Teaching without Telling: Questioning strategies

Foundations for Teaching in Higher Education

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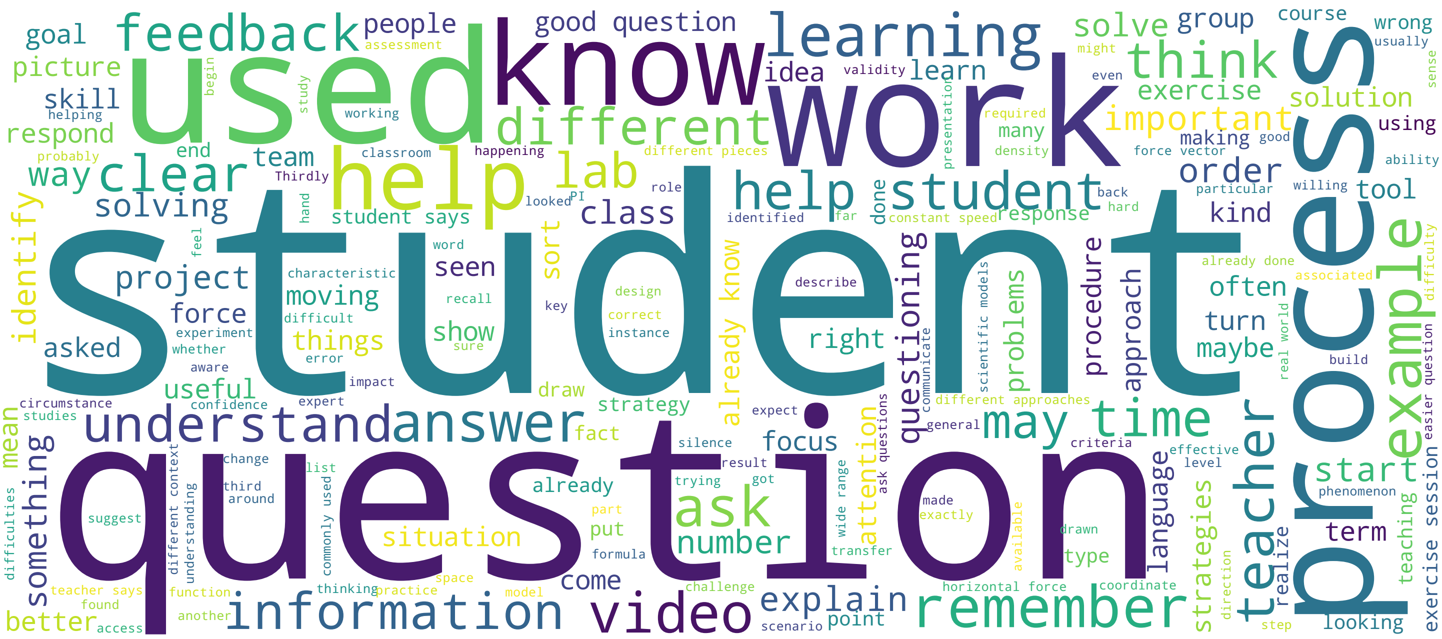

