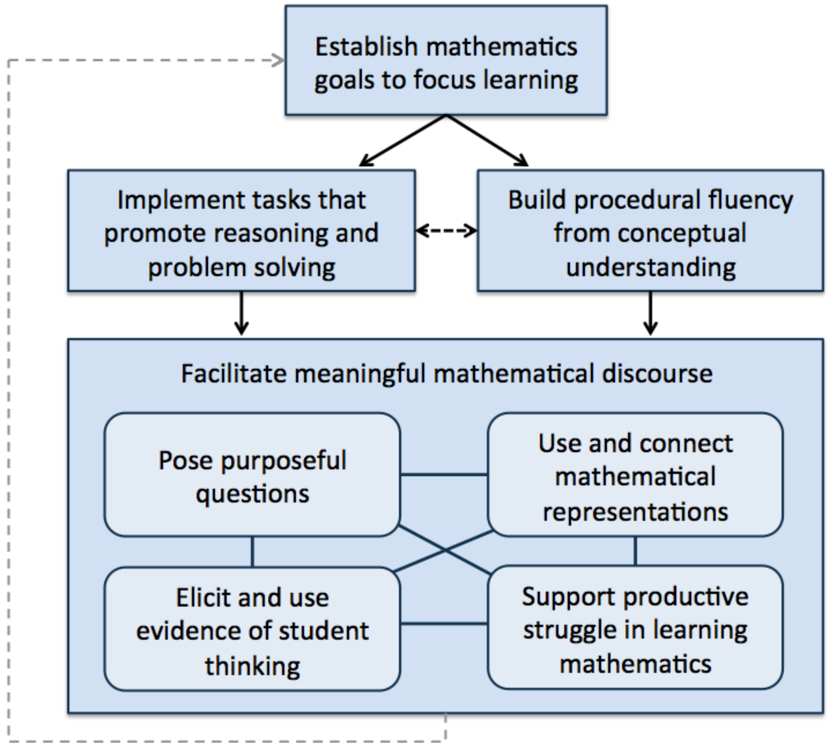
The effect of presenting experimental errors to the students BEFORE the lab on conceptual understanding of energy and calorimetry

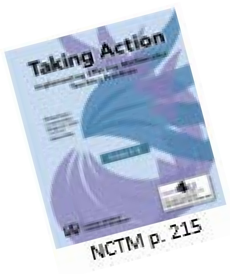


Using a t-test to compare each class to each other; 3rd being the control and 5th/6th being the experimental groups		
3rd to 5th	3rd to 6th	5th to 6th
0.0256	0.003	0.4784

It was outstanding to see that there were no MI's (minimal's) in any of the groups, which I think speaks to the positive outcomes that result from having the students engaged in lab activities. The assessment at the end of the unit didn't have any of the "problem data" associated with it, so there was no chance for the students that were not a part of the experimental group to have an unfair advantage over the other two classes. The questions on the assessment were just about practicing the math involved in doing calorimetry and a conceptual question asking about the procedure.

Framework Highlighting Effective Teaching Practices for Mathematics





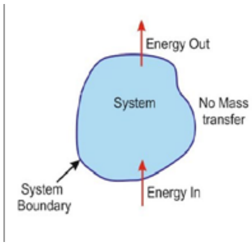
Student Self-Assessment

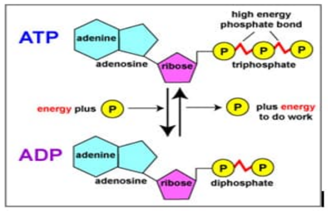
NAME:			**DATE:**		**BLOCK:**	
LEARNING INTENTION:						
SUCCESS CRITERIA:						
#	**STUDENT SELF-ASSESSMENT**		I've got this- I could teach it to others	I'm starting to understand- I still need some practice	I don't understand yet- I need help!	I did not try
	SOLVING PROBLEMS					
1	How do you feel about today's **DO NOW** problem?					
2	How do you fee about today's ACTIVITY ( )?					
3	How do you feel about today's textbook problems?					
4	How do you feel about today's HANDOUT – practice problems?					
	STUDENT MOTIVATION		**HIGHLY**	**SOMEWHAT**	**A LITTLE**	**NOT AT ALL**
4	How **motivated** did you feel during today's lesson?	12:15 - 12:45				
5	How **motivated** did you feel during today's lesson?	12:45 - 1:15				
6	How **motivated** did you feel during today's lesson?	1:15 - 1:45				
			GREAT	**OK**	**AWFUL**	**ASLEEP**
	OVERALL – RATE TODAY'S LESSON					
7	Why did you rate the lesson this way? What did you like/dislike? If you were sleeping or felt it was awful --- tell me why?					

