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*Speaker 1:* Two interdisciplinary research in engineering education. The basic idea is to understand what higher order thinking skills are and how it is practiced in the context of engineering education, basically. It is, and by nature, interdisciplinary with the interaction from multiple disciplines. So as a first step towards my research to frame the foundational framework or to develop the foundational framework, I try to combine insights from teachers and researchers in the field of engineering education. And what do they perceive and how do they practice higher order thinking skills? And this is the overall context for me to have a better understanding of how the thinking skills is perceived and practiced in classrooms and in academia, leading me towards what formulation of a general definition of such skills and identification of different classified skills. So this is the first step towards my research, and you are the first person to be my interviewee who who quickly accommodated my request in your schedule. So thank you very much for that.

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*Speaker 2:* Okay, so thank you. I thank though you are afterwards, I'm not totally sure how if I can help you much with your.

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*Speaker 1:* Yes. So that is the overall context and the purpose of doing this interview. And if you have any reservations and doubts and clarifications, please feel free to ask. And all the data that I record now would be handled according to UT's data policy management rules and regulations, and will be stored if necessary, only in the university server. So to make you, yeah, it is my problem. It is my responsibility to make you let you know all of these things before I proceed to the formal interview. Yes. By this time, do you have any concerns regarding this interview?

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*Speaker 2:* No, no. The concerns I have is just because it's difficult to estimate what you want to know and and as you just said before, and this is the subject, but didn't ask me to do any preparatory work. I have no idea what to expect, so I'm not sure if I can help you at all.

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*Speaker 1:* Yeah. So it is just a conversational interview, more of semi structured interview, and that gives me a kind of an insight into your world of teaching, etc. So that is what I want as well. I did not want pre-prepared insight. So that is why I didn't send you anything beforehand.

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*Speaker 2:* No, it's right.

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*Speaker 1:* Yeah. OK, then if everything is OK, then I can go with the questions or formal interview. So to say, would you please introduce yourself briefly?

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*Speaker 2:* Yeah. What you want to know? My name, my name is x Given I miss what officially is called a senior lecturer, and that is because I am a what is called on the Onderviezer. And I asked when we when I got that rank as it were, I asked, OK, so what is the official English translation? And they have to think about it because they didn't think

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about it before, which is a bit stupid. So I'm a teacher, and I guess the senior is just because I'm doing this already for for a long time. Mm-Hmm. And next to that, I also have a very small researcher, and I just select a task, but that's that's relatively small only a few hours. So I'm mostly teaching in ITC faculty and I do see faculty masters and in the Y bachelor's program at the xxx university.

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*Speaker 1:* Thank you. Thank you very much for the nice introduction. I got to know a little bit more about your background as well. Mm-Hmm. So in terms of the subject, I would like to ask **what is your perception concerning the importance of higher order thinking skills in higher education and engineering education in particular?**

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*Speaker 2:* That's a very broad question, right? Yes. So what what? What are my what did you say? How did you shape? What am I?

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*Speaker 1:* **What is your perception concerning the importance of higher order thinking skills?**

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*Speaker 2:* Yeah. So since they're both engineering and but the other thing you said, the higher, higher education is supposed to be academic. **Higher order thinking skills seem to be very important.** It's almost implicitly. As implicitly supposed in the degree descriptions that that this is one of the skills that people get, in my opinion, academic and higher order thinking are actually never connected. Let's, let's call it like that, I guess.

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*Speaker 1:* Yeah.

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*Speaker 2:* I'm a bit I'm a bit struggling here because higher order thinking is a is a is a concept which I think I know what you mean by that. I don't exactly know what you mean by it, of course, because there is probably many different definitions of that.