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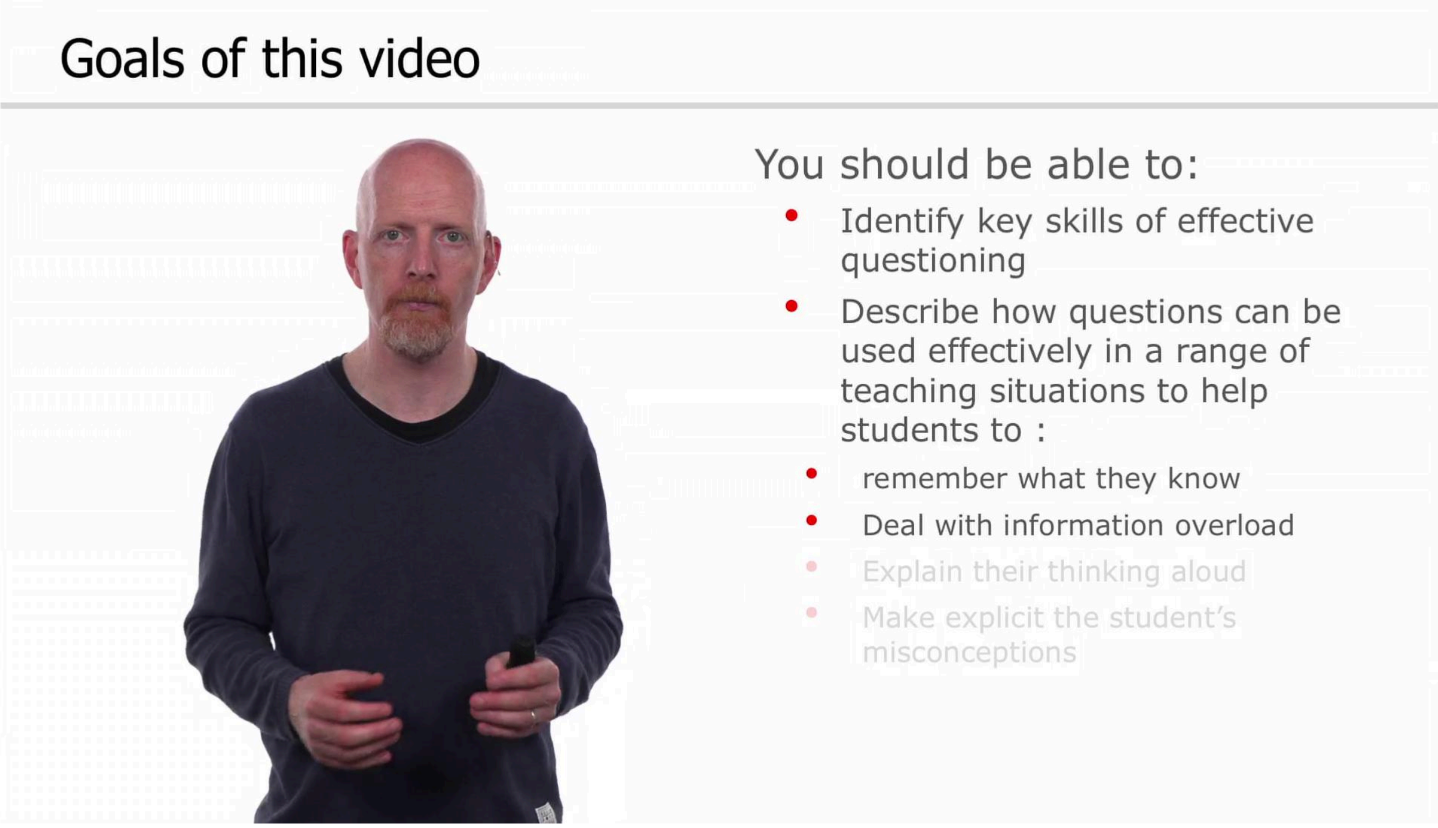
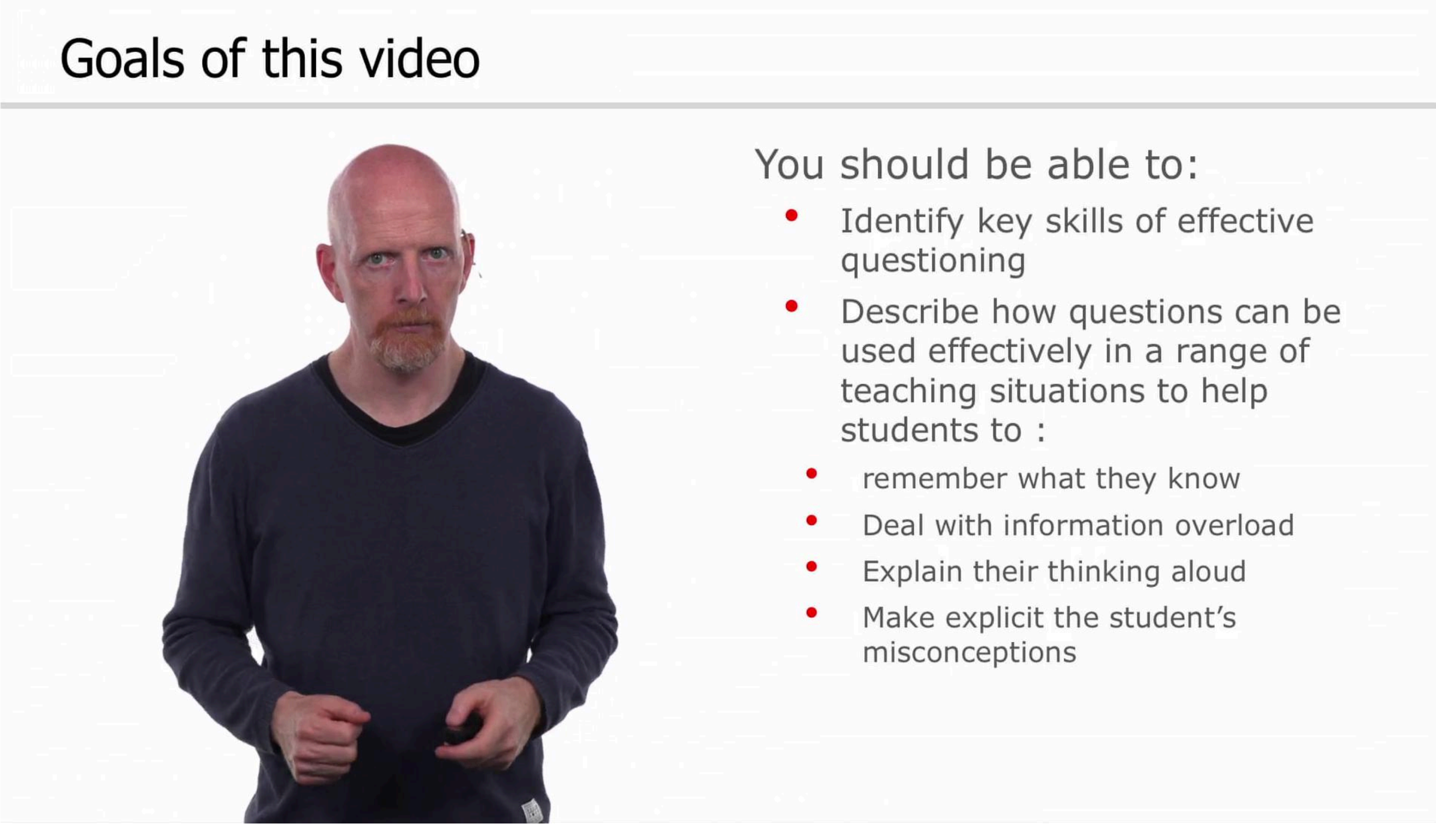


