On the Definition of Learning

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Contents

An interview with Paul Cobb

Interviewed by Ane Qvortrup, Merete Wiberg and Peder Holm-Pedersen

Paul Cobb is Professor in mathematics education in the Department of Teaching & Learning at Vanderbilt University Peabody College. He is the author of several articles and books and has received a large number of awards for his contributions to the educational research field.

Paul's work is interesting for different reasons in our work in the network On the Definition of Learning. During his career, Paul Cobb has travelled along a conceptual and methodological pathway and has modified, more than once, his theoretical position (Yackel, Gravemeijer & Sfard 2011) from radical constructivism over social constructivism, to his current work with the large MIST project (Middle-school Mathematics and the Institutional Setting of Teaching) based on a design research approach with a pragmatic approach to theory (Skott 2008)[1]. Both through his theoretical modifications and his pragmatic approach in the MIST project, he exemplifies on the one hand the use of different learning theories and learning concepts, and on the other hand different approaches to- and important development trends in educational research and practice. This is central to the work of the network. Furthermore it was the reading of the well-reputed article "Putting Philosophy to work – Coping with multiple theoretical perspectives" that inspired us to investigate the relation between learning theory and teaching theory and to combine different theoretical perspectives in order to describe learning, taking into account aspects of interaction and participation in classroom practices. Paul Cobb suggests characterizing teaching and teacher development as design sciences involving developing, testing and revising designs for supporting learning processes. This way of describing the relation between teaching and learning has been a great inspiration for us in our work and still is, together with Cobb's reflections over methods that provide empirical information to constrain explanatory theories. Therefore, it is a great pleasure to include this interview with him in this first contribution from the network On the Definition of Learning.

In the interview, he talks about his MIST project and their way of working with professional development, while he reflects on the development he has undergone during his research career.

The interview took place at Vanderbilt University December 2014.

Support of learning – a question of organizational learning

Interviewer A: *What is the background for, and the idea behind the MIST project?*

Paul Cobb: The guiding question for the project is: What does it take to support improvement in the quality of math teaching and student learning on a large scale? And in the context of what current US math teaching looks like, and also of what we ourselves value in kids math learning, we think of improvement in terms of teachers not just extending or elaborating what they already doing and reorganizing in their current practice, but rethinking their answers to fundamental questions such as: What does it mean to know and do math? What should the goals for student learning be? How do students learn? The whole bit. It would involve a fundamental reorganization of current practice. Not just an elaboration or extension. So that is the challenge.

So how would you do that? I have done it and a lot of (other) people have done it. A group of researchers going camp out on one or two schools and work very closely with teachers. You can really support their learning if you stay there for an extended period of time, so that is not the question. The question is: How can this be done on a large scale? And the way we think about it is: How can we support the development of school and district capacity to support teachers learning? And when you frame that question, you will be getting into principle's learning, coaching of learning, development of tools, reorganization of routines, the whole bit. So it is also for us a question of organizational learning. It is not either-or. It is not just teachers learning. If you have to support the learning of a large number of teachers, the organization has to learn how to do that. So it is viewing teachers' practices, which are very much influenced by organizational niches, the school context in which they work. So that is the kind of questions we have been interested in. For many years I worked at the classroom level doing

design experiments where we would be responsible for the learning of a group of kids for fifteen weeks or something. And a lot came out of that, not just from my work, but from a lot of other people's work. We made a lot of progress at least in math and science in developing long term trajectories, not just of learning and how to support that learning, but to do so, requires fundamental change for teachers and groups of teachers. And we learned a lot about professional development. But that work had very little impact on US classrooms. If you go into most US math classrooms, you will see very little impact of any of that research. Hence this focus on the sort of broader level or broader scale, so it does fit with this sort of concern with practice. So, that is the basic idea. And also the last thing I did before this was a long-term partnership with two groups of middle school teachers, meaning lower secondary school, teaching kids age 12 to 14, in two districts, where we were working to support their learning. And they did make a lot of progress. These were math teachers and we worked with them for five years. But also in the context of that work we realized ahead of time, that in order to do that work we had to understand the settings in which the teachers were working. So we also collected data about the school and district contexts, and that was critical to us, it actually influenced the design in the group I worked with. So we ended up actually feeding back some of what we were finding about their school leaders without naming them to the teachers and it influenced our work with the teachers as well, because they then formed an agenda to try to influence the settings, in which they worked, so they could be more productive. And so, based on that work, we realized it would be really critical to attend to the whole system, and system as far as we go is the district from kindergarten through the end of high school.

