A TIME for Physics First

Academy for Teachers
Inquiry and Modeling Experiences for Physics First

Leadership in Freshman Physics, 2009-14

NEWSLETTER: Vol 5, No. 2, August 2011

Administrator Academy 2011

Ann Wallenmeyer, Springfield Public Schools

Adding anything to an already hectic schedule is difficult, but the 17 administrators attending the *2011 Physics First Administrators' Academy* found the two days time well spent and the collaboration priceless. Some of their big take-aways included: modeling strategies such as whiteboarding and multiple representation, overlap between math and science concepts, support for their teachers through mentors/coaches, administrator support strategies to guide teachers and empower them in leadership roles.

Administrators worked in groups collaborating, solving and communicating their reasoning. "How do you know…?" and "Why did you do…?" were questions asked as administrators shared their solutions. The strategy was whiteboarding, and the problem was tough. Using dry erase markers and plain old whiteboards, they showed multiple representations of their thinking. The change in the tone of the room as it shifted from individual problem solving to group problem solving was exciting. One administrator said, "Whiteboarding practice was an awesome experience to help us appreciate the thought processes we are trying to encourage through Physics First." Another administrator shared, "This is a great program. I really want to have these types of instruction techniques for all our classes."

Many of the administrators were not aware of the coaching/mentoring support that is embedded within the program, until this meeting. One of the biggest differences between Cohort 1 and Cohort 2 Fellows is the use of coaches and mentors. Cohort 1 Fellows have coaches that visit once a month to observe, reflect and support. Cohort 2 Fellows have mentors that will never physically visit the Fellow but will collaborate, reflect and advise through online methods. Either way, this provides a great support system for the Fellows expected to implement not only the new curriculum, but also the new strategies involved with Physics First.

On the first day of the academy administrators were instructed to brainstorm a list of things they could do to support their Physics First Fellows. Unbeknownst to administrators, the Fellows had already submitted their ideas of what they needed for support from their administrators. During the second day of the academy, administrators processed the Fellows' suggestions and created a bulleted list of ideas. It was interesting to see that the administrator list and the Fellows' list were similar. Some of the ideas found on both lists were resources, time, collaboration, parents and discipline. One administrator summed it up by saying, "Provide collaboration time. Let Physics First teachers inform other staff members of what they are doing. Find equipment for teachers to help them perform their jobs. Give your teachers freedom to teach. Inform parents of the program."

One of the goals for the *A TIME for Physics First* project is to create a cadre of teacher-leaders who will become advocates for excellence in physics content and research-based pedagogy. This goal is addressed through a leadership class, PLC groups, and individual action plans. One administrator shared, "The leadership component with the teachers is an important part. Let them know that administrators are counting on them to set an example. We want to be supportive

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Here's What Physics First Participants are Saying...

Summer Academy 2011

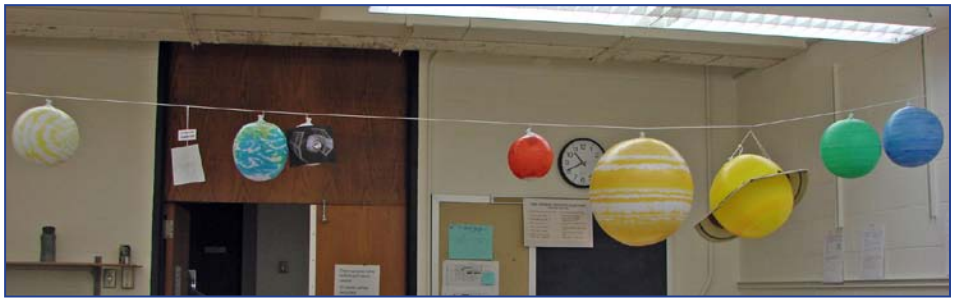
BRAD BUTLER, Versailles High School; Physics First was a blast. To learn a half years' curriculum in 16 days is amazing. I have taught for 22 years so I thought I would get 100% on all of our activities. Not so. That made it a challenge. The instructors were awesome. Meera's quotes of "If you do that you will really be in a soup" and "John – John, you know better. Put the cell phone up" were very funny. Marsha made you want to go back to the classroom and teach the material exactly like she did. MU was great. Food was good but the walks to the restaurants were better. All in all I am looking forward to teaching the curriculum to my incoming freshman next year.

JOHN GILBERT, Salisbury High School: As a first year teacher who has gone through two programs that push for inquiry, it tells me that inquiry is the way to go. I have seen how non-inquiry teaching works and how inquiry works and I will use inquiry as much as possible. I am from Columbia but if there was one thing I missed it was naps. I really was grateful for the support that I received from both the staff and Fellows in my cohort (who are for sure my friends now) during my mother's troubles with her health. It just shows me how great the people that are associated with this program really are.

Joan Twillman, C2 Mentor:

Each morning I read the New York Times. Then the St. Louis Post- Dispatch: A cup of tea; no noise. The word, "read" in the previous sentence is pronounced, "red" because I cancelled my subscription to the Times before the summer Physics First workshops began - after all, I was not going to be home. When I got to Columbia, Physics First days were full from 6:30 to 11 p.m. - working hard and playing hard. (What a worthwhile month! But there was no time for following the news.) Weekends turned out to be totally full- no time for me to watch the political scene. Somehow, it's now seven weeks later and I have still am not studying the news. Oh, I hear comments about the crisis in Washington, and the occasional political speech or program on the radio or TV, but no print, and no on-line coverage.

I have found that when I listen to the President speak or see a snippet of TV news, I pick up the storyline - just where they left off 7 weeks ago, reminiscent of when my college friends were able to follow the plot of their soaps by watching only during Christmas vacations. The time I used to spend on keeping up with the news of the world- 3 or 4 hours per day is now free. Better yet, I do not worry and fret about what is and is not being done in the world; Washington; Jefferson City; St. Charles. Oh, I know that back to school will mean returning to being an Informed Citizen but it has been awfully comfortable to let someone else watch the politicians this summer.



Shawn Hayden, our artistic teaching assistant, hung up a model of the solar system just in time for the Planetary Motion unit. Who says that college teachers don't decorate their classrooms?

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of all programs. I wish this type of staff development was available to all subject areas." Another administrator shared that the administrators' academy helped administrators gain an understanding of their role in helping/supporting teachers and having teachers lead others through the learning process.

Overall, there were many insights, much collaboration, and a "bucket full" of networking taking place at the 2011 Physics First Administrators' Academy. For more information about any of the topics covered, check out the *A TIME for Physics First* website. The PowerPoint, handouts and processing notes can be found under the administrator's section. There will be one more opportunity to attend the Physics First Administrator Academy during the summer of 2012. This academy will give you a basic understanding of Physics First and the associated pedagogy. As one of our attending administrators put it, "Be prepared to explain why PF doesn't look like other high school classes!"

Elizabeth Dyer, Kingston High School:

To read my emails sent home during the summer, you'd think my main purpose of coming to Physics First academy is to eat at as many new restaurants as possible. Every summer, my month in Columbia gives me the opportunity to taste things that I have only seen on the Travel Channel and Food Network channels.

But on the non-culinary side, I really appreciated the Wednesday afternoon talks from different professors. Even if I could only follow the outside edges of their research, they showed that scientists can have a passion for solving problems. That is something I hope to share with my students using Twitter feeds. So hopefully social networking will be a way for my students to see real science in progress.

Jack Wiegers, C1 Coach:

Musings on the 2011 Academy and the question: How do we know the Earth rotates?

The mother of I. I. Rabi, one of the father figures of American physics in the twentieth century, asked little Rabi when he came home from school each day: Did you ask any good questions today? Mrs. Rabi understood the heart of inquiry learning and teaching. I found the inquiry instructional model used this summer and the questions raised by everyone participating in the Academy this summer very helpful in improving my understanding of inquiry learning and teaching. The focus of this summer's academy was asking questions and gathering evidence to answer questions.

