

Web-based Pedagogical Assistance for Under-prepared Teachers of Physics

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Physics Teaching Web Advisory Pathway

www.physicspathway.org

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Goal

Provide just in time assistance on the pedagogy of physics

- The need
- Our approach to a solution
 - Introduction
 - The real thing
 - Simulated
- Feedback so far

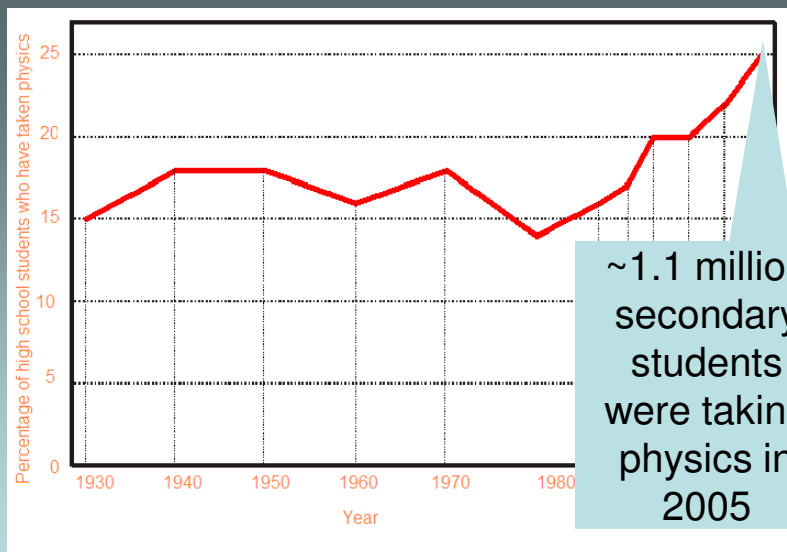
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The problem

“Yet in high schools, more than 20 percent of students in math and more than 60 percent of students in chemistry and physics are taught by teachers without expertise in these fields.”

- President Obama
Speech to the National Academies,
2009



Source: American Institute of Physics



Why are they learning physics

- At present medical colleges & biological sciences degrees require physics at University
- Engineering also requires University physics
- Students believe
 - Completing secondary level physics gives them an advantage in University physics
- Very few wish to study physics at University

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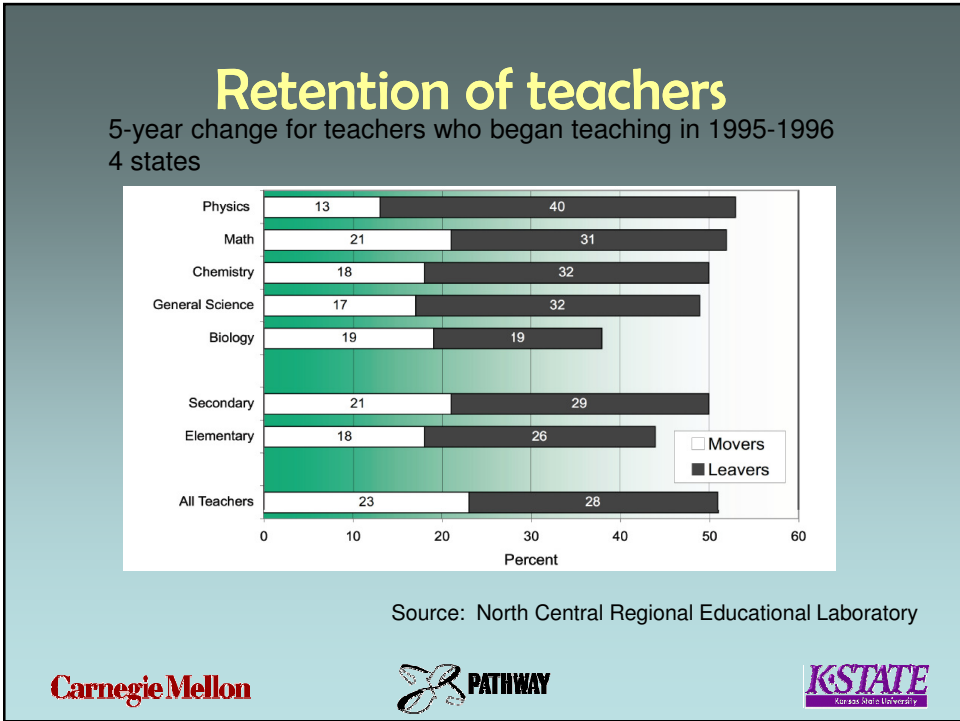
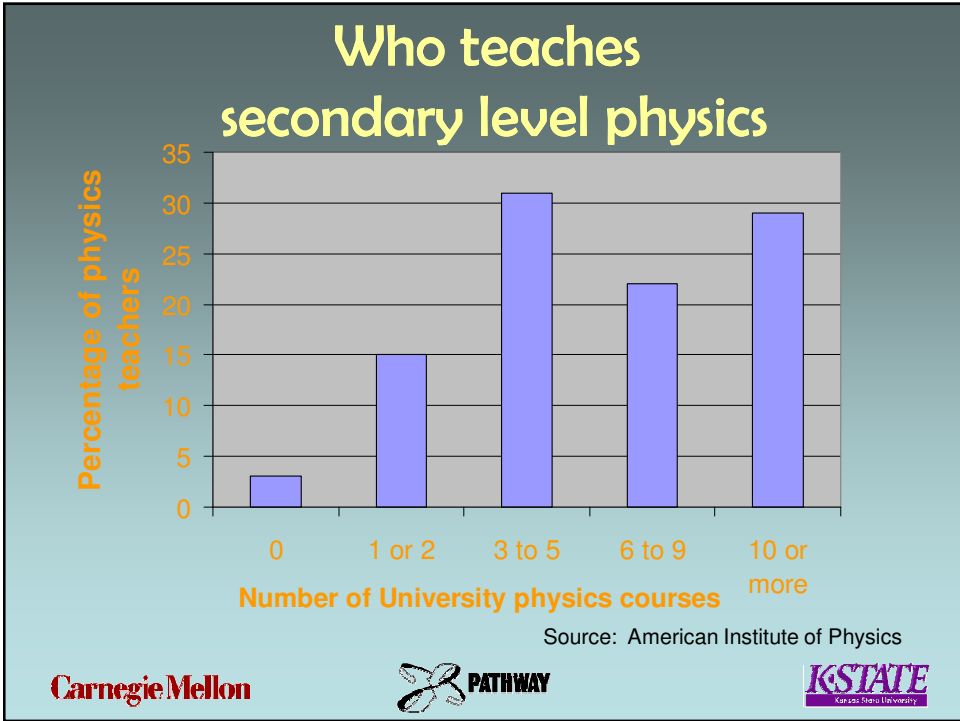


