Q1: I'm with a caffeine-saturated Eric Mazur, who's Balkanski Professor of Physics and Applied Physics and Area Dean of Applied Physics at Harvard University. And he's an internationally renowned researcher into better ways of organising large group learning. Eric's going to be a keynote speaker at this September's Association of Learning Technology conference, but today he's in my home town, Sheffield, to speak at the University of Sheffield. And Eric has kindly agreed to be interviewed in a gap before his talk, which is later today. My questions have mainly been sourced from members of the Association for Learning Technology. Thanks Eric.

A1: My pleasure.

Q2: And I'm going to kick things off by asking you … was there a breakthrough moment when the idea of peer instruction came to you?

A2: Yes. There were two. There were two “aha” moments. The first one was discovering that my students didn't learn with the traditional approach to teaching. So I think it was in 1990 I gave my students a word based test, conceptual inventory that tests the most basic principles in physics. And I initially thought this was way too simple for my students. But I'd seen data from other parts of the country that were absolutely abominable. So I thought “I'm going to show that my students do better.” I gave it to my students and as soon as I gave it to them, one student raised her hand and she said “Professor Mazur, how should I answer these questions? According to what you taught me or according to the way I usually think about these things?” That was the first big red warning light. But it didn't register right away. I didn't exactly understand what the student said. But it became very clear when I looked at the results from this test that my students had never internalised the information. They were able to manipulate the equations, but didn't understand the underlying concepts. So that was the first “aha” moment. There was a moment that said the traditional approach does not work.
Q2: And these are students...

A2: At Harvard.

Q4: … at Harvard. And doing...

A4: … pre-medical students and engineers.

Q5: Who needed to have a general physics introduction.

A5: Right. So they were not physics majors, they were required to take physics in order to satisfy their concentration requirements. The second “aha” moment came a few weeks later when I discussed the content of that test with my students. And I got to a question which I, to me was trivial. But anyway the students hadn't done that well, so I made some drawings on the board, explained it to them. I gave what, in my opinion, was a very clear explanation and then I turned around and I could see from their faces they were confused. So I asked “Does anybody have a question?” They were so confused they couldn't articulate a question, you know how it is, right? This was a question that dealt with Newton's third law, which was very basic. So I thought “Well, I better explain it better.” So I erased the board. I brought in Newton's second law. I gave what, in my opinion, was the most brilliant explanation one could possibly give. I turned around triumphantly after five minutes only to see that they were even more confused, and they could still not articulate a question. So I did, in sort of a moment of despair, I did something I'd never done before. I said to them “What if you turn to your neighbour and discuss it with each other.” Because I knew that 50 per cent had gotten the right answer. Complete chaos in my classroom. All 250 students started to talk to one another. And in just two minutes they figured it out. I thought “How can that be? I tried for ten minutes to explain it unsuccessfully. They figured out in two minutes.” But then it dawned on me that if you leverage the students in explanation you accomplish two things. One is they get actively engaged. But the second thing is a student often explains things... or always explains things in his or her own words, at a level that other students can understand. I learned it such a long time ago, to me it makes so much sense, that I can no longer understand what a beginning learner does not understand about it. So that was sort of actually the epiphany during which the idea of peer instruction was born.

Q6: And how did you follow up on that?

A6: Well the next year I said to myself “Look, I'm standing year after year in front of the class, basically regurgitating the textbook.” And I asked myself “Is that what education really is? Is that just, you know, regurgitating information in front of students?” And I said, and I thought you know “No. It's really the learner who needs to make sense of the information.” And where did that sense making for example occur for me, did it occur in the classroom when I was listening to my professors teaching? I think the answer's no. It came outside of the classroom when I went over my notes, started to ask myself, you know, does this make sense? Why, why is this like this? Or I'm wondering why this or that. So I thought, you know, what we should really do is we should put the information transfer out of the classroom, have students either read the book or watch a videotape of a lecture and then in class work on sense
making. So the next year that I taught, that's what I did. I assigned a book as reading, and in class, rather than teaching by telling, I taught by questioning.

