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Speaker 1: So can you briefly explain yourself as to what you do and what you teach?

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Speaker 2: So my name is X, and I teach mathematics in a class in the first semester and the course that I teach you some introduction to calculus and linear algebra. And I also give two elective courses for calculus two and more advanced linear algebra. But basically, the main course that they have you seen semester one

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Speaker 1: is the great. So obviously, your mathematics at the very young concrete subject to teach and also abstract for students to understand. And because a lot of, let's say, imagination and abstract thinking to understand most of the things. So how in the context of your subject, how do you define higher order thinking skills and what is your idea regarding these things?

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Speaker 2: So I think I am lucky in this part because the first degree that happens in physics, if I continue with my master's and Ph.D. in theoretical cosmology, so that was applied mathematics. So I think that's the way that I teach. Actually, we are not expecting from students to have any definitions or we are not giving them any abstract theorems. You know, we just make sure that we give them the basis and let's say the rules. And then after that, we just ask them to just be building on knowledge. So for example, when you want to describe limits for them, we try to show them what is the meaning of off limits? I tried to use an example. And then it slowly, slowly we tried to build more knowledge and give them more advanced examples. So we are not. At least this is how I teach. And I think also Martin has the same way of teaching. We are not emphasizing on theorems because this is, as you said, abstract. And to be honest, I never use theorems in my life. Maybe I just wrote one or two of them in my Ph.D., but this was just my basis to continue. You know, my Ph.D. work. But for students, I think the main idea for them is to understand what is happening, recall the theorems, but not rewrite. So I will not be the teacher who will ask them, OK, write down these theorem based on the definition of limits. I will never do that, but I will ask them using the definition to solve something else. So I think this is a better way to approach students with math because they do have math and physics at the same time. And I think the reason is that the way that it is traditionally taught is, as we said, we just give you theorems solve samples and back to it. But they cannot connect to higher, let's say, higher topics or to two different topics. Mm-Hmm. So I think the main idea is for them to have the basis and then try to build, you know, horizontally and then try to recall when they have, for example, calculus two. I always ask them to recall what we had in Calculus one, or when we, let's say, another topic in linear algebra, I was always asking them, Do you remember what we did before, when we will use this as a basis to continue? Yes.

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Speaker 1: So if you can actually make a definition as to a general higher order thinking ability that you know, required across different concepts that you teach from your students what that definition would be?

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Speaker 2: Definition. I cannot think of a single sentence that I am, I'm going to use, but definitely within this sentence I have to use **repetition**. Um. **Practice**, definitely. **Reasoning, maybe, and critical thinking**, so these are the four things that I would like to have in this **simple sentence of definition of higher building skills** so it could keep things in order to, you know, make them part of your, let's say, cognitive part of the brain practice, because this is only when you will be able to apply what you have studied before being able to have a critical thinking because this is how you will be able to apply what you have had in other courses or in other, let's say, fields, not just mathematics necessarily. And I forgot the last one.

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Speaker 1: War would be practice critical thinking, reasoning,

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Speaker 2: reasoning, yes, **reasoning and then the repetition**

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Speaker 1: recognition. So how, in your own words, would you define critical thinking for that matters? I understand repeat repetition and practice. Obviously, it is part of the teaching methodology. And what is your definition of critical thinking?

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Speaker 2: Well, in math, you know, it's a bit different than in social science, because in social science, you need to have. You need to, let's say, to read some literacy that would be given to you and then you have to reflect on that. Critically, what happens in math? I think it's a bit different. **You are given a problem and you are asked to solve it. Critical thinking. So you know that there is a solution. OK, two. That doesn't necessarily mean that there is only one solution, but you are thinking towards the solution critically based on what you had before** and also your, let's say, the **student's ability to um and to understand whether or not they did it correct or not. So I think this is my critical thinking of math. So to be able to solve but also reflect on whether or not this is the correct way of solving it,** I think that they will follow some teenagers. Yes. But then they have to feel comfortable enough that yes, I am doing it correctly or is the result, let's say physical. Because if I ask you, for example, to solve the problem or what is, let's say that the height of the tree and someone comes in says, Well, it is 100 meters. Well, they have to be critical thinking and say, no, it's impossible to have, you know, 100 meter tree. **So just be able to have a reality in there, a theoretical concept as well.**

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Speaker 1: So would you then say **that the ability to connect reality with what they study and reason along critically?** Yes. Yeah. And you also mentioned about reflecting on whether they have actually arrived at the correct answer or not. We didn't say it is not a part of problem solving framework. Yes.

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Speaker 2: Yes.

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Speaker 1: Yeah. You understand and analyze and solve and then reflect and then change, if

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not, OK. And so your critical thinking aspect, or definition probably could also be engulfed by or in the broader context of problem solving in mathematics. Yes.