Student Modeling Action Research Quarter 1

Research Question: Will the use of different models for energy have an effect on student achievement in an 11th grade Biology class?

Model #1 Model #2





Date Table:

The type of model used in class to understand energy	Mean grades for quiz on cellular respiration	Mean grades for quiz on photosynthesis	Mean grades for Unit test on cellular energy and matter
Control group – general model of energy and matter (21 students)	70.2 - PR	67.6 – BA	81.3 - PR
Experimental group- specific model (18 students)	76.1 - PR	74.6 - PR	70.5 - PR

The type of model used in class to understand energy	t-test for grades on quiz for photosynthesis	t-test for grades on quiz for photosynthesis	t-test for grades on Unit test for cellular energy and matter
Control group compared to experimental group	1.46 – Null hypothesis is accepted (no significant difference)	1.56 - Null hypothesis is accepted (no significant difference)	2.76 – Null hypothesis is rejected (significant difference)

Student Engagement Action Research Quarter 4

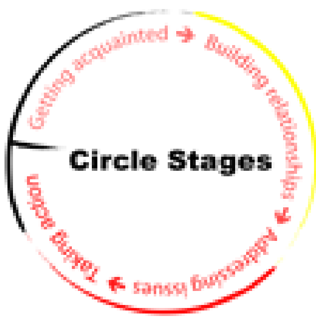
Research Question: What is the effect of choice on student's grades within their achievement band?

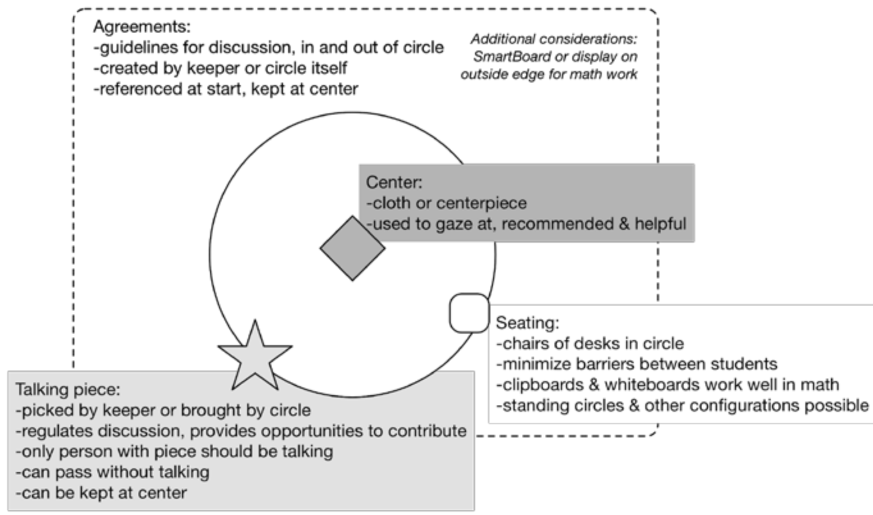
Date Table: *The 12 student who completed IB Biology year 1 with the traditional assessments and the same students who completed IB Biology year 2 with their choice of assessment.*

The type of assessment used – Traditional Junior year & Choice Senior Year	t-test for grades Semester 1 of Junior & Senior Year	t-test for grades Semester 2 of Junior and Senior Year	t-test for grades the entire year for Junior and Senior Year
Junior Year IB Biology Grades compared to Senior Year IB Biology Grades	2.46 – Null hypothesis is rejected (significant difference)	2.76 - Null hypothesis is rejected (significant difference)	4.96 – Null hypothesis is rejected (significant difference)

Using Restorative Circles for Math Discourse and Content

A Restorative Circle (related to the Socratic seminar, originated in Aboriginal communities) is a structure that can support students in developing the productive community relationships that lay the groundwork for meaningful mathematics discourse practices. Essentials include guided questions considering “Circle Stages”, circle format to reduce barriers, agreements and a talking piece.





Why Use Restorative Circles

1. Student-centered teaching requires us to engage students in discourse, reasoning, & argumentation (Standard for Mathematical Practice 3)
2. Math talk is only effective for all when there is an atmosphere where everyone feels comfortable to share ideas and justifications
3. Meaningful mathematics discourse needs to be scaffolded and fostered, particularly at the secondary level
4. Promotes a culture of caring, trust, and community in the classroom

> [When] students are held responsible for justifying their reasoning, [they are] increasing their mathematical knowledge and understanding. (Rawding and Wills 2012)

> Circles give people an opportunity to speak and listen to one another in an atmosphere of safety, decorum and equality. (IIRP 2017)

Observation Rubric for Restorative Circles

Date: Total in Class: Total Time:

Question Description *	Meaningful Response Tally: Time:______	Observations: