Pathway – 24/7 Online Pedagogical Assistance for Teachers of Physics

Dean Zollman

Brian Adrian

Sytil Murphy

Scott Stevens

Mike Christel

Kansas State University

Carnegie Mellon University

Supported by the National Science Foundation under Grants 0455772 & 0455813

Teachers' Needs

- 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 the Science Standards

Our Approach

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

Carnegie Mellon PATHWAY K-STATE Kansas State University

Pathway

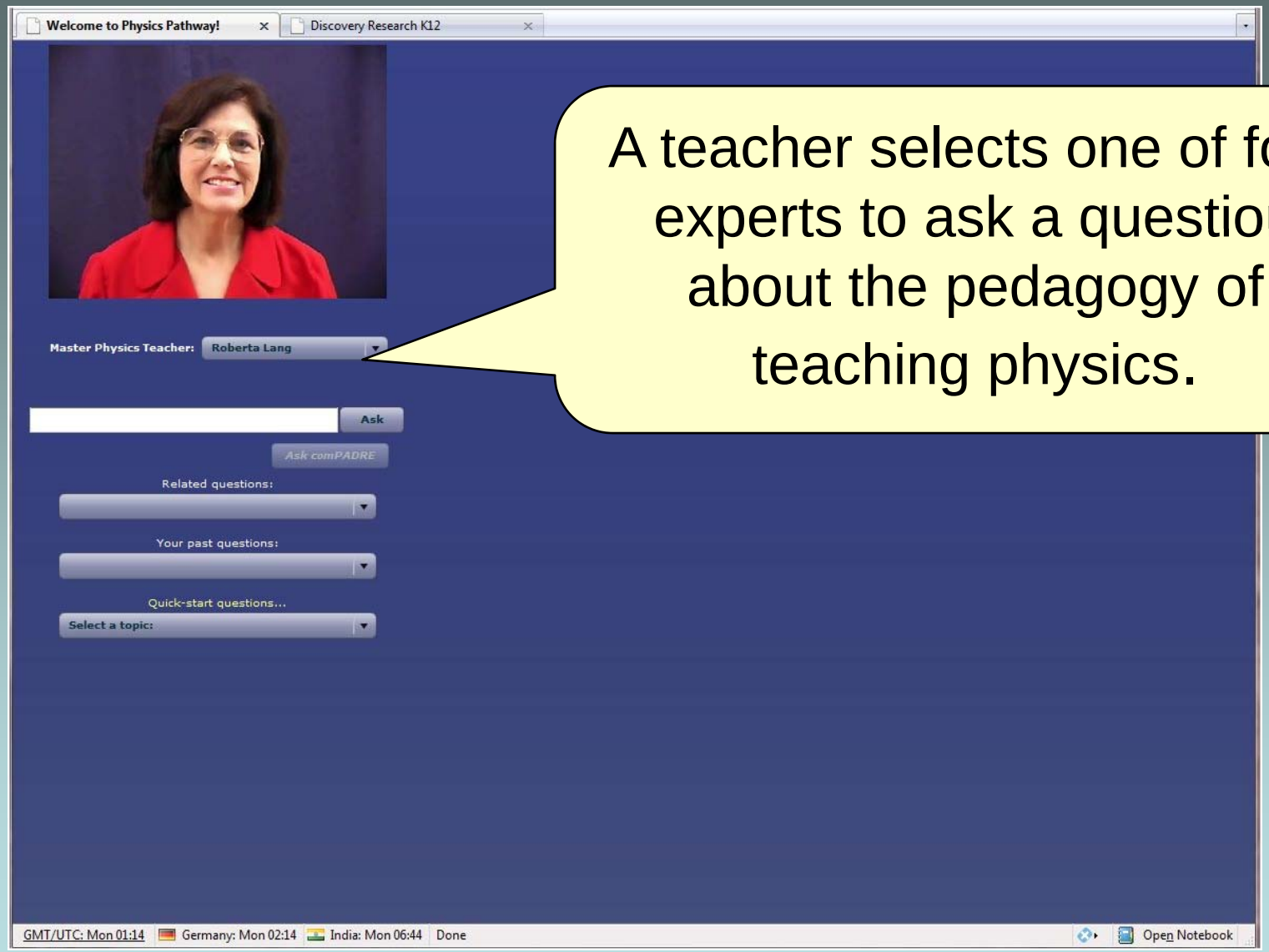
The Physics Teaching Web Advisory

http://www.physicspathway.org

Carnegie Mellon

PATHWAY

K-STATE Kansas State University



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

Carnegie Mellon

PATHWAY

K-STATE Kansas State University

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

Carnegie Mellon

PATHWAY

K-STATE Kansas State University

The Experienced Teachers

Roberta Lang

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