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Speaker 2: But I think for for most students, you know, it doesn't work in this order because there some some kind of stages. So you have, as you said, the analyze and then you have to make the solution, see the results and then you have to go back and reflect. So for some students, this is not as clear as we can say at the moment. And I think it becomes much clearer after maybe they understand what they're doing after you make it, after you highlight for them that, OK, look, the first thing that you have to do is just to sit and read the problem. Yes, after that, you understand from them, it will not be obvious that they have to follow these stages unless someone taught them before in high school, that this is the way that you have to follow. In the beginning, it takes some time just to show them you don't have necessarily to say, Look, there are six stages of problem solving and you know do them, you just have to show them okay for stage or not even mention the stage. We start by creating the problem, understanding the problem, analyzing the problem, solving the problem, and then reflect if we had the correct solution or not. So yeah, these are all part of problem solving. Not necessarily with this namings, but at least the students have an order.

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Speaker 1: Yeah, indeed. Indeed. I totally understand. So now that I think I kind of have an idea about what kind of skill that you focus on in the broader context of problem solving, of course, and specifically the thinking skills, the critical reasoning, etc. How then are you trying or helping your students to achieve that? What kind of explicit methodologies do you use apart from the content your practice materials? Do you use certain strategies that are aimed at developing, particularly these kinds of things and skills?

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Speaker 2: Well, what I did the first semester, it was actually the first year that I started working. I don't think that I can say that it was very successful because of the COVID as well. So what I always try to do is to give the students a topic and then ask them first to read it and say what they learn from themselves. So it's some kind of a flipped classroom environment. And then when I ask them to explain what they understood from that, then we try to have some kind of a meeting, a group meeting with students to solve them and solve some problems while I'm guiding them. So I used to have traditional lectures, let's say, once per week. And then in the second meeting, we just used to sit together. Ask them what we are. What do you understand, combat or how do you think that we can solve these questions, so maybe give them some kind of freedom just to see what they understood because it would be different for me to just sit and say, OK, this is the solution, and this is how you have to work. So I like to give student some freedom. And also what I use is some problem based learning. So I give them again some kind of a problem that it is applied in engineering or applied in real life. And I ask them to use what they have learned up to that fact to describe peace. But as I said, it was not. I cannot say that I'm one hundred percent. Um, let's say I'm happy with the results because it was COVID. We couldn't meet physically, so we had to try this online. So I'm hoping that this year will be better for us. Mm hmm. So this is the methodology. I try to have a student driven classroom. Mm hmm. I give them the

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learning objectives. They know what this is about. If they want to make an additional the learning objectives they can do so. Otherwise, I just give them the freedom to explore.

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Speaker 1: Yes. Great. So how then would you quantify, you know, such abilities apart from or do you use only your assignment as the indicator? Or do you have any other methodologies that you use to assess?

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Speaker 2: Well, I cannot assess attendance because I'm not asking students to be present there every time if they want to come, it's OK. I use presentations just to see their oral skills and their written skills and their communication skills, and also the way that they interact in the classroom. I show the way that they give answers to problems that they ask them. So this is a way for me also to check on their, let's say, way of thinking. So yeah, I think it has to do with that with not just the assignments or the final exams or the midterms of the problem, problem based learning, the overall behavior of the student. But of course you cannot. You cannot tell them that I'm going to test you if you are, you know, respectful or if you are. This is like a package that you expect students to have.

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Speaker 1: Indeed, indeed. Oh, I totally agree. So then you obviously mentioned that there are certain attributes in their behavior that you expect them to exhibit, which you probably use as an assessment data. Yes. But then those attributes are, would you say then are completely objective and standardized, are based? Or is it based on your intuition and experience that you grasp those attributes when you've been presented?

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Speaker 2: So as you said, I cannot I will then actually put them in a standard, let's say, rubric because every student is different. So I cannot expect, let's say, from the first student to perform, let's say these high and then say, Oh, because I know the second student, I know that he will perform this. So it's based on my experience. I try very hard to get to know each one of the students separately just to understand, you know, a bit of how they think, what their expectations. So I think within one semester, these expectations are not fully covered. In my experience this semester, one student that I had. I know them better now after one year, so I will be much more comfortable to assess them on that. But of course, this is not a legible criteria that they can use. It's not maybe valid as well, because, you know, we are human beings, so one day I might be feeling well and I might see that, oh, you know, everyone is behaving well in the class and well, that other day I might have, you know, a bad day and then I will I will not be feeling well to teach, you know, mentally and then I will think that everyone is not participating in. So this is why I don't think that these are criteria to be tested to students because you are asking them to be part of a certain model that you want them to be. And this is exactly the opposite that I want to have. Everyone is different. But it's my past as a teacher to have ways to extract those differences from each student. Yeah, and doing it online, it doesn't help. That's why I am hoping that physical, it would be able to see those reactions.