Certainly one of the most important questions in critical thinking is: How do we know? What is the evidence? Here is an example from one of the class sessions of the importance of these questions. (MU Professor) Angela Speck asked the question: How do we know the Earth rotates?

The evidence to answer this question does not flow from directly experiencing the Earth's rotation or revolution. Rather we experience the Earth as not moving. It took a very long time to assemble the evidence that the Earth rotates.

Angela Speck's question generated a rich discussion. From this discussion, places to look for evidence that support the statement the earth rotates emerged. The observed behavior of a Foucault pendulum provides important evidence. The Coriolis Effect as seen in the paths of long range artillery shells and in major wind patterns provides evidence. The observed Doppler Shift also adds to the evidence.

It was a great discussion and added to my knowledge of the evidence that answers the question: How do we know the Earth rotates? Perhaps even more importantly, it reinforced my belief that students need to be encouraged to keep asking the question: How do we know?

Crystal Turner, Greenfield High School;

If I had realized that living on a college campus would have turned in to a five star resort experience, I definitely would have become a professional student. The weather was warm and the living was easy.

What a great experience to have, you start your day with a nice stroll to class, you get to listen, learn, and experience Physics among a brilliant group of professors and teacher students. In the evening you have a wide range of entertainment and dining choices at very reasonable distances and prices. Hello, 50-meter pool, the Grotto, Trops, Shakespeare's.

I thought I had been teaching science in an inquiry based manner, until I had my first inquiry based science lesson ever on June 7th. The modeling of the modeling method helped me to understand that I have been a bit of an information giver in the past. Thank you so much *A TIME for Physics First*, for allowing my colleagues and I to expand our horizons, make great connections, and most of all help our students to look at the world with a more thoughtful and curious mind.

GEORGE ALLAN, North Kansas City High School:

Let me start by saying that I had no idea of what to expect from this venture for the summer.

I must say this experience ranked as one of the most thorough and enlightening professional development events that I have ever witnessed as a professional person. The University of Missouri staff was a well-coordinated and delightful team to work with this summer. The ice cream at Buck's Ice Cream was truly a delight and the servings were twice the amount expected for the money!

I feel a great deal more confident to teach physics as a direct result of this splendid Physics First Summer Academy.

George Allan, Eldonna Rose and Chris Goll, North Kansas City School District, work on plotting data

Reflections on the 2011 Summer Academy

Glenn Owens, Coach and Mentor

Now that I'm semi-retired, I have a lot more time to read things other than textbooks. One of my reading sources now includes the opinion and editorial sections of newspapers and magazines. Ya know, it's amazing how many people claim to know how to "fix the educational system" in the US. Another amazing thing is that most folks agree that having better teachers is a key element to the fix. However, this is where the fix gets complicated. How do you improve the quality of teachers?

The article I read this morning in the WSJ was based upon the philanthropic work of Bill Gates and his work to improve the educational system. Gates cited two main points: First, the amount of money spent on education is not a reflection of the quality or quantity of education produced in schools. The second point seems to march right along with the Physics First Program which focuses on research and development to make the proper changes in education.

The Gates Foundation is now focusing on reliable methods of measuring teachers' effectiveness. The methods used by effective teachers are observed, video-taped and studied. The Foundation has a five-year, $335 million project to determine whether effective teaching strategies (including classroom management, clearly expressed objectives, identifying and addressing common student misconceptions) can be videotaped and used as training tools for other teachers.

Admittedly, the PF program has less funding than the Gates Foundation project, but the basic method of improving the education is the same with an enhancement. The PF teachers are tasked to become the leaders in their schools. Not only to improve the teaching of others, but to encourage other teachers, even those in different disciplines, to observe the PF classrooms in an effort to gain feedback that could be used to improve their own lessons.

It seems that the biggest challenge for teachers is finding the time to do what needs to be done.

When I was teaching, I dreaded grading lab reports. It was tedious, time consuming and, for the most part, not the best investment of time input vs. learning gained. I asked an English teacher how he could grade students' writing and assign an "objective" grade to it. That's when I learned about the "scoring guide." What a concept. It saved me hours of grading time and the students produced better products.

Sometimes innovative ideas come from unexpected sources. Teachers need to share with their colleagues. When teachers collaborate, ideas are exchanged and education improves. That's the goal of the Gates Foundation and they're backing it with an investment of over a third of a billion dollars. The PF program is doing the same thing with its summer academy and extending it throughout the school year via the Action Plan. The best thing to do as a Fellow in the PF program is to choose an action plan that is reasonable and practical. Document all that you do and feel good that you are doing the same thing that the big foundations do….only you're doing it spending less money.

What do Coaches and Mentors Do?

Sara Torres, Coach-Mentor Coordinator, Arizona Science Teachers Association

A TIME for Physics First in Missouri provides support throughout the year to sustain the professional development teachers experienced during the summer academy. Professional Learning Communities, follow-up sessions, online discussion abilities, and coaches/mentors are components of the support system built into the program to assist teachers and schools as they implement 9th grade physics. During the 2011 summer academy, coaches and mentors worked diligently to learn more about their Fellows' (teachers) needs, learn the curriculum and pedagogy, and worked together to build common understanding about the tools they will use during the academic year.

Coaches visit each of their Fellows monthly during the school year and complete classroom observations. In 2010-11 the coaches used a modified Missouri School Improvement Plan Observation Sheet that was adjusted during the year to meet the needs of the coaches and Fellows. Although this document is simple to use, the coaches had varying degrees of common definitions of each of the observation descriptors. Therefore, during the academy, the coaches observed the teaching team of Cohort 1, completed the observation form and posted observation conversation as a group and then discussed the tool and how they completed the form. Through these activities, the coaches' internal reliability on the completion of the observation tool was increased and changes were made to assist the coaches, Fellows and the management team.

Just as the coaches were tweaking their observation form, the mentors did the same. Unlike the coaches, the mentors will not be visiting the Fellows in their classrooms. Instead, the Fellows will be responsible for completing a Self-Reflection Tool on a lesson each month, sending that to their mentor electronically, and have a virtual post-lesson conversation. To help the Fellows and the mentors understand how this will work during the academic year, the teaching team of Cohort 2 and the mentors modeled this process multiple times throughout the academy. The teaching team of Cohort 2 completed a Self-Reflection Tool following a lesson with the Fellows observing and even assisting the completion of the form. The Self-Reflection was given to a mentor to review and then in front of the class, the mentor guided the teaching team through a post-lesson conversation based upon the Self-Reflection. Through these experiences, the mentors and the teaching team modeled the expectation for the academic year, the teaching team had time to digest how the learning was occurring in their class and made adjustments to the curriculum and future lessons due to the feedback during the post-lesson conversation, and the mentors revised the Self-Reflection to meet the needs of all. These experiences also assisted the mentors in their ability to ask reflective questions which will help them as they work with Fellows during the academic year to think about the lessons taught and the learning that occurred.

Just as the teachers practiced their learning of physics throughout the academy, coaches and mentors practiced with the support tools they will use throughout the academic year. The coaches and mentors are not evaluators and tools they use are not for evaluation purposes. Physics First coaches and mentors support the 9th grade physics teacher in successful implementation of 9th grade physics, which in turn will enhance student success.

Left: One of the Cohort 1 classes.
Right: Cohort 2 works on Leadership

This is Physics?

Ann Neubauer, South Shelby County Schools

Note from the Editors: Ann Neubauer provided information for this article for her local newspaper. We reproduce it as an example for Fellows interested in writing for local newspapers or district newsletters.