Supporting learning on the whole system level

Interviewer A: *What does it take to support improvement across the system?*

Paul Cobb: We worked with four districts for four years and they ranged from 35,000 to 140,000 students. And then, we continued on for another four years with two more districts, the one with 85,000 students and the

other with 100,000 students. Now, we did try to recruit districts, which were atypical in the US at that time, because they were aiming high in terms of their goals for student learning. They were not just aiming at kids getting through the low level test. They also had higher goals for the kids developing conceptual understanding. And they had teachers with a pretty sophisticated inquiry oriented set of instruction practices.

What we did initially was to go to the district to interview a bunch of district leaders. And if we look at the central offices, there are a number of different departments. So, we interviewed people mainly from two departments initially, which is curriculum instruction and includes the math specialists, and leadership, which is responsible for hiring, moving around and monitoring school leaders. And what we were trying to find out in the initial interviews was: what are the plans, strategies and policies for trying to support improvement. Then we wrote up about five pages on these audio-recorded interviews and we said: Here is what we see as your major strategies. And we actually send that to them saying: Did we get this right? We have to make sure, that from their point of view we understand what they are trying to do. So in other words, our initial points of reference are their strategies. We call these district theories of action. Then we carried out large data collection from January through to March each year, where we collected data to try and document how these policies and strategies are actually playing out in schools and classrooms. We can tell you about some of the data we collect. In the first four years we focused on six schools in each district, and we selected them in consultation with the districts locals: Here, we want a representative group of schools. We wanted to be representative in terms of capacity for improvement. So we did not want the weakest schools and we did not want the strongest schools. We do not want to tell a story about successful schools in the district. We want to be representative. And then, within that we randomly selected a total of 30 teachers in each district, so we have 120 teachers altogether. We organize getting two consecutive lessons video-recorded in each of their classrooms. The success of that is near to 100 % in every district, every year. Then we went to each district for a week, and we do 50 audio-recorded interviews with teachers, school leaders and coaches. Then the coaches, the principles and the teachers do online surveys complementing the interviews. And what we are trying to get at is: What is it like to be a teacher, or a principal or a coach in this

district? What are the supports, both formal and informal, improving teaching? What do you perceive yourself accountable for? To whom are you accountable? What tools do you use as part of your practice? That sort of thing. What is happening on the ground? And there is a measure developed at the University of Michigan on mathematical knowledge for teaching, which has been shown to be related to student achievement. The teachers and the coaches use this measure. We are also videoing professional development. And when teachers meet in collaboration, they audio-recorded their own meetings and then sent us the tapes. And then, as we are also interested in teachers' informal networks, we have an online network survey: Who do you turn to when you have an issue or a question? What did you talk to them about? And so on. That was online. And for that, it is not just 120, for network data you have to get everybody in a school, 300 teachers. And then the schools provide all of their student achievement data so we can link teachers and kids participating in the teachers' classroom. So we get all of that every year. So to give you an idea of the scale, as of now, because we have done this for a large number of years, we now have 1,700 fully coded videos, so it is a big longitudinal database. And they are all coded and we do that every summer.