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Speaker 1: Yeah, no, no. I totally agree. The online modalities, it is not even easy to observe

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whether the student has a good understanding through expressions and everything. So what could help in that regard? For example, you said, obviously it is based on your experience and your personal mood and your mental state could affect at the moment, you make those judgments and assessments in order to avoid that, but still be able to give some sort of personal evaluation and understanding what kind of things could help a teacher like you.

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Speaker 2: Well, to be honest, before COVID I, we didn't think that they have a bad day in teaching because, you know, I I honestly did not have. Maybe I just woke up a bit later, but that was the main problem that I had as a teacher. Or, you know, the kids didn't go to school on time. So I was late at work, maybe five or 10 minutes, but that was the issues that they had to deal with. With online, the mental stability of, you know, me as a teacher changed because I started questioning myself, Am I doing it correctly? Do they understand? So I started judging myself as a teacher, and I think this started questioning myself to the extent that I was able to do that job. And for me, what helped during this period was that UTQ courses that I was taking because I get to know, you know, the methodologies. I got to see how to design the course, how to design a lecture. And at the end of the day, I said, OK, I'm not. I don't suck that. You know, I I am good actually at that. But OK, this is how it is. It is meant to be when it comes to professional and academic standards. So taking courses really, really helped me. And when it comes to my own, let's say, as mental stability, I think it has to do with the online. I'm pretty sure that, you know, if we go back, I will stop judging myself because I will know that, OK, I will take this. As I said, the reaction from the student and I will know immediately that I have to repeat this, or they understood that. So for me, what is what is essential is to improve myself as a teacher. That's why I always want to have more courses when it comes to education. Um, yeah. Just to feel confident that you know, you are doing things in the correct way and.

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Speaker 1: So, for example, professionalisation continuous professionalization could help. Which enables you to get the state of the art, probably understanding of teaching and learning methodologies so that then you would like to feel confident about your judgments when you make it. So my question is again regarding that. **What kind of things could help you gain confidence if you can, you know, I'm just trying to push you a little bit further.**

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Speaker 2: Gain confidence. What they used to do before, and I used to have, you know, everything ready. So every assessment ready, every solution ready, and then I was confident that they have all the materials ready from September and then I said, Okay, now I just sleep at night. This is what I used to do before coming in atlas. So I tried to do it in September, and apparently it doesn't work because I had different question levels for different students. So I cooled and align the preparation that I had with the level of the students that I got. So I will feel more confident. I think if I stop doing that, I cannot prepare the whole semester prior. I just need to maybe make the first three weeks and then once I get to know the students align what I am going to teach on their level. That's why every semester has to be different. So I think this is how I will gain more confidence when it comes to my teaching, but it has to do with the kind of students that you will have. Yeah. And to be honest, preparation of materials. I think you also know it takes a lot of time. And of course, we will feel much more

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comfortable if we have everything ready one month before the actual course starts. But it doesn't help most of the times you just need to make arrangements and adjustments and, you know, add questions, remove questions. So I think keeping track of the material of the teaching material is the thing that will make me feel more confident. But I think it has to do with having more experience with the students, you know, because this is the first time, but that was also exposed to teaching students at honors level. Um yeah, I think these and also gain confidence after I finally understand how Atlas is working, you know, with all these assessments and criteria that we have. Yeah, but I think it has to do with just spending more time here and getting to know it.

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Speaker 1: Yeah, it totally can relate that with my experiences, well. So now, after completing one year, I feel much more confident about, OK, this is what is going to come, I guess at least. So my next question would be on the challenges aspect. So there are certain skills. Obviously, you have a, let's say, more or less. Since it's mathematics, it's very kind of clear-cut even for me to understand the problem solving and the critical thinking and reasoning that is involved in such aspects. And what challenges do students face in that regard? If they you definitely, you know, put the 30 group of students, not everybody gets to the same level. So few students struggle to get to the level that you want them to be. What what are the challenges that they face?

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Speaker 2: So this is exactly what I faced the first semester. So especially you have students that come from high school to university and you have international students as well. So it's not that you're all you have, you know, just have bad students are, you know, that they will have math ability in high school. You have students coming from Europe, you have students coming from India. So they they know mathematics, but in a different way because this is how mathematics was taught in their country. **And also they did not have the chance to have it. Everything that I thought that they had, they had covered. So I had, let's say, in in a class of 38 students, you know, 30 students knew the topics. And then I had to make sure that the rest of the eight students also have to get to know that topics. But it had to be done in such a way that I** was not going to be behind on schedule and no students had to work fast just to catch up. So I think this created some kind of stress because they knew that they don't know this. They have to know this and they have to compete with the rest 30 students in the classroom. Mm-Hmm. Um, so this is immediately why I suggested that we we have some kind of a preparatory course for the students just to make sure that we will handle these situations, and that's why we try to grasp all this year. I don't know if it will work. We will find out after we finalize the semester, but this is some kind of a welcoming course to mathematics. Hmm. So that will start with the basic things that they have to know from high school. If they don't know these four chapters, let's say that I'm expecting that they will do now. Then I will make sure that, um, within three weeks, we will give them exercises and they can have sessions with me or with their teaching assistants that they will have just to catch up. So we fully acknowledge this, this thing. And unfortunately, it's not just not like it happens everywhere. So even if you finish, let's say, high school in another country and you are all coming from the same school, you will have different levels of understanding of mathematics.