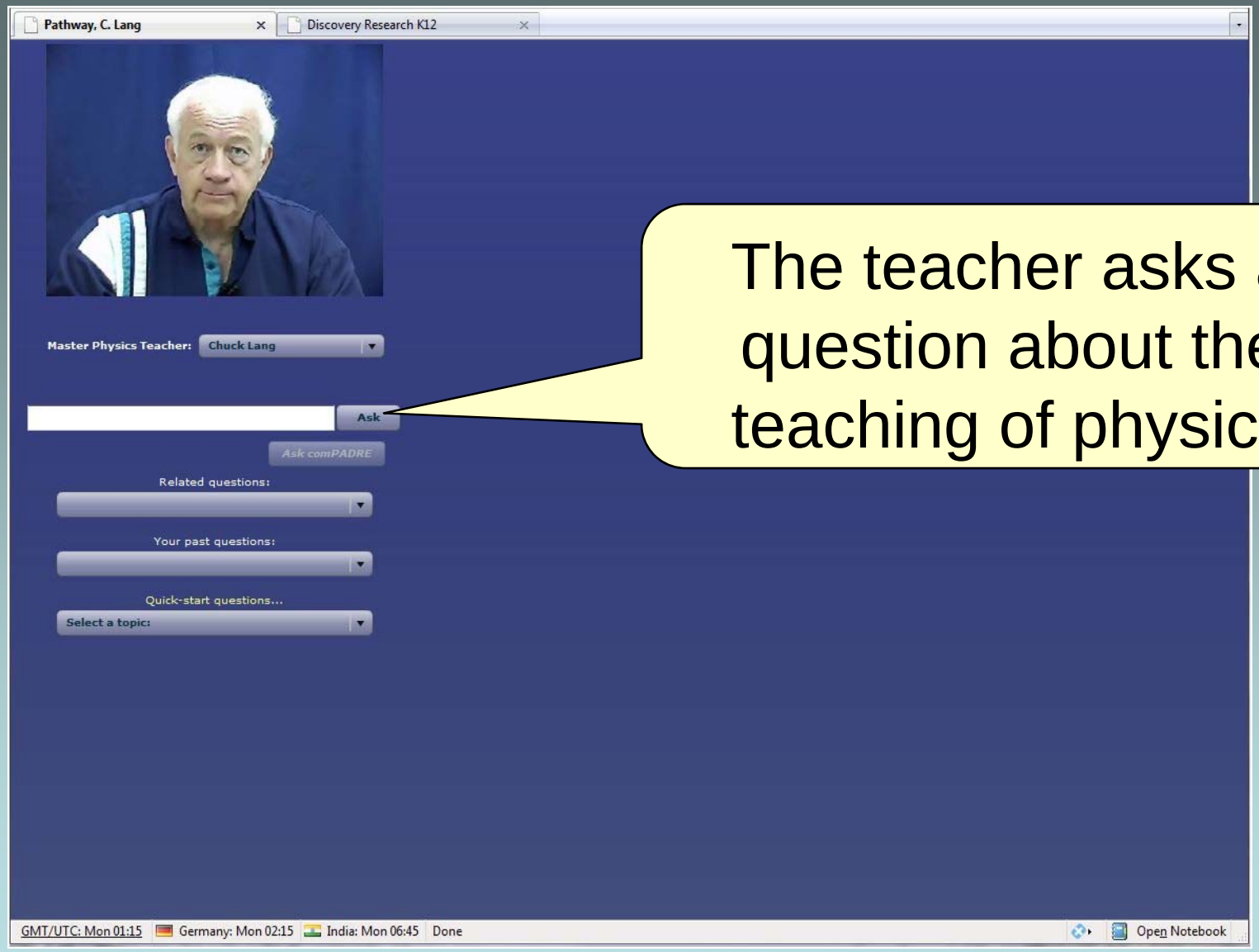
Leroy Salary

Physics & teacher educator at Norfolk State University

Carnegie Mellon

PATHWAY

K-STATE Kansas State University

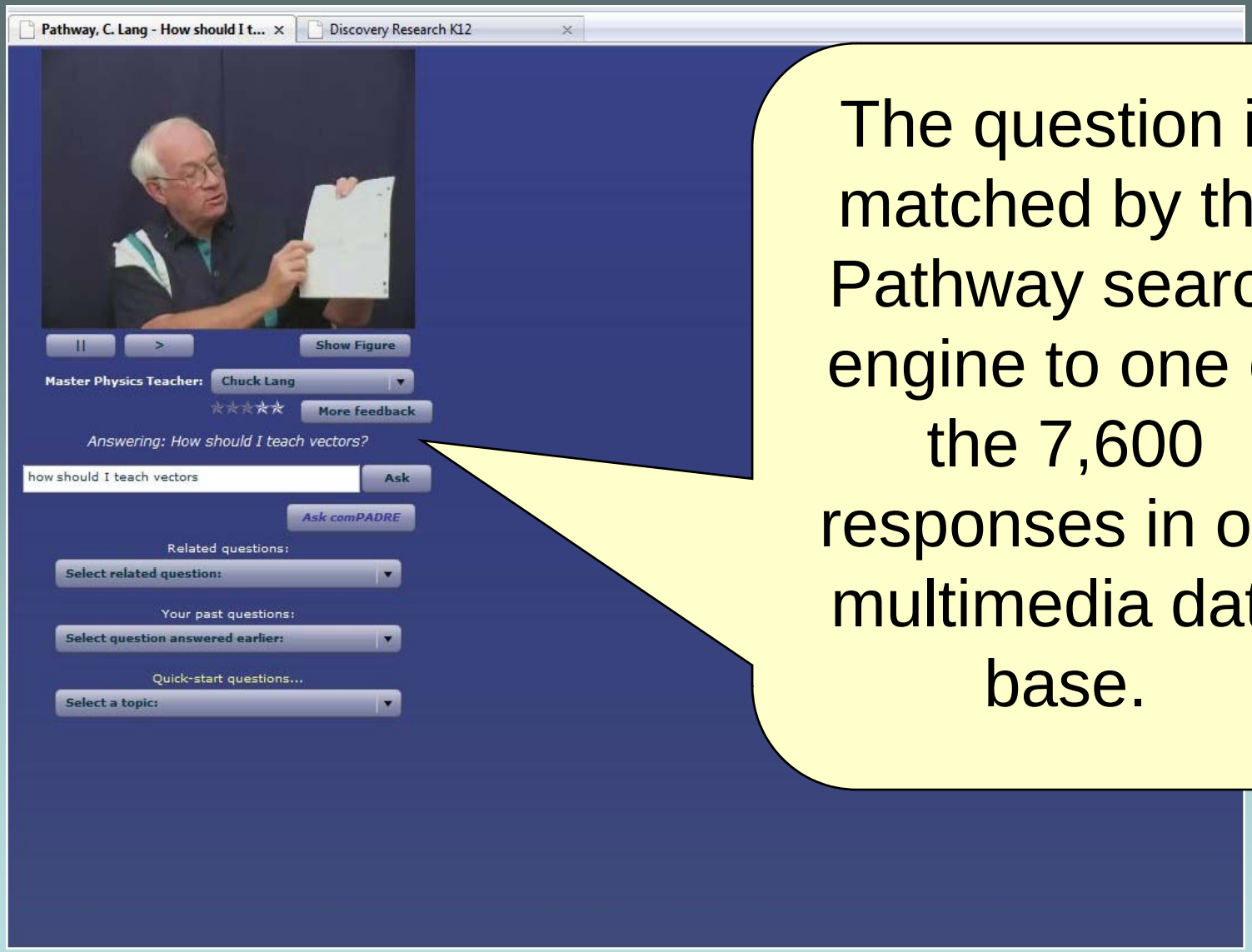


The teacher asks a question about the teaching of physics

Carnegie Mellon

PATHWAY

K-STATE Kansas State University

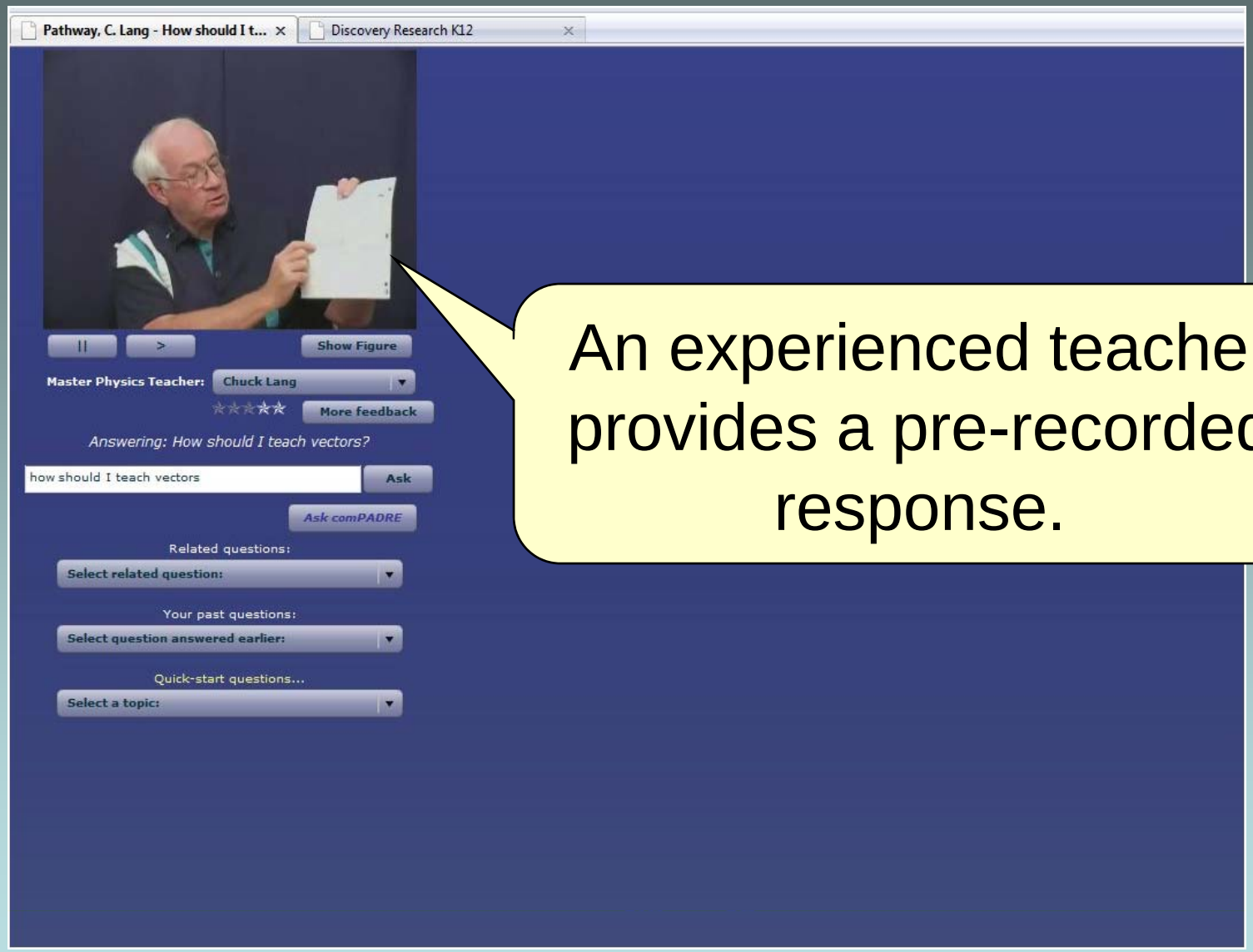


The question is matched by the Pathway search engine to one of the 7,600 responses in our multimedia data base.

