**Interviewer 1:** Um, do you have the questions?

**Interviewer 2:** Yes, I do!

**Interviewer 1:** We have had our first interview with Arne, and right now, in half an hour, we have our second interview/design session. We were especially curious as to how the interactions and the lessons you give go. Could you describe how that goes?

**Mathematics professor:** Uh, first, can you maybe give a little bit of the background that you what you are doing with Arne?

**Interviewer 1:** We’re from Industrial Design Engineering, and we do a project, which is called design for specific users where we have to – or we all get assigned a specific user with some kind of interesting situation

**Mathematics professor:** That's very interesting.

**Interviewer 1:** And um, we didn't have to design a product that supports them in some way, but depending on your case that will be vastly different.

**Mathematics professor:** Is there any product that you have designed so far for Arne's case?

**Interviewer 1:** For Arne’s case, not yet. We've made some quick paper prototypes just for just now where we have printed out numbers and things, but we're still in the exploration phase of it all.

**Mathematics professor:** Okay, games. So maybe a game for him. Yeah, yeah, okay, yeah. So, could you ask again?

**Interviewer 1:** Sorry, uh, yes, we were wondering, because, his dad told us that you give him lessons. We were wondering, how does that go? Does Arne come in this office? Or where do you do those lessons?

**Mathematics professor:** Yes, Arne comes in here necessarily, of course, with one or both generally of his parents. His mother reached out to me and said that they were interested in getting Arne into the Calculus courses that we are giving. And I thought it was not a good idea because this course need some background knowledge, and then after that they have attended one of the tutorials that I was giving, and Anna was there, but it was not a lot of explanation. And if it is a lot of explanation, still, I don't know if Anna would be interested because his span of attention is much shorter. Then we decided that I can support him to my Capisti's. But I think we can call him gifted. He's gifted. So he comes here with his parents. He's generally interested in the things that are here, like this thing. He just directly comes in and then takes one of the board markers and then write some things on the board. He's also interested in that pens there and then in the back of black thing, and it's just like how we left it he likes to because these are. Just different, how do you say different pens to draw and they have different different thicknesses: HB and 3HB or something like that. He likes to put them in order, so this kind of thing. So that's how it goes. And the oh, the first thing that he does is write something he knows what he learned from the previous to this current meeting that we have. So, do you provide him with, like, potentially homework, to bring home and then bring back to the meeting? We are kind of exploring how we should structure this. These meetings are like half an hour things and. And this, this was the second such a meeting. My first meeting Arne was here, and I met him, and then he was at the tutorial and the first teaching meeting was like I gave a curriculum like for Arne. For learning mathematics because Arne has a different system in his mind, as far as I know. But this doesn't necessarily always align with the real mathematics or the mathematics that we are doing. Sometimes he has different systems. Uh, shall I write some examples here?