Q7: Okay. And how did you use data to support proving to yourself that the change was beneficial?

A7: Not only... I'm glad you mention that, because it's actually shocking to see how anecdotal most scientists are when it comes to teaching. Right, I mean scientists who would never use anecdotal evidence in his or her scholarly research doesn't blink to say “Well my students learn better when I do lots of demonstrations.” Without any data to back it up. So from the start I decided it would be very important to convince myself and my colleagues, not just myself – my colleagues too, that what I was doing was good by actually collecting data. So I started collecting data, pre and post test for example, that FCI, the force concept inventory, this conceptual survey that I just mentioned a moment ago. I started using that as a pre test at the beginning of the semester and as a post test at the end of semester to look at the differential and determine how much they've learned. I did it first when I was teaching a traditional class, so I could compare it to the gains obtained when I switched to more interactive teaching. I also repeated exam questions so I could track students' performance on more traditional exam questions and it showed huge gains. And anybody who's interested in more detail can download those data on my website, because I think it's absolutely crucial that we document improvements in teaching. Because that's the only legitimate way of convincing somebody else that this is the right approach.

Q8: So that work was going on pre-internet? Or at the dawn of the internet?

A8: Well yeah, yeah. I mean, I was, at that time it was called the Arpanet, okay. I already had an Arpanet email address in the 1990s.

Q9: So you were one of these people with an Arpanet address...?

A9: I was one of the, yes...

Q10: … but your students didn't and many other academics didn't?

A10: No, no. Hardly anybody had.

Q11: So what difference has the internet and the widespread availability of always on devices made to your thinking on peer based instruction, if any?

A11: Well I mean, first of all I love technology, okay. You'll find the latest gadget in my pocket, in my briefcase. I just, I'm total technology junkie. However, I believe technology has done very little to improve education. And in my mind it's the pedagogy that matters, not the technology. The technology should always be at the service of the pedagogy. And to me, any use of technology in education has to pass one very important filter – it has to make something possible that was not possible before. And if you actually evaluate it, you'd say “Well that's obvious.” But if you evaluate most uses of technology in education, you find that it's a new way of doing old things. New wine in old bottles. You know, SMART Boards, Powerpoint, you name it right, putting a lecture video on the internet. There's nothing new about it,
because watching a video of a lecture is not very different from watching the lecturer live. So to me the important part is really the pedagogy, and then if we can try the technological way of facilitating that pedagogy, that's good, right. So I've always focussed on the pedagogy, not on the technology. We could go back 500 years to the biggest IT invention ever – Gutenberg and the printing press, right. You may ask yourself why in the early sixteenth century didn't we stop lecturing now that there were books? You could say “Well before the industrial revolution books were not a commodity, and therefore people couldn't afford books.” So it was at least until the Industrial Revolution 150 years ago, lecturing was a necessity. But the last 150 years, long before the internet, long before the computer technology, the technology already existed to transfer information outside of the classroom, yet we never jumped on the bandwagon. I think what the internet has done though is it has rubbed in people's faces the fact that yeah, we can transfer information in a much more efficient way and much more widely, take for example Coursera or Udacity and EdX and all of these. Or the Khan Academy, right, which have hundreds of thousands of visitors to any given course or course module. So I think, I think the technology is very good for use outside of the classroom. However I don't think that we'll ever obviate the need for interaction inside the classroom and the facilitation of, the assimilation of information by, you know, under the guidance of an instructor.

Q12: So that your view would be that the kind of mediation of the peer to peer interaction is best done uncluttered by kind of technology getting in the way of that. So having students talk to each other is kind of more effective than having them email each other, so to speak.