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*Speaker 1:* Yes, indeed. Exactly. And that is what my next question was. So I wanted to I wanted to leave you slowly there. But then you've got early into **how do you define in your own field of teaching that you teach as a teacher or in your context, higher order thinking skills?**

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*Speaker 2:* Yeah, I guess those are the type of skills that you find in all those typical educational or what they to these these you have these triangles and pyramids of thinking. So you first learn things by heart and then you learn to make relations and then you actually know things and then you know how to use things and then you know how to reason about things. **And there are several of these systems that that people have or actually of names for that the ones higher up in the pyramid as it were, I guess, is what you would call higher order thinking. So when you not only know things but also know how they interrelate and how they can be used to get to know further things. So to analyze them and do things like**

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what you call that, Oh, I forgot the word now, and you can extrapolate them into what will happen in the future. Or you can interrelate them to to to find out why things happened. Like that happens that kind of skills. I guess that this kind of reasoning skills are what I would call higher order think. I guess that's what most people would would define as higher order thinking.

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*Speaker 1:* Nice. You mentioned that some sort of a triangle kind of a pyramid structures or classifications. Do you base your understanding of higher order thinking skills on such classifications or of any particular researcher that you know of?

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*Speaker 2:* No, I'm not very big on these theories. I'm not very knowledgeable about them. I've seen them around and I, for example, I wouldn't know now which one I have in my mind who was the researcher who introduced that, for example. I know they use it in many courses on teaching and so on. The problem, of course, also with academic teachers like myself in the Netherlands, at least, is that we never have/ had a formal training in educational skills. Actually, it's a bit strange about the Dutch academic system is basically if you are an academic yourself, you're supposed to be able to teach academics. And nowadays, of course, we have these things like UTQ University training qualification and so on. But when I started teaching in academia, it was basically, Well, you're an academic yourself, you have a degree, so you're supposed to be able to do this. There was hardly any theoretical background that you were taught, which is strange, of course, because even our primary schoolchildren, teachers get all kinds of formal training, which we don't we don't make it compulsory for for higher education teachers, which which is strange to us.

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*Speaker 1:* Indeed, indeed, I totally can relate that. I think that there's also some cases here in India where the kind of system in place, it's a little bit strange. I agree.

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*Speaker 2:* Are you thinking at the moment? Oh yeah, yeah. With all this the other day when

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*Speaker 1:* I yes, I am in India because my mum has been infected with COVID, but she's recovering. She's at home now.

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*Speaker 2:* You're probably the last. I mean, mother meeting you.

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*Speaker 1:* Yeah, yeah. So yeah, we're coming back to the the higher order thinking skills. So you generally have a kind of an understanding of, OK, what does it mean by to thinking skills? And I would like to know if you have any specific focus on certain types of skills that suits better to your academic context when you teach that you expect from students in your classroom.

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*Speaker 2:* That's over very broad, and it worked well. How did you worded if I if I warn

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*Speaker 1:* do you focus on certain types of higher order thinking skills in the context of your teaching in your own subject? For example, certain courses need analytical thinking. Certain courses need creative thinking. Likewise, or do you focus on certain types of higher order thinking skills?

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*Speaker 2:* That depends on which course I teach, I guess. Yeah. So for for for my I teach visualization as a big part of my my work cartographer, shall I teach cartography and data visualization? And there are, of course, next to an analytical skills. Creative skills are very important. And then I also teach in their, I guess, analytical skills, because you, we we try to teach people how to first analyze the data. What you want to visualize, what your usual group and so on. So there's a user centred design cycle that we teach people and that needs analytical thinking in the beginning, of course. And then in general, I also help people writing thesis and reports and so on. So that's also analytical skills and creative skills, but also, let's say, academic reasoning skills. So it is also an important part of where you where I use those, where I teach those skills or make people aware that they need them. I don't I'm not so much involved in the actual teaching of academic skills, they're separate courses. Forget that I teach you for the Msc students. Mm-Hmm. Which, of course, then they go and recommend right there their actual thesis. And if I'm then a supervisor or a reviewer, I, I sort of help them use those skills that they have been taught formally.