**Interviewer 1:** Oh yes.

 *\*Mathematics professor starts writing on a paper\**

**Mathematics professor:** Maybe he says he wrote first, a system like this: three in all the corners. There are things, but then I was asking him what is 3 to the power 3, and he really knows this. And then 3 to the power 5, etc. Then he started to write 3 to the power 3, 3, 3. Of course, this is such a big number that he doesn't know, but he doesn't know that this is not equal to three to the to the power 3 plus 3 plus 3, you know. This is another system that he thinks, this is another number than this, and I don't even know what this 3 in all these 4 corners there are 3`s, I don't know. He has a different mindset. So, unfortunately, or fortunately, I do not know, he has to learn how to communicate these things. That's why I said, okay, let's start with a curriculum, so I made a curriculum, and then we started with fractions and their decimals, etc. All these things. Mainly, let's say. The concepts of high school because he's interested in Calculus. Then he came here. It was the first meeting. Our first teaching meeting. Then I asked them to get him to learn some questions and stuff like that. Then he was writing this: Half was half of this one 4th, plus half of this. Always taking half of this. And then he wrote dot dot dot. It's all here in his notes, and also I didn't take this. And then he wrote 1 over to 2 to the power n is equal to 1. Now, I was thinking, okay. I wasn't expecting him to to write this, of course. I told this is a great way of thinking if you know fractions. And if you know, I was like preparing to explain him how the fractions work, how we do the four operations with this, but he went to this one. So I thought, and then this is a summation signal, and then we have to take the limit when n approaches to Infinity and then to the power n. This is equal to one. This is not equal to one. Okay, yeah, okay, it is, but he wrote something, like, not very uh, perfectly in mathematical terms. So, and then I thought, okay, he needs some some more notation, like limits. He needs to understand limits and summation sign all these things. Then, I thought, okay, we can really actually start with some Calculus concepts. So, if I try to show him something, he really grasps it. He looks at what I'm writing or what I'm saying, and then if it is interesting I see him looking, and otherwise he's writing something, and then he's sometimes interested, sometimes that he's coming, and it's more like in the face, like in the moves like, I'm talking to his parents. And he's around. And then I after this. I, I thought. Maybe we can start with some pre-Calculus things, so I, I wanted to teach him some trigonometry, but for that, I need some properties of triangles. I had homework for him in the last one. I had a drawn a rectangle on grid paper, so there were squares, so I really need to counted them. He likes counting, and then I said, okay, this is six by four. So I looked at the area of it. And then he really came to my lab, and then he was like drawing other different rectangles. He likes to do his own thing. And then I really thought, this is the then the area is 24. Okay, you multiply this or you count the squares I was showing you. Then I was about to show him, but then I almost lost him. And then, I was like, he was drawing different, uh squares. These are also his, but that's that is not here. He was also drawing different rectangles, and I said: one second, if I divide it by half try to him to understand the area of the triangle is half area of the rectangle, and then he was like one second. I had to really keep him, and then he was like looking, okay, what am I doing? And then he understood it. And then he's gone. It's like, and I thought that I, I could also talk, talk about solving all these things. No, that was. That was too long.Then I gave him homework. Now, next time, what I will do is to, I will show him some unit circle, uh properties, and then introduce him the trigonometric functions. But I mentioned it, so I am sure he will be coming here with having studied them.

**Interviewer 2:** That is very interesting.

**Mathematics professor:** So, he likes homework, and I try to give him homework. But I also, for instance, I cut a triangle, and I cut all these angles, and I put them together, and I showed them with a tape, and then I showed: Oh yeah, look, this is at the right, so it's inner angles, some up to 180 degrees. I showed it, and then he was, like: oh, wow. he really enjoyed it. He likes this kind of hands on materials to be used.

**Interviewer 1:** Okay, yeah.

**Interviewer 2:** Do you think that there is some sort of tool or product that we could create, that would actually help you in these sessions. You're saying that he really likes practical things to help for him. But, that would kind of keep his attention. So, you're saying he really does like playing with practical objects to help with the learning?

**Mathematics professor:** Uh, yeah. Well, I didn't meet him for a long long while, but I think he does. He likes to do it himself, and this was interesting, but because I cut it and then these things, etc, etc, because I think he's mathematically he's with with the screen alone generally without me. And here there were these things, and then someone is cutting something, Etc. Okay, can you ask again?

**Interviewer 1:** Something that we could make exactly for a project, but that would make it easier or support you in these sessions.

**Mathematics professor:** Oh, there can be many things these are there can be. Yes, there can be many things actually, but is it specific to Arne, or is it? It can be also something that we can use even for high school level or say at the university level. There are many activities for teaching mathematics. For instance, in the complex numbers or in the unit triangle, they make, from I don't know some tools, a unit circle, and then they look at, how do I say this? There is this unit circle, they create such a thing, and then this is the cosine. This is the sine, so they look at different different angles, and then this would be the shadow, of course, and the shadow would be cosine or some or the length, and this would be sine, and this would would be tangent, and then to show these kind of things. I think I'll never be really interested because now he can think about angles and he can think about trigonometry, but he doesn't know trigonometry someone has to tell. Okay, this is defined as cosine sine blah, blah, blah. So there can be many things actually. But if, yeah, but don't do the unit circles. Once he is here. People have known, for instance, it can be in a lot of geometric objects. you can create a lot of things. And if you need to create such a thing, I can also direct you to some sources.