A12: I think so. Because I think deep down learning is a social experience. And you know, you could say ‘Well you can have a social life on the internet and your Second Life or anything else.’ But I think deep down we are very social beings, and we like interacting and seeing each others in the eye and seeing each other's expressions and so on. So I think that yeah, we might be able to move, migrate some learning to the internet, but I think, you know, training the leaders of the next generation will always need a brick and mortar university for that and bring people together in the same place. I think what the internet is really good for is to disseminate information, to transfer information. Which means we can offload that task from the instructor in the classroom, right. No need for an auditorium where you put down 200 students passively listening to an instructor, with their brain shutting down and just, you know, copying down what the instructor says. You can do that on the internet, students can look at it whenever they want and the classroom can evolve into a new format, where there's interaction, where people practise their knowledge, assimilate the information that has been transferred. So, and I think in a sense the internet is facilitating that transition.

Q13: Right. So I want you to talk a bit about your observations on these mass innovations like Coursera and Udacity and so on. But before that, are there any contexts in which conventional lectures have a place?

A13: Oh absolutely, absolutely. I mean, I...

Q14: You're about to give one, for a start.
A14: I'm gonna give one, right, but I'm not going to try to teach something that's conceptually very difficult. I'm going... the purpose of my lecture here at the University of Sheffield and at ALT in a few months is not to teach; it's really to motivate people for something, right. So as a form of motivating people, engaging people for a particular subject, I think a lecture still has a place. Also if there's no other medium available to transfer the information, the lecture is the only way, right. So I think the lecture will never go, never go away. As a vehicle for teaching, however, I think the lecture is largely ineffective. I don't know if I will have a chance to show this at the ALT, I will show it at my talk this afternoon here at the University of Sheffield, I saw recently a paper out of MIT, the Media Lab, where they basically developed a little sensor which can be worn around the wrist, that measures students' or people's neurological activity. And they gave it to students at MIT to wear for a week, and they recorded the neurological activity for a week, and you can see these traces. And the traces go completely flat during the lecture period. You should see it – it's hilarious. Students are more asleep in a lecture than they are when they're asleep, when you can actually see a lot of brain activity. There's only one activity that matches the lecture. I'll let you guess which one that is.

Q15: Sat in front of the telly.

A15: Exactly, watching TV. And in fact, you know, many people have done studies in the seventies and eighties, they've done studies about basically putting electrodes on the skull and looking at people's brain activity. And they found that when you sit in front of the TV, you're more asleep, you get into this passive mode where basically your brain shuts down.

Q16: Time passes, you're awake but nothing's going on.

A16: And time passes. You're awake but you're not, your brain is not acting because you're... the pace is set by the television not by your... our minds are made to wander, right.

Q17: Did they collect data about people when they were using the web?

A17: They collected data when people were doing homework, when they were doing laboratory exercises. Even when they're doing chores, like dish washing, they're a little bit more active than a lecture. It's just television and lecture where the trace goes flat. And you know, it's not that surprising right, because television and lecture is not that different, right. So if you just watch a lecture on the web, it's the same as watching television or a live lecture. If you have watching for a few minutes and then you ask a question, that's different.

Q18: So that's essen', that takes us quite neatly to the approach that say Udacity has taken in the design of its online courses, which are very small snippets with a lot of challenging interaction.

A18: … questions, right.

Q19: … breaking it up.
A19: In fact you know, what's his name, Peter Norvig in his latest Ted talk refers to my work on peer instruction and says that Udacity is a sort of combination of lecture and this peer instruction.

Q20: So comments on those developments, Udacity, Coursera and so on.

A20: I think they're very good. I mean, they're very good because they basically reinforce the message that I want to get across. However, I think most of them put all of the effort on the easy part of education, namely the transfer of information. Not on the hard part, namely... which has to happen in the brains of the learner, namely making sense of the information. That's where peer instruction actually comes in I think.

Q21: You're a prominent researcher in physics and you run an active research group. And some would say that an interest in research informed teaching is quite unusual for someone who's an active scientist. And I'd like your comments on that.

A21: Yeah. I've heard that remark many, many times and each time I find it strange, because to me it comes so naturally. In a sense...

Q22: But do you think it's true, the comment?

A22: No, I...

Q23: Do you think the comment, is it the...?