Positives & Uncertainties

- Side effect: ~50% students in secondary level physics are girls
 - But they do not become physics students at University
- Physics requirement may change, but not soon
 - Medical Colleges Admission Test (MCAT) will be revised in the next few years
 - New report from Association of American Medical Colleges recommends “competencies not courses”
 - Competencies in physics (even quantum) included.

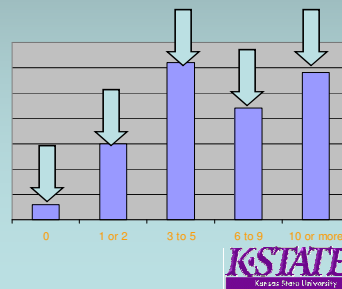
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Who teaches physics (Kansas)

- Physics student with teaching certificate
 - Same preparation as other physics students with additional study in education
- Science education student with physics specialty
 - About equal study in physics and education
- Science or math education student with ~3 courses in physics
 - Primary study in other science & education
- Emergency Certification



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Tories: Dumber days are over

Ofqual, the exam regulator has admitted that the current level of rigour in GCSE science is not good enough.

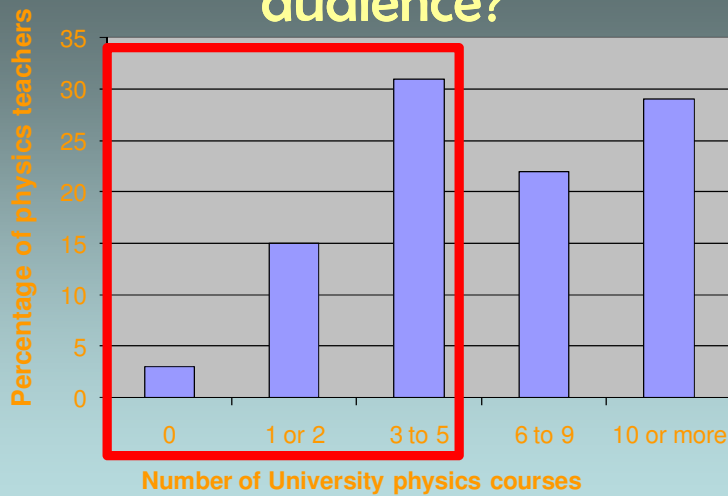
Sir Peter Williams

Quoted in Leicester Mercury, today

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Who is Pathway's target audience?



Source: American Institute of Physics

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Teachers' needs

Particularly the under-prepared teachers

- Immediate relevance
- Need it tomorrow
- Completeness
 - Little time for searching out additional information
 - Background in physics is limited
- Proof that they are teaching the “right thing”
 - Consistent with their State Science Standards



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Some advice is on the web



BBC Horizons, 1981

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But not very useful

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Our approach

- Web-based access to thoughts of experienced physics teachers
- ~6,500 pre-recorded answers to questions about physics teaching
- Conversation mode interface
- Frequent improvements based on input & feedback

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Ask an Experienced Physics Teacher the night before the lesson