South Shelby is one of the partner schools participating in Physics First. As part of the program and NSF grant, the science department got one group set and additional equipment worth $2300 to help us implement Physics First. Thanks to the generous grant to South Shelby from the Coca-Cola Foundation for which the Mayes family applied, we were able to purchase the additional equipment, technology and computers to fully implement Physics First.

So what is the difference between Physics First and Physical Science, the course freshmen have been taking? Physical Science included a little over a semester of physics, then Earth Science and Space and Universe Science. Physics First will be a full year of freshmen level physics that includes some Space and Universe science. The key difference is in how the students learn. Physics First leads students through labs, experiments and activities to discover the key ideas of physics and how everyday things work.

In this summer's academy we science teachers did the lessons our students will do. Here are examples of the lessons about electricity.

The first lab below shows one of the ways we learned about static electricity. Did you know that if you rub a balloon on your head you can then get it to stick to the wall?

Next, we measured how the resistance of a pencil lead changed as the length and the diameter of the pencil lead changed.

We were given a battery, a wire and a light bulb and had to figure out how to get the light bulb to light. This introduced us to the electrical circuit. With each activity each lab group summarized what we learned on a whiteboard and shared what we learned with the rest of the class.

Then we learned more about electrical circuits by making different circuits and seeing how brightly light bulbs light up, by measuring resistances and by determining the current in the circuit. Through these activities and labs the students will develop an understanding of what a circuit is and how resistance, voltage and current relate to each other.

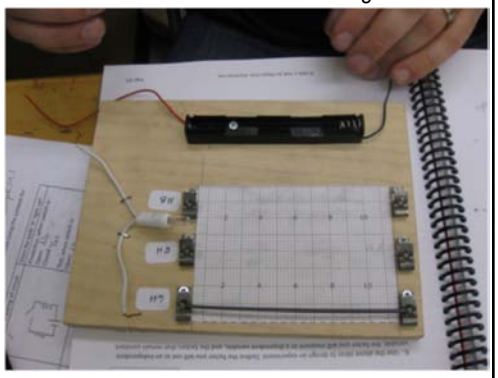
The MU Physics First program is part of a national movement to implement year-long physics courses in 9th grade and to better prepare high school students for science and engineering courses in college. "Our knowledge of science has changed dramatically during the past century," said Meera Chandrasekhar, program director and Curators' Teaching Professor of Physics and Astronomy in the College of Arts and Science. "Because biology courses now include elements of physics and chemistry, it's more practical to teach physics first so students are better prepared to handle the material."

So why do we need Physics First?

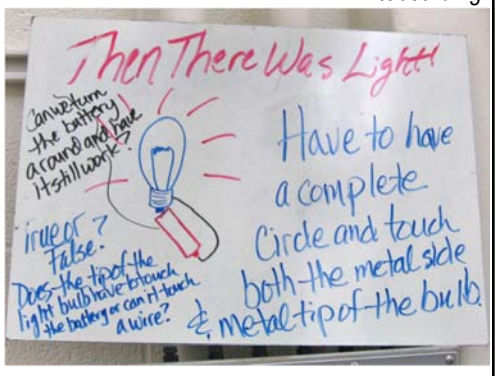
In 2000, The National Commission on Mathematics and Science

Static Electricity

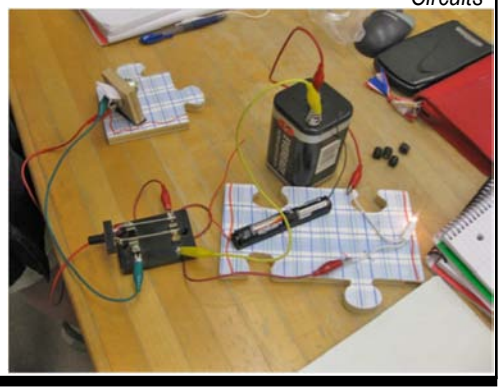
Measuring resistance



Whiteboarding



Circuits



Teaching for the 21st Century issued a report "Before It's Too Late." The Executive Summary makes these key points:

- The primary message of this report holds that America's students must improve their performance in mathematics and science if they are to succeed in today's world and if the United States is to stay competitive in an integrated global economy. The report's second message points in the direction of a solution: the most direct route to improving mathematics and science achievement for all students is better mathematics and science teaching.
- In an age now driven by the relentless necessity of scientific and technological advance, the current preparation that students in the United States receive in mathematics and science is, in a word, unacceptable.
- Reports of the performance of our country's students from both the Third International Mathematics and Science Study (TIMSS) and the National Assessment of Educational Progress (NAEP) echo a dismal message of lackluster performance, now three decades old; it's time the nation heeded it - before it's too late.
- Four important and enduring reasons underscore the need for our children to achieve competency in mathematics and science: (1) the rapid pace of change in both the increasingly interdependent

A TIME for Physics First (Academy for Teachers using Inquiry and Modeling Experiences) at MU

As part of the program Ms. Neubauer attended a four week summer academy (8:30 am to 4:30 p.m. Monday – Friday) this summer at MU. She will also attend a four-week academy next summer to learn the second half of the curriculum and a two week academy the following year. The goal of the academy is to build teacher physics content knowledge integrated with inquiry, modeling, technology and intellectual leadership.

The Summer Academy curriculum is based on inquiry and modeling pedagogies (hands on discovery activities) and leadership training. Physics topics are aligned with Missouri Course Level Expectations (CLEs) and National Science Education Standards (NSES). The academies are team-taught by university faculty and experienced peer teachers. The physics content courses will be organized as follows:

- First Summer Academy (4 weeks): Electricity, Uniform and Accelerated Motion, Forces, Newton's Laws
- Second Summer Academy (4 weeks): Applications of Newton's Laws, Energy, Astronomy, Heat, Waves
- Third Summer Academy (2 weeks): Track 1: for Praxis exam applicants: History of Science, Modern Physics, Magnetism and Electromagnetism, and additional topics
- Track 2: Flexible scheduling includes practice in content leadership skills, learn to conduct PD, work on curriculum revision, produce electronic resources, revisit concepts, work on National Board Certification materials.

A one-week academy is scheduled for math teacher colleagues from Fellows' districts along with a two-day administrator academy, both offered concurrently during the Fellows' academy in years 1 and 2. South Shelby Principal, Deacon Windsor, attended the administrator academy this summer.

Academic year activities are designed to support Fellows as they implement the Physics First curriculum in their 9th grade classrooms. Fellows will:

- Attend three face-to-face Saturday follow-up sessions that focus on content, pedagogy and leadership.
- Fully participate in Professional Learning Communities (PLC) and online discussions.
- Receive support from trained coaches/mentors.
- Access a web-based learning community.
- Utilize a kit-lending program for classroom sets of materials.
- Receive direct access to knowledgeable project staff.
- Attend Leadership in Science Education, a one-hour online seminar/course through MU.

Upon completion of the Physics First program, Ms. Neubauer will have completed 13 hours of tuition-free graduate credit (10 in physics, 3 in science education) and will receive a MU graduate certificate.

Yes! Physics is fun. This fall Physics First comes to South Shelby! Ann Neubauer is one of 72 teachers in Missouri chosen as a Physics First Fellow to attend the Physics First Academy, a graduate program through the Physics Department at MU and supported by a $5 million grant from the National Science Foundation (NSF).

Ms. Neubauer attended the Academy the month of June and learned the first semester of a new hands-on curriculum to teach Physics to high school freshmen. Now don't panic, this is discovering how everyday things work by doing labs and activities. No higher math, no just doing worksheets and memorizing formulas in this.

Physics First is playing broom ball to learn about how things move and using photogates, sparktimers, video, computers and cars to learn about speed and acceleration!

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global economy and in the American workplace demands widespread mathematics- and science-related knowledge and abilities; (2) our citizens need both mathematics and science for their everyday decision-making; (3) mathematics and science are inextricably linked to the nation's security interests; and (4) the deeper, intrinsic value of mathematical and scientific knowledge shape and define our common life, history, and culture. Mathematics and science are primary sources of lifelong learning and the progress of our civilization.