This video is one of a number of different videos looking at transferable teaching. strategies, that is, strategies that can be used in a whole range of different contexts irrespective of whether you're making a presentation or in a lab or in an exercise session. This video focuses in on questioning. So empirical evidence from looking at classrooms tells us that questioning is the second most commonly used strategy by teachers after teacher talking. But what makes a good question? What sort of skills do you need to have in order to question effectively in the classroom? In this video, we're going to look at a number of different aspects of questioning. First of all, we're going to identify what are the key skills of effective questions, what does a good question look like. Secondly, we'll look at different ways in which questions can be used in a range of different teaching situations. So for example, we look at how questions can be used to help students remember what it is they already know. Secondly, we look at how questions can be used to help students deal with the situation in which they have just too much information.

Notes

Summary

0m 04s



Thirdly, we'll look at how questions can be used to help students check their own work and to understand better where they've made errors. Fourthly, we look at how questions can be used to help students make the connections between the concepts and models they're learning in their scientific education and real-world phenomena.

Notes

Summary

1m 11s

Key questioning skills

- Make the question clear
  - Pitch the language to the audience
  - Shorter is often better
- Make clear you want a response
  - Use pauses

Kyriacou *Essential Teaching Skills* 1998, p. 35

So what are the characteristics of good questions? This comes from work by Chris Kyriacou in the book ‘Essential teaching skills’. So one of the first characteristics of a good question is that the question is clear. Maybe two important things to remember in terms of making the question clear. First of all, you, as an expert will often have access to a language or a way of thinking that the student won't have access to. They're still learning to think like that. They're still learning that language. And so, you may need to put the question to the student in a language which they will understand. A second thing to remember those good questions is that they are very often short questions. Questions which have a lot of different pieces of information on them will often be hard for the student to process and hard for the student to clarify exactly what's being required of them. A second important characteristic of good questions is that you make clear to the student that you want a response. Here, it can be really important to use pauses. It may be that you will ask a question and the student won't respond: you'll be met with silence.

Notes

Summary

1m 32s

Key questioning skills

- Make the question clear
  - Pitch the language to the audience
  - Shorter is often better
- Make clear you want a response
  - Use pauses
- Use responses in a positive way (even wrong ones)
  - "Good answer"..."Great "
- Raise the challenge level
  - Start simple and work up

Kyriacou *Essential Teaching Skills* 1998, p. 35

You have to be willing to meet that silence with silence, you have to be willing to leave the space to make clear to the student that you're waiting for a response. You can encourage them to respond but what you should try and avoid doing is jumping in and filling that space by answering the question yourself. If you do that, then you're telling them that implicitly you didn't really expect them to respond. Thirdly, it's important to use the responses you get in a positive way; that can be easy to do when the answer is correct, it can be more difficult to do when the answer is incorrect and maybe the key issue here is to respond with warmth. what's important is that the student knows that getting this wrong is just a normal part of the learning process. It's not a big problem; it's not something they should feel bad about, it's just what people do as they're learning. A fourth point to make about questions is about how you link one question to the next. Oftentimes, it's better to start with an easier question and build to more complex questions. If you start with a question which is very abstract or maybe very difficult, well then maybe that sets up a situation in which the student feels that they are not able to respond and then they become less likely to respond to future questions.