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Speaker 1: Indeed, indeed. No, that definitely explains a lot of the things as well. And also, for me, it gives an idea of. About the content difficulties that they have, so they don't really know the concepts that are required to have higher understanding in mathematics. But then the sort of thinking that you expect them to exhibit it kind of slightly differs from the content knowledge. Right. And so from that aspect. So for example, a group of students probably know those basic integration differentiation in concepts that are needed, but still struggles to perform at the level that we expect critically and do such things. So in that cases, what are the challenges or what do you do to actually enable them to reach the same level as others?

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Speaker 2: So what I was doing, I was giving them a set of questions to solve, and I was telling them, OK, these are the easy questions. So these are the medium level questions, and these are the advanced questions you know that you have to reach at the advanced level because of you are in atlas, but you cannot start immediately with the advanced. You just have to start with the easy ones. So for example, in integration, we have substitution and we have also integration by parts that is the trigonometric integration. So they're they're asked not just to understand, you know, how to solve it, but they recognize when to use what. So in order to do that, they have to be exposed to many exercises and many examples. You know, so I cannot I cannot, because what they did, what they did in high school was one question that was arguing and solve the integral using substitution. So they knew directly, even though they couldn't recognize that this is substitution, we had to use substitution for that. So this is what I was trying to implement in my teaching. I will not say how you are going to solve it. You have to be able to have the techniques and then apply them on your own. But to be able to do that, you have to be exposed. And I kept a bit free. There was, let's say, a set of 30 questions, and I just asked them solve as many as you can or as many as you think that are necessary for you. And I think this is where students struggle. They don't know themselves. So one may say I am comfortable in solving these questions? The other will say two questions is enough. The I would say I need to solve all three of them. So they need to know also how to self, you know, study how to make arrangements for their own studies. Because up to now, they had a teacher in high school that was telling them, All of you have to solve these five questions. All of you have to read these chapters. All of you have to perform like this at the end. Between that last, we tell them, OK, this is the basics, OK? And if you want to explore more do that. So we put them in a different, let's say, shoe, you know, we ask them to change the way of thinking, and I think this is what we have to do first. And when their way of thinking changes, then they will be able to follow our reasoning easily.

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Speaker 1: Indeed. I totally agree. So in terms of changing their thinking, I'm I'm I'm not even sure it's changing. But yeah, let's say bringing the thinking to the level that we want them to be at. So do you think those things helped in the sense when you give them these questions to perform on their own level? So did it contribute in changing their thinking, or at least made it explicit that they are not yet able to self evaluate properly, their abilities?

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Speaker 2: Well, I had both cases. I had students that understood after solving, let's say, five easy ones and five medium one, and they were able to identify immediately how the

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question is supposed to be solved. I had other students that solve all 30 questions, but still were having troubles with that. And I had also shooters that were asking me to provide the solution, and this is what I was fighting against. I don't want to share solutions because it means that I am forcing the students to follow my own solution. And, you know, then they start thinking, Oh no, but I just want to see this. The final answer? This is not what they do. I don't want to show you that, OK, this is how it has to be done. You have to think about it. So when they ask for solutions, it means that they are not confident, they're not comfortable in solving. And this is what I was trying to teach them, and I have to repeat this next semester as well because they're asking for solutions. And I was always telling them, guys, come on, use the internet. You know, you can find the solution of the book everywhere on the web. Still, they were asking me for my own solution, and I think they thought that it will be. So I will grade them based on my own solution, which is not true I think on the back of their mind, this is what they were used to. There's only one correct solution, and we have to make sure that we follow those steps. So I followed the course in UTQ, it was called how to activate the learning plane. And basically it was just to **get people and repeat and have such a pattern that will make a strong connection in their brain** and then it would become a habit for them. Hmm. So there are six steps, let's say, of of this procedure. The first one was repetition, and the teacher said, if you repeat things, then you will make stronger neuron connections and then it will it will stick to the brain. So if you solve an itegral 10 times. Then even if you don't know it, it would be here, you know it would be in your mind. So this is one that was also asking the students to go take a piece of paper. Take a pen and write it down. It's not history that you can just read it and then it would be memorized. You have to solve it. And I think this is what math is all about, solving and repeating.