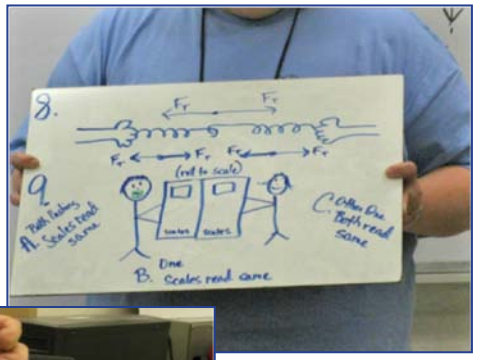
The results of the NAEP science test were updated in 2005 (http://nces.ed.gov/nationsreportcard/pdf/main2005/2006466_2.pdf). The study found overall performance in science declined since 1996 and performance of the nation's twelfth-graders in 2005 was unchanged from 2000; however, it was lower than that in 1996. This was true for both overall scores and scores for Earth, physical, and life sciences.

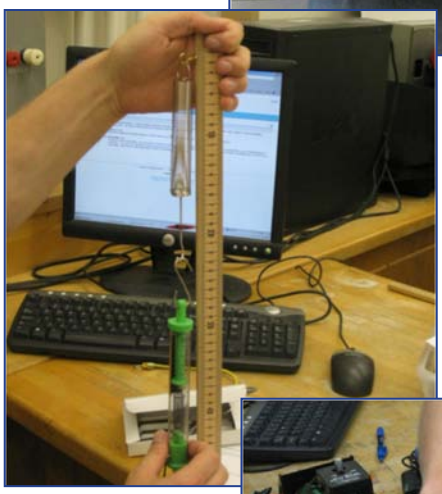
The study* did find that students in Midwest lead the nation! "Twelfth-graders in the Midwest scored higher than their peers in the Northeast, and both groups scored higher than twelfth-graders in either the South or the West. The study concluded a rigorous high school curriculum provides students with more options for postsecondary education, training, and employment. For that reason, many states have increased the number of courses required for high school graduation, especially in mathematics and science, as a part of their educational reform efforts.

The 2005 science results show that twelfth-graders who took biology, chemistry, and physics scored higher than students who took biology and chemistry, and both groups scored higher than those who took just biology or other science courses."

Physics First addresses several concerns by changing the way science courses are presented. Concepts and ideas are taught using activities, labs and experiments with students then summarizing what they learn. Through these steps students develop an understanding of the physics concepts. Ms. Neubauer said "I am so excited about starting Physics First at South Shelby! If the students have even half the fun and excitement I had this summer they will really enjoy Physics First and learn a lot."

*http://nces.ed.gov/nationsreportcard/science/interpretresults.asp





Newton's Third Law
Top: Whiteboarding a problem
Center: Observing the effect of the Law with springs
Bottom: Testing the Law with a track, car and force probes.

Excerpt from "Physics First in Science Education Reform"

By Vikram Pattanayak, http://www.jyi.org/volumes/volume6/issue7/features/pattanayak.html

This call for reform is supported by more than just the results of the TIMSS and NAEP studies. A leading science education reformer, Marge Bardeen, manager of the Fermi National Accelerator Laboratory Education Office, notes that what we learn in science courses could relate more to everyday life.

"Generally, I think people do not understand that science is a way of approaching problems, rather than a body of knowledge. As a result, they are often unable to assess claims and counter claims as they make choices on critical issues that face them as citizens," Bardeen says. "This is what we need to be concerned about - as we call it, scientific literacy for citizenship." Targeting high school science curricula is a way to increase science literacy, since all students, not just future scientists, must take high school science classes."

Physics First Math Academy Feedback

The letters below have been written by high school mathematics teachers attending the summer academy. They are addressed to mathematics teachers who were unable to attend the academy with the goal of providing insight into the needed collaborative effort between the mathematics and physics teachers.

David Tidwell, Hancock Place:

In collaborating with the Physics First teachers and other mathematics teachers over the past school year and last two summer sessions, I have learned many ways to help assist and collaborate with Physics First teachers. I have compiled a list of suggestions and vocabulary to share with other mathematics teachers to hopefully effectively assist and provide discussion topics with Physics First teachers.

- Ask the Physics First teachers to compile a list of formulas used throughout the school year. These formulas can be incorporated throughout the year in many algebra lessons. For example, when teaching students to solve formulas for a specific variable, using real-life formulas that they will see in Physics First would be ideal problems to use.
- Determine a rough draft of the timing and scope and sequence on concepts taught in Physics First and concepts taught in Algebra. These concepts do not necessarily need to be taught at the same time, but it would be important to be aware of when each class teaches each concept.
- Discuss the idea of graphing functions with independent variables and dependent variables. In Physics First, "x" is sometimes used to represent the position variable, and is plotted along the vertical axis. The letter "t" is sometimes used to represent time, and is plotted along the horizontal axis. A discussion on how to help students understand the underlying concept (and not get stressed out about the letters used) would be beneficial in this case.
- Physics First uses many variables with subscripts. Mathematics teachers could use these variables with subscripts to help students understand what they stand for. For example, one could say the formula for the area of a rectangle is $A = l \cdot w$ or in a slightly changed formula, $A_R = l \cdot w$ where the subscript represents the area of the rectangle. Another mathematics teacher suggested an example of having three students named Tiffany in the same class. Each student could be described as T_1, T_2, T_3 or classified by using the subscript letter of the first letter of their last name.
- Use real data collected from student experiments from the Physics First class to use in the mathematics class. This real-life data is relevant to the students and can be used to increase understanding of graphing and the mathematics teacher can use this to teach students how to write equations of best fit and how those equations can be applied in the real world.
- Physics First stresses to students to label mathematical calculations with units and will "cancel" units to come up with final answers. This could be introduced and used as needed in the classroom per discussion with the Physics First teacher and other mathematics teachers in the school/district.
- Discuss how to find the area under a graph and the real life application of what this "number" represents in physics.
- Discuss the use of whiteboarding and how it could potentially be used in the classroom
- Slope is used often and sometimes the formula is seen many differ-

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During the week of June 13-17, 2011, mathematics teachers from participating high schools in Missouri attended the second Physics First Summer Academy on the University of Missouri Columbia campus. This gave them the opportunity to work collectively as a group as well as to attend Physics First classes with their science teacher colleagues. In the process, mathematics teachers have familiarized themselves with key components of the Physics First curriculum and pedagogy, engaged in discussing implications for the mathematics curriculum of the Physics First course, explored in group discussions their role in implementing the Physics First curriculum in their respective schools, established the basic working parameters for an on-going collaboration with their science colleagues (as it relates to the Physics First course), deepened their mathematics content knowledge and their problem solving skills, and had the chance to meet with administrators to bring forward their suggestions regarding ways in which administrators may help facilitate the collaboration that needs to take place between the mathematics and science teachers at schools implementing the Physics First curriculum.

-- Dorina Mitrea, Professor of Mathematics, MU

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ent ways. A discussion with colleagues about the most frequently used ways to calculate the slope in both mathematics and physics classes would help make everyone aware of how it is used in both classes. This doesn't necessarily mean that both Physics First and mathematics teachers need to use the exact notations. This is just to make both parties aware of each other's practices.

- There are many slight changes in formulas that may be encountered. For example, in a mathematics class, a student might use the formula $D = rt$, and in the Physics First class, a student might use the formula $D = st$ or $\Delta x = v\Delta t$. It would be beneficial share with students that although the variables are different in each scenario, the idea is still the same.
- It is good to get an understanding of certain vocabulary words and symbols that show up often in Physics First. A few words that could be discussed as a collaborative team could include definitions of displacement, work, slope, velocity, vector, and force.
- A discussion about the use of decimals, fractions, scientific notation, etc. in each class might also be beneficial.