A23: Well I think it's true in the sense that, yes there are not that many people who are active in both areas. At the same time, I think it's a total shame, because you know why, if you're a scholar in a given academic discipline, why not also be a scholar in teaching? I mean, in a sense I see my classroom as an extension to my laboratory. In the laboratory I collect data on the interaction of short (...) of (...) matter. In the classroom I collect data on learning. When I'm asked to teach anyway, it's not that much more work to collect a little bit of data and to have sort of, to apply in a sense the scientific method, this iterative process of, you know, I try something, see if it improves the learning. If it doesn't, I toss it away. If it does, I try to refine it. I mean, it's not that it takes more effort. I just, I think it's just making better use of my time, not putting in more effort. I think that many people have this sort of mental block, they think “Oh if I've got to do research on education it's going to take, my teaching is going to take much more time.” I think that's a fallacy, it's just a better... it's just a matter of using your time better rather than putting in more time.

Q24: Evidence informing how you use your time in teaching.

A24: Absolutely. Absolutely. And you know now when I, I cannot plan a course any more without at the same time thinking “How am I going to measure in some kind of an objective manner, you know, how much my students learn?” And so I always make, pr you know “Is there a way that I can measure how, how my approach to teaching affects the gender gap between men and women? Or minorities in the classroom. Or the effectiveness of certain aspects of the course.” So I always try to plan some research project for my courses.
Q25: So you touched on your work on gender and physics education and I think it would be useful for listeners to hear your views on how best to close the gender gap.

A25: … the gender gap. Well I found out very early on that on this FCI, this force concept inventory, the scores for men were higher than those for women, as students get out of high school in the US. And when I taught a traditional class, the men gained, the women gained, but the gap just translated up – it remained. And I read in the literature that women tend not to perform that well when you have a competitive environment, one that isolates people. Women tend to prefer collaborative environment, one that has a lot of verbal discourse. When I read that, I thought “Peer instruction, right, students teaching one another, students arguing, discussing.” So I thought one of the things we should look is to see to what extent peer instruction mitigates this gap. Because I can't do anything about what happens in high school, right, I mean that gap on the input end is a given. What we found was that peer instruction makes men gain more than the traditional method, but women gain disproportionately more, catching up with the men and closing the gap. So I found that very encouraging. Because that means we can reverse the damage that has been done earlier on. The next question would be what causes that damage early on. And that I don't know exactly. What I do know is the following – I've done a little bit of research in other countries in Europe and in Asia, done one in Belgium. I never published those data because the number of data points is relatively small, so the statistics is not very good. But what I found was that the gender gap is very different. So there is a cultural influence on the gender gap. In Belgium the gender gap is twice as large as in the US, average data over the entire country. In Taiwan at the university where I tested, it was only one university, it was Taiwan National Normal University, which is a teacher training university, the gap was zero. It was not significant. So that means there are cultural differences, and probably the only… but this is not, this is not, this would require more data in order to back up this claim. So at this point it's a hypothesis, rather than a solid claim. In Belgium there were no female faculty in the physics department – none. So the women had no role models, nothing. In Taiwan, gender equality at that university, as many female faculty as there were male faculty.

Q26: So that data related to progress made by learners in HE in universities. Or did it relate to the input differences?

A26: No, this was at the output, at the end of the course. So I don't… that would be one of the type of data that would be, that we would need to have. Right, what is it on the input end? Also at best the type of data that I just articulated here can signify a correlation but not a causation, right. In other words, there's a correlation between the gap and the number of female faculty, but that doesn't mean that's the reason for it, right. So there's a correlation, but no causation. So I think that more research needs to be done.

Q27: And have you any sense that yours and other work in the area of peer instruction is having kind of wash down effects into schools?

A27: Yes, more and more. I'm really very pleased by that, to see more and more schools who are applying interactive teaching, and not just teaching by, you know, having the instructor regurgitate the text book, but by actually engaging the students
and questioning them in science. I would say, you know, when I started it was only physics. When my book came out, physicists start to adopt the method. Then there actually the technology was helpful, because peer instruction sort of facilitated the spread of the clicker, right. And the clicker of course was not bound by discipline, so as soon as physicists start to adopt clickers, chemists jumped on board, biologists jumped on board, and then other disciplines, so that helped it spread from one discipline to another. And eventually also from the academia, from university and college level to high school.

