Andrea: Okay, welcome. Thank you. This is the question and answer session that we're doing for the online MOOC on Assessment for Learning so thank you very much from National STEM Learning Centre that's a part of this. We've done a few of these before but this is the first time that we've actually got Dylan and Chris and myself albeit not in the same place but together at the same so it's very exciting. We're going to be able to get some live interaction between our two experts and find out what their thinking is. Thank you very much to everybody for submitting your questions. I hope that you'll be please to hear the responses that you get as we go through.
We're going to start by looking at questions that have been submitted about the writing of hinge-point questions and we're going to ask Dylan first of all if he can respond to a question that has been submitted by Vimala. Her question is, "Do you think that hinge-point questions need to be differentiated?" so, over to you Dylan.

Dylan: I think it depends on what you mean by differentiation so, should hinge-point questions be equally appropriate for all members in the group? Absolutely yes, but do you need to have different questions for different students in the group? My view is no. I think one of the most powerful ideas here is the idea of a question with multiple correct responses. So students who are used to multiple choice questions with just one correct response, having multiple correct responses allow you to do two things.
First, it creates much greater certainty that if students give you the correct responses, they've really got it right. If you have five options then they can get it right by guess work, 20% of the time, if they know there's only one correct answer but if they don't know how many correct answers there are, students have to make an independent decision about each of the five options so you have 2 x 2 x 2 x 2 x 2 or 32 different combinations of response students can make. That means that if students give you the right response, you know they understand it.
The second advantage of multiple correct responses is you can make them at different levels of difficulty. You might pitch one at a standard that you hope all students who've been in the lesson understand and you pitch the others at a higher level, some maybe only accessible to your most gifted students. The advantage is, all students should be able to get at least one option right but you'll keep your more gifted students on their toes because they'll be scrutinizing all the other options to see if they are correct answers that don't look correct.

Andrea: Thank you Dylan and thank you Vimala for your question. As you can see that Dylan has given you a couple of different reason why actually thinking about multiple choices will help with differentiation.
We have a similar question from Lucy Johnstone so I think Lucy that Dylan just answered your question as well which was, "Can we use hinge-point questions with more than one among correct answers?" I think you will find that from the response that Dylan just gave that you will have received and some advise on that too.
Looking now, Chris a question that we have submitted from Siobhan McInally. Siobhan is asking about, "When writing hinge-point questions, how do we make sure that the language is simple enough in terms for Assessment for Learning so that when she's got a class of students, there's a large number of EAL pupils that they're able to access the questions."

Chris: Okay, well always you've got EAL students whatever the type of questions, you have to work that much harder on getting the language simple enough so that literacy doesn't interfere with their conceptual understanding. That's always a challenge for any teacher.
When you got your hinge-point question, what I would suggest is you go through several iterations of the question to get that language right and clearly, after you try it out with different classes your hinge-point question, will get more refined.

In terms of differentiation generally, just picking up on what Dylan was just talking about, I think we need to think not just about the construction of hinge-point question and the structures into that but also the use of them, when to use them in the lesson. Really hinge-point questions are designed to use when most students have actually accessed the learning and made sense of quite a lot of it. When most of them have actually developed that conceptual understanding… so it's like a check before you move on.

Andrea: Moving on now. Chris, the question here… In fact Sanne's submitted a couple of questions. This is the first question that they've asked. They're wondering about any particular challenges that you've encountered when you've been working with teachers who are designing hinge-point questions particularly if there's any, the people who've been working on our course, our online course and whether these challenges are similar for educators at different levels or phases of the education. Challenges that teachers face in designing them, Chris. Any general ones you've come across?

Chris: I think the main challenge for teachers is about four letter word 'time.' They don't have the time nor sometimes get the time to working on the questions and thinking it through and maybe trialing them. We don't do it with whole class, we just trial it with a small group of students. Maybe if you're doing the question with 14-year olds take your class of 15 year olds and try out the questions. They should be able to at least have a go at them because they've done it the… The understanding the previous year. Give yourself time to have several goes at writing the question and also sharing with colleagues.
One thing that I learned early on and this was in a project that Dylan and I did nearly 20 years ago now, the KMOFAP Project was that teachers don't naturally share questions. I was amazed listening to some of the Science and Maths teachers that the questions they use… These are just ordinary questions would really causing kids to talk rather than hinge-point questions but I hadn't realized certain questions were just so good at revealing children's thinking. I learned a lot from those teachers. I'd encourage teachers to share with colleagues and to talk, not just about the question itself but how it works in their classrooms because it's actually the interactions that ensue from any question that's going to be useful

Andrea: Thank you Chris and Dylan you would like to add something to the question [Crosstalk 00:06:40]

Dylan: It was one of the teachers in the KMOFAP Project that Chris mentioned. This teacher said to me you can't think of good questions on your own. You will be victim to your own way of thinking about this stuff. I think I just want to reinforce the fact, the point that Chris made. Hinge questions, when they're delivered well collaboratively are durable and portable. What are good questions now will be good questions in 20 years time because students will have say misconceptions with scientific and mathematical content they do right now.
The other thing we've discovered is, good questions developed in Australia works just as well in England. The extraordinary thing is the time spent developing these questions and then sharing with colleagues is rarely wasted.

Andrea: Absolutely, thank you very much. It reminds me of something I've read Dylan that you wrote that it's much easier for teachers to share questions than it is to share lesson plans and it's thinking about when we use those assessments as you said Chris during that learning and how are we going to response to the evidence we elicit.
Okay, thank you everybody for those questions about writing hinge-point questions. I think the key things that have come out from our experts are thinking about when we use them to actually using multiple correct answers is beneficial for all students in the class and for us as educators to find out.

I think the really strong message is, they need to be trialed with collaboration and that actually it's through using them that you're going to keep evolving them. That you might not get there first time, you might not get there second time. As Dylan says, "Asking for reasons behind the answers is going to help you keep evolving them as well as those discussion with all the professionals." Thank you very much.
Moving on now, we've got a couple of questions which are very similar about using students' questions as hinge-point questions. Chris, a question here from Nora El-Shewy and Jessica Southworth- very similar, "Should hinge-point questions address only the common misconceptions about the topic or can we use misconceptions or unexpected questions that students give us as part of our hinge-point question design?" What are your thoughts?

Chris: I certainly think you can use the misconceptions to rise in the classroom particularly if those students have voiced those in the whole classroom situation because they actually will get other students thinking about it. May even unsettle a few students.
I remember watching one of our pre-service teachers, teaching a lesson about the heart and was trying to get over the idea of the double circulation. She just asked a simple question of, "Why do you need to have two sides of the heart and four chambers?"
The kid's talked for a little while and then came back and this one boy very confidently said, "Well, it's because... Well, this side of the heart actually takes the blood in and then it will pump it to the lungs and then it will then go back and then can in again and drains into this side of the heart, and then drain across against this one." It got completely mixed up with the whole mechanism of what was going on but he said it so confidently that the teacher didn't critique at that time.
I would hope that in either later that lesson… Well, it wasn't later that lesson because I saw the rest of the it. In another lesson, hopefully that was quizzed. Misconception about how double circulation works, really needed picking up again and it could easily been done in the hinge-point question. That's not common misconception or at least one that's been reported in the literature.
Yeah, do use those that come up but you need to sort of distinguish really between what is actually a misconception. What is something that's actually just a naive idea?