There were many more ideas and concepts learned throughout the time spent during the academy. One of the best resources and discussions is the collaboration with other mathematics teachers. Sharing ideas and thoughts is a great way to increase student learning in the classroom. I would highly suggest sharing email addresses with other mathematics teachers in the hopes that discussions, ideas and suggestions can continue throughout the year.

A long version of this article that includes all letters written by math teachers is published in a Supplement that accompanies this newsletter.

Sandy Davidson, Moberly:

I am sorry you could not attend 'Physics First' where we learned several fun applications between math and physics. Don't worry, with open lines of communication between your school's Physics First teacher and yourself, you will be able to catch up on what we learned. Here are some key points to help get you started.

Physics has a lot of labs that produce data that in turn can be extended in your math class. Instead of creating random data to teach or extend a topic in your classroom, you can use the data from physics labs. Furthermore, you can use physics formulas as examples to have students solve for variables to increase their familiarity. When creating real-life examples of slope and quadratics, simply use situations from physics.

A big misconception for students that you as a math teacher can help prevent deals with slope. In physics, the variable x may be plotted on the vertical (y-axis) as position. Students may incorrectly calculate the slope with the x-values on the numerator instead of in the denominator if they use the formula for slope literally! In addition, emphasize using different variables along the vertical and horizontal axes so students have to remember that the slope is the change in the vertical-axis (Δy) over the change in the horizontal-axis (Δx).

You can help students by having them explain graphs compared to its labeling. What does it really mean at the point (x,y)? For example, at time 5 seconds, the rock is 3 feet above ground level. Of course, there will be many pay offs within your math class as well.

If you can collaborate with your physics teacher and get similar terminology then students can spend more time on solving problems.

When students see a cyclical teaching of slope, graphs, units, and problem solving between physics and math they will be better for it. I hope you have a wonderful year with great collaboration between you and your physics teacher.

Sarah Doss, Willow Springs, MO

I have to admit my hesitation about freshmen taking Physics First, feeling that the combination of algebra and physics was too much for their level of development and math skills. However, upon completion of the academy, this order is beneficial. The skills they learn in physics can and do complement high order thinking, which is the base for the other science courses.

So how can algebra complement physics and vice versa? There are multiple ways the two use similar terminology and concepts, thus strengthening the students' skills in the long run.

How does this transition begin? As math teachers we can start using units. This is an easy way to merge. Then go over curriculum and what the two classes can do to support each other … in slopes, graphs, etc. It would be helpful to no longer say that, "That is wrong," but instead challenge ourselves to explore the possibilities.

Isn't that what math is about, exploring the possibilities? Math and science departments working together…imagine the possibilities? Most importantly, imagine how much more the students would learn from this marriage? It's exciting to think about.

BRAIN BENDERS

Dorina Kosztin, University of Missouri

The Turning Earth

You know that the Earth rotates around its axis, making a complete rotation in 24 hours. Why is it then that when you jump vertically upward, you land in your own footsteps rather than at a distance equal to the distance traveled by the Earth in the time it took you to jump?

Which physics law helps you explain this?

Down...down...down...

A coin and a feather fall at the same rate (equal speeds at any given instant) in an evacuated tube. Would it be correct to say that in a vacuum equal forces of gravity act on both the coin and the feather?

Tug-the-Strongman

Strongman has his hands tied to ropes connected to two horses that are pulling in opposite directions. He can withstand the tension force exerted by the two horses.

How would the tension force compare if only one horse pulled and the other rope was tied to a tree?

The Black Belt

When you deliver a karate chop to a stack of bricks, how will the impulse differ if your hand bounces back upon striking the bricks vs. if your hand remains in contact with the bricks?

How does the force exerted on the bricks compare to the force exerted on your hand?

Windmills

Rows of wind-powered generators are used in various windy locations to generate electric power. Does the power generated affect the speed of the wind?

Would locations behind the "wind mills" be windier if they weren't there?

Falling Freely

Pretend you are in an elevator at the top of a tall building. Mounted in the elevator is a video camera that takes pictures of you holding a ball in front of your face, then dropping the ball.

If you drop the ball at the same time the elevator cable snaps, so the elevator falls freely, how will the video footage of you dropping the ball be similar to or different from footage of you dropping the same ball in the orbiting space shuttle?

Fast Facts:

Grant period: September 1, 2009 - August 31, 2014
Funding Agency: National Science Foundation
Target Participants: Ninth grade science teachers in Missouri school districts

2012 summer academy starts June 4, 2012
Follow-up meetings: Oct 8, 2011 (Columbia); two 2012 dates TBA

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Support: This project is supported by the National Science Foundation grant # NSF DUE 0928924. NSF is not responsible for the opinions expressed in this publication.

Above: Academy participants enjoy their end-of-academy lunch
Left: A Cohort 2 class tests Newton's second law with the help of John Gilbert's low-friction "cart."

From:
A TIME for Physics First
223 Physics Building
University of Missouri
Columbia MO 65211

A TIME for Physics First

Academy for Teachers
Inquiry and Modeling Experiences for Physics First

Leadership in Freshman Physics, 2009-14

Supplement to Vol 5, No. 2, August 2011

Reflections on the Summer Mathematics Academy at A TIME for Physics First, 2011

During the week of June 13-17, 2011, mathematics teachers from participating high schools in Missouri attended the second Physics First Summer Academy on the University of Missouri Columbia campus. This gave them the opportunity to work collectively as a group as well as to attend Physics First classes with their science teacher colleagues. In the process, mathematics teachers have familiarized themselves with key components of the Physics First curriculum and pedagogy, engaged in discussing implications for the mathematics curriculum of the Physics First course, explored in group discussions their role in implementing the Physics First curriculum in their respective schools, established the basic working parameters for an on-going collaboration with their science colleagues (as it relates to the Physics First course), deepened their mathematics content knowledge and their problem solving skills, and had the chance to meet with administrators to bring forward their suggestions regarding ways in which administrators may help facilitate the collaboration that needs to take place between the mathematics and science teachers at the schools implementing the Physics First course.

-- Dorina Mitrea, Professor of Mathematics, MU

The letters below were written by mathematics teachers attending the summer academy. They are addressed to mathematics teachers who were unable to attend the academy with the goal of providing insight into the needed collaborative effort between the mathematics and physics teachers.

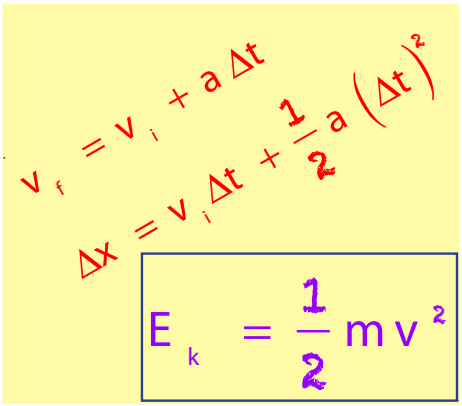
David Tidwell, Hancock Place:

In collaborating with the Physics First teachers and other Mathematics teachers over the past school year and last two summer sessions, I have learned many ways to help assist and collaborate with Physics First teachers. I have compiled a list of suggestions and vocabulary to share with other mathematics teachers to hopefully effectively assist and provide discussion topics with Physics First teachers.

