

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

Dean Zollman

Kansas State University



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Scott Stevens
Michael Christel
Carnegie Mellon University

Sytil Murphy
Brian Adrian
Kansas State University

Physics Teaching Web Advisory Pathway

www.physicspathway.org

Goal

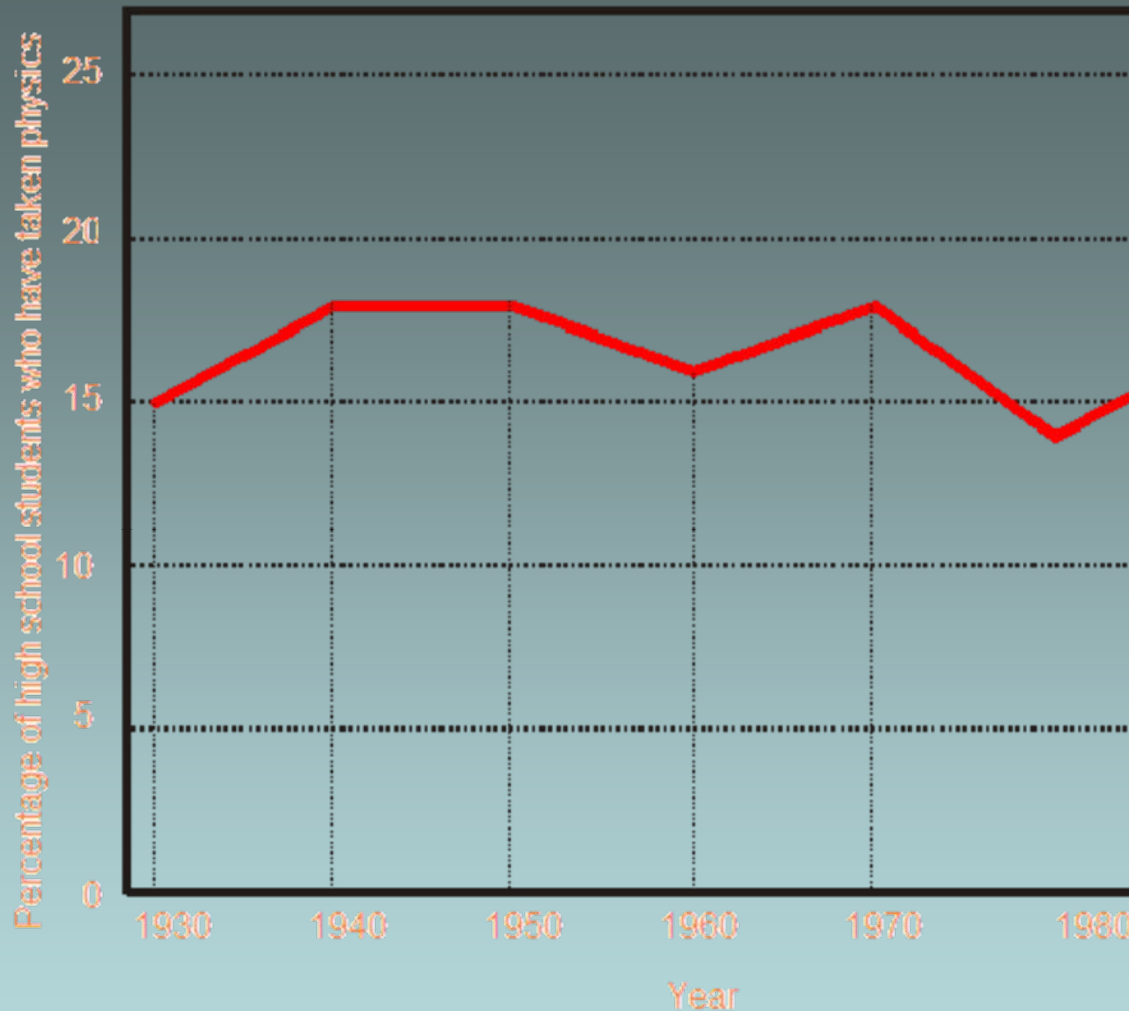
Provide just in time assistance on the pedagogy of physics