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Speaker 1: Indeed, I agree. Thank you. So obviously, you know that there are certain skills that you expect and you also have to kind of teach them more less. And you also kind of recognize some sort of, yeah, challenges. And also need for change in thinking that requires a certain intervention from your end in order to change the students. **So my next question is how do you select on identifying those skills, those thinking patterns? Is that all based on your experience? Or do you refer to some sort of theories that you use come across for especially, you know, related to mathematics** the next twice your overall understanding about, yeah, the kind of thinking that you want, the kind of skills that you expect.

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Speaker 2: It's to be honest for teaching theories and educational theories. I came across only this semester because it was the first time that they actually saw them through the U T Q and before the knowledge that they had was based on experience and based on what they had with the senior teachers and advises that they got. So I knew how to teach, but it was based on my own equation, you know? So even though now I have read some theories that I apparently am following, some without even knowing that I so I tried to check to check those skills based on different exercises that I am using. Hmm. So you will not have traditional exercises from number one to number 10. Of course, because you want to check different skills, you have to use different questions. I'm not using true or false or multiple choice questions. I only use them now in grapple because it was part of the platform. For me, it just makes more complicated things and I don't want to complicate students with

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these kind of questions. If it is online just to keep them activated, yes, but not when it comes to final exams. So I think I use different exercises and different assessments just to check different skills.

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Speaker 1: I totally I totally understand. And my question was also not entirely about the teaching methodology, the selection of, you know, that yeah, critical thinking, reasoning and problem solving and a change in thinking patterns should occur. How do you come to those selection of some particular things when it comes to higher thinking skills that are many that you can actually list down and there are very complex as well? **My question is, how do you come to this very particular set of skills?**

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Speaker 2: How twice? How do you assess those skills or how do you

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Speaker 1: how do you choose? I'd expect them. So for example, as a teacher, you expect them that this is important. This is important. How do you come to this decision?

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Speaker 2: Um. Hmm. Well, I think it has to do with me as a teacher and as a person. This is how I think that a student has to be so. Um, yeah, I think it has to do with Um. Um, I do not know if it is mentioned many of the theories, but know **based on my experience, I do believe that these are the skills that students need, you know, to finalize calculus one. And I know that this is what they will need in calculus, in calculus three when they go for master's. So I use my own experience when it comes to teaching my own experience as a student.** Of course, they will choose different academic patterns, but at least I know what will be important for them. And I think this is why I chose not to use any theories in math because none of them will have a clear math degree from Atlas or even afterwards.

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Speaker 1: Yeah, yeah. Indeed, I totally I totally understand. I mean, even if you refer to some theories, there will not be much dissimilarities with what we perceive. Obviously, there will be a lot of clarity that you can have by reading those. But in terms of expectations, yeah, I guarantee that there will not be much difference. But obviously, you can improve by referring and reading and what has been studied.

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Speaker 2: I was I was reading more psychology books than actual educational books. You know how to approach students because this is also a gap that we have as teachers. Luckily, because we are younger age, I'm not, let's say, 60 or 70, because when students come and see a person with gray hair, you know, immediately, either they will have respect because of their knowledge or they will just immediately say, Yeah, we cannot communicate with you. So this is an issue I never had because of the younger age that I have. So I was always interacting with students. Of course, I cannot follow the music that they're following at the moment. I don't even know, you know, who are the speakers at the moment. But being able to communicate with was one of my strong points. So, um, I think they feel comfortable to approach me and say, if something is wrong and I think everything starts with

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communication. What I expect from them and also what the students expect from me as a teacher, so the issues I see the key point of teaching

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Speaker 1: my career, no, I totally I still can relate and we are with age factors. You're approachable, obviously, and your mind shift as well. You have not yet fully convinced of your beliefs because you have limited. We have limited experience, so we are still flexible

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Speaker 2: and open to go. Yes, exactly. Yeah.

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Speaker 1: And we are great. I mean, my section about higher thinking skills is almost done, and I just wanted to know a little bit. Yeah, it's a brief section on interdisciplinarity. What is your definition of interdisciplinarity as a mathematics teacher in a class and what skills are particularly relevant for interdisciplinary approaches that you think are important?

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Speaker 2: So I use interdisciplinarity in my elective courses because I had more chance to approach those problems. So what I did that was I was giving am the basic theory, you know, behind the course. And then for the final project, I was asking students to solve based on what they were taught before and also tried to explain the phenomenon, let's say, in real life. So they had to observe, they had to apply, maybe something that they learned in social science and Newtonian mechanics, fluids and heat. So everything was linked. So that's why I gave them seven different problems. And throughout the elective course also, I gave I ask lecturers to come and present, you know, two lectures for them just to show that this is why we apply mathematics. Let's say in the category, this is how we model it. It's not just talking about things you have to be able to see. You know, if you want to model the category, you have to know how, you know, just to start measuring the heartbeat. You know, this is something that might seem dumb, but it's not far from there. So interdisciplinary means, at least for me, the students have a basis in mathematics. They know how to solve things and then they know how to observe. And see how to apply everything from the field of mathematics and physics in real life as well. So if it has, I don't know if it's applicable for social science because there are different kind of theories there, but definitely you can find patterns that can be explained. So mathematics and physics, I think, is the basis for all the other sciences. But I'm not pretty sure if it's the same for for social science because I haven't done this by this. I know for philosophy most of the philosophers were using. You know, these abstract ideas, especially the Greek philosophers, they were using they were astronomers, first of all, they were mathematicians, and then they had formulated all those theories. So for me, interdisciplinary is to be able to have a strong basis in those domains. Mathematics, physics, social science. I don't know exactly where to focus, but then based on their own knowledge, to explain the phenomenon around them.