- Ask the Physics First teachers to compile a list of formulas used throughout the school year. These formulas can be incorporated throughout the year in many algebra lessons. For example, when teaching students to solve formulas for a specific variable, using real-life formulas that they will see in Physics First would be ideal problems to use.
- Determine a rough draft of the timing and scope and sequence on concepts taught in Physics First and concepts taught in Algebra. These concepts do not necessarily need to be taught at the same time, but it would be important to be aware of when each class teaches each concept.
- Discuss the idea of graphing functions with independent variables and dependent variables. In Physics First, "x" is sometimes used to represent the position variable, and is plotted along the vertical axis. The letter "t" is sometimes used to represent time, and is plotted along the horizontal axis. A discussion on how to help students understand the underlying concept (and not get stressed out about the letters used) would be beneficial in this case.
- Physics First uses many variables with subscripts. Mathematics teachers could use these variables with subscripts to help students understand what they stand for. For example, one could say the formula for the area of a rectangle is $A = l \cdot w$ or in a slightly changed formula, $A_R = l \cdot w$ where the sub-

script represents the area of the rectangle. Another mathematics teacher suggested an example of having three students named Tiffany in the same class. Each student could be described as T_1, T_2, T_3 or classified by using the subscript letter of the first letter of their last name.

- Mathematics teachers can use real data collected from student experiments from the Physics First class to use in the mathematics class. This real-life data is relevant to the students and can be used to increase understanding of graphing and to teach students how to write equations of best fit and how those equations can be applied in the real world.
- Physics First stresses to students to label mathematical calculations with units and will "cancel" units to come up with final answers. This could be introduced and used as needed in the classroom per discussion with the Physics First teacher and other mathematics teachers in the school/district.
- Discuss how to find the area under a graph and the real life application of what this "number" represents in physics.
- Discuss the use of whiteboarding and how it could potentially be used in the classroom
- Slope is used often and sometimes the formula is seen many different ways. A discussion with colleagues about the most frequently used ways to calculate the slope in both mathematics and physics classes would help make everyone aware of how it is used in both classes. This doesn't necessarily mean that both Physics First and mathematics teachers need to use the exact notations. This is just to make both parties aware of each other's practices.
- There are many slight changes in formulas that may be encountered. For example, in a mathematics class, a student might use the formula $D = r \cdot t$, and in the Physics First class, a student might use the formula $D = s \cdot t$ or $\Delta x = v \cdot \Delta t$. It would be beneficial share with students that although the variables are different in each scenario, the idea is still the same.
- It is good to get an understanding of certain vocabulary words and symbols that show up often in Physics First. A few words that could be discussed as a collaborative team could include definitions of displacement, work, slope, velocity, vector, and force.
- A discussion about the use of decimals, fractions, scientific notation, etc. in each class might also be beneficial.
- There were many more ideas and concepts learned throughout the time spent here. One of the best resources and discussions is the collaboration with other mathematics teachers. Sharing ideas and thoughts is a great way to increase student learning in the classroom. I would highly suggest sharing email addresses with other mathematics teachers in the hopes that discussions, ideas and suggestions can continue throughout the year.



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A big misconception for students you as a math teacher can help prevent deals with slope. In physics, they have x on the y-axis as position. We have x on the x-axis. Now, when students try to find slope by putting x-values on top instead of in the denominator, you can help explain this. In addition, really emphasize using different variables when finding slope so students have to remember the change in the y-axis (ΔV) over the change in the x-axis (IV).

You can help students with their physics by having them explain graphs compared to its labeling. What does it really mean at the point (x,y)? For example, at time 5 seconds, the rock is 3 feet above ground level. Of course, there will be many pay offs within your math class as well.

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Math and Physics First teachers discuss results of their experiments: L-R: Emily Augustine and Cathy Dweik, math and physics teachers, respectively, from Jefferson Junior High School; Lisa Groteweil and Randall Siddens, physics and math teachers, respectively, from Keytesville High School

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When students see a cyclical teaching of slope, graphs, units, problem solving … between physics and math the students will be better for it. I hope you have a wonderful year with great collaboration between you and your physics teacher.

Sarah Doss, Willow Springs R-4:

I have to admit my hesitation in regards to freshman taking Physics First, feeling that the combination of Algebra and Physics was too much for them at their level of development and math skills. However, upon completion of the academy, this order is beneficial. The skills they learn in Physics can and do complement higher order thinking, which is the base for the other science courses.

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Isn't that what math is about, exploring the possibilities? Math and science departments working together … imagine the possibilities? Most importantly, imagine how much more the students would learn from this marriage? It's exciting to think about.

Scott Neeman, Springfield R-12:

Recently a group of math teachers including myself had the opportunity to attend a week of Physics First training in Columbia. During this time we identified some areas where math and Physics First teachers can work together to strengthen students' skills in both math and science. While the Physics First curriculum requires dramatic changes in the science classroom, math teachers can assist the implementation of this new curriculum by making a few very minor changes in their teaching.

Evaluating expressions and solving equations

Instead of using generic expressions exclusively, teachers can also include some examples from the Physics First material. For example, in the equation for the position of an object in accelerated motion,:

$$x_f = x_0 + v_i t + \frac{1}{2} a t^2$$

Teachers could provide four of the values and have students evaluate or solve for the other. This example also provides an opportunity to discuss subscripts and units of measure.

Slope

Math teachers typically define slope as rise/run or $(y_2-y_1)/(x_2-x_1)$ or some similar way. It can also be defined as vertical change / horizontal change which would help the Physics First curriculum because their axes do not always have x on the independent axis and y on the dependent axis. For example, they may have time on the dependent axis and x (displacement) on the independent axis. Additionally, when analyzing slope on the graph, it will help to use increments other than one on the axes.

Area

When calculating composite areas, include some piecewise linear examples. Additionally, area problems provide another opportunity to analyze units of measure in your calculations.

It is our belief that when implemented with some cooperation be-

tween math and science teachers, the Physics First curriculum will deepen students' understanding of mathematical concepts.

Randall Siddens, Keytesville R-3:

As a first year teacher, I have learned a lot of ideas that could help math teachers and Physics First teachers in their efforts to teach in their respective subjects. Some things will require making changes from traditional teaching methods, while other ideas will fit in well and improve the learning process. I will start with a few ideas that are easy to use.

Math and Physics teachers can both gain a lot by just using the same terminology. We all talk about similar concepts and ideas, so let's use the same vocabulary and descriptions. Taking this idea even further, we can even work similar problems with the same steps. Math teachers can use some examples from physics that relate abstract concepts to something students understand in real life. This requires some purposeful collaboration between teachers.

In addition to small changes, make attempts to find ways to connect physics and math. The two courses can and will help the other out. It will take a small amount of extra work, and some purposeful collaboration, but it will definitely pay off.

Kim Belanger, Kirksville R-3:

The Physics First Academy will be a very well spent week. You will refresh your mathematics skills and gain a new respect for the effort required of the freshman science teachers in your district.

Be prepared to keep track of data and discover equations. Using the lab equipment to collect data (as opposed to having it handed to you) is a learning experience in itself. It was a great reminder of the effort needed to have the proper equipment out for each group.

The mathematics problems are a fun way to work across the curriculum. It is very easy to see how mathematics and science can be brought together to keep students actively engaged in their educations.

Becky McCurdy, Community R-6:

When I first learned of my fellow science teacher's involvement with the Physics First program, I thought great, but this doesn't affect me. Then as I learned more about the program and was asked to attend the Math Teachers Academy, I began to worry that this might affect me. After attending the Academy this week, I am positive that my colleague's involvement will affect me, but the emotion is no longer worry, but instead it is excitement!

The science teachers involved in the Physics First program will be incorporating a great deal of mathematics into their classrooms. This is going to require us to be flexible in our classrooms to support them. However, they can be of great assistance to our classes as well. Their programs give some real world application and can provide numerous examples and reinforcement to our instruction. The reinforcement can go both directions.

Ohm's Law Clock

Don't be afraid to collaborate with your science teacher and get your curricula in order so that you can maximize both your instruction and get the most from your programs!