Andrea: Next couple of questions, I'm looking at the idea... Moving on now about using students to write our hinge-point question. I think that will be interesting from what we've just been talking about in terms of teacher knowledge and expertise. Lucy Johnstone asked the question asked the question and Maria Rodriguez Marcos asked a question Dylan. Their questions are very similar basically, "Can we use students or can we get students to actually start designing hinge-point questions to test each of those?" What are your thoughts on that?

Dylan: Well, there's no doubt that there's quite robust evidence about the value of student-generated questions. One study that we included in our view of research in 1998 Paul Black and I found the study of students generating questions for each other. Now, doing practice tests is good for retrieval and good for long term memory but it looks like having students design their own questions about what they've been learning is actually more effective.
Of course, it also allows students to really push themselves to come up with what are the traps or what are the misconceptions. I think having students generate questions is very valuable. Obviously, you don't want to do this all the time but it builds on well known psychological phenomenon called the 'generation effect'. This suggests that when people generate responses they actually... Or generate questions or generate their own responses, they remember them longer than if they memorise somebody else's telling of responses to them.
It could also echo something that Daniel William, the American psychologist has pointed out, "Memory is the residue of thought." Students remember what they've been thinking about and writing questions is a lot more cognitively demanding that answering somebody else's questions. It's a way of really deepening that engagement that students have. I absolutely would agree that having

students write their own question is a very useful part of effective teaching in the STEM subjects.

Andrea: Lovely, thank you. You think, how could we support and scaffold students do you think in writing hinge-point questions? I'm just thinking about using things like examiner's report or something so they can start identifying what are these difficulties. Do you have any thoughts or ideas on that? Either of you, or both.

Dylan: Well first I'll start. I mean I think absolutely yes. There are some very good ideas. In particular, get students to talk about the traps in questions. Get students to talk about at a meta-cognitive level. What are the traps in this question? Why did that person put that incorrect answer in there? Is it just a random guess or is it related to something that somebody might have?
One of things I've done in my own teaching is ask students, why would somebody have chosen this incorrect answer, and get them to think about the potential traps and get them a bit more aware of their own though processes and being aware that even experienced mathematicians or scientists can fall into traps. There's really interesting research that suggests that the naive conceptions that we develop about how the world works never go away.
They did some studies on physics professors in universities and their initial reaction to a physics question was often the naive school child answer but they learned to suppress that and then engage their principles of physics to answer the question correctly. On a cold day, it feels like cold is coming in but if you're trained as a physicist, you start thinking about that as a problem of loss of heat. That initial reaction is often the misconception. Getting students aware of that I think is very helpful.

Andrea: Absolutely, thank you Dylan. Chris, your own advice then for helping getting students writing hinge-point questions?

Chris: Yeah, I think what Dylan says is perfectly right. Getting the students involved really does help them in their learning. I don't really think most students could write hinge-point questions because I think the level of finesse that you need and level of expertise probably, they're not at that stage yet. I just get them to generate questions and certainly on the KOSAP project which is a project that I did with colleagues, where we look at year eight and that's 12, 13-year olds and the types of assessment they get in class to sum up how they were understanding their Mathematics and English in this case. In that particular project, what we actually found was that students could come up with questions and the questions that they came up with, well, seemed to be more useful were was, if you gave somebody a topic, what would be a good question that would really test out if they understood that topic? Teacher can set a task to the test, we've done Pythagoras, what would be a really question that would test whether I understood Pythagoras or not?

Andrea: Our next questions, I'm looking at how we actually manage using hinge-point questions in the classroom. Chris, we've had a question submitted from Edith Swinley and Charlotte Neary both are asking a very similar thing which is, "How can we stop the children copying the responses of their peers when we start using hinge-point questions in the class?"

Chris: Okay, thank you Edith and Charlotte for one.
Yeah, when you start off, you probably will need to use some silent secretive way of giving answers in the class because you will get some students who are anxious and want to get the questions right. Teachers use different things. Some will use hand signals so they might use one finger for A and then two for B either against the cheek or against the shoulder. That's one way of signaling back to the teacher. Other teachers position children so it's much more difficult for them to stare at or at least look at other students when they're answering.
What you'll find after a while is that you don't need to have the secrecy for all of this because once students start to realize that hinge-point questions are beneficial for them, that in answering

truthfully what you think, you will find out as a student but also your teacher will find out just where your conceptual understanding is. Then, if you're not here with it, your teacher will try and help remediate that or if you have got it, then the teacher will move on so the learning moves at the speed that's right for your learning.
You probably will need some structures early but later, it should be fine because the students and the teacher join together in taking the ideas forward in a climate that it's all about improvements and challenging. It's challenging to answer hinge-point questions. Students will rise to the challenge if they know it's going to help them later.

Andrea: Thank you, Chris. Thank you. Dylan?
Dylan I think Chris is absolutely right. This is a problem for many teachers and I think in the short term, you can actually just call kids on it. If this child is looking around, you say "Why are you looking around. I'm trying to help you." I think there's a couple of things you can do and Chris mentions some techniques.
There's one called 'Plickers' which are a series of cards that teachers can use, that students can hold up in one of four orientations. The teacher can take a photograph of the whole class with an iPhone and it identifies which child has held card up which card in which orientation but I'm not really happy with that approach.
It's the same with the electronic clickers. They're anonymous but you're recording every single response a child makes. If we would have created a culture where every child is happy making mistakes in the classroom, the last thing we should do is record every single one of them.
I would actually talk to students about a recently discovered psychological phenomenon called the 'hyper-correction effect'. It turn out that if you're asked a question and you aren't really sure about the answer but you make a choice, and in that choice, there's a incorrect, you remember the correct answer for longer than if you get it right the first time.
Every teacher I've ever met says, "It's okay to make mistakes in classrooms." but very few teachers talk to students about the fact that making mistakes is better than not making mistakes in the classroom. I think the whole idea of creating this culture where students make a mistake as part of a learning, by the normal learning process, is absolutely essential.
I remember talking to one primary schoolchild who was asked to compare lollipop sticks with ABCD cards. She said, "I much prefer ABCD cards because even if you get it wrong, there's always someone else who gets the same wrong answer as you." That, I think, is a really powerful idea, creating that classroom culture where students understand that making mistakes is valuable because it deepens your long term understanding.