Notes

Summary

2m 39s

Key questioning skills

- Make the question clear
  - Pitch the language to the audience
  - Shorter is often better
- Make clear you want a response
  - Use pauses
- Use responses in a positive way (even wrong ones)
  - "Good answer"..."Great "
- Raise the challenge level
  - Start simple and work up

Kyriacou *Essential Teaching Skills* 1998, p. 35

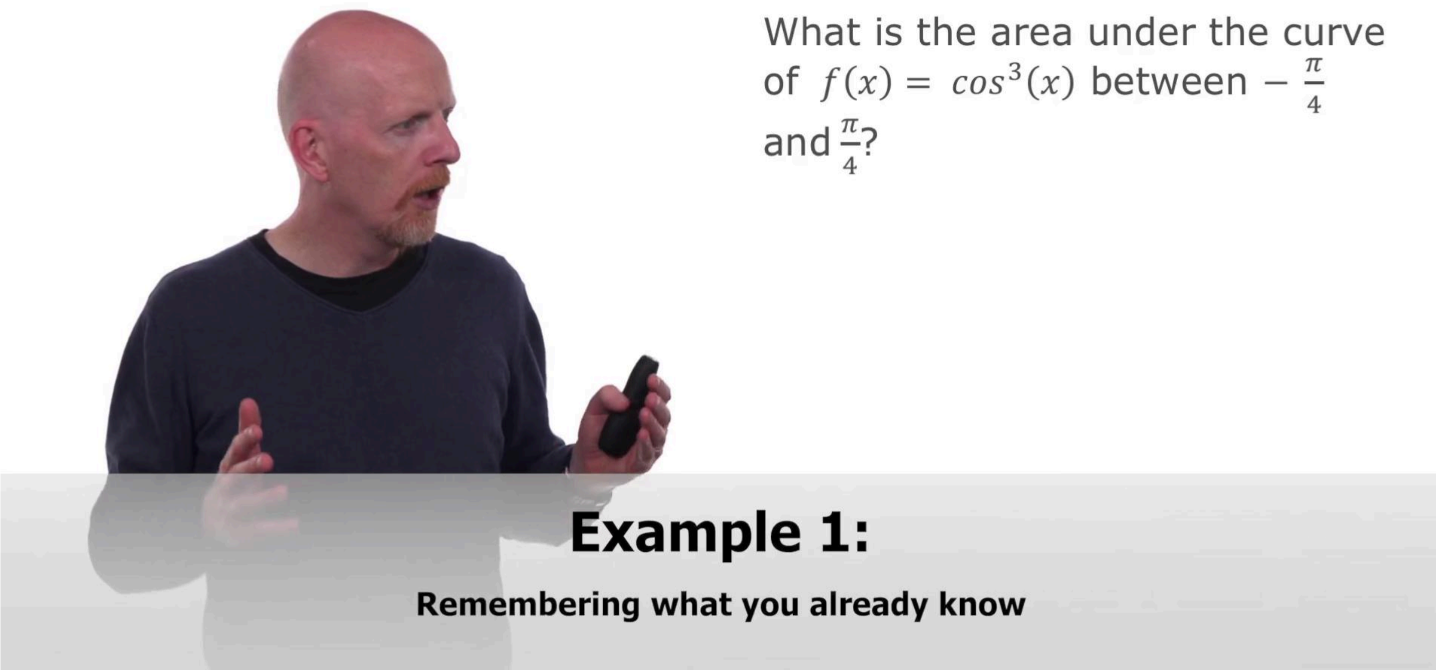
If you start with an easier question, then the student can show themselves that they're able to respond, build their confidence as they move from one question to a more challenging one.

Notes

Summary

3m 54s

Activating Student Knowledge (ASK)



So again, this is an example that we've used in a previous video. In this case, the student is asked to calculate the area under a curve of f(x) which is equal to cos cubed of X between minus PI over 4 and PI over 4.

Notes

Summary

4m 07s

Activating Student Knowledge (ASK)

What is the area under the curve of $f(x) = cos^3(x)$ between $-\frac{\pi}{4}$ and $\frac{\pi}{4}$?

The student doesn't know where to begin. In the class, the teacher has done an example but not exactly the same example and it can't be solved using exactly the same method, even if the general procedure will work. So how do you help a student to cope in this situation? One difficulty they have is just the sheer number of different things they need to remember; they need to remember the procedure, they need to remember about trigonometry identities, they need to remember how to integrate functions and the different methods of integration of functions and which ones work in which kind of circumstances. So having to remember all those things while at the same time as trying to figure this out is going to be to cognitively heavy for the student. One way around this is for the students to actually remember these things that they need to remember first, and then focus their attention on solving the problem. So this is an approach which we call 'Activating Student Knowledge' or the ASK method. The ASK method involves starting by activating what it is the student already knows. In this case, what is it that the student already knows?