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

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



~1.1 million secondary students were taking physics in 2005

Source: American Institute of Physics

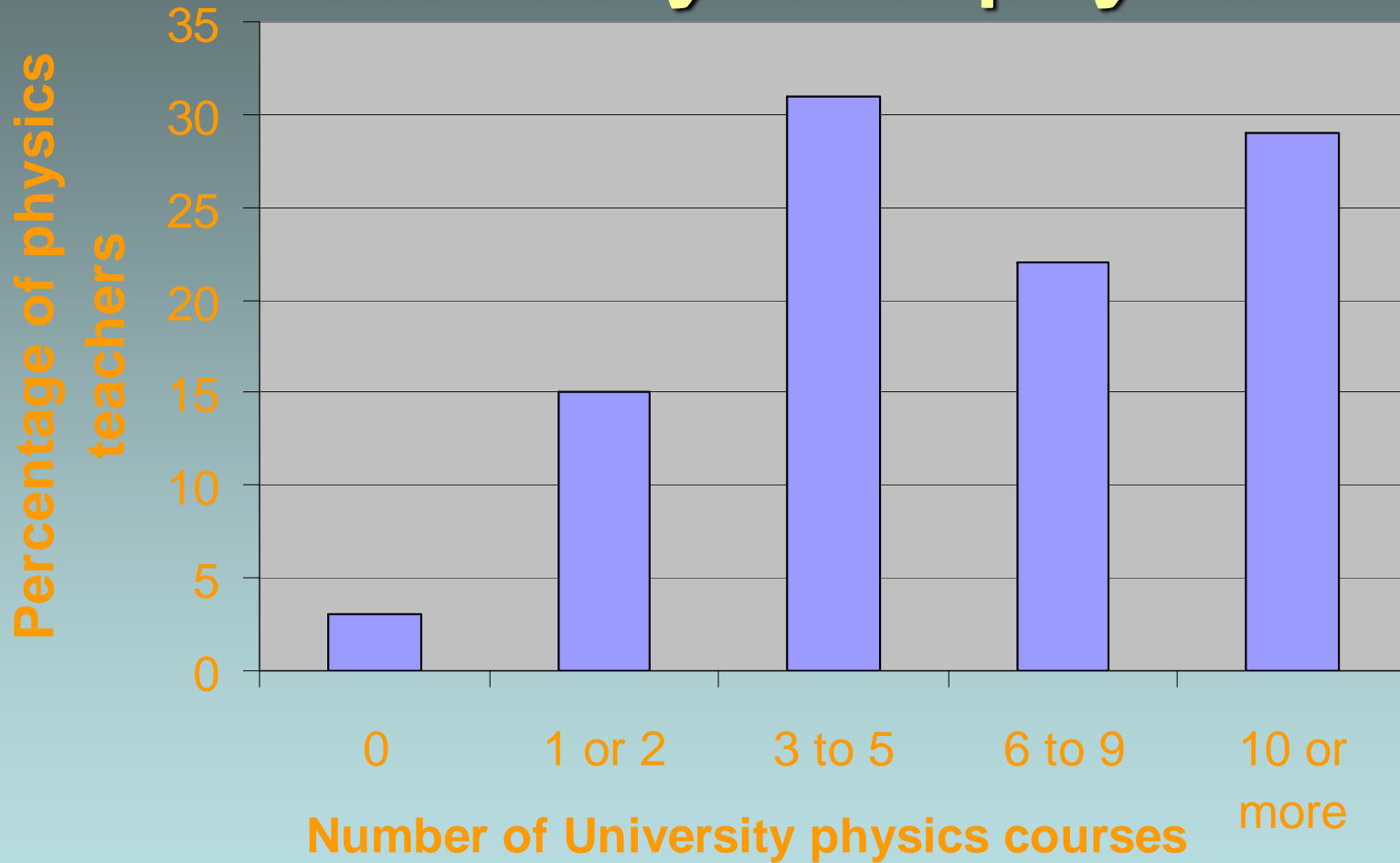
Why are they learning physics

- 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

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.