Q28: Just switching away from that area of discussion, I wanted you to talk a bit about the peer instruction network that you've set up with Julie Schell, and explain the initiative and sort of how it's shaping up.

A28: So it, I think that you know, peer instruction has become somewhat popular, but still the number of faculty who are actually using an interactive approach to teaching is a small percentage worldwide. And I would say it's probably safe to say that 99.9 per cent of all courses taught around this globe are still taught in the completely passive format, with the instructor just delivering information and the students...

Q29: The (...) format.

A29: Exactly. Exactly. But you know as I travel, I kept running into people who said “Oh I read your book.” Or “I saw your video and I started applying it. And it works so well.” You know, and I say “Oh, I'll give you... well here's my business card, please send me an email.” And then the person sends me an email describing his or her experiences. And then it stops there, right. I thought you know “I have to find a way to connect people.” Because sometimes I have faculty who write me “I'm teaching veterinary medicine. Do you know of anybody applying peer instruction in veterinary medicine?” And I think “Let me think. In 2002, somebody...” I have to just dig in my email, find it. So I thought “Providing a social network for people to help each other, to see that they're not isolated and alone, right.” I mean you're let's say at University of Buenos Aires and you're thinking about using peer instruction. You think “I don't want to be the only one in Argentina doing it. Let's see who else in Argentina is using or interested in peer instruction.” So that was the main idea, forming a social network of people, so as to facilitate finding others who have applied the method in the discipline. And also getting access to materials. Because you know, the idea is one thing, right. The method is one thing. The other is, we could call that the software. The hardware is the questions, right. You still need to find a way of spreading the content. There are no books. There's a book on physics, there's a book on chemistry, (...) there's a book on astronomy, there's one on calculus. It's still very, very limited. And if somebody wants to apply peer instruction in a field where nobody's done it yet, you have to invent lots of questions to stimulate student thinking in the classroom.

Q30: So there's big scale advantages if you can get people to (...) across the discipline.

A30: Exactly, exactly.

Q31: So how's the network going?
A31: Well we have, I mean, we finally... in the beginning we had a network that was sort of simply a registration page. But now we actually have the network up. I don't know if you've looked, it's been up for three weeks or something like that. It's quite nice – you can type in a city or country or discipline and then see who else matches that search criterion. We have about I think 3,000 people on our register.

Q31: Within three weeks?

A32: Well that's not completely fair because we had a pre-registration portal beforehand, yeah.

Q32: Okay. So...

A33: I'm advertising...

Q34: … the jury's out as to whether it really develops or not?

A34: Yes. I mean, the initial uptake was very, very rapid. I hope to continue to grow that, but I think it will continue. The blog is extremely popular. I mean there's a blog that goes along with it; Julie posts once a week a blog posting. We've a number of guest blog posts right now. Mostly about questions that people have about applying the method. I'm very pleased with that, I'm very pleased. So I urge anybody interested in peer instruction to go to peerinstruction.net and take two minutes to register, so that they can find others who are interested.

Q35: Great. Turning now to Learning Catalytics, which as I understand it is a start up of some kind that you are associated with, hat's your role in the company?

A35: Well maybe before we talk about what my role is in the company, and remind me to come back to that question if I forget, maybe should talk about what learning catalytics is first, right. So when I started peer instruction there were no clickers, there was no technology, there was nothing. There was the pedagogy, and feedback is very important in peer instruction, because basically the process goes as follows. I ask a question, I make students commit to an answer. I take a poll. I used to do that by having a show of hands. Actually, not a show of hands, I had people put their hands on their chest, using their fingers to indicate a choice. So it was three fingers for choice three, two fingers, and I could just scan the room. And because I wanted data, I had scantron sheets where I had people also write down their answer, so I could scan those afterwards and actually have a record of what people had selected as answer. And then in '93, we teamed up with a company called Better Education, that developed a network of hand held calculators by HP, which ran a very primitive form of DOS. And we had this wired network of calculators, and it was very expensive but it was fantastic. I knew exactly “Oh that's Seb sitting in that seat.” That's great.