Andrea: Lovely, thank you both very much. This idea about culture shift and failure in learning at the heart of it which I think throws up the challenge then to for us as teachers that there is a challenge that everybody's going to have the opportunity to fail. That brings in line ideas about differentiation which is a whole other course that people that can do if they want to be online.
Thank you Edith and Charlotte, some great advice there.
Sanne, we've now got your second questions which Dylan, I'm going to ask to you first. Sanne Nielsen is asking, "What the rationale for only two minutes or ideally less than one in terms of actually using the hinge-point question in the classroom?" What's your advice on this one Dylan?

Dylan: The reason we've made that suggestion, a maximum of two minutes, is to clearly distinguish hinge-point questions from other kinds of questions that might be a normal part of learning. If you want to make something, a quick check on understanding, it mustn't be too much of a detour. The idea was that you'd actually give students something just to check their understanding.
Now, it's not a hard and fast rule. You might give them five minutes, if you want to explore something really deep but I think you need to be aware that you are no longer doing a quick check on understanding. You are actually doing something that's every different, maybe even a teaching

activity.
It's just an idea of a way of communicating to teachers but this is a different kind of thing from normal group work around a focus question. The idea is, a quick check on understanding and if the students are spending more than two minutes coming up with a response, it's probably a very different kind of thing from a quick check on understanding.

Andrea: Okay, thank you Dylan. Thank you for question Sanne. Actually, Sanne had a follow-up question Dylan which I think kind of likens as to what you're saying and it's "How does the hinge-point question then supplement other types of questions raised in the classrooms?" You're are saying that hinge-point is the quick check and what other types of questions should be used and what would their purpose be?

Dylan: Well, I think of the interesting things about the Mathematics teaching in Japan for example is there's a really strong culture of starting a whole lesson with a big question which is called "Hatsumon". You can use questions to motivate your whole range of thinking.
I saw a lovely example in a Science classroom. A teacher began the lesson by asking the students, "Why does it take longer to cook potatoes at 220 degree Celsius in an oven than it does at 100 degree Celsius in a pan of boiling water?" which, I thought was a lovely question. I'd never thought about it even though I knew those two facts. The point is, that teacher thought it was a really good way of getting the students engaged in a discussion about the big scientific principles.
Questions can be used to motivate discussion. They can be used to motivate an entire two-week project of work.
The specific idea of a hinge-point question is it's helping teachers get good at writing a different kind of question which is one way you do not need to have the children explain their answers. Any question is better if students explain their answers but you don't have time to hear the reasons from 30 student. The idea of proposing this specific thing called a 'hinge question' or 'hinge-point question' is helping teachers get the skills of asking questions where you don't need to have student explain their answers to make a smart decision about what to do next.

Andrea: Lovely, thank you Dylan. Thank you Sanne, I think you got some great advice there. We can have questions as big questions which are great motivators. There, I'll be using that question about potato. I like that one Dylan, thank you.
Moving on to the question then Chris that we've had from Martin Boyce and Martin is asking whether we should inform students that we're actually using hinge-point questions. What's your thoughts on this one?

Chris: I think yes. I mean, if you can change the way you teach then tell the students you're going to do that and why you're doing it, that it's for their benefits and the role that they have to play in terms of answering the question. Because they'll start to understand much more why you're doing things stranger to what you've done before. It always makes me think back again, I'm thinking about the KMOFAP project. When one of our teachers tried to…

Andrea: All right, Chris we've lost your audio again. We've got to the point where you just about to start talking about the KMOFAP project.

Chris: [Inaudible 00:24:18] work at Stanford. This teacher as I said, tried to increase his wait time, didn't tell the students and they thought something was seriously wrong because he'd suddenly become silent and usually, he only did that before he was going to get cross and tell them off. They weren't really thinking about the answer. It didn't actually achieve what he wanted it achieve. Being honest about changing things… Oh no, okay. [Crosstalk 00:24:53]. Can you hear me now?

Dylan: Yeah, just start telling [Inaudible 00:25:02] story. We got everything up to that point

Chris: Okay so, we had one teacher on the KMOFAP project that I mentioned earlier, who wanted to increase his wait time and he's keen and eager… [Inaudible 00:25:20] started lengthen the time between asking the question and taking an answer. The students hadn't realized what he was doing and actually though he'd gone silent because he's going to get cross with them. Just what he tended to do previously. When he went quiet, he'd tell them off, so they didn't really play the part.
I think telling students why you are changing your practice, how it's going to help them, and the role that they need to play in these interactions is important.

Andrea: How we plan to segregate the guessed response aspect when we're evaluating responses so that the calls of action taken by the teachers are going to be more successful in both terms of learning and attainment upon summing up?

Dylan: The question of students getting multiple choice questions is right by guessing has plagued psychometricians for years. It's been a big argument about whether you should actually have a penalty for guessing incorrectly.
Well I think my view is that if the questions are well-designed, you do not need to worry about that. With well-designed questions, students will be better off guessing than thinking because if they're not really understanding the topic, they'll go for the attractive-looking answers, which turn out to be wrong.
I think Philip Sadler, a Science educator in America, was the first to propose the idea of what he called 'distractor-driven multiple choice questions'. The idea there is, that we write these questions by starting with the misconceptions, then writing the responses that somebody with that misconception would choose, then watching the question, then writing the correct solution. With really good distractor-driven multiple choice questions, you don't need to worry about guessing. It's highly unlikely because students will think and they'll be drawn by the plausible but incorrect answers.
The other option as I mentioned earlier is multiple correct responses. If you have six correct options or six options in the question that students don't know how many correct answers there are, then the chance of getting a right by guess work is 1 in 64. I don't think you need to worry about that. The multiple correct answers would help you make fast modern decisions and reduce the likelihood of students making correct responses by guesswork practically down to zero, at least down to a negligible level.

Andrea: All right, thank you very much Dylan. Thank you, Kudakwashe for your question.
Chris, I've got a question here from Nicholas Myint who is asking, "Do you advise repetition in hinge-point questions? If so, how many repeats of the same content question that would you suggest?
Chris I think that depends on what the first response is, have you judged it right, to start off with or have you given the hinge-point question too early and so you're unsure of your evidences and you need to use again. You know that many haven't got it but you need to several activities before you move on and maybe try it again.
I think on the whole, using hinge-point question sparingly is better than overusing them because the role as we've tried to explain is about that last check before you move on. It's monitoring how students are doing through the other types of assessment that you're doing. Then make a decision about using your hinge-point question.
As long as you've got it right and between say 70 and 90 percent of your class are getting the answers that suggest that they conceptually understood, then you move on to the next phase of learning. If it's way below that, then you need make decisions about what you need to do to remediate.

Use them sparingly, use them towards the end of a period of learning on that particular concept. Occasionally use them again if you've misjudged it.