Gary Jones, Greenfield R-4:

I have recently completed the math teacher portion of the Physics First academy conducted at the University of Missouri. This program contained many laboratory exercises, which should help students understand math concepts at the 9th grade level. Math can also help the student better understand physics concepts in a number of ways and methods. Some are standardization in terminology, clarifying definition of slopes, and how slope magnitude is recorded. These are but a few of the areas that can facilitate learning.

The success of the Physics First program can help the student not only in higher physics courses but in higher math courses as well. I look forward to meeting with you to explain the many aspects of this exciting program.

Kim Hurst, McDonald County R-1:

I would like to advise you to use more formulas. The more comfortable students are with using variables other than x and y, the easier it will be for them to adjust to the formulas in Physics First.

Also teach slope early. They don't need to know how to solve equations to plug in for slope.

Finally, collaborate!! Your science teacher wants to help you and you can help them. In time you will see how beneficial the program is to Algebra 1.

Todd Brendel, Lone Jack C-6:

I teach 7th-9th grade math in my district. I have seen the importance of vocabulary in both math and physics and know that I need to interchange terms in my classroom so students are familiar with terminology. When solving for variables in Algebra, I will begin using Physics formulas as part of my examples. This will demonstrate their knowledge of solving for variables for me and reinforcing formulas for the physics classroom. The x- and y-axis don't have to be labeled x and y and it would be helpful to randomly pick other letters like t (for time) and v (for velocity) to use at different times. Find out what math ideas the Physics teachers are going to cover and try to overlap some of the ideas at the same general time. The two programs can complement each other if you will work with your science teacher.

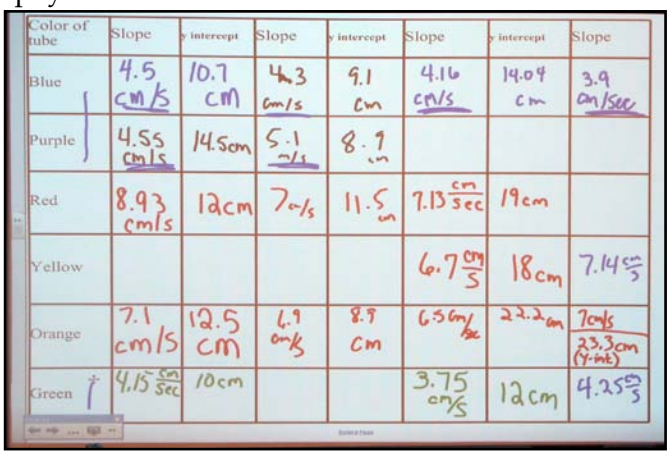
Denise Corio, Grandvew R-2:

I have just completed the Physics First Academy for math teachers and have some suggestions for you.

First, your science teacher is your teammate, not your foe. He/She will be using many of the concepts you will be teaching. You can reinforce each other's lessons. For example, they use the concept of slope in their force and motion unit.

Second, be flexible. Scientists do not always label their axes as x and y. They label them according to what they represent (as we SHOULD). You will find they may label the horizontal axis as t (for time) and the vertical axis as x (for displacement).

Finally, be positive! This is a new program for all of us. If you remember my first two suggestions, the program will reap benefits for our math AND Science students.



Color of tube	Slope	y intercept	Slope	y intercept	Slope	y intercept	Slope
Blue	4.5 cm/s	10.7 cm	4.3 cm/s	9.1 cm	4.16 cm/s	14.04 cm	3.9 cm/sec
Purple	4.55 cm/s	14.5cm	5.1 cm/s	8.9 cm			
Red	8.93 cm/s	12cm	7cm/s	11.5 cm	7.13 cm/sec	19cm	
Yellow					6.7 cm/s	18cm	7.14 cm/s
Orange	7.1 cm/s	12.5 cm	6.9 cm/s	8.9 cm	6.56 cm/sec	22.2cm	7cm/s 23.3cm (y-int)
Green	4.15 cm/sec	10cm			3.75 cm/s	12cm	4.25 cm/s

Slopes obtained from the bubble tube lab

Brent Burton, Springfield R-12:

Information to collaborate with your Physics First teacher.

1. Both teachers can use similar language for same subject.

2. Units (use them when solving equations, as applicable)

3. Align dates when certain subjects (i.e. equations) are taught

4. Graphs (labels, slopes, axes, etc.)

5. Specific mathematical operations (Clear up w/ teachers) for example, show the distributive property in equations such as

$$x = \frac{1}{V}\left[\frac{V}{3} + \frac{V}{4} + \frac{V}{5}\right]$$

6. Introduce subscripts to students.

Julie Coffey, North Kansas City:

Next year you will have a colleague in your building teaching the Physics First curriculum. Many concepts from Algebra are taught in the Physics First curriculum as well. If you work with your physics teacher you can create an ideal situation in which ideas, concepts, and vocabulary are repeated and reinforced in both courses. Also, you may find that using examples from the Physics First curriculum in your Algebra class just might answer the age-old "When will we ever need this?" question. Finally, if you are interested in broadening the problem solving skills of your students or increasing the DOK of your question then the Physics First curriculum should prove helpful.

Angela Camillo, Kingston K-14:

There are some issues that you need to consider as you are teaching Algebra students who are also enrolled in Phyiscs First. I would highly recommend that you spend some time collaborating with the science department. It will not be the goal of the Math department to teach the Physics curriculum, but to look at how the Science and Math can complement each other. There are many topics that overlap in the Math and Science curricula that you need to consider how they are addressed by both departments. The Math and Science departments both need to address the similarities and differences in the concepts. For example, slope is addressed in different ways by each subject. Math and science teachers need to be aware of these differences so they can be addressed to students. By working with your Physics teacher to address how these concepts are taught in both classes will help provide a better understanding for the teachers & students in the long

run. Collaboration with the Physics First teacher is not asking for you to do more work, but to expand your knowledge of the math concepts used in other areas.

Erin King, Ferguson-Florissant:

As you prepare for your upcoming year of Algebra 1, here are a few things to keep in mind:

The 9th grade science students will be embarking upon a year of physics. This should be an exciting year for math and science education because Algebra 1 and Physics are so related. The main thing to remember is that physics and algebra have slightly different notations for the same concepts (i.e. graphing, writing equations, slope, etc).

These differences should be no big deal since I went to the summer Physics First academy this summer.

Let's get together during our first PLC meeting to discuss what the differences are and how we as math teachers can help the physics program. Synchronizing our notation & vocabulary will help improve our own classes! Do you remember when kids came to class and said that their science teacher did Δx on top for slope? They weren't lying! Let's meet soon!

It's going to be a great year!

Yancy Cody, Cooper Co. R-4:

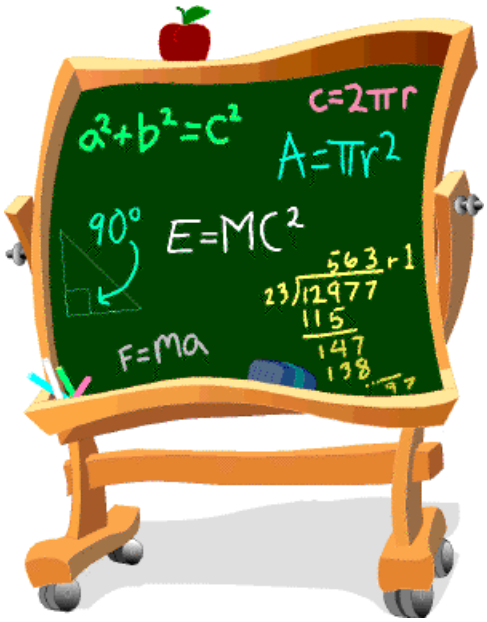
My best advice for you is to be open minded and collaborate closely with your Physics First teacher. Remember we as teachers are here to help students learn, so we should do the little extra things to make learning easier for them. In graphing lines it doesn't always hav to be x and y axes and since in physics the axis are switched we should say independent and dependent variables. Also let them use the data they've collected from a lab to teach them how to plot points, because this will help them to understand why graphing is important.

