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00:00:02

Speaker 1: Indeed, successful.

00:00:04

Speaker 2: Correct.

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Speaker 1: So I would like to start with the very definition of the quest or the topic of my research, which is higher order thinking skills. In your experience as a researcher and also as a teacher, how do you define higher order thinking skills or how do you perceive higher order thinking skills?

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Speaker 2: Well, I don't I think I was looking to you for that definition, since you're the one who's asking the question, what do you consider higher order thinking skills?

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Speaker 1: So basically my the goal of the research goal of this particular interview is collect is to collect teachers and researchers perception about what I higher thinking skills, not because they are the ones who are actively engaging in grooming and researchers and teaching the up coming academicians. There are certain literature and educational sciences, which I can now give us a definition. But before biasing with any sort of existing theories or definition, if you have intuitively any notion regarding higher level performances in terms of thinking, skills or academic skills, would you be able to characterize not necessarily as a definition, but a sort of an understanding that you have.

00:01:25

Speaker 2: Well, I think of it in two context. So one is doing science and that involves observing phenomena. And asking questions and thinking of experiments to try to answer the questions and then analyzing the results. So that's one form of higher order thinking. Another is problem solving where students want to solve some problem and. So I teach courses in both of those areas.

00:02:09

Speaker 1: Nice. So but when I say I higher order thinking skills, obviously there are there is no consensus even in educational sciences, what does it exactly mean? But the at least from teacher's perspective, the widely accepted notion is based on Bloom's taxonomy. What Bloom's proposed and his colleague basically about understand, analyze, evaluate, create and associated cognitive functions in classroom from how can one develop such thinking skills and observe such skills in classrooms through workouts and many other assignments, etc.? So this is one way of approaching higher order thinking skills. The other way is also about particularly focusing on critical thinking as the overarching goal of higher order thinking skills. And as you said, problem solving can be or can be categorized under this wide umbrella term of critical thinking or critical thinking can be categorized under problem solving. So there are different number of ways how different research is at the moment approach to thinking skills. So that is why I went on to now at least understand and define for the context of higher education. I would like to now see from teacher's point of view to such a point of view, what is it that really suitable, appropriate apart from the existing theories of higher order thinking skills?

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Speaker 2: I don't particularly like that approach because it's too vague. The Blum's categories, they don't. They're just words. They don't mean anything. And so I think you've got to if you're going to try to understand a problem, you've got to define it in a way that you can actually measure and decide whether it's being done or not. So I think that the metric that we use in science about whether we're being successful or not is whether we can make predictions that are accurate about the future. And likewise, in problem-solving, it's about whether we actually can solve the problem or not. And and so I much prefer to talk about things that we can measure.

00:04:35

Speaker 1: Indeed, I totally agree. And importantly, I interestingly, I've already mentioned about science observing, asking the relevant questions and as moving on from this basic as you said basic understanding to a much more concrete ways of understanding and observing, you know, our thinking abilities. I'm very much focused on students understanding of scientific paradigms. So for example, if the hypothesis are hypothetico-detective paradigm as it is in philosophy of science, we believe legacy and limits their understanding, our ability to ask relevant questions to arrive at a predicting stage or that enables them to go after evidences that will enable eventually to kind of help them predict. So especially in the context of asking questions, how would you, for example, train your your junior researchers are your students in asking the right kind of questions when it comes to observation or predicting, for example.

00:05:46

Speaker 1: So I put a lot of questions, but one question that I would like to highlight is that how would they help train your young researchers or students in asking the right kind of questions?

00:05:59

Speaker 2: Well, I would train them to ask questions, I don't like the concept that there are over the right kind of questions and the wrong kind of questions. There are just questions and we decide their utility later. But the main thing, I think, is to give students permission. People naturally ask questions, children ask questions all the time and we inhibit it in our current educational system, by the Con, by transmitting the concept that there are right answers to everything. And and don't ask questions. So I think the first thing which is the hardest thing in any environment where you're trying to stimulate creative thinking is to create an environment where students understand that it's OK not to know the answer that we don't know the answer about a lot of things. And there are no right questions and wrong questions. There's just the process of inquiry, indeed.