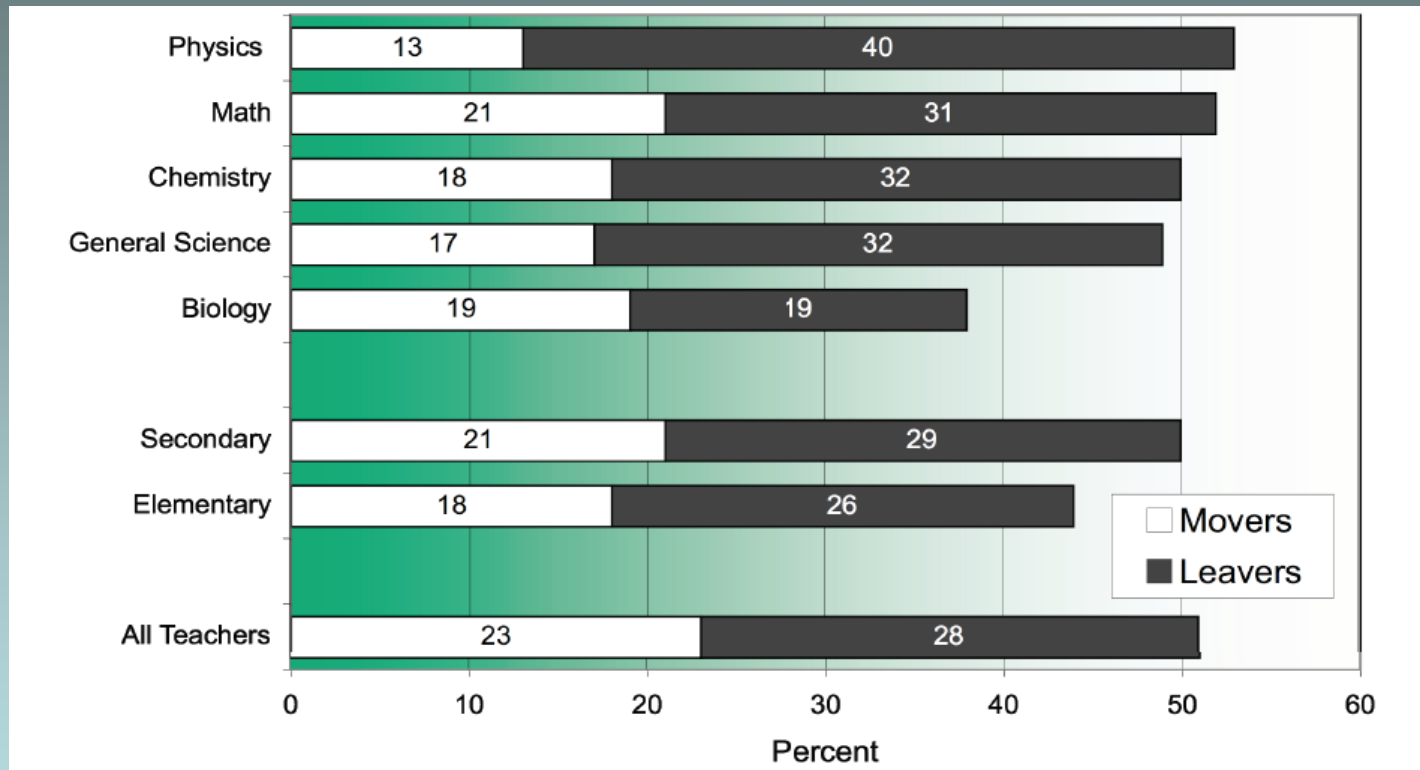
Who teaches secondary level physics



Source: American Institute of Physics

Retention of teachers

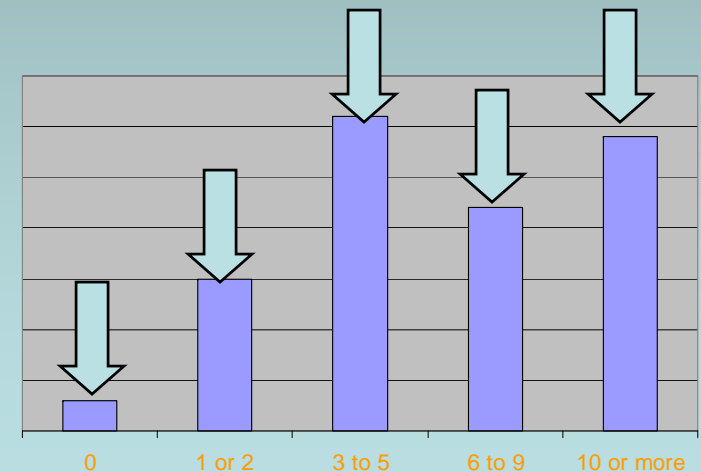
5-year change for teachers who began teaching in 1995-1996
4 states