Andrea: Lovely, thank you Chris and thank you Nicholas. In terms of our section, looking at managing the implementation of hinge-point question, we're getting that theme coming out [Inaudible 00:29:33] that it's evolving the use and the writing of them overtime, and when you're using them in terms of the learner's journey and evaluating our practice that's going to help those improve?
When we're using our questions, probably for explanations is really important. Also I think what's coming up really strongly from what Dylan and Chris had said in that little section is the classroom culture and it's a culture about learning. It's not about when we're right. It's about where you're at. It's about all of our roles within that. You as the student being honest and open so that I as the teacher can evaluate and then respond to what you're telling me to the benefit of all.
Lots of research evidence quoted again by our experts that all depends on this guidance that they're providing so thank you very much.
Moving on from our writing and using hinge-point questions and then what we're moving on to next is a question Dylan coming from Barry Medwell who is asking about how we actually respond to that and some productive strategies then when we're looking at the variety of different responses that the students have given us? How can we move forward their learning as a consequence of using that hinge-point question in the classroom?

Dylan: In Science for example, if it's the particular nature of matter, every child needs to get this. If it's the phases of the moon, maybe not, In Math, place value is pretty important, Roman numerals, not so much. I think you need to be very careful about saying that everybody's got to get this, if this is a topic that's not that consequential for teacher progress, for students.
If it's something that you're going to build on, again and again, over the course of the unit or even the course of the year, then you probably do need to take some time to go back and make sure that the vast majority of the students get it.
I think Chris hit the nail on the head earlier, when she said about 80%... I think that, if a few kids aren't getting it, then you need to say to them, "You need to come and see me after school and I'll help you sort this out." It's not productive for the whole class to be going over things that most students understand.
Where, more of the class don't understand? One technique that I think works very well, is to ask three or four students who've answered correctly, to explain to the class, why they think their answer's correct. Then get to students to vote for which of those explanations they find the most helpful.
The idea is you actually make this into a piece of work for these high achieving students, to explain their ideas most carefully and most clearly. You create an element of competition because then everybody wants to be the person who gives the best explanation.
You're going to create it into a whole class activity, which uses the diversity of achievement in the class, as a teaching resource rather than seeing it as a problem, which teachers too often do in my view.

Andrea: Lovely. Thank you Dylan, that's really helpful. [inaudible 00:32:27] Thank you very much for your question there Barry. I hope Dylan's responded and given you some practical ideas for deeper thinking points for you to reflect on as well.
We've now got a question from Kristy Parkinson, which I'm going to ask you, Chris, to respond to first. When posing a hinge-point question, Kristy asks, "Is there a need to record the data to justify the choices that she then makes as a consequence of actually using the question?"

Chris: I think it depends, Kristy. It depends what other data, evidence you're collecting to actually

record progress or record achievements at various times. You could take the evidence you got from the hinge-point questions. It would certainly indicate to others, how you've used your teaching skills in order to attend to student's needs.
If you're actually, just wanting to map out student progress over the year, you're probably better choosing relevant activities that really show what students can and can't do. I think primary schools have got this right in England, who in literacy, tend to do a writing task early on in the year, they'll then do a second one around half way through the year and a third one towards the end of the year. Just through a quick look at those three pieces of work, you can see the sorts of progress that students have made. Of course if you want to analyze that, that gives you a lot of evidence for how these students have moved on with their learning.
We could take a similar thing in science and mathematics and do that. Just think about what would be the most relevant task. Equally, you know you could support that with any test data or any answers to the hinge-point question. It really depends on what sort of accountability you've got in your school and what's expected.
I tend to not use the hinge-point question data. I think that's for another purpose really. It's just telling you what needs to be done next in terms of the teaching schedule, rather than necessarily mapping student's progress.

Andrea: Lovely. Thank you, Chris. Dylan you'd like to add something to that for Kristy?

Dylan: I think Chris is right. The main purpose of hinge questions is for teachers to make smarter decisions and therefore the evidence of the hinge-question being used appropriately is a smarter decision by the teacher about what to do next. As soon as we start getting into the business of recording responses, I think we pervert their use.
I'm aware that in many countries now there's a pressure on teacher to demonstrate progress in a lesson. I just think that's wrong-headed. As John Mason has pointed out, teaching takes place in time but learning takes place over time.
Paul Kirschner's definition is that learning is a change in long term memory. If nothing has been changed in long term memory nothing has been learnt. Therefore the important point is, what are we looking for, over the longer term.
The point that students can do something today does not mean they can definitely tomorrow but the fact that they can't do it today means it's highly unlikely they can do it tomorrow.
I think the important point is, the driving force behind hinge-questions is to help us make smarter decisions about what to do next. You might record a really interesting, incorrect response a student makes. You might just jot down the names of three or four students who've given completely wrong answers and you need to see individually. Beyond that, I think, any recording to prove you've been doing your job, I think is fundamentally misguided.
If your teacher's are being told that, I just think that's wrong. The purpose of these questions is to help to make smarter decisions about what to do next by getting quality evidence than you'd get if you just got two or three kids to answer the question.

Andrea: Lovely. Thank you both very much. Thank you Kristy for your question, I'm sure lots of teachers will appreciate the responses we've had.
In terms of action on the evidence, the key ideas coming out, that it's the purpose of the question and the importance of the big idea and concept, for students learning in the subject. Again, we've got the idea about peoples explaining. As Dylan and Chris have both just been responding, it's this noting the exceptions that are interesting in terms of conceptual understanding.
Okay, thank you very much. Moving on, our next questions. Interesting set of questions we've got here; I'm going to ask Dylan the first question. I categorize these as hinge-point questions being used for summative assessments.
We've got questions here from Mukadi, Helia and Bev. Dylan, they're all asking similar questions

about, “Whether or not hinge-point questions can be used for test in exams, summative assessment purposes?” I wonder what your thoughts are on that one.

Dylan: Can hinge-point questions be used for tests and exams? Yes, but why would you.
The idea is that hinge questions give you far more than a simple question, that’s designed to assess the relative degree of the student’s mastery. They’re designed to reveal issues around misconceptions which help you make smarter decisions about what to do next. They’re time consuming to produce. I think using a hinge-point question in a test is just wasteful. You haven’t got the time to use that information from 10 different hinge questions in a 10 item test. Yes of course you could, but I’m suggesting you wouldn’t.
The really important point is to realize that there’s no such thing as a summative assessment or a formative assessment. The words summative and formative, I think, are best used to describe the conclusions we draw on the basis of assessment outcomes.
If I give some students a multiplication times table test and I see that this child has got 80% right, I can record that they have 80% mastery of their number facts. That’s a summative conclusion. I might also notice, from exactly the same test responses that this child is having particular difficulties with their seven times table. That’s a formative inference. I’m now drawing conclusions about what I need to do to help that child’s learning move forward.
The important point is, summative and formative are descriptions of the uses we make of the evidence, not the evidence themselves or the way that we get it. The really important point about hinge-point questions is, they help you make smarter decisions in real time teaching about what to do next. I think that you could use them for summative purposes, but you probably shouldn’t.