What we have to do between the January interviews and May is analyze the 200 interviews and write a feedback report for each district, and these are separate. They do not just look alike. Each one is specific to each district. And the reason that we have to do that by May is because it is the beginning of the summer. School leaders and district leaders in this country typically make plans for the following year over the summer, so we do that and then we send these back to them and then we go a week later to each district, and then we meet with senior district leaders to talk it through and discuss implications for the coming year and I should just explain. We did this for four districts for four years and then we went down to two districts and we worked with them even more closely by jointly designing and leading professional development work. We doubled the number of teachers to have adequate statistical power. And doubled the number of schools as well, so we had 25 schools. In total about 200 participants.

Different measures

Interviewer A: *Can you talk a little bit more about your measures?*

Paul Cobb: There is a real shortage with measures. We had a conference or a meeting last week which we called small measures and I will clarify why. We had to develop – and this was part of our research proposal – what we call big measures, and big does not mean grand, it means it is quite demanding to get the data and to analyze it. So we have this measure from University of Michigan of mathematical knowledge for teaching. That is not straight math knowledge, it is a good measure, because it is mathematical knowledge specific to the practice of teaching and I read these initial questions and I know the people who have developed them and know, it has got face validity. Some of the things we ask would be: Here is a kid's solution to a problem. Is this going to always work? Is it trying to get the sort of decisions arising either when you are planning for instruction or when you are teaching that actually come up? And my guess is that most teachers are actually thinking about teaching when they are responding to these items. And that is why it is a good measure. In addition, we got the coding scheme for the videos. So many coding schemes just code teacher performance and that is really unhelpful, rather than coding what goes on between teachers and students to try to get at, in some way, student learning opportunities. We adopted a coding scheme developed at the University of Pittsburgh called Instruction Quality Assessment and the basics or the logic of it, is as follows. First of all, it looks at, or codes the level of rigor and cognitive challenge of the task. What task the teacher selected to use today. Then basically it looks at the extent to which the teacher maintains that level of challenge throughout the lesson. The reason for that is, that the default case in this country is teachers show kids how to solve a problem. They procedualise it. So they take a high level task and convert it into a low level task, which then reduces the learning opportunities. Another thing we are interested in is the concluding whole class discussion. To what extend are kids pressed to explain and justify their thinking? To what extend is a connection made between solutions? Who are making those connections, the teacher or the students? And so forth. We developed initial rubrics because the original things that the Pittsburgh people did, did not

look at how tasks are introduced. And, we noticed that that is were a lot of things went wrong. You watch the first five minutes and a lot of these kids are screwed, either because of the level of challenge that is introduced or because of the way it is introduced, because of this incredible diversity of students in the class in two of our districts, I am trying to think about the percentage of English language learners across these districts, maybe 30 percent of the kids' first language is not English, and no attention is made to language, the context of the task, the story, the scenario around the task might be unfamiliar to kids and this is not addressed in any way in the introduction. There might be some key mathematical ideas that kids need, not to solve it (mathematical problems), but just to understand what is being asked, and they do not address this at all. So we developed some rubrics for the launch in collaboration with the original rubric developers. And we added those. So that is one big measure. The second one is developed by a doctoral student. He is now a faculty member, at the University of Pittsburgh, and in all of the interviews, not just with teachers, we have this little script in our interviews, where we say to whoever: Suppose that you could go into a math class, where you can stay as long you like. What would you look for to find out if it is high quality instruction? And then there is a series of probes, and what we probe on – at first let them talk and see what they say – but if they don't bring it up, and often they don't, we then want to know: If it is high quality math instruction, what would the task look like? And because we do not have a good language in math, a common technical language, they might say that they want to be problem solving. Then we ask: Could you give us an example? Because what they mean by problem solving might be different from what we mean by problem solving, so we try to get to examples. So we focus on the task, we focus on the concluding whole class discussion, which we expect to be a summary or concluding discussion. If yes, we then try to probe on, who is doing the talking of the discussion and what they are talking about?