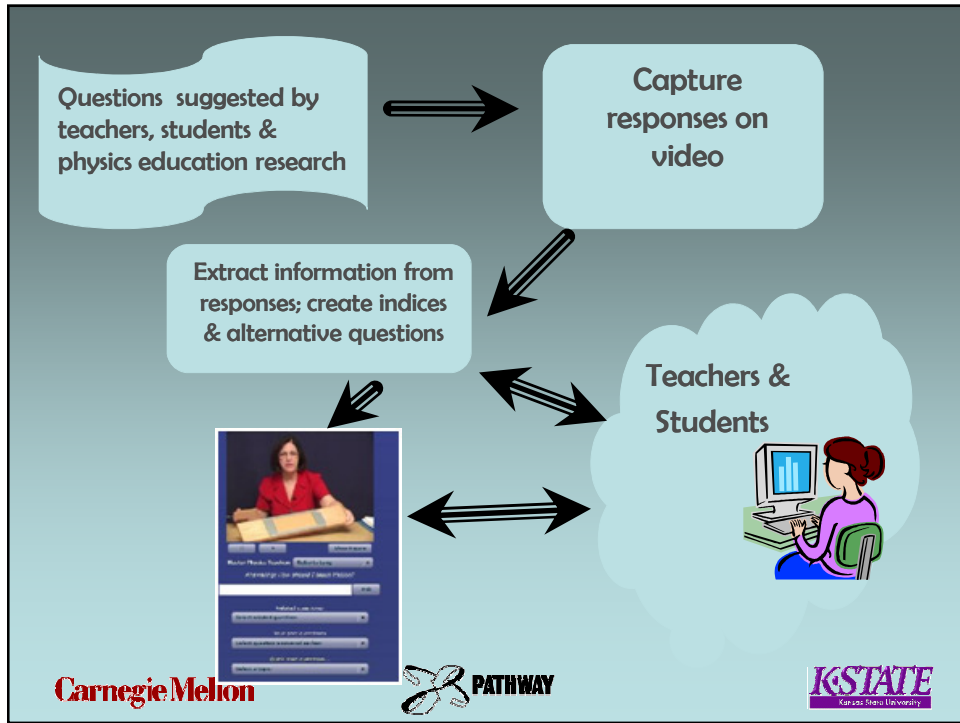


Paul Hewitt

What topic should I teach first?

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The experienced teachers

Paul Hewitt

Author of highly popular physics and physical science textbooks for both high school and college



Charles Lang

High school physics teacher in rural Nebraska & Omaha; Presidential Award recipient



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The experienced teachers

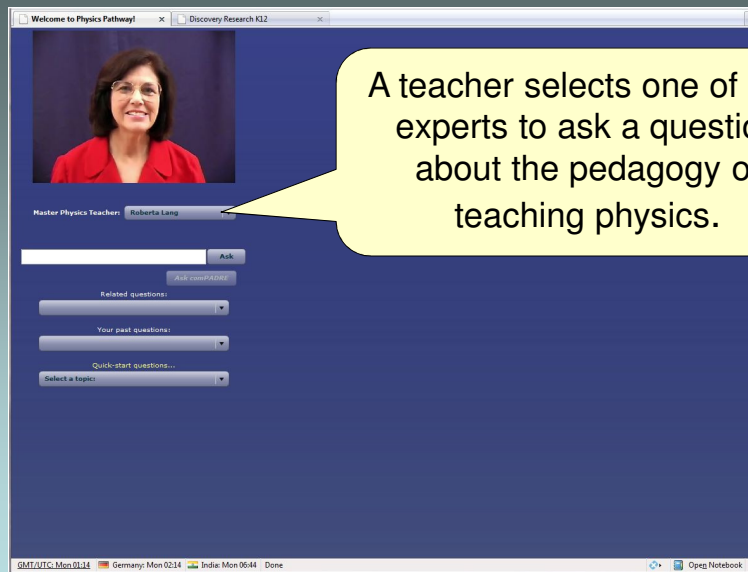
Roberta Lang

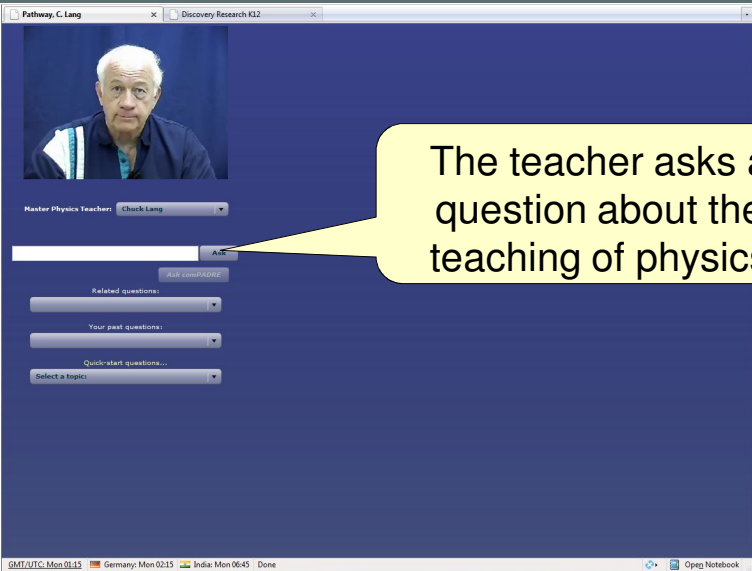
High school physics teacher
in Orlando; trained as a
chemistry teacher