Carnegie Mellon

PATHWAY

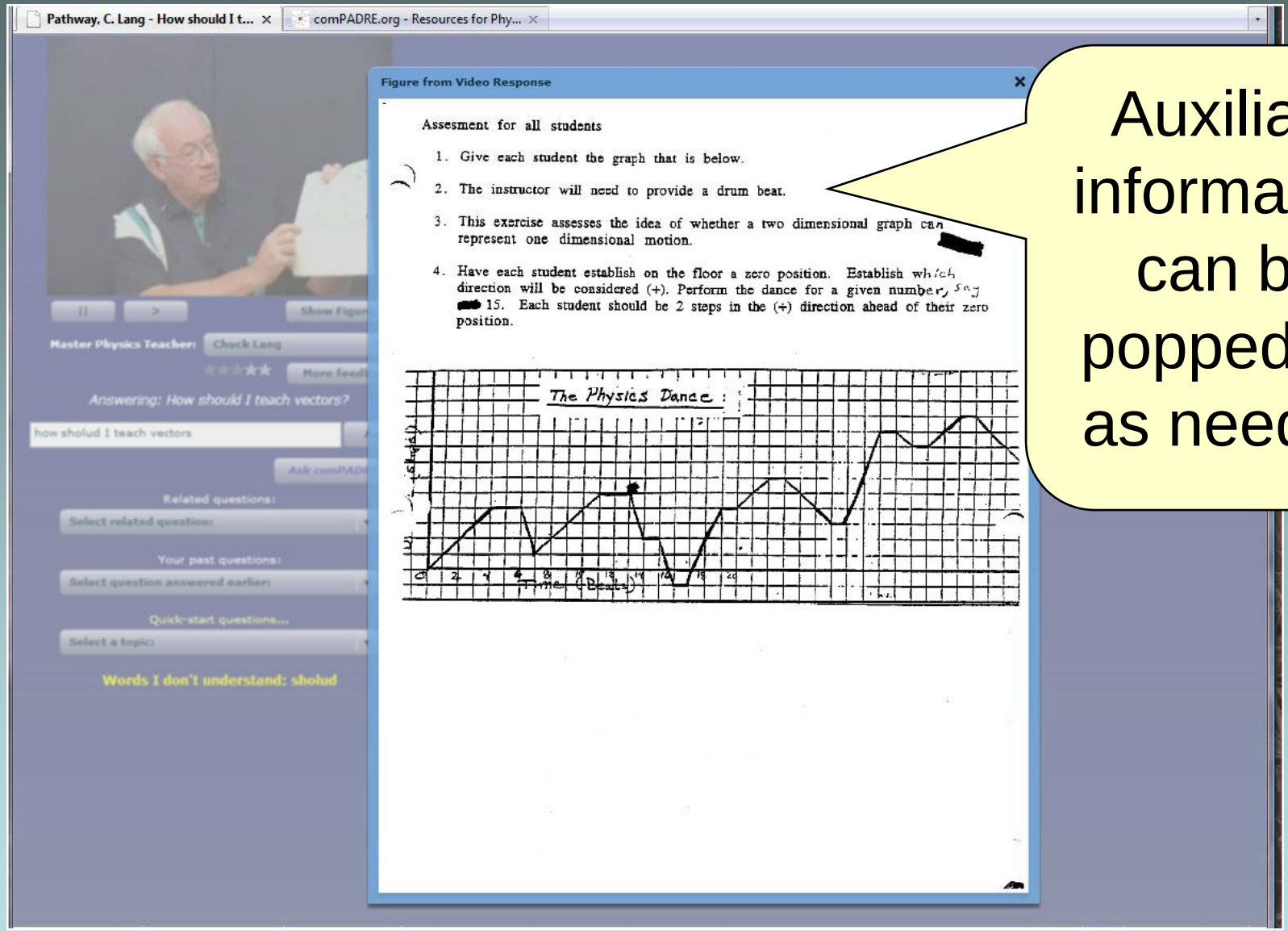
K-STATE Kansas State University



Carnegie Mellon

PATHWAY

K-STATE Kansas State University

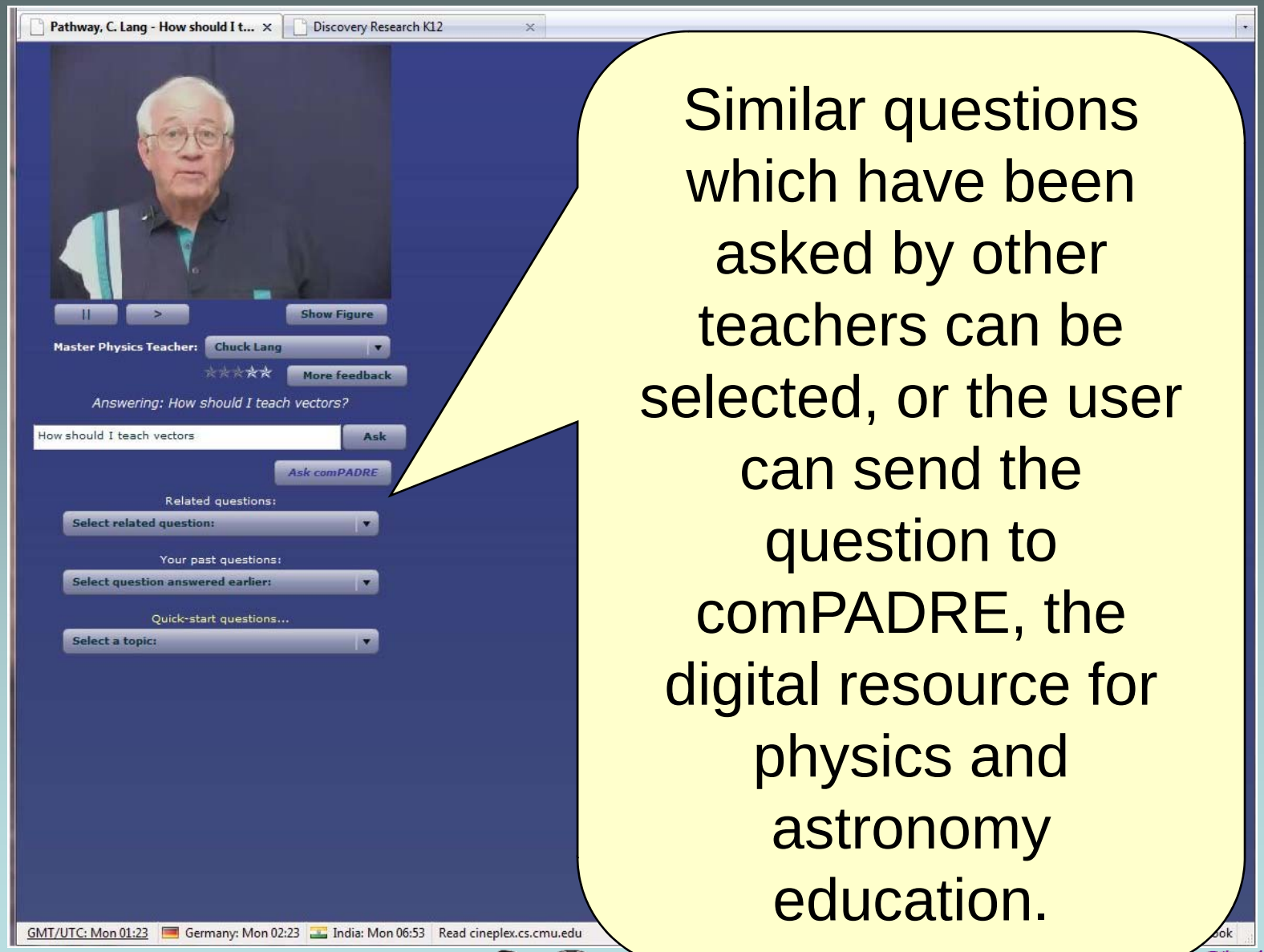


Auxiliary information can be popped up as needed

Carnegie Mellon

PATHWAY

K-STATE Kansas State University

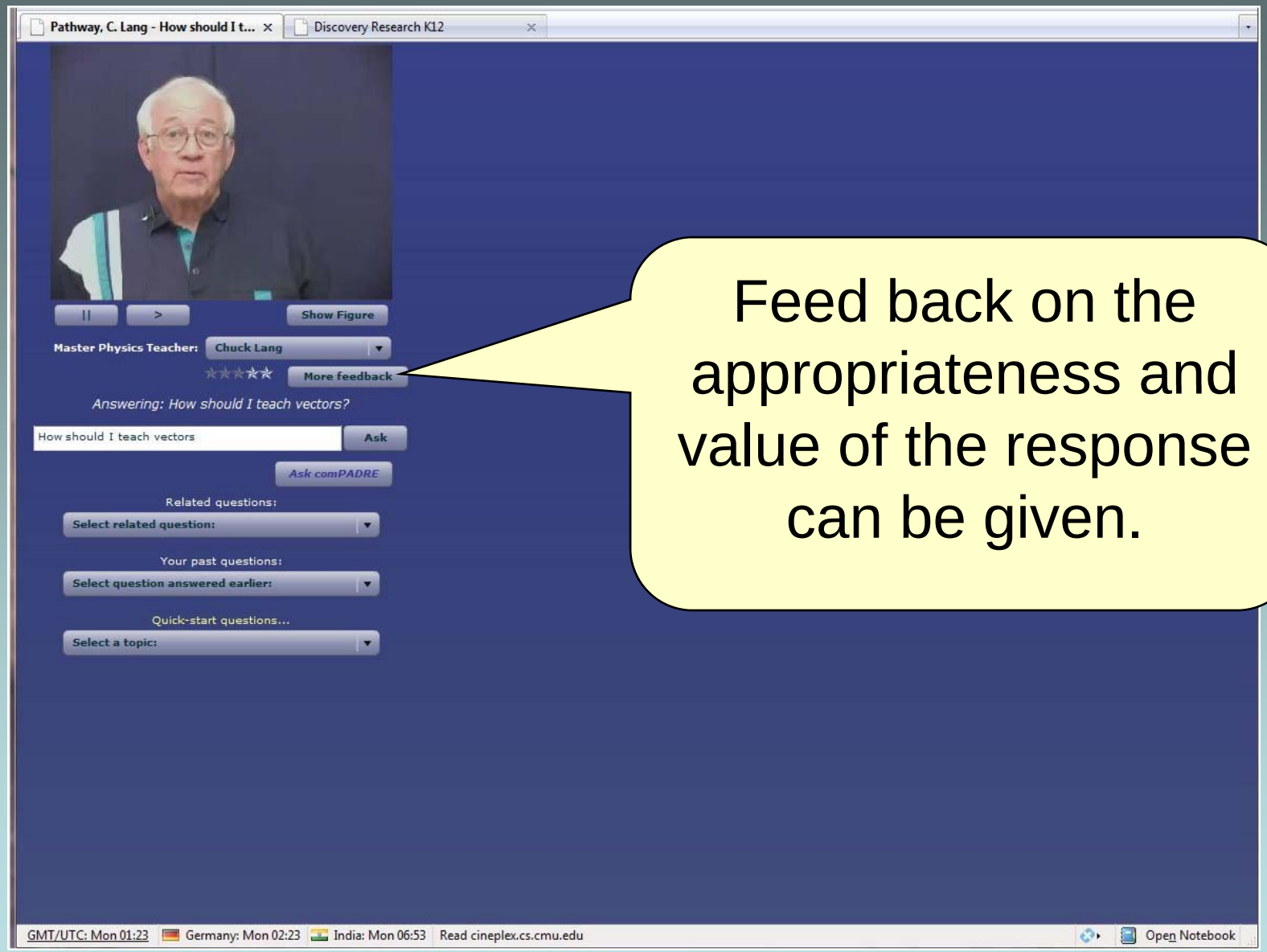


Similar questions which have been asked by other teachers can be selected, or the user can send the question to comPADRE, the digital resource for physics and astronomy education.

Carnegie Mellon

PATHWAY

K-STATE Kansas State University



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

Carnegie Mellon

PATHWAY

K-STATE Kansas State University

The Answers – Chuck Lang

- What general advice would you offer to a first time physics teacher? (2:00)
- Often a first year physics teacher is not necessarily a first year teacher. .... First of all, don't teach it as a math course. ... Second of all, ... feel free to discover ... ideas right along with the students. .... And the third ... don't get hung up on mechanics. ... we revisit (it) in things like sound, light, electricity ...