Source: North Central Regional Educational Laboratory

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



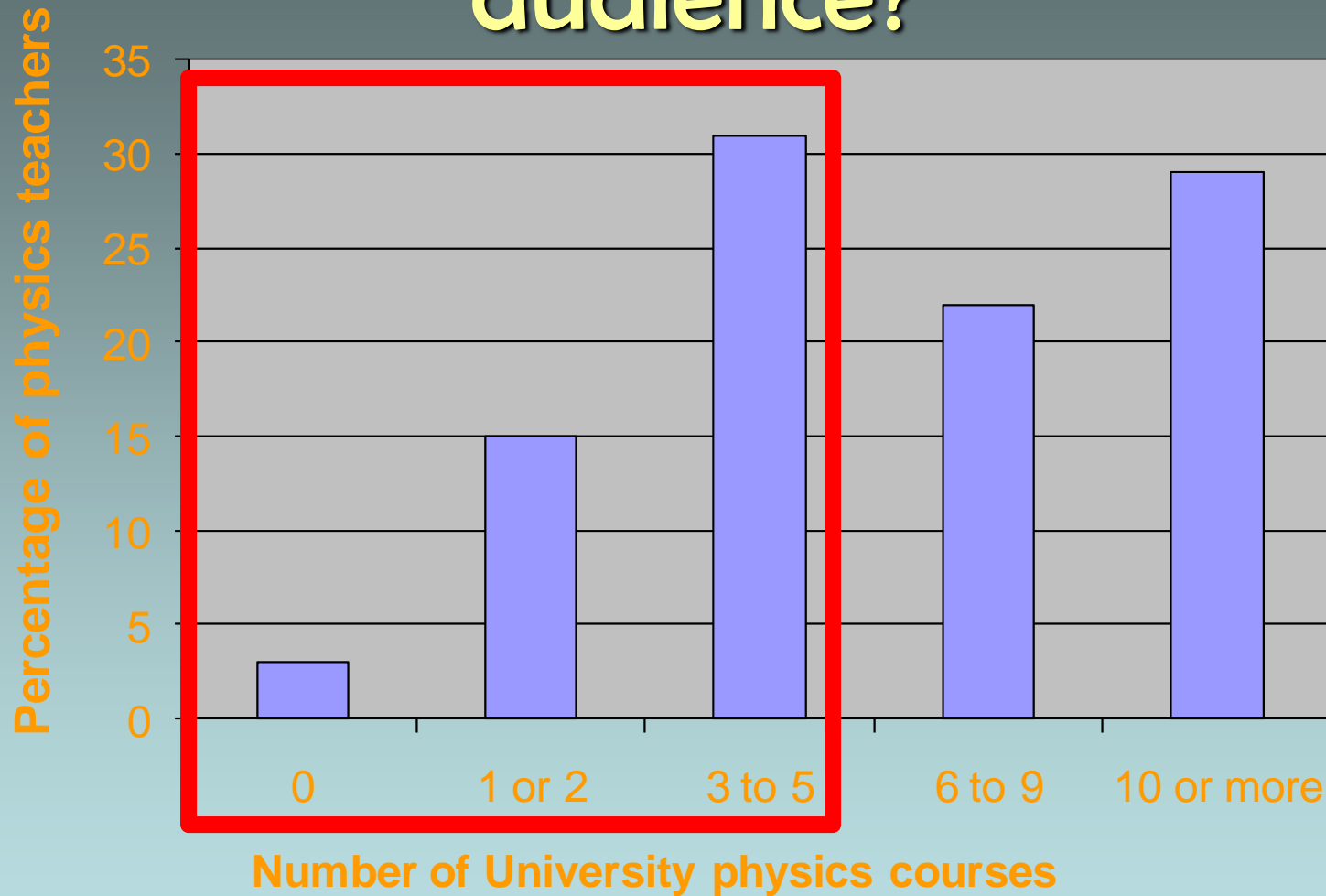
Tories: Dumber days are over

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

Who is Pathway's target audience?