Leroy Salary

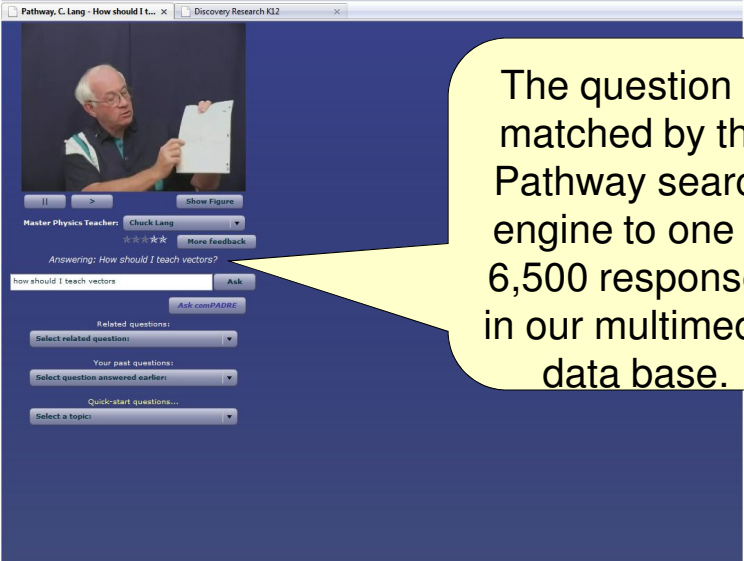
Physics & teacher educator
at Norfolk State
University







The screenshot shows a web browser window with two tabs: "Pathway, C. Lang" and "Discovery Research K12". The main content area features a video player showing a man (Chuck Lang) speaking. Below the video, there is a "Master Physics Teacher:" dropdown menu set to "Chuck Lang". A search bar is present with the text "Ask" and a button "Ask cove/PADRE". Below the search bar are sections for "Related questions:", "Your past questions:", and "Quick-start questions..." with a "Select a topic:" dropdown. A yellow callout bubble points to the search bar with the text: "The teacher asks a question about the teaching of physics". At the bottom of the browser window, there is a status bar with time and location information for GMT/UTC, Germany, and India.

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The screenshot shows the same Pathway interface as above, but with a video of the teacher holding a piece of paper. The search bar now contains the question "how should I teach vectors" and the "Ask" button is highlighted. A yellow callout bubble points to the search bar with the text: "The question is matched by the Pathway search engine to one of 6,500 responses in our multimedia data base." The status bar at the bottom of the browser window is also visible.

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Pathway, C. Lang - How should I t... x Discovery Research K12

Master Physics Teacher: Chuck Lang

 More feedback

Answering: How should I teach vectors?

How should I teach vectors Ask

Ask comPADRE

Related questions:
 Select related question:

Your past questions:
 Select question answered earlier:

Quick-start questions...
 Select a topic:

An experienced teacher provides a pre-recorded response.

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Pathway, C. Lang - How should I t... x comPADRE.org - Resources for Phy... x

Figure from Video Response

Assessment for all students

1. Give each student the graph that is below.
2. The instructor will need to provide a drum beat.
3. This exercise assesses the idea of whether a two dimensional graph can represent one dimensional motion.
4. Have each student establish on the floor a zero position. Establish which direction will be considered (+). Perform the dance for a given number, N .

15. Each student should be 2 steps in the (+) direction ahead of their zero position.

The Physics Dance

Words I don't understand: shobal

Auxiliary information can be popped up as needed

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Pathway, C. Lang - How should I t... x Discovery Research K12 x

Master Physics Teacher: Chuck Lang
 More feedback
 Answering: How should I teach vectors?
 How should I teach vectors Ask
 Ask comPADRE

Related questions:
 Select related question:
 Your past questions:
 Select question answered earlier:
 Quick-start questions...
 Select a topic:

Quick questions for the teacher who does not know where to start.