**Interviewer 1:** Right, because I think the problem with such a thing would be that Arne is very quick and understanding and grasping such a thing, so we would be done with such a thing quite quickly.

**Mathematics professor:** So you want it to be sustainable.

**Interviewer 1:** Yeah, at least at least for longer than once or twice, we were looking for something like that.

**Mathematics professor:** So, maybe something you can that Arnie can use more than once?

**Interviewer 2:**We're moving into making something that would be a type of building block for him to then create potentially his own questions or problems with. With something you said, would you find something like this useful?

**Mathematics professor:** What I know for us activities in mathematics, these are to use in the next class for a teacher. But if you are looking for some such solutions, so it can be sustainable. If a teacher uses this, but if if you want to design something specifically for Arne and then for his specific use. Then it can be some mathematical kind of game. I can imagine or some some pattern finding thing, like, I don't know. Maybe I was, I was at the Asian Museum. There are a lot of things, and I'm sure Arne will be thinking of a lot of things. He also, when it was geometry last time he he came before, and he also liked I see to create a lot of triangles and the shapes with the triangles. So it became almost a circle. A product. I say it's a difficult question. I have to think about it.

**Interviewer 1:** It's a very difficult question. It's like our project pretty.

**Mathematics professor:**  Yeah. Yeah, look. That is also what Arne was drawing, so it's like. How do you call it? These shapes are all unique, and they are created by 5 squares. And then together, making them together and bringing them together, it's a known game before

**Interviewer 2:** Tetris?

**Mathematics professor:** No Tetris. No, no, not Tetris, bringing them together there are different shapes, the shape is shown. But you do not know how it is created, and you need to make the same shape. Is already there, but you can also think of such a game for Arne. Um, yeah. Inspired by such a thing? I don't know, the name of it.

**Interviewer 2:** Have you seen him stay quite busy playing now, or just from what his parents have said?

**Mathematics professor:** No, his parents said that, and then he was drawing there.

**Interviewer 2:** So, what would you say is the biggest? Well, I know, you've only met him once or twice three times now. But what would you say makes it the most challenging when you're teaching him? What could be improved upon?

**Mathematics professor:** It's another challenge I see. There's Joy. I looked at him, and I'm like, it's the mind that I'm sure we will, if directed and correctly, and if he finds his right spirits people see him doing some great things.

**Interviewer 2:** Oh, absolutely.

**Mathematics professor:** He's not going to be an engineer, in my opinion. This is my opinion because it includes social interaction. He is better than the first time. I have seen him in terms of. Yeah, I've seen him from the summer. Actually, beginning of yeah, almost a year in the end of this academy almost a year. Uh, he's different. Now, he can socialize much better. But I don't think it. I can’t imagine. Okay, it's my opinion, of course, to say that, but he's going to be a very good theoretical scientist. I think working in the laboratory. For instance, He's a very theoretical mind. He's creating all these numbers all these things and then looking at the bigger side of these things. I mean, like, if you are having one over two, one over four, etcetera. Yeah, I am quite quite impressed. What is the most challenging thing? Well, I do try to understand how he thinks. I mean, it is. Of course. I am not saying that I do understand how he thinks because I don't think there is anyone who can. That's why we are trying to teach him. To communicate mathematically, in other ways. But I think I can communicate him from different level and to understand how he thinks is always, I'm not going to say this is a challenge because I like to think of that.

**Interviewer 1:** Fun challenge?

**Mathematics professor:** Yeah, I don't know how he thinks, and I'm really curious. I mean, he's drawing these things there and then, making these calculations. Sometimes also it's not another challenge, but sometimes I learn how to guide him. So sometimes I really have to stop him and then say, no, no, this is not correct. Because he's so correct. That is not easy to understand that this whatever he did is not correct, you know? So you have to be the person who's in the teacher role for him, so that you say, hey, you know, what? This is not correct because it's generally in. In many things, he's very fast and it is correct, but it can be in this notation, not.

