AAPT/PTRA SUMMER INTERNSHIP

Patrick Mangan

AAPT
PHYSICS EDUCATION

SPS

MY PROJECTS

- Contact network of US STEM-focused high schools
- Organization of the NGSS
- PTRA resource document updates
- Work with new AAPT staff member

CONTACT NETWORK

- Network of STEM-focused high schools across the US
  - US News & World Report list of top STEM Schools
  - National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMST)
- Organized by state and region
- Physics contacts at each school (teachers, etc.)
  - Contact info taken from school websites

State	School	Address	Physics Contact(s)	Contact Info
Ohio				
Indiana	Indiana Academy for Science, Mathematics, and Humanities	301 North Talley Street Ball State University Muncie, IN, 47306	George Devendorf	gsdevendorf@bsu.edu
			Hasan Fakhruddin	hfakhrud@bsu.edu
			Dain Kavars	dwkavars@bsu.edu
			Jeff Sayers	jdsayers@bsu.edu
			Stephen Schuh	sschuh1@bsu.edu
Illinois	Illinois Mathematics and Science Academy	1500 Sullivan Rd., Aurora, IL 60506	Dr. Mark Carlson	mcarlson@imsa.edu
			Dr. Peter Clancy	pclancy@imsa.edu
			Dr. Peter Dong	pdong@imsa.edu
			Dr. Eric Hawker	ehawker@imsa.edu
			Brooke Schmidt	bschmidt@imsa.edu
Iowa	Cedar Falls High School	1015 Division St. Cedar Falls, IA 50613	Ron Hoofnagle	Ron.Hoofnagle@cfschools.org
			Kenton Swartley	kenton.swartley@cfschools.org
	Linn-Mar High School	3111 North 10th St. Marion, IA 52302	Karla Blakely	Email address upon request
			Kyle Hoffman	
			Craig Pilcher	
Missouri	Missouri Academy of Science, Mathematics, and Computing	800 University Dr. Maryville, MO 64468		
Nebraska				
Kansas	Blue Valley North High	12200 Lamar Ave. Overland Park, KS 66209	Raji Prakash	rprakash@bluevalleyk12.org
			Randall Rose	rrose@bluevalleyk12.org
			Theresa Rudnick	tmrudnick@bluevalleyk12.org
	Buhler High School	611 North Main Street Buhler, KS 67522	Jana Moler	jmoler@buhlerschools.org

NEXT GENERATION SCIENCE STANDARDS

- ❖ Task: Arrange the NGSS in a way that is useful to physics teachers
- ❖ Flow chart of the physics-related performance expectations
  - To see how well they lead into one another
  - To see how cohesive the standards are altogether

Students who demonstrate understanding can:

HS-PS3-1 **Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.** [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [*Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.*]

HS-PS3-2. **Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).** [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]

HS-PS3-3. **Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*** [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [*Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.*]

HS-PS3-4. **Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).** [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [*Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.*]

HS-PS3-5. **Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.** [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [*Assessment Boundary: Assessment is limited to systems containing two objects.*]

Science and Engineering Practices

Developing and Using Models

Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2), (HS-PS3-5)

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-4)

Using Mathematics and Computational Thinking

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1), (HS-PS3-2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)

PS3.B: Conservation of Energy and Energy Transfer

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)
- The availability of energy limits what can occur in any system. (HS-PS3-1)
- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill,

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4)
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)

Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3)
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)