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Pathway, C. Lang - How should I t... x Discovery Research K12 x

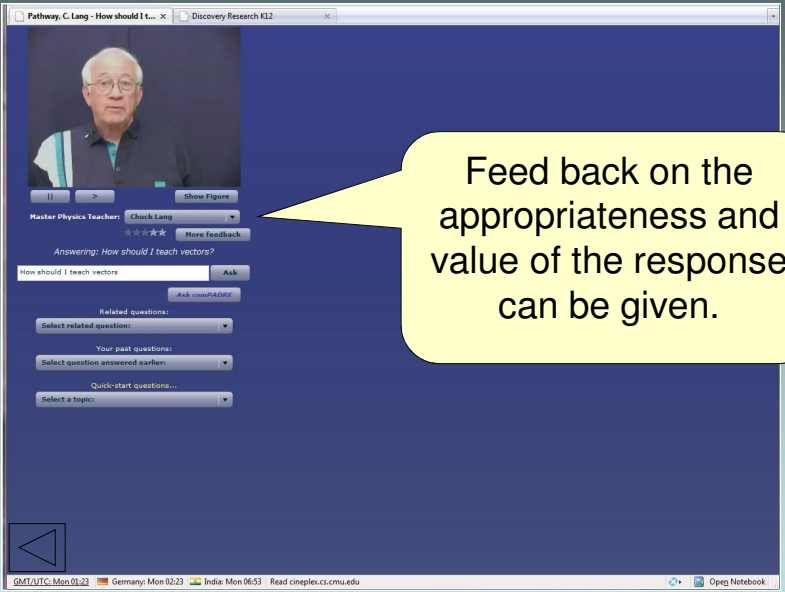
Master Physics Teacher: Chuck Lang
 More feedback
 Answering: How should I teach vectors?
 How should I teach vectors Ask
 Ask comPADRE

Related questions:
 Select related question:
 Your past questions:
 Select question answered earlier:
 Quick-start questions...
 Select a topic:

Similar questions which are have been asked by other teachers can be selected, or the user can send the question to comPADRE, the digital resource for physics and astronomy education.



GMT/UTC: Mon 01:22 Germany: Mon 02:23 India: Mon 06:53 Read cinplex.cs.cmu.edu

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The screenshot shows a web browser window with two tabs: "Pathway, C. Lang - How should I L..." and "Discovery Research K12". The main content area features a video player with a portrait of an older man with glasses. Below the video, there is a "Master Physics Teacher" section with a dropdown menu set to "Chuck Lang" and a "More feedback" button. A question is displayed: "Answering: How should I teach vectors?" with a sub-question "How should I teach vectors" and an "Ask" button. Below this are sections for "Related questions:", "Your past questions:", and "Quick-start questions:", each with a dropdown menu. At the bottom of the browser window, the system tray shows "GMTA/UTC: Mon 01:23", "Germany: Mon 02:23", "India: Mon 06:53", and "Read cinplex.cs.cmu.edu".

Feed back on the appropriateness and value of the response can be given.

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<http://www.physicspathway.org>

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Some questions

- What topic is best to begin teaching physics?
- What is a good way to introduce sound?
- How do you teach vectors
- What concepts should I use to teach acceleration?
- What senses help student feel the difference between constant velocity and acceleration?
- How you use mathematics to teach physics?

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More questions

- How should I introduce pendulum motion?
- What is gravity?
- Should magnetism be taught as vectors?
- What misconceptions do students have about forces?
- Should I use activities to teach electrostatics?
 - Conservation of charge



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Simulated Examples

- [Bobbie Lang - What is a good way to introduce sound?](#)
- [Chuck Lang - How can I help students understand the difference between constant velocity and acceleration?](#)
- [Bobbie Lang - What topic should I teach first?](#)
- [Leroy Salary - What topic should I teach first?](#)
- [Chuck Lang - What topic should I teach first?](#)
- [Chuck Lang - How should I introduce waves?](#)



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||
>
Show Figure
Standards...

Master Physics Teacher: Roberta Lang

★★★★★ More feedback

Answering: *How should I introduce sound?*

Ask

Ask comPADRE

Related questions:


Select related question:

Your past questions:


Select question answered earlier:


Quick-start questions...
Other quick starters...

Select a topic:
More topics:



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Chuck Lang

Master Physics Teacher: **Chuck Lang**

☆☆☆☆ More feedback

Answering: *What senses help student feel the difference between constant velocity and acceleration?*

Ask

Ask comPADRE




Related questions:

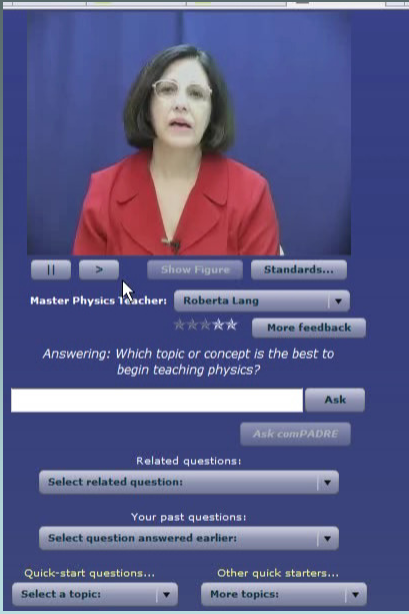
Select related question:

Your past questions:

Select question answered earlier:

Confident questions... Other quick starters...