**Interviewer 1:** Right. Do we have any other questions that we missed?

**Interviewer 2:** We've been very in-depth. Thank you very much. Thank you.

**Mathematics professor:** Welcome.

 **Interviewer 1:** I think so.

 **Interviewer 1:** No, I'm also just now processing. Thinking what we can do.

**Mathematics professor:** Yes, it is. It is a challenge. But there, um, have you looked at mathematical games and how to create a mathematical game because I think it it cannot be something to teach him. But it is something that you give to him, and then he's like playing with it. And he will tell you the mathematical background.

**Interviewer 2:** We have three concepts that we're bringing to the co-design session. One of them is going to be more of a potentially matching type game. So, have you heard of the game Set?

**Mathematics professor:** No.

**Interviewer 2:** it's pretty much based off Cap Sets. It's presented in a way with, uh, different colours and shapes and patterns. And then, you have to match three that are exactly like each other. Two cards only has one other that it will match with, so it's got a kind of mathematical background that's presented with shapes and colors. So we are going to trial that and see if he likes it. Um, we're also going to do some building blocks.

**Interviewer 1:** Yes, we also were thinking because his dad also mentioned that he invents his own notations. So we were thinking about making blocks with numbers, letters, and just operators to kind of restrict the way he can write stuff down. For example, you have a summation block that has at the bottom two spaces for two little numbered blocks and at the top one space for a little number block and that way we were thinking about he could more easily explain his own thoughts using existing mathematical notations. So, that's the second one.

**Interviewer 2:**And then, we have, like, in a way, making him a toolbox that he can then make his equations out of, rather than writing down and trying to interpret that.

**Interviewer 1:** And then the third one was also more of a matching thing, but that one wasn't worked out very far. But it's, it's a a concept that is in Dutch primary schools where you have tiles with solutions and a back with patterns, and you can check your solutions using the patterns on the back.

**Interviewer 2:** It's called Luk, L-U-K in German. But it is also called tutor systems.

**Mathematics professor:** Okay, um, all right, there are quite some thing I guess. You can also look at the IQ tests. They also have mainly pattern recognition. So, he's very good in it. And then he might enjoy it. The only thing I'm trying to be a bit careful is to not to limit him. I mean, of course, he needs to understand this mathematical notation. But he can also invent his own systems. And if he has a system here by writing three in the four sides of three, I don't understand. But that doesn't mean that it is incorrect, so if I say this is incorrect, I have tried not to, right? If I say that as incorrect, there's no that doesn't exist. If I say that doesn't exist as a teacher here. So he would believe that it doesn't exist, but in fact, maybe he has a good system and a new thing in his mind, that that works. So I don't want to tell him that doesn't exist. I don't want to tell him that is not correct. I try to make him convince him that in this within this notation and system that it does not work like that, and then I try to tell why. So the why of things is maybe very important for Arne's case if he can. This is a very simple example, just if he can try to see things fitting and not fitting by hands-on materials or, see, understand why it doesn't work. Then he will be convinced.

**Interviewer 2:** So, maybe perhaps a product that more fosters the translation of his drawings notations rather than teaching them the correct ones and building blocks.

**Mathematics professor:** Yeah.

**Interviewer 2:** How can we teach them to communicate that?

**Mathematics professor:** Yes, it can be. You can also, uh, think of language in building blocks, and then you have a system within that building box, and then you can ask to make a system and no, communicate the system in Dutch communicate. The system is also good by here in English, and I'm speaking English with him a little bit much, but my Dutch is not that good. So different languages mathematics are seen as one of the languages as well. But yeah, I'm not sure how it works, of course, but for Arne, it is difficult to to to create something, but I think he's in the end, a child. He's going to enjoy that someone is interested in him. So, I think that's already very good.

**Interviewer 1:** Do you have any more questions?

**Interviewer 2:** I don't think we do actually.

**Interviewer 1:** Yeah, thank you very much.

**Interviewer 2:** You've been very, very interesting. Thank you so much.

**Mathematics professor:** You're welcome.