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Speaker 1: Now, could you please briefly introduce yourself?

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Speaker 2: Oh, yeah, of course. My name is X. Now, I think I was in September, I started my fifth year at Y and my background is mathematics and physics. And before I entered Atlas, I was all over the place big companies, small companies, startups and self-employed. So I come from a kind of different world. Within our program,, I teach mathematics like subjects and guard students projects and mentoring and academic advising.

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Speaker 1: I think we are all I think have, you know, in at least most of us do not have a very proper street, a kind of a journey. All of us have different.

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Speaker 2: Yes. Yeah, that's nice.

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Speaker 1: Indeed. So yeah, my first question would be obviously about higher order thinking skills in your definition or in your context of the course. What would be your definition of higher order thinking?

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Speaker 2: Yeah, that's a good question, because I don't. To be honest, I do not exactly know what you mean by a higher order thinking skills. So what I observe as students is that most of them are very good ultimately at, say, solving problems using kind of template finding and integral. So for me, the differential equation is always the same template and. That is, for instance, very different from the course, from a course like programming, where there is always creative step involved going from scratch to something. And if you and if I do courses that involve modeling steps, modeling of problems, then. Yeah, if students have some experience in, say, doing the template form and done, they can come sometimes to a model that falls into the template, for instance, if they have quite some experience with solving First Order or differential equations and they got some intuition about what it is and what the solution is occur and that it is related to change, and then they are able to say recognize that in a particular fiscal problem. Oh, then it would be a good means to model that. So I'm not sure whether that is a higher order thinking skills. I'm absolutely unaware about the meaning of that word and. So maybe you should help me.

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Speaker 1: Certainly, yes. So there are different theories and assumptions about tighter thinking skills in general that is widely probably discussed in the educational setup. Context is you might have heard about Bloom's taxonomy. So one's ability to just remember, understand and then analyze and then evaluate and then create is considered to be one of the higher form of thinking. So this represents this taxonomy represents the cognitive processes involved in obviously combinations of separate, different processes in in cognitive processes, good form, complex critical thinking or higher order thinking skills in in in different context. For example, in one context, I might be using more analytical thinking than creative thinking or creating something that would be more suitable for it. And in other contexts, I would be creating more than critically analyzing. So it is. It has a different

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dynamics, but this is a general taxonomy that kind of is used as a base. . So so from that point of view, obviously, you now have described some sort of behavior that you see from students. You consider that that seems to be, you know, at a higher level. So how would you then verbalize now if you try to reflect on their behaviors from this point of view, how would you then formalize it?

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Speaker 2: Now for former us, in what sense, so I observed that most users have very much difficulty with creation, so if not, so if I understand you correctly, the higher on this blooms taxonomy does this what you mean by higher order thinking skills? Is that clear?

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Speaker 1: Yeah, it could be. I do not just want to restrict that to the context of Bloom's taxonomy. Examples. So in other way, their ability to think automata level other than what you provide as a foundation for the course, what they can actually build on, what you provide with them. So these kind of things, as you see from your own class rather than, yeah, I just do not want to give any perception that is why I did not give you any information as well regarding this.

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Speaker 2: Yeah, yeah. So I'm always surprised by how much difficulty humans have with the creative part. So and thinking out of the box and making solutions that are not. So most of us, as I said, most humans are able to apply a certain schedule schema certain template for solving typical types of problems. Some students are able to analyze, say, properties of the solution or properties of the problem or properties of a physical problem, and that might be related to, say, mathematics. But very few students are able to create something new and. Also in the design projects, for instance, creation is often. Connected to, say, to the design sketching. But the core of the solution, say a mechanical device with a really clever functioning over a new type of apparatus that's almost never been found. So, so so the creative and the associative aspects are certainly important for the engineer is instant. And they are a bit missing and. I don't. I do not know really how to train them, how to. Stimulate them because, well, they need all the time for, say, the standard material. So maybe what I was. I also sometimes tried to. To investigate what can you, for instance, refrain from , in a mathematics course or physics course, can you refrain from all these standard things? And just let them start with a small problem without having the mathematical background and see how far they come. And that works to some extent, but that requires much more time than you no time to cover. But they were you if I should cover us or what is expected. Indeed. And at the same time, you can also say, well, change the learning goals. So don't expect that they are able to solve a wide variety of ODE. But do all learning goal that they really understand what is an ODE?

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Speaker 1: So, um, so my next question is basically on the learning goals. Do you make those skills that you just mentioned? I assume that these, for example, creative or associated skills are the skills that you expect from your students t reach out, you know, understanding of your concepts and able to apply at a higher level or at an advanced level. And if you can add a bit more on that question as well, it would be nice. But my question is following up on that. Do you make this as explicit learning goals and evaluate them?