Roberta Lang

Master Physics Teacher: **Roberta Lang**

☆☆☆☆ More feedback

Answering: *Which topic or concept is the best to begin teaching physics?*

Ask

Ask comPADRE

Related questions:




Select related question:

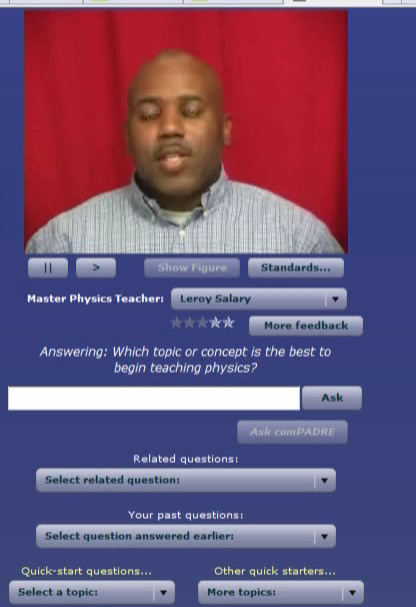
Your past questions:

Select question answered earlier:

Quick-start questions... Other quick starters...

Select a topic: More topics:



Master Physics Teacher: Leroy Salary
☆☆☆☆ More feedback

Answering: Which topic or concept is the best to begin teaching physics?

Ask


Ask comPADRE

Related questions:
Select related question:

Your past questions:
Select question answered earlier:

Quick-start questions... Other quick starters...
Select a topic: More topics:

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Master Physics Teacher: Chuck Lang
☆☆☆☆ More feedback

Answering: Which topic or concept is the best to begin teaching physics?

Ask

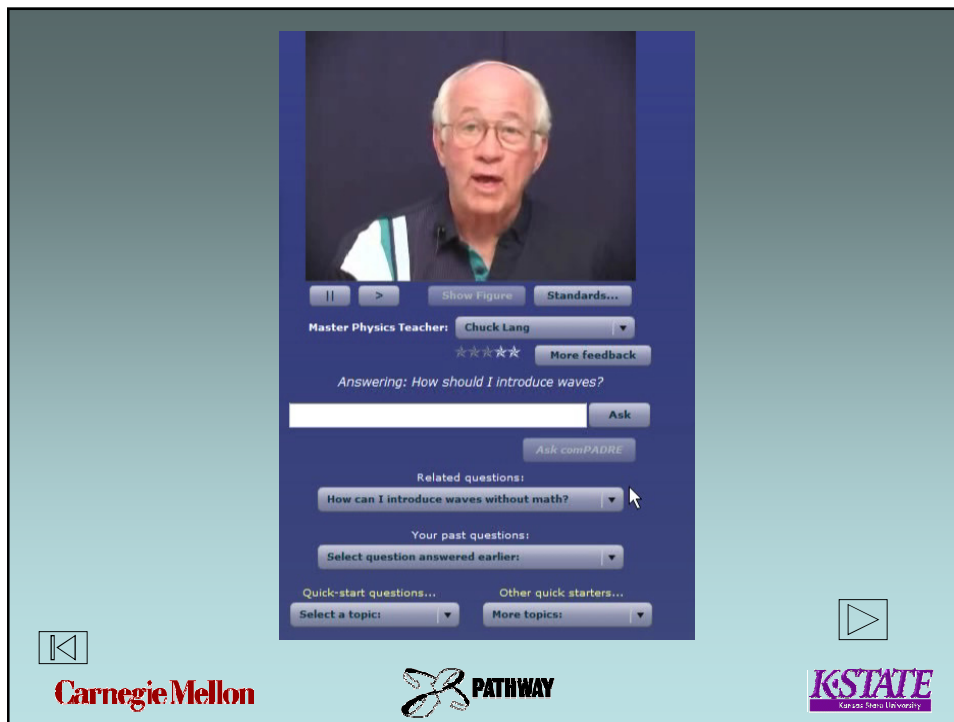
Ask comPADRE

Related questions:
Select related question:

Your past questions:
Select question answered earlier:


Quick-start questions... Other quick starters...
Select a topic: More topics:


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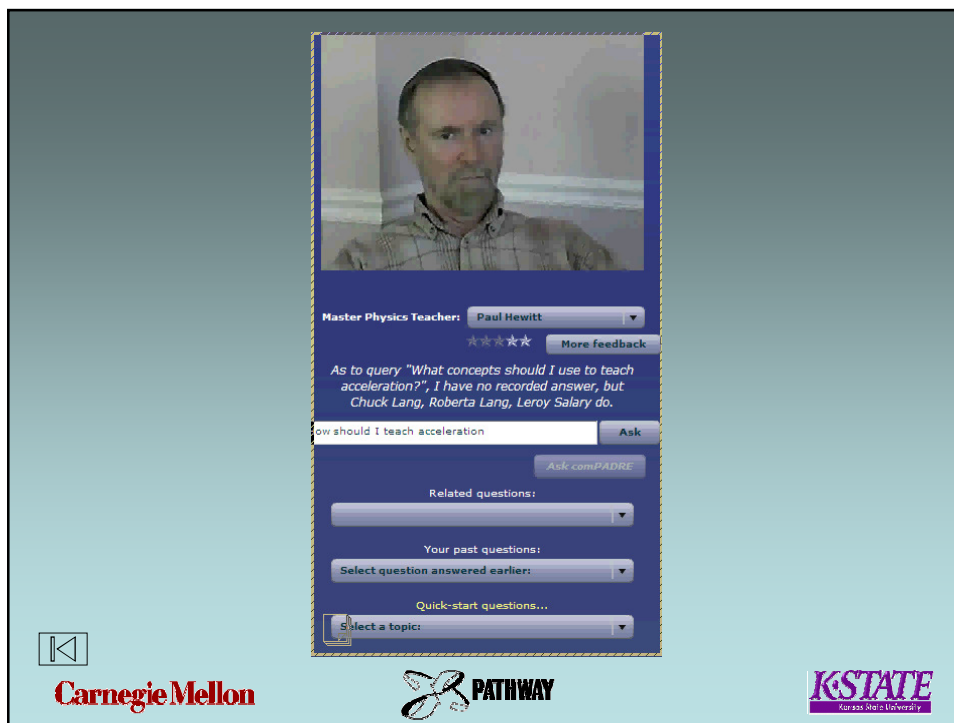