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Speaker 1: So especially the hypothesis underlying my research project sort of say is that the current science education at the school level, which obviously prepares them for university level education, teaches science in a much more reductionist way. To give you a much concrete example, science is nothing but building models of the existing real world. And one example of would be I'm taking the example given in the Ronald Giere book of Understanding. Scientific reasoning is a map street map. A street map is obviously a representation of existing reality, but it is not 100 percent accurate. It is a mere representation that help us navigate through it. But in reality, there are much more true than the rectangles and these squares that is on the map. Likewise, in science as well, all the discoveries or representation that that fits more accurate more or less accurately, but not 100 percent existing reality of the world. And the underlying hypothesis is that this idea is not being properly transmitted, where students take the understanding of models as and as a direct reality of the external world or the real world. That way, even the questions they pose kind of not geared towards new discoveries or geared towards much more critical analysis of the field in itself. So what would be your opinion on this? Yeah. For example, my hypothesis.

00:08:52
Speaker 2: Well, I think it's true that. You you want students to understand that our explanations for things are always hypotheses. We never know the truth. And and we should judge them by the accuracy of their predictions.

00:09:19
Speaker 1: Indeed. So this is where my research comes into play. How can we enable students to kind of change their understanding about what science is all about? And thus we can enable them to ask all the relevant questions or questions, basically, as you said, whether right or not, but questions that enable them to learn better and predict better then in that way, do you have any strategies that you particularly use other than giving the complete freedom to ask questions? Do you engage in a dialogical process where you understand and kind of probe? Or do you just let them ask and listen?

00:10:03
Speaker 2: I let them talk. So basically, you have to present a an observation that. We want to understand, and that's not understood. And so a very rich area for us to do that, that the problem with getting students involved in thinking about science is that you often have to learn a lot before you can get to the unknown in that particular area of science. And second, you often need a lot of sophisticated equipment to do it. So what I set my mind to was, can I create problems in which there's a rich amount of of poorly understood observations that students can think about and do experiments with? And what I've come to is, is human sensory perception. Is is we don't understand anything about our vision or hearing or touch or smell, and therefore. And yet all students experience these things and have the relatives relevant sensors. And so I find out a really rich area, particularly visual cognition, is what I what I tend to focus on. So you just make an observation, go sit somewhere, put some glasses on and tape your central vision so you can't see at the front and just sit and see what you see in your peripheral vision and your all of a sudden become aware of something, even though you use your peripheral vision. Day after day after day your whole life, you don't really realize that it's there and what it's doing. OK. That becomes it turns out it has very poor acuity, you can't tell really what's there, but you're very sensitive to motion. So peripheral vision is primarily a motion detector that tells us when to change our vision, from our attention, from one thing to another. You can discover something so basic like that that you use every day and don't understand. Another sort of general question is that you can explore very simply is and I've done this and in. Just six seventh grade classes is the question is, is our eye like a camera? And it seems like it is, because if you look at the scene and then you take a picture of it, they look the same. But it's very easy to do some simple experiments

showing that your vision is nothing like a camera. And anyway, so so the phenomenon. The basic thing is to start with a phenomenon and then open up the questions. And the second thing, I think, is to do it and advise social environment. An individual student is intimidated to do this. But if you because they think you know the answers, but if you start, if you do it with a group of students and participate with them as if as it's true that you're learning at the same time, they're learning and you're thinking the same time they're throwing, and all of a sudden they begin to realize that this is just a game. You know, we can all think we can all have ideas.

00:14:01
Speaker 1: Indeed, indeed. Very well said. Thank you very much Prof. Hartwell. So the my next question is about challenges for students and primarily at the moment because I did not have to ask as much as much questions as I did with other teachers because you just got on to the questioning part, which I ended up arriving off the three four questions with other teachers. So what are the challenges do you face when enabling are, for example, instigating students to ask questions and what kind of difficulties that students face to do to have that breakthrough from not asking any questions or asking kind of a different, irrelevant questions and then asking all the relevant questions.