Notes

Summary

4m 22s

Activating Student Knowledge (ASK)

What is the area under the curve of $f(x) = cos^3(x)$ between $-\frac{\pi}{4}$ and $\frac{\pi}{4}$?

- What was the procedure the teacher followed in class to solve this kind of problem?
- What are the different approaches for solving integrals, and when do you use each?
- What trigonomic identities do you know?

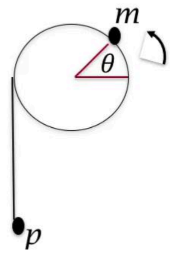
Well they know what procedure the teacher followed in the classroom, they know what the teacher did. They may describe it in very task specific terms and you may need to get them to take a step back and look at it as a more general procedure but nonetheless, they know what that procedure is. You can ask them 'Explain to me what procedure did a teacher follow in the class for this kind of problem?' Secondly, in solving that, the teacher will have looked at different approaches to solving integrals, there will be a particular approach which will work best in this circumstance because the integral will take a particular form or the function will take a particular form. So the student will need to know what are the different approaches and which ones work best in which circumstances. So again, you can ask them; "what are the different approaches which you have and which one's work in which circumstances?" Thirdly, the student will also need to be aware of different trigonometric identities, which could be used to help solve this and so that's a third thing you could ask them in advance. So before the student actually begins to solve the exercise a series of questions can help them recall what it is they already know and this in turn will allow them to focus their efforts on trying to understand what's actually happening in this particular integral.

Notes

Summary

5m 30s

Questions in context (2): Narrow the focus



A smooth circular beam of radius R is horizontal, and fixed to a wall so that it will not rotate. A light string is placed over the beam with a mass m at one end and a mass p at the other. The mass m is initially at rest at the same height as the centre of the cylinder, while p is hanging lower than the cylinder on the other side. Mass m begins to slide anticlockwise up the side of the cylinder. The angle between its position and its starting position is θ (as shown).

What is $\ddot{\theta}$ of mass m, expressed in terms of p, m, g, θ and R?

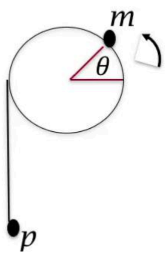
In the previous example, the question itself was quite short, the question didn't contain a lot of information but in order to solve it, the student needed to recall a lot of things that they already knew. In this case, the scenario is a little bit different; this question involves quite a lot of information and in order to set up the question the student has to process quite a number of different pieces of information in the first place. Now when faced with questions like this, students often take an approach which is that they choose very quickly a solution method and they keep going with that solution method. So how could a student better approach this question and what sort of questions would help the student to better approach this exercise? First of all, draw a picture, secondly, look at the problem and try and identify 'what sort of coordinate systems are available and what sort of coordinate system will they use?' Thirdly, try to identify 'what sort of tools are available what do they know, what are the formulas which were already used in class?' Now, if the student actually answers those three questions the student will already have enough information to enable them to solve this problem.

Notes

Summary

6m 49s

Questions in context (2): Narrow the focus



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What is $\ddot{\theta}$ of mass m, expressed in terms of p, m, g, θ and R?