In closing I hope you give this program a chance and encourage your students to do the best they can in this program. It involves a lot of math that students will struggle with and we need to be there to help them along the way. So try to stay on the same page as your Physics First teacher.

Lindsey Wenger, Morgan County R-2:

This has been an enlightening week. There are aspects of math that I have taught that I never would have thought about needing to "revamp." For example, I used to teach the slope formula very strongly: $(y_2-y_1)/(x_2-x_1)$. After this week and seeing the differences in Physics First I will not stress this anymore. Instead I will discuss slope as the vertical change over the horizontal change.

There are many areas that can be tweaked to make Physics First and mathematics flow together better, but I think the number one most important piece of information I am taking away from this conference is the need for collaboration. I think it will be imperative for the math and science teachers to have a time set aside to discuss what concepts are overlapping and how they should be presented or discussed in class.



Unsigned:

I would like to strongly encourage you to sit down with your Physics First teachers and start a conversation. Physics First will have a lot of concepts that will help your students understand math better. Knowing what labs they do and how they use slope can help you explain the same concepts in math class better. If nothing else in the first year, both teachers should know the notation and vocabulary used in both math and science. Without the awareness of vocabulary there could be a huge disconnect for kids, but by being aware of this issue both teachers can support each other and make the understanding stronger for the student.

As a math teacher you can help support your physics teachers by working with different variables other than x and y and by using the formulas they will see in that class for solving for a variable and evaluating problems in your class.

Unsigned:

This was a week of learning and observing. I had the opportunity to observe the science teachers work on their Physics First class. Seeing them perform experiments and discuss the material was very enlightening. It helped me make more connections between physics and algebra. My advice to you is to take the time to not only talk with the Physics First teachers at your school but also really listen to what

they have to say. I think you will find there are many ways you can help each other through vocabulary, examples and just simple reminders of what they have seen in not only their physics class but also in their algebra class.

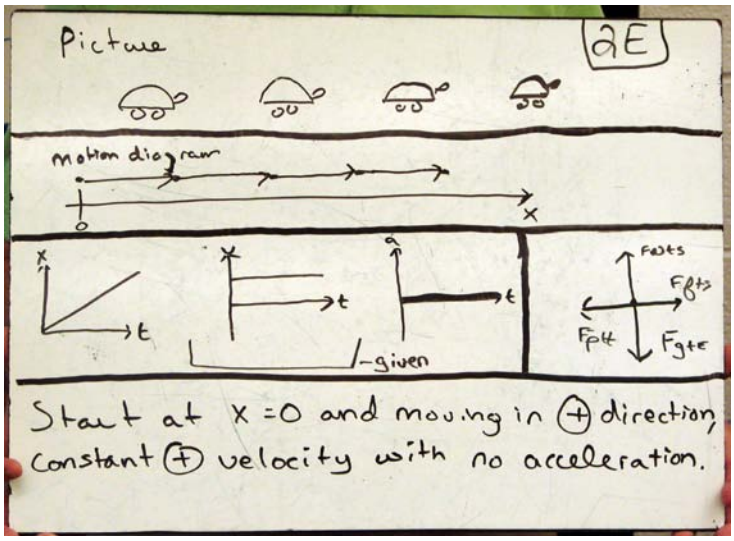
Unsigned:

After attending the Physics First academy, I have gained useful information that I would like to share. I will be working with my Physics First teacher during PLC time to exchange ideas and information. I found that I really needed to have conversations with my classes/students about how the axes on which we plot independent and dependant variables can be interchanged based on what is being measured/graphed. Another problem that I found was that the two curricula were not aligned very well, which caused confusion. By having conversations with your fellow Physics First instructors, you may be able to combat problems before they start. A common misunderstanding is labeling axis and using slope. Physics uses different letter variables to label graphs, while mathematics typically uses x and y. One conversation that occurred was for mathematics instructors to use different letters/symbols to label axis. In a second conversation, we were told to ALWAYS make sure students include units of measure. I will be making small changes in class discussion, and possibly team teaching with my Physics First teacher.

I hope this gives you a basic idea of how we can aid student learning for algebra and Physics First.

Unsigned:

Attending the Physics First academy is beneficial for all math teachers. While at this academy a teacher is able to gain the understanding of a variety of techniques that physics teachers use in their class. The hands-on experiments are very interesting and a math teacher could use the ideas behind the experiments as a real-life tool within their class. The conference is also beneficial for the communication you gain with your physics teacher in your district. Something we focused on was the vocabulary differences and similarities.



Whiteboard of pictorial, graphical and verbal representation of uniform motion

We worked on reaching a common ground on particular language we want to both cover that would clear up confusions in both classes. Lastly, we talked about pacing and topics covered that help both classes. We all felt that if we continued to work together we would be able to increase the level/depth of knowledge in all math and science classes.

Unsigned:

After attending the Physics First academy, there are small changes we can make in our classrooms that will help the Physics First teachers in our district.

Most of the changes are in how we approach concepts. Since x(t) is the vertical axis in the PF class, then perhaps we need to get rid of the "horizontal is always x and vertical is always y" way of graphing. We can talk about independent and dependent axis or name them other things besides x and y. Instead of always finding slope with an equation, we need to look at it as a change in rise over change in run. We can use subscripts more and have the students verbalize concepts more often.

I think it's important that we collaborate and support our Physics First coworkers by meeting with them and talking to them about coordinating our approaches and terminology. We must do what's best for the kids.

Stand together or we will hang separately.

Unsigned:

It is important to be open to thinking about our methods & procedures in a different way. You will not have to change everything you do. Open communication between you and your PF colleagues will be important. You are not teaching PF and they are not teaching your Algebra class. Instead, you are supporting each other to help your students to be successful in both classes. Talk to the PF teachers about what math concepts are important. Then figure out how you can incorporate some PF notation or concepts into your current curriculum. Also, discuss verbiage that is used in both math and PF classes. Try to be consistent in both classes when teaching the

same concepts to reduce your students' confusion and misconceptions. Take time to clarify what vocabulary is important for the PF teachers. For example, a horizontal line has zero slope, not no slope. If you and your PF teachers work together, students will benefit!

Unsigned:

Physics First is an exciting program to participate in and observe. There are so many ways that the Physics First program overlaps with our math curriculum and I am excited to see how student performance is affected.

I do not expect to make major changes to my curriculum. Instead, my adjustments will be small. Really, I think I will gain an appreciation for what is going on in the Physics First classroom and be able to answer questions or clear up student misconceptions. Enjoy the collaboration.

Unsigned:

Physics First is a program I was attended this summer that informed me about the relation between Physics and Algebra 1. My 9th grade science teacher was able to come for a month to learn the entire curriculum. A few things I noticed that us as math teachers can do to help the Physics First science teacher are:

1. Use independent and dependent to label the x and y axis, because in physics the y-axis is called the x. "x" stands for position.

2. Make sure to include units when solving problems.

3. Use physics formulas for substitution lessons so students are more familiar with them.

There are so many more things we can do, but collaborating with your science teacher will make the process much easier!

Unsigned:

It would be my suggestion to meet with your Physics First teacher and iron out the vocabulary, formulas, and topics that will be discussed throughout the year. It is important to get a consistent vocabulary and to use similar variables in both classes. Make sure to cover similar material at an appropriate time so that the ideas from Physics First and math classrooms reinforce each other. You don't need to change your curriculum, just modify it to support Physics First. With proper collaboration both science and math departments in your district can benefit from the program.

Willow Springs High School Physics First teacher Kevin Hummel takes data for a uniform motion experiment with the math teacher from his school, Sarah Doss. Sarah's letter is on page 3.

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