Andrea: Lovely. Thank you, Dylan. I remember somebody saying to me, “Assessments are assessments; it is what you do with it.” You’re saying that, that is the key thing and categorizes the differences. Thank you, Dylan. I hope that answers your question Mukadi, Helia and Bev.
Chris, we’ve got a question here from Martin, Eirini and Tony. Martin’s asking, “Can hinge-point questions be given as homework?” That’s another way of using hinge point questions and you’re thoughts on that.

Chris: I think I’ll just play what Dylan just said, “Yes they can, but why would you?” Because, really, it’s you, the teacher that wants that information there and then. If you give a home work and then you collect that in, and then you deal with it several days later, you’ve missed the opportunity to act on, where the children are at, at that particular time.
I would tend to use hinge-point questions in class. Fit it in. Get your evidence there. Make your decision. It’s a speedy, quick way of collecting evidence to make next steps. That’s how you should really try and bring it into your teaching rather than thinking “Can I put here, can I put there.”
Too often as teachers, we put things as homework that we think we haven’t got time to do, so you have to decide, is it important enough, is it important enough to get this evidence. If it is, do it in class. I think in most cases; in fact I want to say in all cases, I can’t think of one that wouldn’t be, I would do my hinge-point questions in class.

Andrea: Lovely. Thank you, Chris. I’m getting nods of agreement there from Dylan.
It makes me think actually, about the other types of questions we’ve got to on the MOOC about our challenging questions to make students think that using one of those as a homework might be better. Then we can actually find out what ideas students have and then maybe later on, down the learning, when we’ve taught the concepts we could use a hinge-point question in class.
I don’t know what your thoughts are, on that Chris.

Chris: Yeah, good idea.

Andrea: Great. Lovely. Right, that's our section looking at hinge-point questions for assessment purposes, that are different as Dylan says in terms of how we act on the evidence.
Now we're moving onto just a couple of direct questions about using hinge point questions. I'm going to ask the first one to Dylan. This is from Eirini. This question is, how could we use the hinge-point questions in other subjects, such as history, PSHE or RE. What are your thoughts, Dylan, on that one?

Dylan: The evidence that we've got is that they apply just as well in other subjects, where you want to make a specific conclusion about whether the students have mastered a particular set of ideas. Harry Fletcher-Wood in his 'improving teaching blog', has written about the use of hinge questions in history. I think, he's done a very good job of explaining how exactly these ideas can be used. We've found teachers in Spanish using them very effectively. I've used hinge questions in my master's level course on psychology of education. It's a very good way of testing whether the students have the reading that I assigned the previous week.
As far as we know, these hinge questions can be used at any age level and for any subject. The question is, is it something that you can actually get a quick decision on, with a quick response? Sometimes you might want to have a much more thoughtful discussion but you might just for example, present, what is the main idea that Emmanuel Kant is making in this following paragraph. You've given the paragraph and you can actually have the multiple choice questions there.
It's just exactly the same as it is. If you're not sure about how to do this very well, I would suggest using exist tickets. You ask a question at the end of a lesson and ask students to write their responses on little 3x5 index cards. One question in history will be, why are historians concerned about bias when analyzing sources? Collect the student responses and then choose the ones with the most interesting and misguided responses, tidy up the language and then you've got yourself a ready-made hinge question.
The idea is, we're using the students own ideas, sometimes they're incorrect or partially formed ideas, to frame our own questions. Then we can use in a much sharper way in the middle of a lesson to make on the fly decisions.

Andrea: Thank you very much Dylan and thank you for that question Irene.
Moving on now, I've got another question here again from Sanne Nielsen, Chris. I think, we've covered part of this earlier in the webinar when we were looking at the benefits of teachers sharing questions with each other.
Sanne is asking, "What are the pros and cons in using pre-designed questions from other teachers or researches? To what degree will other people recognize the potentials and pitfalls in the questions?" It's about the quality of questions being used from somebody else's writing. Chris what are your thoughts?

Chris: Well, I think it's pretty hard to always come up with the questions yourself, even if you're a good a biologist or physicist or chemist or mathematician. You'll think about your subject in your way. Coming up with questions from other people and adapting those or adopting those and finding out, I think it's a good idea.
It's not always obvious, what the best questions will be if you've not had a lot of experience in that subject. Particularly for more novice teachers, I certainly would use more experienced teacher's questions or questions from the literature.
The important thing, more is, actually talking with people about the questions and trying to get some interpretation of what the question might to do in the lesson and the sorts of ways that you might respond, if say, students do come with a particular problem that's there. Deciding on what is next steps, if they've really got this might be important to deciding what to do with, say 50% choose this one particular distractor and get the other ones right.
I think sharing not just the question, but sharing the use and how they work is good professional

learning for everybody, whether they're researches or teachers. Even student teachers when they're starting out, particularly to share best practice to help them move forward.

Andrea: We've got a question from Cheryl Pocknell. Cheryl is asking, "Have you got any advice how we could use assessment for learning, when somebody is working on a one to one relationship with a student?" In Cheryl's particular context, she's training an apprentice. It's that one to one relationship, how could we use AFL for their learning?

Chris: The basis of any AfL is to listen more, and to think carefully about what questions you're going to ask. You want your apprentice or your student to talk and explain their ideas. You want to get at their thinking. Finding ways of doing that is really the main drive.
Then, you need to listen and give yourself time to think before you respond. At the same time you don't want to have big gaps so that they feel uncomfortable. Trying to keep the conversation going but making sure that they are doing most of the talking and not you as the expert or the teacher is actually doing all of the talking, which tends to happen some of the time, particularly when you get first to work with somebody new or with a new class.

Andrea: Lovely. Thank you, Chris. Thank you Cheryl. I hope you'll find that really useful for you with the student that you're working with.
Moving on, Dylan we've got a question from Andrew Sobala. Andrew is asking about when we're working with groups, "If the groups are not accessing the topic introduced on a deep level, how can you encourage them to do so without starting to give answers?"

Dylan: Well, I think, if you like, the question contains it's own answers because you do have to start structuring. If the question you've asked isn't getting them focused on the things you want them to think about, then the question wasn't successful. You need to think about asking the question in a different way.
Sometimes you might need to start them down the correct path. The challenge is always, that when we give students too much guidance we end up doing their thinking for them so they are not required to develop their thinking themselves. That I think is the magic of teacher expertise. Good teachers seem to have this way of asking questions that leads students really quickly and productively to focus on the important things.
Like most kinds of expertise, it takes years and years of practice. I think, teachers get better at this by practicing it. The thing to be aware of is, who's doing the thinking. That's the thing that we learned in our work with teachers all over the world is that the major shift that comes when teachers embrace this whole idea of classroom formative assessment is that they start focusing less on what they're putting into the process and what the learners are getting out of it.
As soon as you start to think about what's happening in the minds of these 30 individuals in front of me, it's very difficult for teachers not to make huge improvements in their practice because that's the only thing that really matters. Not what you're doing, it's what they're doing.
I think that in scaffolding, creating a bit of structure, starting them thinking along the right lines, critiquing their ideas. For example, just getting them to follow through the conclusions of their assumptions. That can also be a good way of getting students at least to recognize that their current ways of thinking aren't helpful and they need to think of new ideas that maybe more productive in that particular area of science or maths.