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Speaker 2: No, not anymore. Because in most courses, there is a kind of expected amount of techniques. But they should know, and that covers all the time, so. And I had often discussions about, for instance, about the concretely the mathematics curriculum for an Atlas student. So maybe you could ask what assets you refrain from all the techniques that focus on the understanding of a concept. the full understanding and the ability to relate it to and I say, application problems in the outside world. I. But that requires a. Decision program wide, what are your learning goals? Yes, so the learning goals for mathematics are more are quite straightforwardly derived from what is required for an engineer. Yes. And if as if we think as atlas that we should prepare our students to partake in any master. Then you have a completely different set of learning goals because then you have to cover all the standard calculus, for instance. Yes. But if you position Atlas as a program that really guides, really educates the holistic engineers system, then you get there, you get much different learning goals and then you are able to redefine the learning goal for mathematics. May maybe use much more programming. So the mathematica like tools? Yeah. Yeah. And. Well, one of the courses of ideas, creative learning goals and associative learning goals is dominant in the programming course and because there you want to, uh, to create something that's not yet there you have an empty screen and you have to make something and that works that's something that you want. Yeah. And there is much creativity in there. There's no general template. So then more than half of the students struggle.

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Speaker 1: great. Thank you. I'm just going back to the the obviously there is a time limit which cannot be ignored at all. So yeah, I would come back to that question later before. I just want to clarify a few things when you told about creative and associated thinking. Do you have some sort of definition that comes based on your experience? Just basically, yeah, that is in the context of mathematics or physics that you teach or it is more general definition that you have.

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Speaker 2: The definition of what exactly of associative thinking

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Speaker 1: is the thinking and creative thinking that you mentioned earlier.

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Speaker 2: Oh yes. That is to. That's a good question. And. So associative thinking, I would say that is to apply and knowledge from one domain to a totally different domain, it is analogies, for instance, or assocaitions and creation is to make something that is not yet there. And. So I that it's not a very sharp definition, I guess.

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Speaker 1: No, I mean, I don't need a quote or definition. I just want, you know, I want to understand your perception regarding these terms. Okay. Well, see when you expect what you expect from students exactly to perform. So that is somewhat clear. So you want them to create something new with what you teach them, not just what you teach.

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Speaker 2: Ideally, yes.

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Speaker 1: Yeah, that's nice. So in the context of this, obviously not all the students are able to perform at the expected level. You mentioned for teachers, time is one of the constraint that you cannot focus too much on developing such skills while you are also supposed to cover the materials. But from students point of view, what do you think are the challenges for them to develop such skills? What limits students?

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Speaker 2: Oh, I think there are two things that limit them, first is the expectations that they think they have to fulfill and they think they have to be excellent and cannot fail. And. And therefore are very focused on getting a good result instead of getting a nice learning experience. And they are also assessed on the results. So they are right basically in their assumption, and that makes them scared. scared to explore like A. And like a child that just explores and tried things and fails and tries again. I think students assume and I think they are right that they don't have the time and also not the safety, the safe environment, and they feel that they have to get this positive BSA one. And so they are at all points and moments in their ATLAS career or in their bachelor career or university degree. They are assessed every time. And. I think that that that limits them.

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Speaker 1: So and what could help teach us, apart from time, let's say that we we may not be able to add more time to the day at the moment. But apart from that, what could help teachers in helping students to develop such a level of thinking skills?

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Speaker 2: And. There are also several aspects. One is give teachers full trust across the program, so. Also in assessing the students. Ensure that you hire the right level teachers and then leave the assessment fully to them and so that they can also little bit experiment. And that they also don't have to assess students at the end of the day, all very well detailed learning goals, etc. So that's just one. So I sometimes compare this say in the early days of Atlas, I think I experienced a little bit of the initial energy that was in ATLAS t. Then there were all kinds of initiatives. It was kind of chaotic, but say a couple of mad scientists walked around and interacted with students and just challenged them and live brainstorming and working on problems. So there was an atmosphere of energy and spirit and creating things and just trying out without having these detailed assessment every time, without so many deadlines, without so many gates, they have to pass and. I think that would at least that would help me very much.

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Speaker 1: I I kind of relate because of the dude that I come from or I came from. So it's somewhat similar in so it offers a lot of freedom and provides a lot of stimulus and opportunities for students to go. And yeah, in an interdisciplinary environment. Mm hmm.

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Speaker 2: Hmm.