The screenshot shows a video player interface with a presentation slide. The slide features a video thumbnail of Chuck Lang, a Master Physics Teacher. Below the thumbnail are controls for 'Show Figure' and 'Standards...'. The slide text includes the teacher's name 'Chuck Lang', a rating of four stars, and a 'More feedback' button. The question being answered is 'How should I introduce waves?'. There is an 'Ask' button and an 'Ask comPADRE' button. Below this are sections for 'Related questions:' with a dropdown menu showing 'How can I introduce waves without math?', 'Your past questions:' with a dropdown menu 'Select question answered earlier:', and 'Quick-start questions...' with a dropdown menu 'Select a topic:'. A 'More topics:' dropdown is also visible. The video player has a play button in the bottom right corner.

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The screenshot shows a video player interface with a presentation slide. The slide features a video thumbnail of Paul Hewitt, a Master Physics Teacher. Below the thumbnail are controls for 'Show Figure' and 'Standards...'. The slide text includes the teacher's name 'Paul Hewitt', a rating of four stars, and a 'More feedback' button. The question being answered is 'How should I teach acceleration?'. There is an 'Ask' button and an 'Ask comPADRE' button. Below this are sections for 'Related questions:', 'Your past questions:' with a dropdown menu 'Select question answered earlier:', and 'Quick-start questions...' with a dropdown menu 'Select a topic:'. The video player has a play button in the bottom right corner.

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Underlying Principles of Teaching

- Actively engage the students in their learning
- Pedagogy is related to physics education research
- Emphasize simple experiments and demonstrations
- Connect with but not focus on National science teaching standards

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Feedback & Evaluation

- Primarily formative so far
 - Significant changes in the interface
 - Provide help without calling it help
 - E.g. Related questions
- Added many questions & topics
- Connections to comPADRE
 - Cannot keep up with research within Pathway
 - Provides additional print resources
- Technical changes
 - Improved searching
 - Flash video

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Lesson Enhancement Case Study

Sound

Monday	Tuesday	Wednesday	Thursday	Friday
<p>What is sound?</p> <ul style="list-style-type: none"> → Call sound energy! → Address difference between sound and light. Compare eyes and ears, and relative speeds. Talk about lightning and thunder! → How is sound created? → Describe as longitudinal and connect to transverse (compressions and rarefactions, nodes and antinodes) → Note no disturbance! → Video: tube with cork just in it to show longitudinal waves! → Demo: broken speaker! → Online: gizmo of sound propagating! → What makes different sounds? → Look at the difference between snapping fingers on computer! → Explain how <i>halum</i> affects voice! → Frequency range: <ul style="list-style-type: none"> o → Ultrasonic! o → Audible! o → Infrasonic! o → DEMO – range of hearing! → Uses: <ul style="list-style-type: none"> o → Ultrasound 	<p>How does sound move?</p> <ul style="list-style-type: none"> → Q&A: Need a medium? (vacuum and bell) → How does the medium affect the sound? (liquid, gas, solid) → Sounds is louder when listening to hammer on table if you put ear on table! → Lab: Sound in a Can! → Demo: Whale sounds! → How fast does sound travel? → vixr with examples and homework! → Lab: Speed of Sound in Air (tube with snap) → Uses: sonar, echolocation (bats), motion detectors! 	<p>Sound Intensity and Sound Level!</p> <ul style="list-style-type: none"> → Inverse square law! → Intensity = ...! → Amplitude (see on Scale!) → Decibel scale! → Just mention decibel, don't make them know how it works! → TRANS – scale! → TRANS – range of hearing and problems...! → How we hear (model of the ear) → Video: cochlear implants! 	<p>Sound Phenomena!</p> <ul style="list-style-type: none"> → Reflection, Refraction, and Diffraction (expand on diffraction)! → Intensity = ...! → Show d_s & d_r by having student talk into paper towel tube over table and another student listen. Where can the sound be heard best? → Example: sonar, echolocation of bats! → Refresh wave interference! → Interference: <ul style="list-style-type: none"> o → Planes! o → Headphones! o → Beats (with tuning fork) o → Dead spots! o → DEMO – find the dead spots! Expand to two days. Spend more time developing diffraction of waves! 	<p>Graduation – No School</p>