The Answers – Roberta Lang

- What general advice would you offer to a first time physics teacher? (2:15)
- The best advice I can give a first time physics teacher is to have fun. Physics is probably the most fun thing that can be taught. … Before you do an experiment or have the students do an experiment, try it out in private. … And have a spare set of equipment …. Don't be afraid to say "I don't know" …

The Answers – Leroy Salary

- What general advice would you offer to a first time physics teacher? (1:10)
- The advice that I would give a first time physics teacher is take your time. … The quality … is much more important than the quantity of the information. … If you are a … professor, then I would suggest that you … spend time solving the problems yourselves…. one last thing, … it's important to have fun. …

The Answers – Paul Hewitt

- What general advice would you offer to a first time physics teacher? (2:50)
- My advice … is not to get bogged down with kinematics …. Get it so that your students at least have an exposure to the whole experience that first term. … If a student's first encounter with physics is one of delight, they will welcome the rigor of the second course. …

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

THANK YOU

http://www.physicspathway.org

Dean Zollman
dzollman@phys.ksu.edu

Carnegie Mellon

PATHWAY

K-STATE
Kansas State University

Lesson Enhancement Case Study

Sound

Monday	Tuesday	Wednesday	Thursday	Friday

What is sound?
• *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:
  ○ Ultrasonic
  ○ Audible
  ○ Infrasonic
  ○ DEMO – range of hearing
• Uses
  ○ Ultrasound
	How does sound move?
	• Does sounds 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*
		Sound Intensity and Sound Level
		• Inverse square law
		• Intensity = …
		• Amplitude (see on Oscillascope)
		• 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
			Sound Phenomena
			• 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
			  ○ Planes
			  ○ Headphones
			  ○ Beats (with tuning forks)
			  ○ Dead spots
			  ○ DEMO – find the dead spots!
			Expand to two days, Spend more time developing diffraction of waves.
				Graduation – No School

Page Break

Carnegie Mellon

PATHWAY

K-STATE Kansas State University

The Answers – Chuck Lang

- I would suggest, and I'll just use this as an example, because this is my sequencing of the first semester's activities. I like to spend one week per concept. Now some of you might question whether there is enough material in a particular concept for one week. Let me just pick one. Newton's 1st law. Now isn't Newton's 1st law just something at rest tends to stay at rest. Like this? How easy can that be? I've known that since 1st grade or before. Or something in motion tends to stay in motion unless there's an outside force. Can't we just tell them that and move on? Now, let's do some things, let's let them discover that principle and if you think there isn't enough there fore that week, you can even get into Einstein's general theory of relativity where he talks about curved space and inertial frames and non-inertial frames. You studied acceleration earlier. You can talk about objects moving at a constant speed like at rest or in motion unless an outside force acts on it which creates an acceleration which gets you over into the general theory, a non inertial frame. With each of these topics, I have absolutely no trouble filling up a week with any single concept o physics. Physics is such an incredibly rich discipline. Now, how do you fill up that week? I use a multi-media approach, there's some computer software involved, maybe a film or a DVD or a CD-ROM or whatever that might fit in there. So, multi-discipline – how about talking abut the history of Newton's 1st law, how about talking about any astronomy aspects, etc, etc... In addition to that, multi-strategy. In the case of Newton's 1st law, I'm going to use a Piagetan learning cycle approach, where I first let them sorta play around with somethings. I think there are 8 different objects that they circle around through, just simple little nickel and dime things Hopefully, they discover what is going on, they can tell me what Newton's 1st law is. Lastly can we accept a multi-level approach. For some students only appreciate what is going on. Some students actually have an interest in what is going on here and "gee I don't really understand this but I kinda know what is going on here" Lastly, we'd love as teachers to have everybody say "Oh I understand this" "I understand what is going on". Well, I was at this game too long. Not all students arrive at a true understanding of the concept even after a week of my absolute superior instruction.

The Answers – Chuck Lang

- How should I teach physics?
- … In the case of Newton's 1st law, I'm going to use a Piagetan learning cycle approach … Hopefully, … they can tell me what Newton's 1st law is. … Not all students arrive at a true understanding of the concept even after a week of my absolute superior instruction.

The Answers – Roberta Lang

- How should I teach Physics?
- I think Physics should be taught as much as possible as a hands-on activity. This means generally to (show) the students how to do something and then the students do it. Try not to use black boxes. Keep the equipment as simple as possible. You don't want to get lost in the mystery of technology. You want to focus on the concepts.