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Speaker 1: Yeah. That I can just relate to that. OK. So, so such level of things could help. Do you believe that these things could help teachers in developing such a level of thinking skills

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and not just the content knowledge? Right? I understand that. Yes. And my next question is about interdisciplinarity. And section on higher order thinking skills, it's been actually surprisingly very short. So they do we will not take much longer. So what does interdisciplinarity mean to you? How do you define it?

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Speaker 2: Now, I find that very difficult, because naturally, I am. Maybe I am. I always approach problems without having a specific discipline in mind. Hmm. So. And. I would define mono disciplinarity in the sense that you take only one set of paradigms as a starting point. And interdisciplinarity if you don't do that. So, yeah, I always struggle with this with this concept of, hey, you have the interdisciplinarity and there are other forms of disciplinarity and Margoth told me some times about that. I always struggle about it. You just have a problem. And well. That's it. And then everything you know, or if you are with more people, everything they know comes together and maybe that's interdisciplinarity using different backgrounds of people. And I would also not say I'm not sure whether I am disciplinary, so I have a mathematical background, but. That's more of a way of thinking kind of structured of thinking that is that I use, but also coupled with a little bit of intuition. Hmm. So I don't know. I don't know what it's exactly disciplinarity and also not exactly what is interdisciplinarity. OK. So I'm afraid that no one should help you much with that. No, no issues.

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Speaker 1: So but then if if you do not have a clear view on interdisciplinarity, I would you then say then you do not have a clear view on the distinction about disciplinary practice and interdisciplinary practice as well.

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Speaker 2: No, no. Also from my background, I've always been in people in projects with a multitude of aspects done by a multitude of very diverse people with very diverse backgrounds. And that's.

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Speaker 1: So you then automatically then would you say that you performed at interdisciplinary level? Do you think as an interdisciplinary researcher, or academician.

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Speaker 2: Yeah. Maybe I have a kind of. Way of thinking that this a be structured focus on analysis. So I don't know whether that's a discipline. Otherwise, I would say. Yeah, and. Now, maybe. Maybe in a different issue, maybe it's

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Speaker 1: nurses don't don't know. Sorry. Yeah, so I can then move on to the final thing, which is about metacognition. Are you familiar with this concept called metacognition? No metacognition. Obviously, we all know that. But yeah, the term is something which is kind of alien is defined as one's ability to think about their own thinking, which is to have a conscious reflection on how you think and how you behave with this definition. I just want your view as a teacher in mathematics course physics course. How important that such level of metacognitive thinking skills are for students.

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Speaker 2: You know, it can sometimes help you students if you can explain the way I think about finding a solution, for instance. And so it's I think it is. It is helpful to show them. That I have a certain approach to some problem, but it is also dangerous in the sense that they should not try to mimic my approach because, well, they can have a different approach, which is equally good indeed.

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Speaker 1: So when I mean metacognition, I mean, it's the student's ability to even reflect about their own thinking process as to how they solve problems and what kind of reasoning that they used. It's similar.

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Speaker 2: Yeah, that is important. I think that they are able to do that because

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Speaker 1: in your course, do you believe that you teach them explicitly in other courses, also based on your observation and experience?

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Speaker 2: I almost always ask them to explain how they arrive at a certain solution and to explain that in plain English. So not only formulas, but they have to explain their thinking. that's the learning goal often.

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Speaker 1: So then you evaluate their ability to kind of reflect and analyze their own thinking reasoning.

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Speaker 2: Yeah, but on a level that they should explain that you tell me. What is the solution strategy and how they think they are not required to? reflect and improve that as learning goal, not so it's on a first level.

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Speaker 1: OK.

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Speaker 2: They must explain it to me. Mm hmm. It's nice if they can reflect on that. Mm hmm. But that's not required.

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Speaker 1: That's nice. It's just for my final question is. The I in the beginning, you mentioned about associate skills, creative skills, and now I would like to see or ask you. If that it would metacognition developing such reflection skills would help in improving these skills, such as associative thinking and creative thinking that you refer to.

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Speaker 2: Yeah, it might help. Might help, but it has also a danger here in the sense that this again, because the kind of framework this is where I say what I think we should hope most will help most is that they've got a different attitude towards exploring and failing and trying and getting some confidence. And just more about the environment they're in.

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Speaker 1: Indeed, indeed. I totally agree. And I think we've covered most of the wait Let me just cross check it, most of the questions. Yes. Yeah. Thank you very much, Martin, for your genuine participation, obviously, and it helps a lot. And yeah, once again, thank you. Do you have any questions and comments? And for me that

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Speaker 2: I hope that although I will, I'm not so familiar with the exact concepts, and maybe I hope that nevertheless help you a bit. Indeed, indeed. And your thesis

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Speaker 1: certainly does contribute to so yeah, thank you very much. OK. Yeah. Then I would like to then stop the interview. Let me see.