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*Speaker 1:* Mm-Hmm. So you mentioned that academic reasoning is one of the important skills there. Also, you you expect you will try to build. Yeah, teach. Not you basically support to separate academic courses in which students develop such skills.

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*Speaker 2:* Can I mean you choose for their Masters students, right? Because Bachelor students also need academic skills, but maybe not to the same level as as as the Masters. If you write a master's thesis, it's more we are more rigorous, more strict on academic rigor and reasoning and so on than we are for a bachelor's, of course.

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*Speaker 1:* Yeah, indeed. Indeed. May I know what is your definition or how do you understand the academic reasoning? When you say academic reasoning, what do you mean by that?

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*Speaker 2:* Yeah. And the research process of of either empirical research or other types of research and how you find data and facts and and findings, and then use them to to either prove a hypothesis or do an engineering task based on depending on what kind of research it is, of course. And then base your, make sure make sure your references are are well supported are of good quality and and those kind of things.

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*Speaker 1:* So basically, how research the process of research, knowing how the process of research is done and to be able to use that while analyzing or reading or reasoning. Yeah. Okay. Great. Thank you. So the next topic is on interdisciplinary research. Mm-Hmm. It is

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also quite broad in nature. I just would like to ask you, what is your understanding our definition of interdisciplinary research?

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*Speaker 2:* I guess, again, this very broad question, what was my understanding of interdisciplinary research where many disciplines this were different disciplines come together, right? That's right. So yeah, yeah. And uh, well, I guess I deal with students who do interdisciplinary research, as well as students who do mono disciplinary research. So I think I see a difference with who the definition to it other than. Well, it's where you use different disciplines in your you need different scientific disciplines to solve your research problem. Basically, the then I guess the definition.

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*Speaker 1:* Mm hmm.

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*Speaker 2:* And then. Yeah. So, you know, I guess people make this distinction inter and intradisciplinary, I never know exactly what and what I mean by that which. I guess I'm of the school of the of the wider idea of interdisciplinary is when you use different techniques and different disciplines and look at the full, narrow definition of if you if you research interdisciplinarity. So what is happening between these disciplines when doing research into interdisciplinarity, which is an interdisciplinary research, which for me is research, which uses two different disciplines. does that make any sense?

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*Speaker 1:* Yeah, it makes total sense because I myself, I have my own understanding part from the dictionary definition. Interdisciplinary research so much. Yes.

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*Speaker 2:* Okay. I never looked it up in the dictionary.

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*Speaker 1:* Indeed, there is a definition. I think. Yeah, it goes, interdisciplinary approach in which mono disciplinary approaches cannot be used that at least two or more disciplines should combine in the process of finding a solution.

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*Speaker 2:* OK, you know, that's probably what I mean, I guess.

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*Speaker 1:* Yeah, yeah. Um, so yeah, then no. My question is more about the role of higher order thinking skills in conducting interdisciplinary research or engaging in interdisciplinary academic practices. How important it is. And how do you yeah, kind of see this relationship?

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*Speaker 2:* How important it is to reach out to war or to what's

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*Speaker 1:* the role of higher order thinking skills in interdisciplinary academic research practices?

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*Speaker 2:* That's a very vague thing in I will say, it's not any bigger or smaller than in any other kind of research, is it? Mm hmm. I wouldn't I wouldn't say that there is a special. Kind of higher order thinking if it's interdisciplinary, is it? I don't think so. It's.

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*Speaker 1:* Do you believe that mono disciplinary students who are trained? Yeah, but certain types of academic skills will be able to efficiently engage in interdisciplinary research practices.

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*Speaker 2:* I see I don't see why not. It's. If you have if you are a good mono disciplinary researcher. Would you not be able to do the same if it's interdisciplinary?

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*Speaker 1:* Mm.