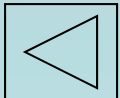


Source: American Institute of Physics

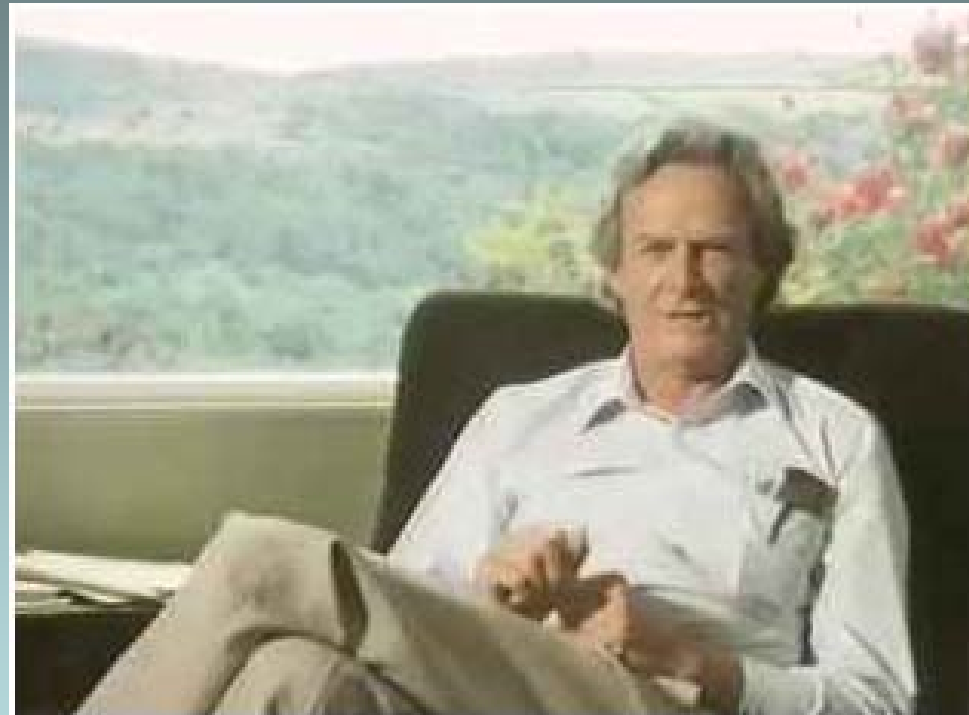
Teachers' needs

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



Some advice is on the web



BBC Horizons, 1981

But not very useful

Our approach

- Web-based access to thoughts of experienced physics teachers
- ~7,600 pre-recorded answers to questions about physics teaching
- Conversation mode interface
- Frequent improvements based on input & feedback