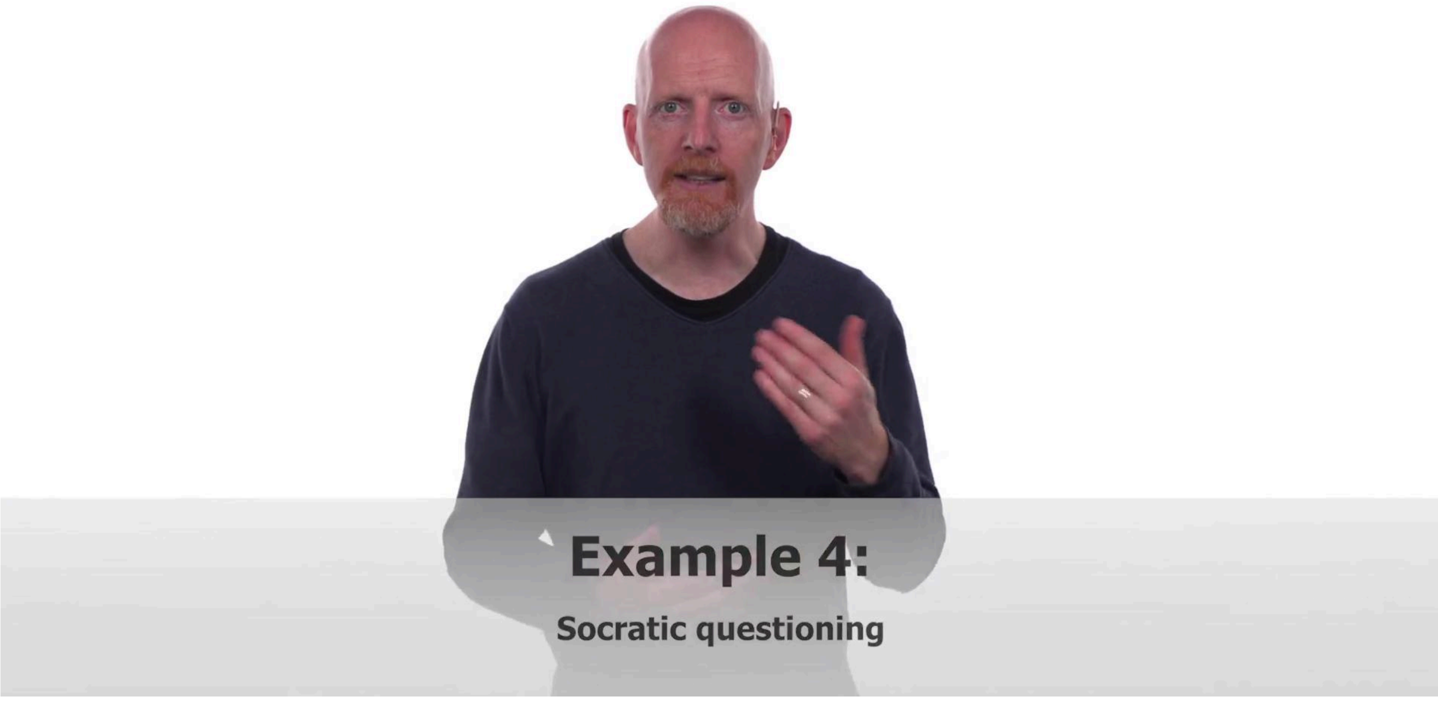
The student may not ask those three questions for themselves, they may need your help to ask those questions but once you ask those questions, you'll be helping the student to clarify for themselves a process. And that's a process which doesn't just work for this question, it's a process which works for questions in general. Draw a picture. Clarify what you know. What you don't know. Clarify what the goal is. Identify a coordinate system. Identify what tools and formulas you have. Usually at this point, the students should be able to see how to use those tools to close the gap between what they need and what they have, and so you've given them not just something that will work for this problem but a strategy that will work for problems in general.

Notes

Summary

8m 03s

Example 4: Socratic questioning



One scenario which often arises in exercise sessions is that the student puts up their hand and asks a question the question turns out to be kind of vague. It’s not all that clear what the problem is. Now, you could work through what they've already done on the page and you could explain to them the errors in it that would be "teacher telling". However, one the interesting strategy is to ask the student to explain to you what they have done. It turns out - this is called a self explanation effect - and it turns out to have a positive impact on learning. We’ve looked so far at how questions can be used in a number of different contexts. First of all, how questions can be used to help students remember what it is they already know. Secondly, how questions can be used where there's a lot of information to process, to help the student focus their attention on how to process that information. Thirdly, questions can also be used to help students better understand the work that they've already done and maybe the errors that they've made in that work. I want to turn my attention now to a phenomenon we've talked about in one of the other videos, that is the phenomenon of scientific misconceptions which students bring with them into the world.

Notes

Summary

8m 47s

Questions in context (4): Going deeper

Socratic Pedagogy in the Introductory Physics Laboratory

By Richard R. Hake

What I cannot create I do not understand.
Richard Feynman

Let us visit the university physics lab of Fig. 1. Why are the instructors asking questions? Why are the students talking so much? Why are they engrossed in seemingly childish activities?

The students are holding iron disks stationary in their hands, lifting the disks upward, carrying the disks across the room, pushing wooden blocks across the table, sliding blocks off the table into the air, observing a block that is slowing to a halt on the table:

"Look...There's a force in the forward direction because the block's moving in that direction!"

"Hey...but the block is slowing down!"

"So what! Look—here's the diagram—the force has gotta be in this direction!"

"But only the table is in contact with the block. A table can't push a block!"

"So what? I put some pushing power into the block when I started it off."

"Well, I'm really confused. Let's ask the prof for some help."

We observe that most of the students are still back with Aristotle or the medievalists, though they have been exposed to Newtonian mechanics for several weeks through text study, problem solving, lucid lectures, and exciting demonstrations. Furthermore, over 70% of them have completed a high-school physics course.

Aside from exposing students' preconceptions, how can such elementary and nonanalytical activities be of any value? Shouldn't someone just give these students the Newtonian "word"? Unfortunately, most research[1] has shown that the usual bombardment of passive students with a formidable flux of physics "factons," formulas, and problem-solving assignments fails to implant conceptual understanding, while there have been several recent studies[2b,c;3-8] demonstrating the relative success of active-engagement methods such as depicted in Fig. 1.