Andrea: That's Lovely. Thank you very much Dylan. Chris you wanted to add something to that?

Chris: Yeah, I just wanted to bring in some new research we've been doing at Kings, looking at enquiry learning in science. Very much what our teachers have wanted is that when students are doing an inquiry, an investigation that they come up with their own questions and they find ways of

doing experimental work, try and answer those questions.
As they are doing that it takes a while to get that going in the classroom. Teachers tend to go round asking questions. One of the ideas that teachers have struggled with but done particularly well I think, particularly the ones we've been working with, is asking questions that don't bring the student directly to the way the teacher would think about. They actually ask questions that get at the students thinking and not sorts of questions that will bring that student along to the teacher thinking type of way.
We've used the work of Harry Torrance and John Pryor they did a paper way back in 2001 where they looked at divergent and convergent assessment. This is was in primary class that they did it but we've used their frame work to look at secondary science. What has been absolutely fascinating for us is that as our teachers have got more confidence and are more experts in inquiry learning in the classroom they tended to guide the students less. They're collecting evidence more, but their guidance is less.
What they tend to do, because they don't want to direct students, is they actually get different groups to report back. They have what they call stopping points in inquiries where maybe once a lesson, twice a lesson, have stopping points and the teacher will select various groups to feedback on where they've got to, why they're doing that and what they plan to do next. They'll just leave it to the students to take in and discuss and move forward.
It's a much more open approach to assessment for learning which an inquiry learning classroom would do. It's fascinating watching how teachers have really come on in terms of framing questions that get at student thinking and don't lead too much towards an easy answer. That makes students think again.
If you want to know more about that, the Assist Me project, just put assist me into google, and it will come up. It's actually on a website in Denmark at the moment. But we have some webpages up within a few weeks.

Andrea: Thank you Chris that's really helpful, Thank you Andrew for the questions. I think we got some great advice there from Dylan and Chris and some ideas about up-to-date research in this area. Our next question, Chris I've you down for this one this is one of two questions that Simon Bambury has submitted. His question we'll just have one about, how about, teachers not giving answers. This question is about, "Should teachers praise wrong answers if it looks like there's a been a great deal of thought and effort or is it best to focus on why right answers are in fact correct?"

Chris: I would say neither. Would be my response to it. You don't want to praise kids for getting things wrong. You want to praise them for the effort that they've put in and the thinking that's there, that will help them and help others to move forward. It's much more subtle than that
I certainly don't think you should praise them for getting things correct, because we are not after right and wrong things usually when children are learning. We are after ideas that help move things forward or ideas that help us sort things out.
I would use, and the research suggested this, you should us praise sparingly and use it when somebody really has put in effort to move some idea forward or to do a particular thing where they really do deserve that praise for the effort, and otherwise don't bother praising for effort. They actually will pick that up just from your body language and the way that you're responding to them. They don't need to be told that in most cases.

Andrea: Lovely. Thank you Chris. That echoes very much what I'm finding from my research looking at oral feedback in the classroom. Actually, teachers, where there's lots of praise, it's not having the impact the students are saying. It's about the learning and that closing the gap in terms of learning intentions. Right thank you very much Simon for that question.
Our next question is, I am going to ask this for you Dylan, this is from Alaa Mencke. They're asking, "How should exams be made to include differential learning?" Interesting question.

Dylan: Well of course, the reason that teaching is so difficult is different students learn different things, from the same teaching. All assessment has to be to a certain extent differentiated because students are always learning different things.
There is a fundamental balancing act that's very difficult to pull off in assessments. If you cast a wide net, have some very easy questions, some very challenging questions, there is something for everybody, but the amount of information you're getting on every individual student is very limited, because for most of the students, most of the questions are either too hard or too easy.
By focusing your assessment you can actually ask a lot more questions that are just around that student's level of performance, which means you get a far more accurate assessment. Then you have to make sure you are giving each student the right assessment in advance and that's very difficult to do as well.
In my view, the answer is not to try to get more reliable assessments by differentiating too greatly. It's to actually have a wide spectrum in our assessments but then accept the answers aren't that reliable. We could always make our assessments more reliable by making them longer. I think we should not do that because it involves taking up far too much time that we could be spending teaching.
I think we want to embrace the unreliability of our assessments. The unreliability of our assessments is optimal, because we've got better things to do with our time. What I think we should get into a habit of doing, is saying to our students, "You've got 75% on this test, plus or minus 15." "Does that mean I passed or not?" "Don't know. Probably yes, maybe not." "Why don't you know?" "Because the test isn't accurate enough." "Why isn't the test more accurate?" "Because we've got better things to do with our time."
I think the really big idea here is the fundamental step in becoming an assessment literate person is understanding that any assessment is not perfectly reliable on a different day, with a different set of questions, with a different student, with a different person marking the work, the result could have been different. Don't over interpret any particular assessment. Get other sources of evidence to complement that, because what the research shows very clearly, is that when you use multiple sources of evidence, you make far smarter decisions than when you over interpret one narrow source of evidence.

Andrea: That's lovely. Thank you Dylan. Chris you want to add to that for us?

Chris: Yeah. I think, I hope government people listening to this, particularly in the UK. I've just made Dylan smile! I agree whole-heartedly.
I think what people need to understand is that exams that are set at the end of the year are just a small sample of what children know and understand. They're unreliable to start off with. You are not getting the whole scope of, the whole amount of their learning.
We need to really just have something that is "good enough" to tell us what we need to know in order to move on. That's what's important and not this whole thing about reliability that people seem to be so het up about. We should be working better on validity, on more valid exams, exams that really access the things that we value and we think are important. Not just on whether this marker has marked it efficiently or whether these questions really have tested on students understanding in a way that means that this student will get ten marks, and this student will get one mark. It's not what we should be looking at, not the discriminatory side of assessment, not reliability but validity of it.

Andrea: Lovely. Thank you. I know that there's a movement building here in the UK, I don't know Dylan if you've come across things, where obviously levels have been taken away and people are starting to look at, people's learning in terms of mapping their understanding and getting rid of the numbers.
There's been quite a lot of work done by a group called Beyond Levels- Learning First. They've got a

website which is really useful for people to look at. There's conferences around the country that are free to attend where people are starting to challenge the old paradigms, as you're saying Chris, about an arbitrary number that indicates something about a child's understanding. Things are changing. It's getting positive.

Dylan: I am concerned about that as well because people often say, "Let's get rid of the numbers and let's instead look at what students are learning." If you haven't got numbers you've just hidden the fact that you may or may not have any idea whether the child has really learned something.
What I want people to embrace is this idea of unreliability, that any assessment can never give you perfectly accurate information and you shouldn't make really important decisions without understanding. The result might have been different on a different occasion.
For me, the first step is getting people to understand that any assessment, whether it's done by a teacher or a multiple choice test is bound to have some degree of unreliability. If you have no estimate of what that unreliability is, you have no business making important decisions on the basis of that assessment outcome.