00:14:48
Speaker 2: Well, I think we've covered that it really is, I think, permission. It is creating an environment where you're all learning together and the teacher doesn't have any more answers than you do. And and it's a social environment where people get ideas from one another.

00:15:09
Speaker 1: Indeed, indeed, I I kind of understood that. But then you say, then all the students, if you create that environment, are able to attain the expected level of skills.

00:15:22
Speaker 2: Well, now that's a very difficult question to answer, because I don't know what the skills are. I don't know how to measure them. Our current educational system evaluates students on whether they remember things. Mm-Hmm. And that's not the skill that I'm looking for because they have Google now. They don't need to remember. The skill I want them to have is is interest, motivation and persistence. Because because I don't think it's really the special attributes that allow students to be successful in being in thinking creatively, it's really persistence. And one of the biggest problems is that teachers expect students to come up with, you know, Newton's understanding of the laws of gravity in an hour. It took Newton a hell of a lot longer than that. OK, so we have to give students time to think, and that's something we don't do.

00:16:34
Speaker 1: Indeed, indeed. Beautifully said. Thank you. Thank you very much. So yeah, my next. Yeah. Before going on to the next part, I just would like to finally understand better so that I covered it well. I have the satisfaction that I covered it well. The part that I wanted to do so immensely. When you talk about, for example, it does not say higher order thinking skills, but any skill or a skill that you want your students to develop in the context of scientific research is about the ability to ask questions. And then slowly you or that's my

understanding. You think that students would develop their ability to to predict, to make contributions in science?

00:17:20

Speaker 2: Well, I think questions naturally lead to experiments, and that's where that the filter is on. Good questions and bad questions aren't good questions and bad questions. But there are questions that lend themselves to experimental answering and questions that don't. So with regard to sensory perception and things, you've got to consider the brain a black box. We're not going to go inside the brain. So any question that requires you to know what's going on inside the brain is is not a functional question. Mm-Hmm. But if you can ask questions about can I do X better than Y? That's something you can test. Yes, and that's that's a functional question.

00:18:15

Speaker 1: Mm hmm. Huh. But then how about things that are not observable, such as, for example, the structure of DNA when they were not able to exactly see how the structure is, but eventually they were able to use certain instruments to gain certain understanding and then finally arrive at a prediction? Would you say this is not a functional question then?

00:18:42

Speaker 2: Well, it was very much a functional question because they were deriving models and they had. So what's the one thing that's very important in thinking is constraint is you can't think of anything as possible. You have to even artists work within limited constraints. They work with watercolors or they work with oils. And they, you know, and the constraints on the structure of DNA were very, very significant. It was known that there were four bases that they were connected along a phosphate backbone that well. And one of the biggest problems they had was the fact that they didn't know at first whether it was the toe or the, you know, form of the Puritans and the primitives. And finally, they found a chemist who was able to tell them which form it was. So once you have enough constraints, then then you have an environment in which you have limited possibilities and you can explore those limits.

00:19:52

Speaker 1: Neat. Great. Thank you very much for elaborating on that part on my repeated question so patiently. So my next part is on interdisciplinary research. And so I know that there is also a lot of attention, the definition in itself or the understanding of it. So how would you probably define, not understand interdisciplinary research?

00:20:16

Speaker 2: Well, I think it is the need for interdisciplinary training and thinking and research is an artificial construct. It's created because we divide knowledge into certain disciplines and we insist that we train students in one of those disciplines. I mean, that's the fundamental thing that's wrong with all of our education, all of our higher education. We got to eliminate that and just have students think in terms of of problems and and using whatever algorithms or metaphors are important for that particular problem. So, so I think what you're doing is what you're asking is how do we create a problem with how do we overcome a problem we've artificially created by forcing students to just learn one discipline? It's very hard because by the time they really need to be an interdisciplinary thinker, they're, you know, at the PhD level. And they have, you know, all these years of thinking, and it's in a strict discipline and having only those algorithms and those metaphors. So I think the basic correction of that problem has to start very young.