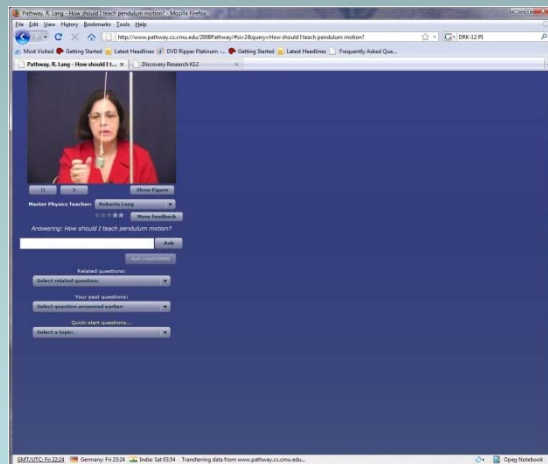
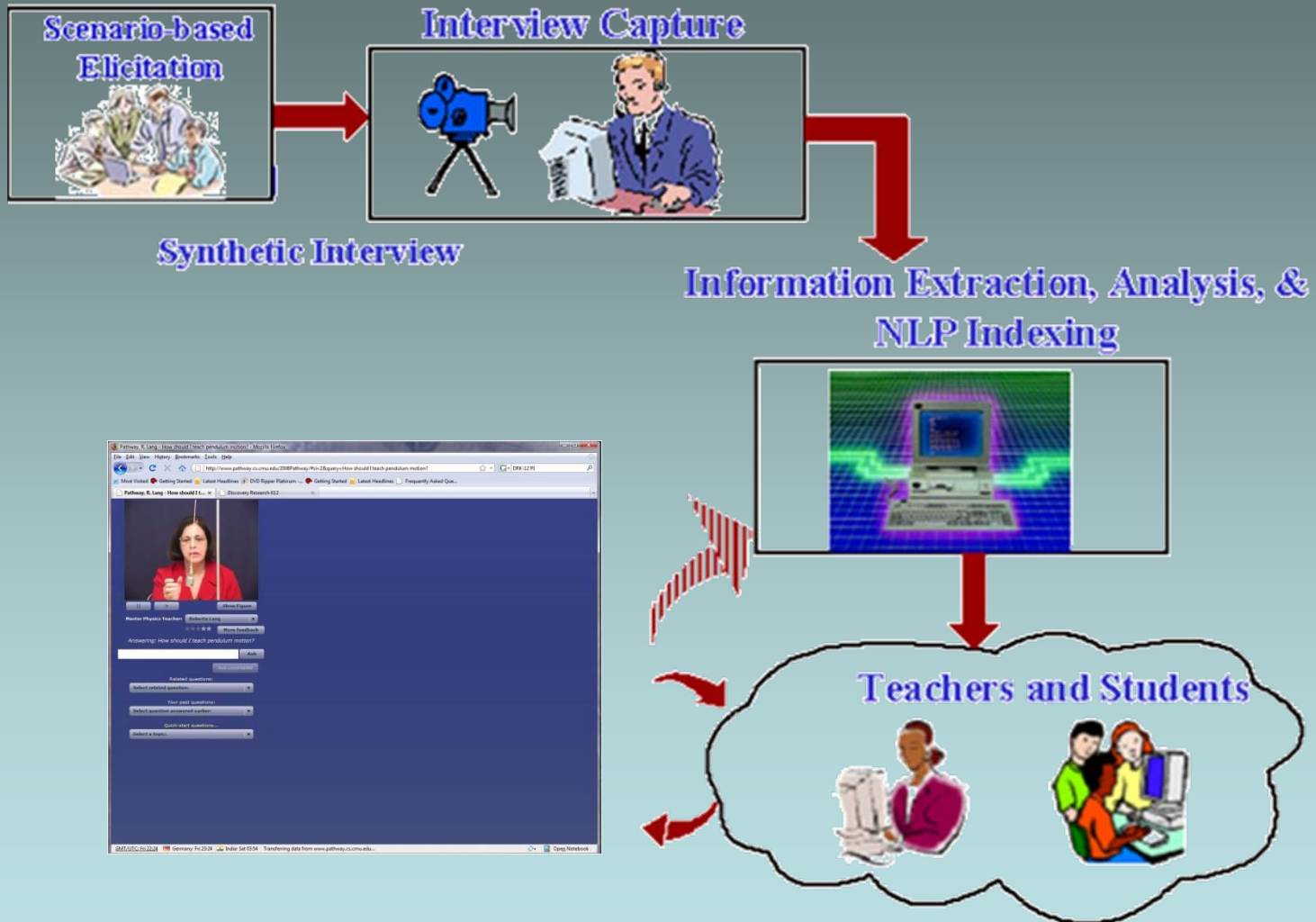
Ask an Experienced Physics Teacher the night before the lesson



Paul Hewitt

What topic should I teach first?

Development Synthetic Interview Conversational Mode



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



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



Welcome to Physics Pathway! x Discovery Research K12 x



Master Physics Teacher: Roberta Lang

Ask

Ask comPADRE

Related questions:

Your past questions:

Quick-start questions...

Select a topic:

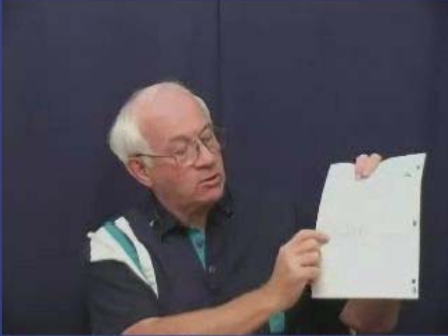
GMT/UTC: Mon 01:14 Germany: Mon 02:14 India: Mon 06:44 Done

Open Notebook

A teacher selects one of four experts to ask a question about the pedagogy of teaching physics.

The screenshot shows a web browser window with two tabs: "Pathway, C. Lang" and "Discovery Research K12". The main content area features a video feed of an older man with white hair, identified as "Master Physics Teacher: Chuck Lang". Below the video is a text input field with an "Ask" button. A yellow speech bubble originates from the "Ask" button and contains the text: "The teacher asks a question about the teaching of physics". Below the input field are several dropdown menus: "Related questions:", "Your past questions:", "Quick-start questions...", and "Select a topic:". At the bottom of the browser window, there is a status bar with time zones (GMT/UTC: Mon 01:15, Germany: Mon 02:15, India: Mon 06:45) and a "Done" button. The bottom right corner of the browser window shows "Open Notebook".