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*Speaker 2:* Where we might need some specific skills that are specific to one of the disciplines ofcourse. And if you don't have, then you have to learn them. Those are not necessarily a special kind of higher order thinking, right? So if you for example you need to know about, I don't know the perception psychology because you want to do something with with what users make out with the data visualization. We don't know anything about the shifts psychology, and you don't know how to use use your research or when you will have to learn that skill with. That's a skill that I wouldn't call that a species of higher order thinking.

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*Speaker 1:* Mm-Hmm. Yeah.

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*Speaker 2:* Thank you. We'll see how that would be. Of course, there are cases where that that is true. You need higher order thinking skills and you need higher order thinking skills anyway to do research, I guess. Otherwise, you research the engineering and research. for research I think you always need higher order thinking skills, but more or specifically, if you do interdisciplinary one. Mm-Hmm. Because I don't think there's anything special in that.

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*Speaker 1:* OK, thank you. Thank you. So my next question would be then what is your view on reflection in learning about reflection? And the possible relationship with higher order thinking skills, how do you perceive reflection?

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*Speaker 2:* Reflection is a higher order thinking skill because if you can't reflect on what you are doing, what will be your your, your research will be less effective, better qualitative or whatever you want to call that. I think you need reflection, skills, reflection. You need to know how to reflect on on things. If you want to do proper research and show reflection, critical thinking, maybe not exactly the same but reflection is an important part of critical thinking, I would say. And critical thinking is necessary to do is a necessary high order skill to do any, any kind of proper research, I would think.

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*Speaker 1:* Mm-Hmm. And so that is very interesting actually for critical thinking and the relationship between reflection and critical thinking. And yeah, the process of doing the research. Do you believe that it is only applicable for academic practices? I mean, the role of critical thinking and reflection are not just any, yeah, professional level functioning.

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*Speaker 2:* Yes, of course, but that's not what you ask, you say, do I think reflection and critical thinking are important in in all kinds of field? Yes, of course. And most and certainly so in in in researching in any kind of research. But it doesn't mean to say that it's not important and other things, of course.

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*Speaker 1:* Indeed. I just wanted to get some clarifications regarding your understanding of that. So likewise, reflection of critical thinking. Can you think of any of the skills that are highly important for academic practices apart from what you already mentioned?

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*Speaker 2:* And any skills are specifically higher order thinking skills

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*Speaker 1:* in order thinking skills such as critical thinking, which we've, you know, you just said no. Likewise, do you have any other specific ayatollah's thinking skills related to academic practices?

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*Speaker 2:* That goes back, we come back to the same question before what what, what, what do we think high order skills, is there a list of that?, probably there is a list t of that, but I don't have them on the top of my head. Mm hmm. OK. And many of them are are needed other than critical thinking, reflection, what extrapolation is that we call that the higher order skill

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*Speaker 1:* extrapolation,

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*Speaker 2:* thinking thing, thinking who, what, what, what if, what if?

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*Speaker 1:* Questions, what if questions

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*Speaker 2:* that is exploration into the into the future or into a new combination of things is that that's a higher order thinking skill, right?

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*Speaker 1:* Yeah, yeah, definitely. Especially, I do mean inferences are predictions. Conclusions drawing conclusions?

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*Speaker 2:* Yes. Now, drawing conclusions is more broad, I think, but inferences and future predictions specifically. Mm. Those are higher order skills that you need, for research what

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else inference. I don't have a list of higher order thinking skills, but. Most of them will be needed, I guess.

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*Speaker 1:* OK, so then let me move on to the next question have you or are you familiar with the concept called metacognition? What, what matter, metacognition?

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*Speaker 2:* I didn't know that was a word, but I can think I can imagine what it would mean, but if you have metadata and meta other things that metacognition is knowing about knowing, right?

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*Speaker 1:* Yes, indeed.

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*Speaker 2:* Yeah. But I wasn't aware that this was a much used word.

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*Speaker 1:* It is indeed actually a much used word in higher order thinking skills, yeah, ecosystem. Yeah, landscape teachers are researchers study about different types of cognitive skills and image. Yeah, metacognition seems to be one of the important I know the thinking skill, which is closely related to reflection. When you reflect, actually, you are doing metacognition.