00:21:56

Speaker 1: Indeed. So that is why I think we try our bachelor's program not to emphasize on disciplinary knowledge, but more give the flexibility for students to work on problems in the context of project. Thus, my project will be valuable, enabling them to giving or teachers the space to dedicate and design activities that will enable them to have interdisciplinary practices and so on and so forth. So if you think any kind of skills that are necessary for interdisciplinary practices, for example in research or in engineering, what is the first thing that comes to your mind? This is the most important thing. If one needs to do interdisciplinary science?

00:22:43

Speaker 2: What level of student are we working or are we talking about?

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Speaker 1: You could ask different answer the bachelor's level and also at probably Ph.D. level, I would appreciate in both levels.

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Speaker 2: Well, see, I would start out at middle school, sixth grade or so or even earlier. But I mean, sixth grade high school is when disciplines really start to get rigid. So we teach chemistry and we teach physics and we teach math. And so, you know, at the higher level, once you've already become a disciplinarian, then you know, I don't know, you've just got, I guess, you know, do the basic groundwork of picking up a textbook and studying the area you haven't become familiar with. So that you understand the basic algorithms and metaphors that are the knowledge construct of that discipline you. You have to do the hard work at some point.

00:23:59

Speaker 1: This is. Indeed. Obviously, so, yeah, I think I now realize with your definition or explanation before we did in the context of school education, if I really wanted change, then go go to school and then start changing it instead of creating that artificial problem and then try to overcome at the education level. Right? Yeah, definitely. Maybe. But in context of research is too limited in that sense, I think. Let me see how far I can go and yeah, have some contributions for future of education, but thank you very much for that. And my next question would be. Yeah. Yeah. Have you? What is your view on the ability to reflect for students and yeah, basically reflect and self-regulate? What is your you said, persistence, motivation and the interest is are the major key things and I am asking along the same lines. How do you consider the significance of reflection ability to reflect on their own processes?

00:25:09

Speaker 2: Well. We're a little little limited in our vocabulary to talk about what mental processes are going on. But in terms of what we're doing when we're asking questions and trying to think of experiments and analyzing results, I think the process of reflecting with the students. So students says something and you say, Oh gee, that gives me an idea. And does that mean this or that? I mean, I think that what you do is to verbalize your own reflections and just give them an example examples of how how you think.

00:26:09
Speaker 1: Indeed. So thank you all, so have you heard. My question is actually a little bit more with the vocabulary as you said. And so my vocabulary is come now at the moment comes from psychology. Have you heard of the term metacognition? Sure. Yeah. So the metacognition I would like to know just yeah, make the definition. The ability to think or reflect about your own thinking processes and then try to self-regulated it. For example, if I am able to remember in a certain way, if I understood about my mental processes that I do think creatively in that pattern, then I could use that knowledge to make advantage for myself when it is required. So in that sense, how do you think this ability, if you think that is important, can be developed in students?

00:27:01
Speaker 2: Yeah, I don't like the whole concept of metacognition, I think it's too vague. You know, you have to work on things where, you know, whether you're making progress or not, and you can measure something. And you know, the one thing I think a mental skill that is useful is is meditation, because that is my experience is allows one to sort of clear the mind so that you. Sort of escape from your your algorithmic constraints. And are more open to thinking more broadly. But I don't I don't understand metacognition. Well, I don't know what it is.

00:28:08
Speaker 1: Thank you. Thank you very much. I think that marks the whole end of my interview, which was relatively short than I had expected. I'm so glad to have a very concise and deep answers my questions. I would just like to stop the recording, and then I would like to have a five minute conversation with you if that's OK.

00:28:26
Speaker 2: Sure.

00:28:27
Speaker 1: Thank you.