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Speaker 1: Mm-Hmm. How?

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Speaker 2: This this is how I see it. Yeah.

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Speaker 1: So I'm just having difficulty in discerning how it is different from disciplinary approach, and if I'm a disciplinary expert, I think a let us say from a mathematician, I'll be able to probably explain the phenomenon around me through mathematical terms and the lens of through mathematical knowledge. So how do you do distinguish it from disciplinary approaches. **How do you distinguish interdisciplinarity from disciplinary approaches?**

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Speaker 2: Well, interdisciplinary, I think, um. Yeah, let me see how I can phrase this, so as a math teacher, let's say most of us think that it's important for us just to teach mathematics, and that's it. But being in atlas and being able to have interdisciplinary courses means that you give. Let's say I give a basis for Martin Hoef, let's say two years in fluid and heat, or then shall give some concepts for you guys to work in project. **So we have different courses coming together to serve the same purpose. So discipline is different because for me, disciplinary means that you have a teacher for math and teacher for physics, a teacher for you, Newtonian mechanics and so on. But interdisciplinary means that, yes, we do have these different domains, but each one of us is working towards the same result. So let's say I will then teach something that will be not relevant for Jose to use or if and yeah, I think this is how I see it. We just try to help each other because this is the only way that students will be able to apply those things.**

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Speaker 1: Hmm. Mm hmm.

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Speaker 2: OK. I think that if it's not correct, you can also let me know what is the correct definition. Maybe because for me, this is how I see discipline at having different things interdisciplinary tried to put them together.

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Speaker 1: There is no correct answer for such questions and the importance to be self-reflective, and your view is what important to them for me. So obviously there are several definitions on interdisciplinarity. One of them being is that, um yeah, it is about a problem that needs to be solved with the help of at least two or more disciplines. When you approach a subject that is usually so, you know, so but it could be applied to any extent what does interdisciplinary means. So in order to enable students, for example, a disciplinary with the mono disciplinary background, what could help? What could we do as teachers to help them contain interdisciplinary level where they can apply these things? What do you think is important for such a level of knowledge to attend for students, especially from interdisciplinary lens?

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Speaker 2: And I think it's something that we are trying to work on as teachers. And this is actually what Atlas is advertising about having project. And then, of courses are on the project. So I think it's not just US teachers, it also has to do with the whole curriculum. So how we kind of work together to make sure that we have a strong core, which is the project and then domain courses that are studying that project because this is what ATLAS is about project based learning.

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Speaker 1: Yes.

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Speaker 2: And I think this is what this is not happening at the moment. And this first semester one, there is an alignment for the natural sciences and mathematics. And I'm just looking because I know mathematics and I can understand what is Martin talking about and what is. And you know, I also know what Jose is talking about I know that there is some kind of a connection between social science and project as well. But I think this is the key point behind everything to make sure that for you, let's say, if you're going to teach something in the project, if you are going to do something, you will be able to say, Oh, wait, next week, I'm going to ask Georgia to come and help us to see how we can approach this one. Mm-Hmm. Because at the moment, what we are doing, I don't know if there is a relation between the project and the math that it has to be somewhere. But we're asking students to identify that. Yeah. Whereas I think that in the first and second semester, we need to highlight these things first. So students will cannot make the connection yet because there's let's say it's the first time that they go to the university, first time that they're exposed to problem based experiences. So once we identify that these are the fields that you are using to solve, you know, something in the project. Then when they go to semester three, four, five and six, there is no longer need for us to do that. They can identify on them themselves. Oh yeah, now I'm using this part, or now I'm using physics, or now I'm using, you know, because at the moment they are using without knowing that this is coming from these concepts or physics, this come from social science, they just use this. Mm hmm. So as teachers, I think it will take a lot of years to do that because we need to change the whole curriculum or at least adjust the curriculum. So it's not something that can be done within one semester.