Connections to Engineering,Technology, and Applications of Science

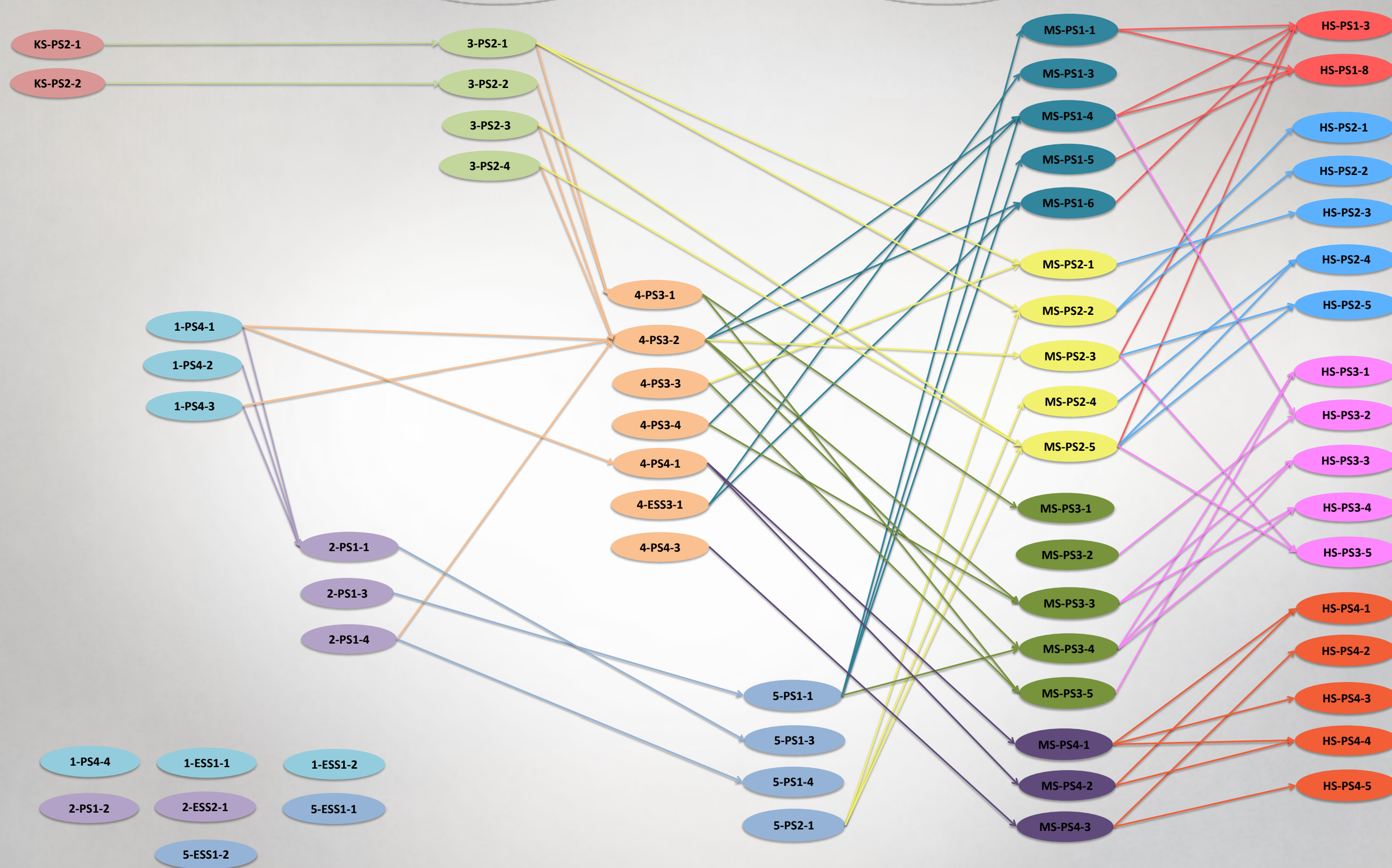
Influence of Science, Engineering and Technology on Society and the Natural World

- Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)