Q36: Every student had a wired device.

A36: Well they shared them between four students and from a pull down menu they... they logged in and then from a pull down menu selected their... three or four students would share one. But it was very hard to maintain, it was incredibly expensive. Then in '98 an alum of the school of engineering and applied sciences at Harvard, together
with a professor from Suny Buffalo developed the first PRS infra-red clicker. Fast forward ten years, you know, you have a zoo of clickers – e-instruction, i-clicker, turning, (...) you name it. And what happened was something that upset me terribly, the focus shifted from the pedagogy to the technology. People would come to me and say “Oh, I've adopted your clicker technology.” I’d get outraged, because in my mind it was not the technology that mattered, it was the pedagogy that mattered. And on top of that, I failed to commercialise my own idea, so that upset me too. But you know, to me it was really the pedagogy. And what also happened was I noticed that a lot of people threw the peer out of peer instruction. So a lot of people just said to the students, you know “Bring your clicker to class.” They gave points so that it became like an attendance taker too. And then they would ask questions that were pretty meaningless - “Which of the following is not a living being – a giraffe, a rock, a flower?” Students pressed B and the instructor says “Okay, let's...” and then goes on. No discussion, nothing.

Q37: I must just interject here to say that in last week's Times Educational Supplement there was an article by Dylan Wiliam (http://www.webcitation.org/69dRfKsfz), who is the originator of assessment for learning in schools in the UK, him and Paul Black. And a very, very influential paper called Inside the Black Box, which is about how really good teachers interact with students and sort of learn how they're learning and shape what they then get them next to do in the light of that. It's not peer instruction, but it's got a kind of, there's a parallel. And many, many school teachers would say that they're using assessment for learning. But in actual fact, what they're doing is just occasionally asking questions. They're not asking questions that are designed to help the learners grasp the subject and move on. And they're not designed to give the teacher data about the progress that the group of learners is making. And there's a real parallel with how you've just described clickers.

A38: Exactly. Because I think, you know, peer instruction is two components. One is the feedback and assessment, but the other one is in a sense crowd sourcing the teaching. Because now, instead of only having me provide my perspective on the material, you have lots of students in parallel interacting and providing a view on what I'm saying. And adapting it to the needs of their neighbours, which I could never do. I could do it for one person, two people, never for all. So, so you know, and I found in the workshops I give on peer instruction, people were not that concerned about the technology. The real questions were how do I develop good questions? Take the question of which is not a living being – a giraffe, a rock or a flower. I mean it's factual recall. It's not really developing a mental model about something. At some level it maybe is, but it's probably a mental level that we follow... that we form when we're a toddler, not when we're in college. And I, you know, so how do you develop good questions? How do you manage time? How do you optimise the discussions in the classroom, those are the... And none of the technological solutions, none of the clickers offers any recipe for doing that. So I thought, you know, what I really would like to do is get rid of multiple choice questions. Because multiple choice questions are really difficult to make, right, because you have the question. As the instructor, hopefully you know what the right answer is. But then what? What are plausible wrong answers, right? What are, in your mind as an instructor doesn't work that way any more. You can't come up with the type of wrong answers that the student comes up with, because you don't think like a student. The only way to really design
meaningful and useful multiple choice question is by giving it as an open ended question to the students, harvesting thousands of answers, tabulating the most frequent incorrect responses.

Q38: And that's reverse engineering questions.

A39: Yeah. But that's... we don't have the time to do that. So that's when I thought we should really develop a system where we don't need to ask multiple choice questions. Also, why have students buy these devices, when more and more students have consumer devices that can do much more than that. So we decided to design a new system from scratch that uses consumer devices- laptops, iPads, Kindles, iPhones, Androids, whatever, right. Anything that has a screen and a mouse or track pad.