Several years ago I reported[6] that the use of Socratic pedagogy in university introductory physics laboratories appeared to be relatively effective in promoting student crossover to the Newtonian World as measured by pre- and post-course testing with the Halloun-Hestenes[2a] exam of conceptual understanding of mechanics. Students' engagement in simple Newtonian experiments such as those of Fig. 1 produced conflict with their commonsense understanding and thereby *induced* collaborative discussion among themselves and/or *Socratic dialogue* with an instructor.

Richard Hake, *after receiving a Ph.D. in physics from the University of Illinois in 1955, was a researcher at North American Aviation and then became a professor of physics at Indiana University (Physics Department, Bloomington, IN 47405) in 1970. An early investigator of high-magnetic-field and Type-II superconducitivity, he has published over 60 papers in condensed-matter physics. In 1980 he was stunned by the failure of the traditional TRAnsmission to Passive Target (TRAPT) method of physics instruction when he discovered that his brilliant lectures and thrilling demonstrations passed though the minds of prospective elementary teachers leaving no measurable trace. Similar results were then obtained for science majors when confronted with conceptually oriented questions. Still stunned, for the past seven years he has been engaged in a research and development program at Indiana to improve introductory physics education.*

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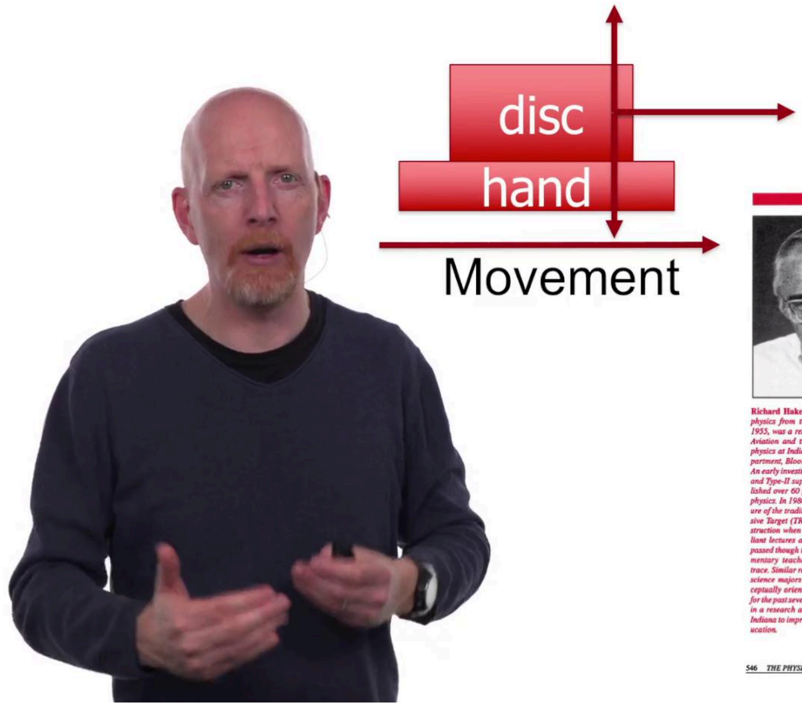
These can also be unearthed using questioning strategies. This kind of approach to questioning is sometimes called Socratic questioning. It's named after the ancient Greek philosopher Socrates who used to respond to questions with a question in order to help people be clear about what it is that they thought they understood but in fact they didn't understand. So the same title 'Socratic questioning' is used by the physicist Richard Hake to describe an approach which he uses in physics labs. Hake gives an example of a student or a group of students who are asked to pick something up and to carry it at a constant speed at eye level.

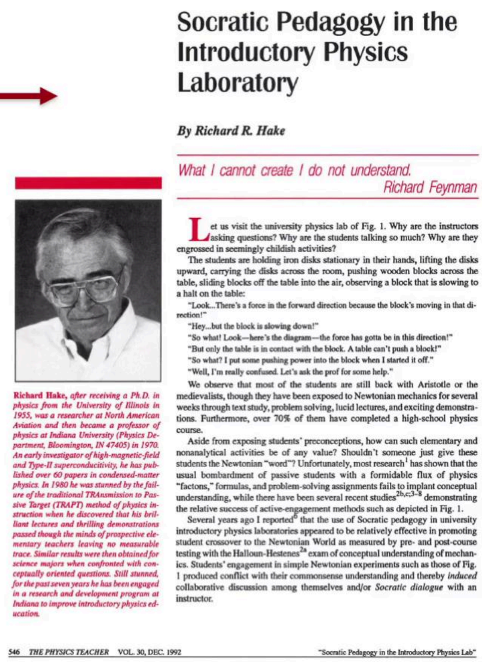
Notes

Summary

9m 57s

Questions in context (4): Going deeper





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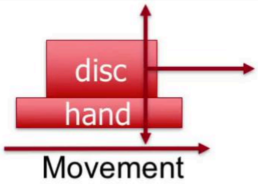
In other words, they are pretty much a constant height and students are asked to draw a diagram which explains what's happening in terms of forces at the beginning of the process as they're carrying it and at the end of the process. Now the picture we have here is a picture that the student has drawn in the middle of the process and the picture is wrong because the picture is indicating that there is a force going in the direction of movement when an actual fact, the weight is been carried at a constant velocity. So the student here is using an Aristotelian model which is they're saying that a force is associated with speed rather than force being associated with acceleration or a change in speed or direction.