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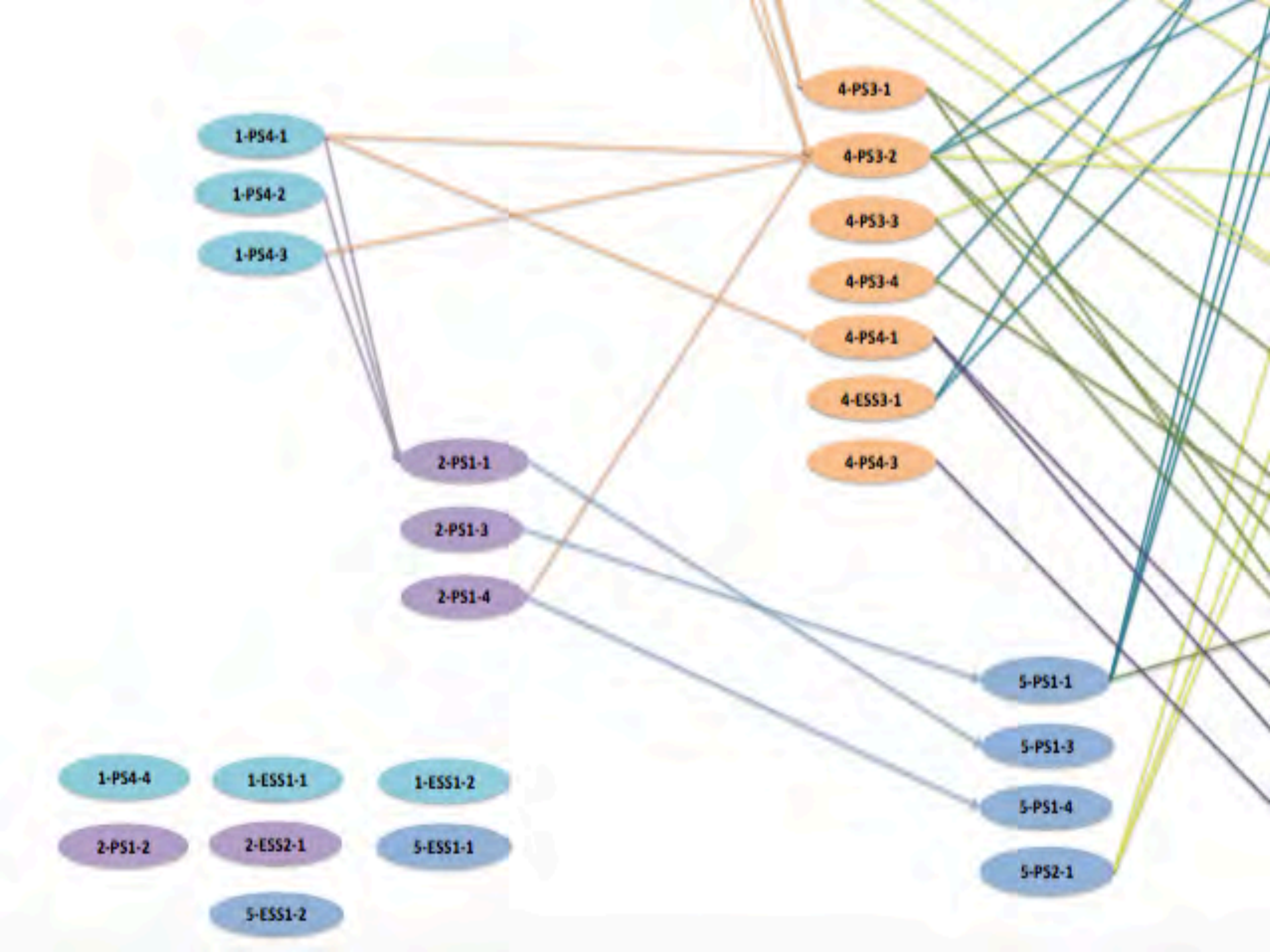

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PTRA DOCUMENTS

- PTRA-Physics Teaching Resource Agents
- Identified parts of old PTRA documents that needed updating
  - NGSS
  - Pedagogy
- Additions to some documents
  - Sections on electronics

EXTRA WORK

- ❖ Worked with new AAPT staff member (Rebecca Vieyra)
- ❖ Compiled list of physics teaching resources for elementary school classrooms
- ❖ Found a lack of resources for younger grades

FINAL THOUGHTS

- ❖ The contact network will be a good resource for AAPT to communicate with STEM-focused high schools
- ❖ The flow chart will be a good resource for teachers in districts/ states adopting the NGSS
- ❖ Physics is under-represented in elementary science education

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