Q40: And is connected.

A41: And it's connected, either via cellular or wi-fi. And now we don't ask multiple choice questions, we ask questions where students can sketch a function. Or they can type in text. Or they can draw a vector. Or they can point at something. And all of that information is processed on the back end and displayed in a way that makes sense to the instructor. So I can, for example, tell my students, I can show them a ray diagram in optics let's say, and ask them to draw the continuation of a ray. They put their finger on the touch screen, draw a vector. And on my screen I see the drawing that the student sees, and all of the vectors that all of the students draw. I don't need to give them a choice – they can draw whatever they want. And I can see at once well so many are correct and so many are incorrect. Or they could... I could have them draw a function, x minus 3 in parentheses squared, plus 4. I show them some graph papers, with their finger they trace the function on the screen of their tablet computers or with the mouse on their computer. And I can overlay all of the graphs and see at once “Oh most students draw it like, you know, a parabola, with the open side up. But there are some who, you know, have inverted it, or shifted it the wrong way” and so on. So again, not constraining the student's answer by multiple choices, by just having open ended responses. The same thing with algebraic functions, free text, you name it.

Q42: And have you got data on the utility of that approach?

A42: We're collecting data. Because the great thing about learning catalytics is the cata', the catalytics of course is strongly connected to analytics. So there's three of us involved in there, all right, I get to your, the question you actually asked. So basically the idea got generated when I hired, I first hired a post-doc, Brian Lukoff, who is the CEO of Learning Catalytics now, who got his PhD in education at Stanford, on a thesis where he showed that he could program computers to do better interpretation of graphical information than trained human beings. And when I saw that, I thought “Wow! That's fantastic, because now we can take graphical input and analyse it.” And then later I interacted with a colleague of mine in the statistics department, Gary King, who has a company called Crimson Hexagon that does free text analysis of social media. Statistical analysis of social media. So he can take, for companies he can look, he can do an analysis of Twitter. Or during the elections for example in 2008, that's what propelled his company to stardom, so to speak. He was able to predict the outcome of the election state by state, early in the morning on election day, way before any exit polls. Simply by looking at what people tweeted on social media.
And he can do many such... But anyway, I asked him you know “What are the algorithms that you use?” And he started to describe these algorithms where you can take free text and sort of do a clustering algorithm to make sense of it. Because imagine you ask an open ended question with text response of 200 students. Right, you could of course display 200 answers, but when you're standing in front of the class as a teacher, it's of no use to you, right. So how do you process it if you're aiming for what...? But that's what catalysed this idea of making learning catalytic.

So if you take that text based analytics, if we take the graphics based input, you know, we have a system where we can design, allow the user to use questions that, you know, are not constrained by multiple choices. So that was the basic idea. And then things got better from there. Because once we had hand held devices, we could ask students to log in again and select their seat in the classroom by pointing on a map of the classroom, just the same way when you check into an airline, right, you pick your seat.

Q43: So group learners according to how they'd done in previous questions.

A43: Exactly. So on my device, rather than Professor Mazur telling me, you know, “Turn to your neighbour” and you know I happen to be a good friend of Graham, I'm sitting next to Graham, I talk to Graham, the device will say on my screen “Turn to your left...” No, it will say “Talk to Seb on your left”, even if I don't know you, right. So it will actually pair the students in an intelligent way, so as to optimise the interactions in the classroom. And you know what? There we do have data. We've shown... we're still collecting data to make it statistically more significant, but the preliminary data shows that, depending on the algorithm that we use, we can triple, triple the gains over student selected pairing, right. So you and I, suppose we're friends, chances are we're going to sit next to each other in the classroom, right. But we might not learn that much from each other.

Q44: So in traditional small group based teaching, face to face, which I did for years and years, a key thing that tutors were doing was making astute judgements about who to put with who, depending on what was happening.

A44: Absolutely. But you can do that in a small setting... with 20 people.