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



|| > Show Figure

Master Physics Teacher: **Chuck Lang**

☆☆☆☆ More feedback

Answering: *How should I teach vectors?*

how should I teach vectors

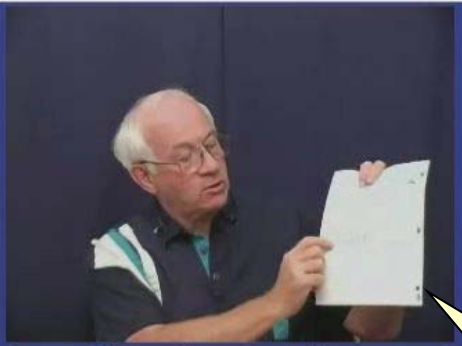
Related questions:

Your past questions:

Quick-start questions...

The question is matched by the Pathway search engine to one of 7,600 responses in our multimedia data base.

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?*

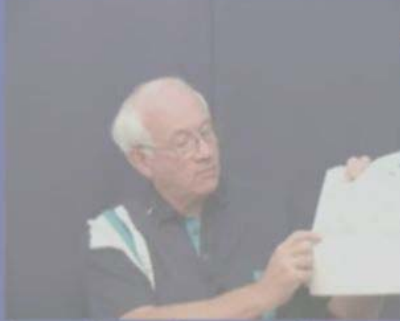
how should I teach vectors

Related questions:

Your past questions:

Quick-start questions...

An experienced teacher provides a pre-recorded response.



Master Physics Teacher: **Chuck Lang**

Answering: How should I teach vectors?

how sholud I teach vectors

Related questions:

Select related question:

Your past questions:

Select question answered earlier:

Quick-start questions...

Select a topic:

Words I don't understand: sholud

Figure from Video Response

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


The Physics Dance:

Auxiliary information can be popped up as needed

The screenshot shows a web browser window with two tabs: "Pathway, C. Lang - How should I t..." and "Discovery Research K12". The main content area features a video player showing a man with glasses, identified as "Master Physics Teacher: Chuck Lang". Below the video are controls for pausing, playing, and showing a figure. A rating system shows five stars and a "More feedback" button. The question being answered is "How should I teach vectors?". Below this, there are several dropdown menus for "Related questions:", "Your past questions:", and "Quick-start questions...". At the bottom of the browser window, there is a status bar with time and location information: "GMT/UTC: Mon 01:23", "Germany: Mon 02:23", "India: Mon 06:53", and a URL "Read cineplex.cs.cmu.edu".

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.

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: ▾

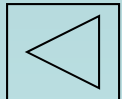
Your past questions:
Select question answered earlier: ▾

Quick-start questions...
Select a topic: ▾

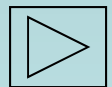
GMT/UTC: Mon 01:23 Germany: Mon 02:23 India: Mon 06:53 Read cineplex.cs.cmu.edu Open Notebook

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

<http://www.physicspathway.org>



Carnegie Mellon



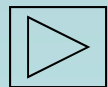
KSTATE
Kansas State University

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?

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



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

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

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) Node = no disturbance Video - tube with cork dust in it to show longitudinal wave Demo - broken speaker Online sim of sound propagating What makes different sounds? Look at the difference between snapping fingers on computer. Explain how helium affects voice Frequency range: <ul style="list-style-type: none"> Ultrasonic Audible Infrasonic DEMO - range of hearing Uses <ul style="list-style-type: none"> Ultrasound 	<p>How does sound move?</p> <ul style="list-style-type: none"> Does sound 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? $v = \lambda f$ 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 Oscilloscope) 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) Show $\theta_i = \theta_r$ 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"> Planes Headphones Beats (with tuning forks) Dead spots DEMO - find the dead spots <p>Expand to two days. Spend more time developing diffraction of waves.</p>	<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

Search Entire Library Browse the Library

Results 1 to 10 of 43: "force momentum."

Page Options ...

Prev Page Next Page Go to Page...

Display Format Image Grid

Ordering Criteria By Relevance Score Descending



Two Car Collision at 90 Degrees - Microsoft Internet Explorer

Force Momentum

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?

PLAY VIEW FULL VIDEO ADD A NOTE VIEW ALL NOTES VIDEO INFO SPEED Stopped ...

Done Internet

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

<http://www.physicspathway.org>

Dean Zollman
dzollman@phys.ksu.edu