The coding of data

Interviewer A: *How do you handle all this data? How do you use them?*

Paul Cobb: All of our data gets formally coded, and we now have reliability on this and retrospectively have gone back and coded all of the interviews. What we did to develop the rubrics was to start coding. In the beginning we had eight or nine colors, and we then reduced it to three to make it feasible. The first rubrics only focused on the top level, you know they were based on case studies of really accomplished math teachers and then we filled in what current math teaching looks like, so we have the top and the bottom and a few cases from research reports. We then focused on some of the gaps and went to our interviews, because we already had interview data filling in some of the gaps. So we coded levels of tasks, it would be like four levels, I think, if it is the vision of what a discussion looks like, we have four levels, which are based on published empirical studies. So there is some empirical grounding. That is where the coding schemes came from. And then the other additional big measure. We are also very interested in issues of equity and we have a particular operationalization, which are not very fashionable, because for a lot of people they think of equity in terms of relations between home and school, and the answer is you have to realign what goes on in school with what goes on at home and then everything is wonderful. I would say that this is the default position and that *was* my position, but when I had the opportunity to really think about these issues and I began to think about it in the late 1990'es, that is about 15 years ago, as I happened to work with a doctoral student, Lynn Hodge, and worked through this. Over time we came to see the limitations of that position, I think it is very nice and comforting from wide liberal point of view, because it means, we are all different. It is all about difference and it ignores relations of power and authority and identity and so forth. We have come to think of it much more, if we look at what goes on in the math classroom, in terms of who is able and wants to participate substantially, and what is happening in that math classroom. For example, our launch rubric I just told you about, we look at the first five minutes of those math lessons and I said the kids are screwed. What that means is, because of the way the teacher introduces that task, a very large segment of those students are unable

– and it is not their fault – to participate substantially in the rest of the math lesson. That is inequitable. It might be because of language issues, it might be because task context is unfamiliar to them, because of their home backgrounds is without school experiences, but it is familiar to other people, it might be because those things to help them visualize what is happening in the task, was not clarified, whatever it is. So we would define equity and inequity in terms of the extent to which kids are able to participate substantially, and it is not the participating in the same way, but in participating substantially in what is going on. So that is the definition we take. And again from the interviews, we realize that there are always kids struggling in the class. And we take the view, there are always kids struggling, so it is not bad, it is what you do about it that is the issue. So: Who are these kids? It may be language learners, it might be poor kids, whatever, who are they? Then the key thing they code on is first of all, asking the reasons why the teacher or whoever it is thinks those kids are struggling and how do they count for it? And basically, an unproductive response would be that it is something to do inherent to the kids, it is something inherent to the kids families, it is something inherent to the kids communities. And the reason why we code that as unproductive is it implies, there is nothing I can do about it, that is the way it is. These kids parents do not care, these kids are lazy, whatever it is. And then a more productive response would be accounting for these kids who are struggling in the relation between student and current or prior instruction. You know: they missed a lot of school, they changed schools and they missed these topics. Because this is implicitly saying that there is something you can do about it. So that is the first thing that gets coded. Then the second thing that gets coded, having asked these kids are they struggling and why, is: What are you doing about it? And we code that response. Unproductive would be, oh I break the math into little pieces, I lower it and get rid of the hard stuff. Productive would be forms of extra support to enable those kids to participate substantially in the challenge, which might be how you introduce the task, it might be helping them with stuff they missed, whatever. Right now we are looking at the relations between these different measures. It is seven or eight measures of aspects of practice and measures of three aspects of teacher knowledge: content knowledge, visions of high quality math instruction and also this last thing we call teachers views of student's capabilities. I have always

had high hopes for this measure. These are big measures. The small measures mean we also need little measures where we can administer that practitioners will actually collect the data themselves and might actually also do the analysis or we would assist and so you can feed it back immediately. So it is a sort of thing you could imagine doing every week or every two weeks on a very specific aspect of the improvement effort. Suppose you came up with a small measure around launch tasks and it might be a little four item student survey, trying to get at: Can I as a student engage in this? Can I do it? Do I understand what is going on? It seems like, to get the data from the students would be the best thing. And the hope is, you would actually focus teachers' attention on an aspect that something is happening in their classroom that they are not attending to right now. We do not think these teachers are saying to hell with these kids, I do not care if half my kids have a chance or not. We think, they do not know it. So it is also a leaver for improvement as well as a measure. That is why we want to go in this direction. We do not have a lot of process measures, the actual mechanisms of change at the micro level, but we have longitudinal data of points.