Digital video library

- Clips from videodiscs by me and others from the last century
- AAPT Film Repository – even older
- Teacher contributed videos
- The big question:
 - How do we make this relevant in the days of YouTube



2 sources | 10 stories, query: momentum

Momentum in Softball Hitting - Is it Conserved?
2:53, produced Jan. 1988

Introduction to Momentum
1:06, produced Jan. 1988

Momentum Conservation in Football Passing and Receiving. Can it be Measured?
2:45, produced Jan. 1988

Air Bag, Impulse, and Passenger Safety
2:33, produced Jan. 1984

Two Car Collision at 90 Degrees
2:32, produced Jan. 1984

Volleyball Spike - Skilled Athletes
2:39, produced Jan. 1988

Two Car Collision at 60 Degrees
2:53, produced Jan. 1984

Collision Time and Car Damage
2:08, produced Jan. 1984

Softball Catch

Two Car Collision at 90 Degrees - Microsoft Internet Explorer

Two Car Collision at 90 Degrees Many real collisions involve motion in two dimensions. Here, for example, cars traveling in perpendicular directions collide and stick together. Conservation of momentum tells us that the momentum of the two-car system immediately after the collision must be equal to the value obtained by adding the momentum vectors of the cars just before the collision. In this view you can see the effect of the collision on the car traveling across the screen. As the car is struck in the side, its motion changes. While the car continues to move to your right, it also moves toward the camera. The after-collision motion is the combination of the two before-collision motions. An overhead view demonstrates the vector addition of momenta. The two cars have almost identical speeds and masses. Thus, the magnitudes of their momenta are approximately equal. To determine the direction after the collision, you must add two equal magnitude vectors which have perpendicular directions. The result of this addition is shown here. Immediately after the collision the cars follow the path predicted by conservation of momentum. However, as shown in this overhead view, they eventually deviate from the motion. Can you explain why?

Done Internet

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Next step

- Search engine searches both our video databases & YouTube
 - Maybe also TeacherTube, and others
 - Collect relevance information from our users
- Display all info on 1 or 2 screens
- Programming problems not yet solved
 - But, I am told they are soluable

www.physicspathway.org

- Available now
- Covers most topics in high school physics
- Focuses on concepts not math
- Seeking field testers who will provide feedback
 - Preservice teachers
 - Workshop participants
 - Inservice teachers

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<http://www.physicspathway.org>

Dean Zollman
dzollman@phys.ksu.edu



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Paul G. Hewitt

Paul G. Hewitt, former boxer, uranium prospector, sign painter, and cartoonist began college at the age of 28 and fell in love with physics. His name is synonymous with *Conceptual Physics* to physics educators everywhere. Before the advent of Professor Hewitt's textbook of the same name, physics was traditionally taught primarily as applied mathematics - geared to students with high math and science aptitudes. As such, any serious study of physics was out of the educational mainstream for most students. Hewitt's conceptual approach changed all this. By translating the central concepts of physics from mathematical language to common English and by extensive use of analogies as a teaching tool, Hewitt brought physics into the educational mainstream. His textbook, the leading physics textbook for nonscientists since 1971, has changed the way physics is taught to both non-science and science majors as well.

Hewitt's teaching career began in 1964 at City College of San Francisco, his home base. He has taught an evening course for the general public at the Exploratorium in San Francisco. He has taken leaves to teach physics at the University of California, both at the Berkeley and Santa Cruz campuses, and more recently at the University of Hawaii at both the Hilo and Manoa campuses.

In 1987 he wrote a high-school version of *Conceptual Physics*. The high school text is now in its third edition. The college text is now in its ninth edition. Translations of both texts find *Conceptual Physics* popular worldwide.

Hewitt's other textbooks include the 2nd Edition of *Conceptual Physical Science*, co-authored with his daughter Leslie, a geologist, and his nephew John Suchocki, a chemistry instructor formerly at Leeward Community College in Oahu, HI.

Very recently, Paul, Leslie, and John have written a version of the physical science book aimed at 9th graders in high school. It is *Conceptual Physical Science-Explorations*.

Hewitt's only trade book (non textbook) is *Touch This-Conceptual Physics for Everyone*. Its former title was simply *Conceptual Physics for Everyone*.

In recognition of Hewitt's achievements, the American Association of Physics Teachers honored him in 1982 with their Millikan Award - the once-per-year prestigious prize for outstanding contributions to physics teaching. At present, Hewitt is a column editor for *The Physics Teacher*, the monthly magazine of the American Association of Physics Teachers.

Hewitt now resides in both St. Petersburg, Florida and Hilo, Hawaii.

- <http://www.conceptualphysics.com/pghewitt.shtml>