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Speaker 1: No, no, no, no. I totally understand. So much of what has been actually. Yeah, you summarized and reflects. Correct me if I'm wrong in members standing organizational aspect of yeah, the courses are the academic experience is in itself, right? So instead of offering courses in parts, we combine them in the context of project and we try to align the content. So for me, it is more about the organization as to how you organize the academic experience of the students, but then you also have certain skills that you expect as a mathematician to achieve. And likewise, don't you think each different subjects will have different sort of skills and mindset? As you said, there is a need in shift in thinking pattern is required. And have you thought about how to integrate such things on how those things could be developed as it could? **Don't you think it is essential for interdisciplinary approaches as well? Is what my question is?**

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Speaker 2: Can you maybe try to explain a bit more? as a math teacher how I can, yeah, because I don't understand the question.

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Speaker 1: So you have a set of skills that yes, as from your own experience as well, that you think are relevant for it to become good in mathematics? likewise jose will have certain thinking expectations? Martin will have certain expectations just by combining them in

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organizational manner. Do you think we would be able to also align such expectations for students? Are we creating an environment where they can combine those thinking and apply it in an interdisciplinary manner? Wait, let me make it a bit more. Yeah. First step, my first step is, **don't you think different thinking patterns exist in different disciplines?**

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Speaker 2: **Yes. Yes. But I also think that there is a different pattern in natural science and social science.** Yeah, but definitely I can recognize the same pattern within physics and mathematics. Like most of it, is the same. Yeah.

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Speaker 1: So much of it has to do with the close alignment of the content. Yes. Yeah. So those differences in my the a follow up question is those differences, don't you think, are necessary? They need to be integrated as you integrate the courses organizationally as a project, probably. I have now the the the opportunity to ask this. It must be coordinator. Do you think you are not creating or you are creating an environment where they can integrate those thinking patterns? Not just integrating the courses for organizational purposes to create an alignment in academic experience, but what about these skills or thinking skills expectations. Just tell me if you did not understand and try to, because it is definitely and I recognize that

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Speaker 2: I know, I understand, I understand. I'm I'm just trying to think of the answer because. We are we have different teachers in that semesters, and all of us have different ways of achieving those skills. So as Georgia, I have to put these these and that, and I think that I would like some. Yeah, of course we have the learning objectives with that, which are the basics, you know, and this is what I'm using every time and this is what everyone is using. So this is, let's say that the pillars, because we are based on that, then we we use our own teaching style to approach those learning objectives and then have students obtaining the skills. Yes. I don't know if. You know, so you mean, as teachers standardize those ways that we used to for students to have their critical thinking skills or.

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Speaker 1: So what I'm asking is, is it enough to have those individual experiences for students to perform at the combined level that these subjects interact in the context of, for example, the project? Do you think those individual experiences are sufficient for students?

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Speaker 2: Oh, **so I will say no, because this is why we need to make sure that we emphasize when we do something that we know it will be used in mathematics, in physics, then I need to emphasize it as a math teacher,** but it doesn't have to do just with courses. **We thought of having the modelling course now. It would be an extra course in semester one, and this is how you know, they will use all the competencies they have for math and physics.** But still, again, there needed to be something to implement social science as well. And I don't think that those skills can also be only gained through the courses. So as you guys said and you are also doing that in the project, you kind of have workshops **so you can train students outside of their books, you know, so outside of the domain courses.** So there are many and **as much times as students are exposed to different patterns.** Yeah, the best will be for them because

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that is one. They will not get one hundred percent from us that we looked at 100 percent from physics, but at least this 50 percent from one course, 50 percent from another course and then something from the workshop, then it has to do with their own thinking on how to put this together. You cannot do it for student to just provide the information for them. You try to make sure that you align them together. But how the student is receiving this information is up to that need. So domain courses, yes, interdisciplinary courses, all we have to work together as teachers to gain the semester goals as teachers, but also we need to have some extra activities that will not create load for them. So how to help them, let's say, study. This is something that they need to then they need to have because they don't know. So either it was they were trained or they have very good time management and they know how to do their load. Yeah. Not just this study with impact, because you can see two hours in front of the computer you thought you knew everything. And then when you come to perform, you know, nothing. Yeah. So there are some kind of skills that us as teachers can help them gain, but it doesn't have to do only with us. So it has to do with how we as a community interact with the students. And what else we offer them?

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Speaker 1: No, indeed, indeed, indeed. This is what I just I wanted to understand about interdisciplinary aspects of this. There is, yeah, I also recognize the same. So that is what I wanted to ask. So how can we integrate not just academically the subjects in terms of organizational fashion, but also at a very conceptual level that students can apply those individual skills in an interdisciplinary fashion? And yeah,

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Speaker 2: I think it will be good. Maybe we can also ask I don't know if it's possible to have this. We could have some kind of a seminar so Fridays are completely free. So instead of asking students to have a deadline, we can ask them, Okay, we all go to Dreinerburgh from nine to five and we have a seminar on something, or we ask you guys to work on something so you work in groups. So not every Friday, but at least eight times in the semester, it would be nice for students to know that we have this thing. So but we, as teachers have to sit together and say, OK, what can we do in semester one for week 37? And then, you know, we have these talking all, but I have a deadline there and have a deadline here and we don't have time and we create stress and we create chaos. So either we need to continue pushing things towards one direction or you just give up and say, Yeah, you know, just do whatever you want. It's OK,