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*Speaker 2:* All right, you realize what you have learned and things like, Yeah, OK, yeah,

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*Speaker 1:* that is what I wanted to know. Yeah, it's basically different words, closely related concepts. I just wanted to know if you are familiar with that. I mean

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*Speaker 2:* I was not familiar with that.

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*Speaker 1:* OK, great. And one question again, it is again coming back to the kind of previous questions they asked. Before moving on to that question, probably I think it is better for me to know if you actively teach certain higher order thinking skills in your course other than the content or technical skills that you teach in your course. Do you also pay specific attention in developing higher order thinking skills?

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*Speaker 2:* I guess we do. And I guess at least specifically, we do a lot, we do force and teach the students to do reflections, and that's one of the ones we talked about. . Do I guess what you call metacognition because they want to make them aware of their own learning process? So that would be recognition. And we do specifically teach that myself in the courses I teach. Maybe not very. Let's say explicitly that we expect them to have learnt that and to use it. And if I'm assessing SERs or PDP, OK, then I check for it. They actually know it's, you know, skills

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*Speaker 2:* but with in atlas. I'm not the one that teaches the skill. It's more people like Pascal and fokko jan. And all those in the first, of course, people who helped in the SER in the beginning stages of the experience.

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*Speaker 1:* Mm hmm.

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*Speaker 2:* But by the time I teach I do the project coordination and semester four. these students are supposed to already have gained these skills and I check for them if they actually need these skills. So its good that they are actually teaching this skill. .

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*Speaker 1:* So you yourself haven't had probably the. Yeah. The opportunity or the kind of a framework to teach this type of skills in the type of courses that you do.

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*Speaker 2:* No, OK, if I if I were asked to to actually teach those skills or practice them with the students. When they first get, I would have to do some preparation. I don't have these these things ready and. Well, I don't I don't have a. I don't teach that kind of stuff anyway to to students. I'm more I'm more on the engineering side, you could say. And so I have never taught that formally to students.

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*Speaker 1:* OK, thank you. Thank you very much. I think I've covered most of the things that I wanted to ask. I just have one final question, which is also really, really broad. And as you've noticed, most of the most of my questions are really broad. So the final question is the role of project based learning or challenge based learning or even problem based learning, for that matter, in developing higher order thinking skills. What is your conviction in following these approaches and the development of or the influence of these educational approaches in developing higher order thinking skills?

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*Speaker 2:* The influence of these approaches. Yes. Well, it's a bit of a chicken and egg thing, right? do you teach those skills by by doing that kind of project of that kind of learning? Or do you need them already to to be able to do that kind of learning? I'm not so sure about it. I probably think they have to go buy a candle hand in hands in a sense, right? So that if you if you want to be able to to to to teach challenge based learning, then you certainly need certain high order thinking skills. And on the other hand, you can learn them also or certainly learn how to use them if you do one of these types of learning, so it should probably be a bit of a step over process. You can't you can't teach students the theory of higher order learning without practicing it. That is for sure. And one of the ways you can practice them is in such projects you certainly need them. But the same goes for. You can't have students write proper capstone or a thesis without having them having acquired those those skills. Maybe this or what? It's a bit of a chicken and egg. So, yeah, indeed.

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*Speaker 1:* I totally agree with you because..

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*Speaker 2:* Let me give an example. We teach at ITC. let's say the standard master the NGO program. We have a separate course called academic skills that goes on throughout the whole year. Every Wednesday, we have a few hours of that with almost always for some of these things that the real when they write their thesis, that's when they say, Oh, now I understand why I had to practice this and learn this, because now I can see how it's actually being used and I can't do without it, right?

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*Speaker 1:* Yes. Yes. I think most of my even me as an engineering student, I had similar kind of experience. I didn't know why I did some things, but in the end, it kind of helped me without, yeah, without that, I would not have been able to finished a few things.