The Answers – Chuck Lang

- Chuck Lang – What general advice would you offer to a first time physics teacher? (2:00)
- Often a first year physics teacher is not necessarily a first year teacher. You've been asked to teach physics though you were possibly trained in something else. I'd give you a couple, three suggestions. First of all, don't teach it as a math course. It's too much fun to incorporate in a lot of just the physics experiments, a lot of the demonstrations, and things like this. In fact, I wouldn't even suggest teaching it as an applied math course. It is indeed a separate discipline. Second of all, since you're going to have some things you're going to have to discover, feel free to discover these ideas right along with the students. Often after I'd taught physics for, let's say, 10-15 years and I had other physics teachers tell me the same thing. That we feel sort of like we've lost some of that discovery that comes along right in our first 2-3 years when we went "Aha – that's what it's all about" and there is nothing wrong with doing that right along with the students. And the third thing I would say is don't get hung up on mechanics. I know you'll want to think that you should arrive at mastery of these topics as you go, I would suggest that you still move right ahead. We revisit things like kinematics over and over. We revisit things like dynamics over and over. In fact, all of mechanics we revisit in things like sound, light, electricity. So don't get hung and spend all your time on kinematics, dynamics, and in other words, the whole topic of mechanics.

The Answers – Roberta Lang

- Roberta Lang -- What general advice would you offer to a first time physics teacher? (2:15)
- The best advice I can give a first time physics teacher is to have fun. Physics is probably the most fun thing that can be taught. You can just do all kinds of things. Let the students see you enjoying physics. They will get pleasure from enjoying it, too. Before you do an experiment or have the students do an experiment, try it out in private. There's a reason why that old saying is, you know, "if it stinks, its biology, etc, etc, and if it doesn't work, it's physics." Because a lot of times, things happen, to the equipment, and it doesn't work as you want it to, the first time. So, try out the experiments first. And have a spare set of equipment so that when that device fails, or somebody breaks something, you've got a set that you can hand out so that the students can proceed without totally wiping out that class period's assignment. Don't be afraid to say "I don't know" If you knew everything, you probably wouldn't be teaching an introductory physics course because your demands would be far greater, you would just be the guru that sits on top of the mountain dispensing information. Now, you can make a little game of it. For example, you can deliberately make some mistakes to see if the students catch you on it or you can say "of course I didn't make a mistake, I did that deliberately to see if you're paying attention. " Or you can say "I really don't know the answer to that but I'll see if I can find out" and then do make the effort to find out.

The Answers – Leroy Salary

- Leroy Salary – What general advice would you offer to a first time physics teacher? (1:10)
- The advice that I would give a first time physics teacher is take your time. There is no rush. The quality of the information is much more important than the quantity of the information. If you are teaching high school, I know there are standards you have to adhere to. And I do not say break the rules, but with physics, the more time you take, the better your students will understand. The less time you take with it and the quality of the information, the less your students will understand. All though you are getting through the standards that are set, you're actually teaching the students of physics. If you are a college professor or university physics professor, then I would suggest that you actually spend time solving the problems yourselves, making sure that you know what you are doing before you begin teaching . Also, one last thing, as a physics professor, it's important to have fun. Physics is one of the most interesting subjects in the field of science. And if you cannot have fun doing it, then it will probably be a little bit more morbid than you want it to be. So enjoy and have fun with it.

The Answers – Paul Hewitt

- Paul Hewitt – What general advice would you offer to a first time physics teacher? (2:50)
- My advice to a first time teacher is not to get bogged down with kinematics and to stay with the fundamental physics – really the essentials. Don't get off in the peripherals. Oh, maybe an antidote here and there if something is of interest to you, is passionate to you. OK. But let your course be central concepts so they can go through mechanics, heat, sound, light, electricity, magnetism, modern physics, some relativity perhaps, nuclear physics, radioactivity, fission, fusion – these are the broad concepts of physics. Be sure you cover that. I was enthralled by Eric Rogers who wrote the book years ago Physics of the Inquiring Mind and he talked about the buckshot approach and that's to say that BOOM, you fire out all the physics so that your students in that one term will at least have a familiarity with the whole shebang. There are too many courses where the only familiarity they have is perhaps finally mastering the distinction between m/s and m/s^2. What's that? It's not that important. So, I think it's important for a new teacher to cover the whole span and how difficult the course is has to do with how deep you set your plow not the field itself. Get it so that your students at least have an exposure to the whole experience that first term. Then you can set your plow deeper later. But the folly is putting the plow way down deep there like when you were in graduate school. Watch out for that. You'll wipe out more kids and that's happening too much. Physics should be a delightful course. If a student's first encounter with physics is one of delight, they will welcome the rigor of the second course. But if the rigor is put in too quickly, you won't see them again. You won't see them again. And that's the problem: too many of us want to make sure that our course is challenging and that's nice for the hotshots but it's not very nice for the overall enrollment in physics that we have today. When you meet someone on the street that's taken a physics course and they find out that you're a physics teacher, they should look at you with a smile and say "WOW. That's one of the courses I loved in school. It made a whole lot of things sensible to me. I could see physics all around me. God. Physics was interesting." That's the way it should be. It shouldn't be "Oh, physics. Oh, I was never good at the math." and you let it go at that. No. Let's stop that. Let's lift our discipline.