Andrea: Do you have any advice then, Dylan, on how to improve reliability from the work that you've been doing?

Dylan: No, no. Because the only way to improve reliability is either to narrow the test, or, to make the test longer.

Andrea: Yeah.

Dylan: I think we've got better things to do with our time. As I said, the public information campaign that I want to launch is getting people to embrace the unreliability of assessments, because the price you pay in getting more reliable assessments is not worth it.
Our kids have better things to do with their time, like learning science and maths.

Andrea: Absolutely. Lovely, thank you both that's really interesting. Could talk to you for hours about this but I know we need to crack on.
We've got another question here Chris, this is from Soheir, and it links to what you've just been talking about. "Is it correct to give different exams to students?" Our question we've just answered is about differentiated exams, but, "Is it suitable to give students in the same class different exams depending on their levels?" is the question asked.

Chris: Yes, if you think that's the evidence you need to collect. We give assessments because we want to find out some particular information, that's going to either help the student understand the learning and the learning journey or for you as a teacher to do that. You can give the same exam, you can give different exams, it's really up to you as the teacher to do that and to make that decision.
Too often we want to do the same thing for all, because we think that's fair, and that's far from fair. What is fair is actually giving students what's appropriate in terms of collecting evidence for what to do next for them. Sometimes maybe different questions or different tests would do that.
Certainly, when I was a teacher, I might give the same test to everybody because it was just simpler to administer it like that, but there would be particular questions I'd look at for specific children to see how they'd answer them. It was evidence from their answers and what they did, that gave me information about how I could help them.
For some students, it might be some of the easy questions, where I just wanted to check have they got the terminology right, and with others it might be, do they really understand the difference between mass and weight in this question. I might be looking at the answer to that one, for them.

Again, I wouldn't look necessarily for everybody, I'd look at a sample of my class of indicator kids to help me decide what to do next.
If we talked about time, as a teacher, you just need to do it in a way that's going to be the most effective in helping all your students move forward, in terms of you doing better teaching. Get your assessments done, and get planning that next lesson or those next activities or those next questions. They're probably going to do more good in taking learning forward in the future.

Andrea: Lovely, thank you Chris. It's that purpose of the assessment again that's coming out strongly. Dylan, you've got something you'd like to add to that, to Chris's point.

Dylan: Yeah, I think that a helpful way of remembering all this is to remember what Lee Cronbach said many years ago about assessments, he said "An assessment is simply a procedure in making inferences". Basically, we give students stuff to do, we look at what they've done, and we draw certain conclusions about those results, about meanings of those results that we get from our assessments.
If your aim is to stretch kids on a continuum from 0 to 100, then it's really quite important that you actually give all the kids the same tests, otherwise you give yourself some very complex equating challenges.
If the conclusions you want to draw are about what to do next with students, then as Chris said, it might be different assessments for different students, it might be assessments where you look at different parts of the student's responses, for different students. The important thing is, what do you want to conclude. As soon as you stat focusing on what conclusions you want to draw, in my experience, people make smarter decisions about the use of assessments.

Andrea: Lovely, thank you both very much. Thank you for your question there Soheir.
Moving on then, to our last two questions, we've got another question here from Simon Bambury. I've categorized these as curriculum questions really.
The first question here, Simon's asking abstract ideas that we teach. He'd been interested to know what particular topics are most difficult to approach in identifying the key quantities.

Chris: Identifying the key quantities?

Andrea: Yeah. "If the topic is something really abstract then what makes it difficult to even define the key quantities? I'd be interested to know what particular topics are most difficult to approach." I'm going to ask Dylan first. Do you want to draw a maths problem? I don't know all the curriculum areas.

Dylan: I think underlying this question is a really important insight, which is that in some aspects of the stuff that we teach, we understand children's development really well, and in other things that we teach, we understand these developments much less well.
When you are clear about what the learning progression is, you are clear about where students are starting out from, you're clear about what the destination is, you're clear about the routes that most students will take to get there, then, working out where they are and what they need to do next is really easy. In other subjects, in other topics, we have much less ideas about what it is that gets better when students get better, and therefore mapping their progress is more difficult.
We've got quite good understandings of a student understanding a place value, for example. We've got quite a good understanding of the student's developments of the concepts of math, or floating and sinking. We've got much less good ideas about what gets better when students get better at scientific investigations.
Basically, teachers' hunches are as good a guide as anything here, and yes it is harder, but the big mistake would be to ignore it because it's too difficult. I think we have to embrace the breadth and

diversity of our curricular. Some things that are well understood some things are less well understood. The important thing is, our students get a balanced education, which means that sometimes we're relying on hunches more often than we're relying on evidence, so be it.

Andrea: Lovely, thank you Dylan. That reminds me of a, Chris of a talk that I once saw you give about… I'm sure it was about a teacher who was trying to find out if students had done the particular aspect of learning. When they retested, they found that they hadn't done what they thought they'd taught, but they'd learned something completely different.

Chris: Yeah, that's from Brenda Denvers, at, Deans that she did with Margaret Brown. They were looking at students' understanding of number in the group of 7-9 year-olds.
What was amazing was Brenda had actually mapped out the various skills that were needed and say, you have to make a decision about what to do next. When the teacher did do that, the learning did improve, but not in the direction the teacher intended, it actually went up another path.
What they believe happened in that particular case was that working on that new bit that the teacher thought they needed actually helped consolidate some of the other ideas that they'd partially got and so all of a sudden the journey took off in another line of skills within number.
Sometimes, not quite often, Dylan said this earlier, you teach something, and the children do learn and understand things, but it's not what you expect. It's whatever builds on their ideas and takes it forward.
It is difficult. Going back to the question we've just been asked, there are some topics particularly in science, where teachers tend to leave teaching it until very late, because they know that they're quite abstract. Genetics is one of them. It usually gets squashed in to the end of the curriculum just before the exams.
I can understand to some extent why teachers do that, because they think students actually will be more developed by then, and maybe can make connections that will help, but in actual fact genetics is a fundamental part of biology. If you don't get it sorted out early on, and don't start to think about things like probability and what does random mean before you even get onto things like looking at genetic crosses and so on, then you just don't really get it in that quick rush before the exam.
It's thinking not just about the topic but thinking about how you might build that conceptual understanding through the one, two, three years you're working on that, so that students, when they do come to the abstract bit, they actually find it easier because they've got their own foundation to build on, and move forward.
One thing for biology's out there, teach genetics earlier than two weeks before the examination, which tends to happen quite a lot in England I think.

Andrea: Lovely, thank you both. Thank you Simon for your questions. Learning is complex, and think about how we build that for the students over time.
Our last question then is from Kaseem Abdurraheem, and Chris I've got this one down for you first, but you both may want to chip in. It kind of links in to what Simon was saying about abstract and difficult concepts, so Kaseem is asking "How best can we teach electricity in a basic class?".