A45: ... you cannot do that with 200. And the system keeps track of it. That's the obvious thing that a human being... I mean, you might have a good intuition for it and know the 20 people and be able to do it. But it's very hard to do it all the time for everybody at the same time. The computer of course has no trouble. Suppose that it pairs you and me, right. And I talk you into the wrong answer. It will actually weigh our interaction a little bit down, give it a slightly lesser weight, and try next time to pair you with somebody else and me with somebody else. And then later tries us again, and if it goes well, you know, the weight goes up again. So the system adapts to what actually happens in the classroom.

Q:46 That's Bayes's theorem in use in another context.

A46: Yes.
Q47: Some listeners to this interview and readers of it will be senior managers in universities and colleges. The people who take big decisions about investments in lecture theatres and other teaching spaces. Institution by institution they're setting long term policies on teaching and learning, that affect millions of students. What's your message for them?

A47: Well my message for them is to really, we're really at a crossroads. I mean, there's no question about it. And suddenly we're starting to learn so much about how people learn. And I think we are now reaching the point that we should stop investing in an architecture, a learning space that was developed by the Ancient Greek, not for teaching by the way. It was developed by the Ancient Greek – the amphitheatre is what I'm referring to, for plays, for performances. With the sole purpose of focussing the attention of many on one. Incidentally, ironically the Greek never used the amphitheatre for teaching. If you look at an illustration of the School of Athens, you see something very different. You see peer instruction. You see people walk around in pairs, right. So I think, I think we need to really start investing in different learning spaces. Learning spaces that put the focus not on the instructor, but put the focus on the students. Because what matters is not what the instructor does. What matters is what happens in the brains of the students. So one of the things, just to tell you something that we haven't published yet, so I'm sort of lifting the veil on a really exciting project that we're doing. We're now, we have batteries of cameras in the front of our lecture hall, high definition, that have facial recognition built in, that film every interaction in the entire classroom. Right, so all my... this took quite a bit to get that past the internal review board.

A48: It's 50 terabytes for one semester. So there are microphones between the seats recording every audio conversation between the students. And we know exactly which student is sitting where. When you're sitting next to me, you turn to me, the computer knows “Seb is turning to Eric and they are interacting.” We also do limb tracking. But we found something really interesting. If you take an amphitheatre and you have people sitting next to each other, and usually at theatres, you know, the seats are pretty close to one another. You're almost sitting shoulder to shoulder. When you tell people to talk to their neighbour, if there's one seat open in between... suppose that you're sitting to my left, I'm sitting to your right, there's one seat open in between, we'll actually turn towards each other. But in a normal environment where... … you're too close to actually comfortably look to each other. So people actually start talking to each other while looking at a distant point, either at the screen of the computer in front of them, or at the screen projected in front. So all of a sudden we're learning how to actually space people comfortably so that they can actually interact in a meaningful way. And I think that people who invest hundreds of thousands, maybe millions in learning spaces in education, really would do well to look at the data that are coming out of it and not take a decision based on historical approaches, but take decisions on pedagogical approaches that have, you know, shown by data that they work better.

Q49: Yeah, sort of they're taking decisions on...
A49: They've been validated.

Q50: … on historical and aesthetic approaches, rather than data driven. They want it to look nice. And how it looks is secondary to whether it supports the right dialogue.

A50: Yes, yeah. I mean for example, let's go to kindergarten, right, you would never put children that are, you know, four, five, six years old, into an amphitheatre. It's chaotic. It's peer instruction; they're teaching one another, they're interacting. In a sense we need to extend that model all the way to, you know, higher education. Bring the kindergarten back into academia. That will be a lot more fun.

Q51: That's a great note to conclude. Is there anything you'd like to have been asked, but haven't been?

A51: Oh I could go on for ever. If I weren't that jet-lagged, I would probably say “Yes, you forgot to ask this.” But I'm not sure, I think we've covered the ground.

Q52: Eric, many, many thanks. And Graham McElearney from the University of Sheffield, who's sat on my right, thank you for doing the recording.

A52: My pleasure, my pleasure.

<<ENDS>>