Notes

Summary

10m 43s

Questions in context (4): Going deeper



Student 1:…I think I have this right.
Socrates: Why did you put a horizontal force vector on your sketches?
Student 1: Because the disc is moving. If it is moving it's gotta have a force on it.
Socrates: Can you describe the motion?
Student 2: Like it say [in the workbook]: "in a straight line at constant speed"
Socrates: Did you feel as if you were exerting a horizontal force?
Student 2: Not much – I walked pretty slow.
Socrates: Then why did you draw horizontal force vectors as large as the vertical force vectors?
Student 1: I guess that's wrong…

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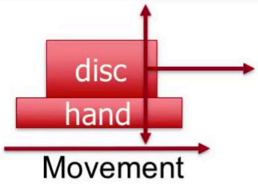
So what Hake describes is a process of questioning the student around this error and so first of all the student says "You know, I think I have this right" and so the teacher, who Hake in this example called Socrates, says "Well why did you put a horizontal force vector on your sketches?" The student says "Oh because the disk is moving, if it's moving it's got to have a force on it" and so here you can see the Aristotelian idea being made explicit. "If it's moving, it's got to have a force on it". Okay so the teacher wants to unpick this and once the student to understand that actually this thing that they think they have right, they don't understand; they don't understand what it is that they think they understand. So the teacher says "Well, can you describe the motion?" "Well it's like it says in the workbook it's in a straight line at constant speed". So now the teacher says "Well did you feel as if you were exerting a horizontal force on it as you were moving?" and the student says "Well not much, I walked pretty slow". The teacher says well you've actually drawn the horizontal force vector as large as the vertical force vectors and the student says, "Okay, I guess that's wrong".

Notes

Summary

11m 31s

Questions in context (4): Going deeper



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So the student is now starting to realize that actually this thing that they think they know they maybe don't know. And the teacher will continue to ask questions of the student until such time as the student starts to realize that they've made a more fundamental mistake here. Hakes approach is to use this kind of Socratic questioning to help students come to grips with and come to an understanding of what are their own misconceptions.

Notes

Summary

12m 45s

Conclusion

- One strategy with different functions
  - Activating prior knowledge
  - Narrow focus of attention
  - Self-explaining
  - Deeper processing of information
- Key skills
  - Show you want an answer
  - Value and use the answer
  - Be clear
  - Start simple and work up

At the start of this video, I identified that questioning is the second most commonly used teaching strategy after teacher talk and actually, that's probably not a surprise because questioning is incredibly flexible. It can be used in a wide range of different settings to solve a wide range of different problems. If the student is overwhelmed by needing to remember what they already know at the same time as focusing on a problem in front of them, questioning can be used to get them to activate their prior knowledge in order to free up headspace to focus in on the problem. If the student is overwhelmed by too many different pieces of information, questioning can be used to narrow their focus and to point them in the right direction. Getting the student to explain to themselves an example or work they've already done will be very useful in terms of helping the student to get a deeper and richer understanding of that material. Obviously, asking questions about how abstract scientific models relates to real-world situations may help students realize if they do have naïve or non-scientific models, which they're using to explain the physical world.

Notes

Summary

13m 13s

Conclusion

- One strategy with different functions
  - Activating prior knowledge
  - Narrow focus of attention
  - Self-explaining
  - Deeper processing of information
- Key skills
  - Show you want an answer
  - Value and use the answer
  - Be clear
  - Start simple and work up

Obviously, if you're going to ask questions you want to ask good questions and so that means you want to show to the student that you actually expect an answer, you want to leave enough space for them to answer the question, you want to give them enough encouragement to give them an answer. When they do answer, you want to value that, you don't want to say to them "no that's wrong" rather you want to say to them "okay that's interesting". You want to communicate to them that actually this is something you want to engage with. You don't want to push them away. Thirdly, you want your questions to be clear, otherwise you just confuse the student further. And finally, it's often a good idea to start simple and work up to more complex questions. This helps the student build a bit of confidence in what they're doing and also helps you lay the groundwork to build more complex ideas upon it.

Notes

Summary

14m 26s