Chris: Electricity is really hard. One of the topics that many teachers find, even physics teachers, is do they really understand the difference between current and charge? Can they really explain potential difference? Do they really know what's happening within complex circuits?
Because it's been simplified so many times in so many teaching schemes, to a few rules that you apply on very simple examples, people think that they understand electricity until they come to more complex questions.
The best questions I've seen on this, although there's quite a lot in the literature, but the best ones I think have been written by Robin Millar when he did his EPSE project a few years ago. That was, I think it's still there, on the University of York website.

Where, he does reason assertion type multiple choice questions. Which means that you have to make a choice, and then you have to give a reason in a particular way. Very much for like, a hinge-point question, in the way it actually works. I challenge any teacher to have a go at those and say how confident they are I got them all right. I was really nervous when I first did some of those.
I think with electricity, you need lots of hands on practical work trying things out, you need to do set-up circuits without circuit boards there, so that they can really understand the connections and what's going on. You need to apply the knowledge in a whole set of examples, so that they start to understand how those rules written in the textbook actually play out, and then maybe they'll start to build some ideas off it.
Andrea is a real physics teacher, so she can probably say more. Teachers tend to model some things, and talk about models and using them is fine, but teachers need to remember to work with their kids on the fact that models don't tell you everything about the circuits that you're working with, and you need to sort of evaluate that as well.

Andrea: Okay. [crosstalk 01:12:24] I'm very impressed. I would say, I think that's a fantastic answer. As you say it's the idea of visualization, and then applying the concepts and critiquing models.
I have to say as a physics teacher, I answer physics questions, I perform throughout exams. I trained to be a teacher, I planned my lessons, but it wasn't until I stood up at my lessons teaching it and the students started asking me questions about it, that actually I started to really understand and take my learning deeper.
I think, in a classroom, I would want to see that happening. I'd want to see students teaching each other, and them asking questions of each other, until they get to a point where they can't answer. That's when I can use that understanding.
I'd also recommend to people that the Institute of Physics, they're supplying physics teaching materials, which they now do, they've got some on their website from primary right through to GCSE level. They've got some great physics narratives about what some of the misconceptions are for students and the ways to challenges them in teaching ideas. I should say I think it's, it's about teaching of it for me, that really started to consolidate my own understanding.
I can see that Dylan's got something he'd like to add as well to the discussion.

Dylan: Yes, as statistician George Box would've said, 'all models are wrong, some are useful'. I think that's a really good maxim for science teacher to use in general, when we're using metaphors.
There's another thing that I'd like to bring in from mathematics education, it's a horrendous title, the book is called 'Didactical Phenomenology of Mathematical Structures'.
The idea of Didactical Phenomenology is this idea of the context that teachers use all the time to try to explain things to students. When we try to explain negative and positive numbers, do we use heights above and below sea levels, do we use negative and positive bank balances, do we use temperature above and below zero. Each of those contexts, each of those metaphors or analogies that you use has some strengths and potential weaknesses.
I think what teachers really need to do, particularly with something that is just as genuinely abstract and hard as electricity, is to have conversations with each other about the strengths and weaknesses of each of these analogies, because none of these things will actually get you all the way.
Water and pressure could be very useful for explaining voltage on a basic level, but if students are hanging on to those models when they go onto electromagnetism, they're going to get really, really confused.
It's about having smarter conversations within schools about what's the strength of this model, what's the weaknesses, and where's this going to get me into trouble, where's this going to break down and is no longer a useful model for helping students understand this content.

Andrea: Lovely, thank you both very much.
Another website where there's lots of useful results that can help with the idea of models and

visualizations is obviously the National STEM Centre. You can search on there for various topics, so thank you Kaseem for that. I think, not only have we pulled out ideas about electricity, we've pulled out ideas about teaching abstract concepts, in a variety of subjects, not just science.
We're getting to a point where I'm going to summarize. I'd like to say thank you very much to Dylan and Chris. It has been such a rich dialogue between you, and I know we're remote and virtual, but I think we have borne with other and the technology. We've had some fantastic strategies and I ideas, some great research mentioned throughout. I know that I'm going to go back through and be noting down the various projects that you've talked about, which I think will really help empower those, whether they've done the course or not I think people could listen to the dialogue we've had and it's going to really help their understanding about assessments for learning.
I'm going to summarize what I think are some of the key themes and Chris and Dylan please feel free to critique these and add more if you think. I think what's come out for me from the dialogue that you've had is that we need to think very carefully about the assessments that we're using, particularly the questions we're asking.
What are the purposes? How is it linking to the learning? What is it we're going to do with it? What is the evidence we're going to elicit, and how are we going to respond to that? Because that's what's been coming out. Our time is finite, we want teachers to be working and have a life. Actually spending time thinking about that is going to be more powerful than some of the other things we can do.
We need to, as educators, listen more carefully, and think about how we're going to use the responses that we're getting. Particularly I think it's come out about where students are getting things wrong as well as things right, what is that telling us as educators. Then one thing that's come out really strongly, and I know this is one of the five key strategies of assessment for learning, is 'peers' learning resources for each other'.
For me, 'peers' learning resources for each other' is not just the students in the class, but it's also as teachers. How we work together as educators to support each other. We've had ideas about collaborating in writing of questions, and just then we've had ideas about how we can have conversations about our teaching approaches, and also collaborating is going to help.
Then in terms of the pupils collaborating, one of the key things that's been coming out is getting pupils collaborating to make them think. Make them think and make them work. Whether that's writing questions, whether that's explaining reasons, whether that's critiquing questions or critiquing models, get pupils working together and thinking.
Then I've got two more things, but all of these things we've talked about don't happen overnight, they're not quick wins. It's through evolution of practice and that dialogue we build this and critically reflecting of what we're finding out, that eventually we're going to build this classroom culture where learning is at the heart, so that everybody in there is going to be responding and working together in this interdependent way, to move forward learning for everybody.
I think that for me is a summary of that, I don't know if Dylan and Chris, if you have anything that you'd like to add?

Chris: No I think you summed it up really well.

Dylan: That's what it was, I had no idea until I heard you summarize it. How what a neat conversation we've had.

Andrea: Lovely. Thank you very much to Dylan and Chris for giving your time, not only today, but throughout the course. In writing it and responding to the questions that we get.
Also I'd like to thank in the background, because people can't see him, but Paul Browning who has been our technical support, again throughout the whole of the course as well as today, we couldn't do what we're doing without him.
Thanks again to the National STEM Learning Centre for giving all of us, as educators, the

opportunity to engage with experts in their field, it is quite a privilege and an honor. I thank Dylan and Chris very much for myself but also on behalf of all of us who’re going to listen to this. That’s it, thank you very much!

Chris: Thank you Andrea.

Dylan: Thank you.