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*Speaker 2:* Hmm.

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*Speaker 1:* Great. Yeah. So yeah, I think we are almost there we are at the end of the interview. Is there anything that you would like to let me know regarding the topics or the interview of the process?

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*Speaker 2:* Well, no. It's nice to talk like this, but I think if you I don't know how many of these interviews you plan to do. But I think it would be a bit more efficient if you send, at least, let's say, a few keywords to the interviewees what to expect. So I wasn't totally unprepared, which in the sense is good. I think if you, for example, would have sent me a list of I want to talk about higher order thinking skills and this is what what I what I what I mean by that? Mm hmm. It would have been a bit more. Yeah, probably a bit more easier to to get started.

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*Speaker 1:* OK.

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*Speaker 2:* And the problem? I mean, it's a semi-structured interview. I understand that. But then it becomes a bit more structured and a little bit more, let's say, starting from the same understanding level or whatever about some of the key concepts?

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*Speaker 1:* Indeed, indeed. Yeah, I would have to check with that, actually. Yeah, in my yeah, ethical approval, I said, I'm not sending anything beforehand to my participants.

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*Speaker 2:* Oh, I wouldn't worry too much about that, because that will hardly be a privacy issue if you send some, some some keywords. OK, OK. Or you don't, maybe you have to send it beforehand. But with in your in your first introduction, you say, Well, this is what I mean with with with these terms.

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*Speaker 1:* Yeah, indeed. But I do not want to bias this is no,

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*Speaker 2:* I understand that there's a yeah, there's a difference between being totally unprepared and being biased, right? Yeah, there's a there's some ground between

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*Speaker 1:* yes, I think good ways to actually just send the keywords without much explanation. Now, for would be touching a higher order thinking skills, interdisciplinary research so that we can have much more meaningful conversation. Yes. That's OK. Thank you. Thank you very much Barend for the tips and also for your valuable time and insights. It's lovely to have this conversation you welcome. Yes, thank you and have a very nice day.

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*Speaker 2:* But I majored in. Where are you in India? Actually?

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*Speaker 1:* I'm in Chennai, the south. Uh-Huh. Yeah, the time is actually the same across the night. So we have nowadays, I get 7:43 in the evening. Yeah, yeah. I'm three and a half hours.

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*Speaker 2:* I had ActionScript and stuffy at the moment. Or what is it, hot and stuffy at the moment or.

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*Speaker 1:* Yes, as you can see, my face is actually with a lot of humidity. And even with the fan running constantly windows open, that's where you keep getting a lot of noises.

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*Speaker 2:* Well, I

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*Speaker 1:* would say

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*Speaker 2:* yes. The hottest I ever was was in Delhi at some stage when it was 50 plus, and it was not really. And I spend I spend a whole month in in Hyderabad, you know, Hyderabad, right? And that was OK when it was hot because it was really dry. But then I had to stay over while flying back. I had to stay over two days in Delhi and I thought I would die.

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*Speaker 1:* Indeed, even in Chennai needs a lot of humidity. It is not really the coastal region, so it's not that nice.

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*Speaker 2:* Well, not another day, actually right now for the first time ever aslo some nice weather So you're missing that now and then we now find the spring nice spring.

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*Speaker 1:* Indeed, that's what the irony is when the weather starts getting better, when the government starts introducing relaxations. I come here with the high temperature and also with a lot of restrictions. We have full lockdown. Yeah, lockdown at the state level.

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*Speaker 2:* OK, well, good luck with that. When are you planning to come back actually or

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*Speaker 1:* in two weeks time? I'm planning to book a ticket in like in 14 or 15 days, at least by the end of June. I should be there by. Yeah, if if something happens.

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*Speaker 2:* So you might be might be back in time for the graduation. Yes. Yes. I'm thinking, OK, let me see you then.

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*Speaker 1:* Yes, you then by then, thank you. Bye bye.