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Speaker 1: maybe I can probably help. This is apart from the interview in the context of our teaching, maybe in the second half of the semester or, yeah, let me see because I would be developing a few things as well. So if I can help students to gain some knowledge and exposure regarding this, along with that, obviously Dr. Boon, not an expert in those field and other philosophers, probably researchers. Yeah, let's let's think about it. How we can actually

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Speaker 2: make it would be nice to have invited speakers every Friday, not just from Project. We just ask one person to come that will align everything. I don't know how we can do that. Um, but yeah, it would be nice for them to be exposed to different things.

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Speaker 1: Indeed. Great. Yeah, I'm almost at the end of the interview. One final question, which I know probably the answer as well. But anyway, I'm going to ask, are you familiar with the the concept called metacognition?

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Speaker 2: Metacognition.

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Speaker 1: And how do you see it as relevant for Mathematics and to develop our thinking skills? Hmm.

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Speaker 2: OK. I was not expecting this question. Can I get let's let me think about it, that meta cognition and math? Yeah. OK. I am. Right. I think that how to help them. So basically, students. Yeah. Metacognition is all about, say, our students being aware of what they're doing. But this is also something that I think that they already have in math. I don't know how I can explain this now. I think metacognition comes maybe at the end of the phase that we discuss in the beginning when it comes to the reflection, because for me, this is the main idea. So they go through a process at the end using metacognition if they know that they had it correct. It means that they are fully aware of what they have been doing, if they have thought about it, then they go back again and start solving again. **But I don't know if each one of the students has these specific skills of being able to be aware of what they are doing correct or not.** So it's definitely one thing that can be **we can train students to have.** Yes. Um, yeah, but for me also, it aligns with repetition, so the more they repeat, the more mistakes, the more they practice, the more aware and they will become of the problem and the more able they will become to solve it. So I think this is what meta cognition in mathematics is about.

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Speaker 1: No, I totally understand. I mean, I agree. I mean, if I understand correctly, you are of the view that it is an important skill and that students need to double up. And not everybody is very good at that. Yeah. And so repetition is important aspect. Where I have actually a difference of opinion is that repetition makes things more routine, more automatic, and meta cognition in definition is opposite to routine. It is more conscious about reflecting on everything from the scratch. So the more you repeat, you become faster and you stop reflecting without reflecting. But you will be correct most of the times. But if any one parameter changes at the end, you will be able to recognize it through or metacognitive thinking odd in the reflection stage by doing it properly consciously. So that is where the small difference that I wanted to actually offer.

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Speaker 2: Concisouly Yeah, yeah, I understand what you mean, so you don't want it to become some kind of a pattern, you want students to be able to critically think on that sort of petition means that. Yeah, OK. OK, so maybe **what I can correct here is to repeat, but in different exercises, let's say so they repeat the same thing integration, but in different level of exercises.**

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Speaker 1: Yeah, I agree.

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Speaker 2: Totally clarified. Yeah. Not OK. Yes, exactly. So this is actually what that application means for me. Not just, you know, sort of the same exercise. Ten times, yes, a different set of exercises, but repeat the pattern.

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Speaker 1: Great. No, actually, it helps a lot. Thank you.

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Speaker 2: OK, now I got it. OK, I'm still confusing the terms. You know, I yeah, I'm I'm a 50 person, you know, I don't have a lot of word for.

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Speaker 1: I'm really glad that you're actually glad we have this opportunity. It would have completely changed my understanding it's not. So thank you very much. I think, yeah, that's it. We are at the end of the interview. And thank you very much for genuinely contributing. It has been a pleasure and glad to know how you teach and what is your perceptions regarding and also your self-development. And I have actually learned a lot and very inspiring conversation altogether. Thank you very much.

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Speaker 2: You're welcome and you can have the same interview again next year in December. I'm pretty sure that things will be completely different. You know, we will have we would be exposed to physical teaching. So maybe you're just not afraid.

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Speaker 1: And I'm actually will actually create another interview where I would mostly understand the needs of you as a teacher. Maybe then to create much more relevant tools that could probably help you. Yeah, it's more of that research. But for now, yeah, it has been a very helpful and enlightening interview. Thank you very much.

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Speaker 2: Thank you. Have a nice day, and I get going on Saturday to the graduation.

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Speaker 1: Yes, I am.

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Speaker 2: OK, so I'll see you there.

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Speaker 1: I have to read two auditions for some students on behalf of Margaux, but I haven't yet gotten anything from what I have to

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Speaker 2: like when they're drinking cocktails. OK.

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Speaker 1: So I guess in and see you on also your podcast that yeah.

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Speaker 2: OK, bye bye.