Interviewer M: *When you say coding. Can you say a little bit more about how they code?*

Paul Cobb: It is qualitative data that gets quantified, and we have to do it, because before I did this large project, we could just do it by hand, but now we have 240 videos per year, so we had to. And it is like all methodologies are interesting. There are always tradeoffs. It is not that there is one right solution, so I would justify the tradeoff but I also acknowledge what we gave up to work at this level of scale. We also do in-depth qualitative analysis of interesting cases and we can use the quantitative data to identify the cases that are interesting outliers to do an in-depth qualitative analysis. So we are hardcore pragmatics when it comes to methodologies. We are not ideological at all, anybody who is, we are trying to stamp out. It is always the question that drives the choice of methodology, so it is really a small quantitative study and a ridiculously large qualitative study. It is both. The trick is: How do you get the data informing each other, so they are not going in different directions, and that is what we are interested in and working very hard on.

We have about five to eight coders in the summer. We hire these coders externally. They are not part of our team. The training process takes about a week and then it takes about another month to establish reliability. So we spend a lot of time making sure that like my number four is the same as his number four, if we would watch a video and code for the quality of discussion – and it is the same as number four was last year. So the numbers, it takes a lot of time to establish reliability across a large group like that. It ends up being over a month before we can actually start coding the real numbers. And then we have to check for drift, the coding drift, so we have to have continuing reliability checks throughout the process, where specific numbers are double coded by you know, very experienced coders, expert coders. That is the only way that we feel comfortable trusting our numbers. We have seen it go horrible wrong in a study where they were not very rigorous about establishing reliability. That is not good. The other thing I want to say about the quantitative thing, is – my background is as a qualitative researcher, so I have no interest in getting into the nitty-gritty of the statistical methods. The thing I care about is *what* you are trying to measure? Is it worth trying to measure? Does it matter? What does everything mean? It is not just numbers, they are actually measures of something, and it is never forgetting that. So that is where I press people. And then they go out and crunch the numbers fine and then they come back and we talk about what it means *in* reality teaching and learning or whatever it is. So it has been hard for us to develop these measures.

Indicators of good teaching

Interviewer A: *You told us that for instance you are looking for how a task is introduced. Could you say a little bit more about: where does that come from? How do you decide on these focus points?*

Paul Cobb: Yes, how do we say this is what teachers should do? So, I was actually somewhat involved or physically present when they were doing that work, and it was quite clever. So we already by that point had quite a large database, so we looked through our quantitative data to identify the positive outliers. So how would you identify positive

outliers? So we got the achievement data and the issues of equity. The launch was about equity from our point of view, it is all about equity, really. But first of all, just looking at achievement data: Which teachers are doing a good job to support everybody's learning or even narrowing these achievement gaps. That is one thing. But it is not enough. Because the teachers could be doing that by being very good at teaching lower level skills to children. So we got a coding of videos, which gets to the rigor of instruction. So we can then put two filters on. Do we have any teachers, where the data indicates the support of everybody's learning or of closing achievement gaps, including kids whose first language is not English and the two groups we are actually focusing on? We had to pick our points. Our African American students are currently struggling. Then, of the teachers who appear to be supporting everybody, are there any of these teachers also choosing high-level tasks and maintaining the rigor of those tasks all the way through, so they appear to be doing it by challenging everybody. There are not many, but there are some, and those are the interesting cases. And what they then did was to do an in-depth qualitative analysis of those teachers' videos - you remember what I said about the two methods – to see if there are any patterns or regularities to identify specific practices in those teachers' instruction. That is where the criteria came from that were put into rubrics. So they grew out of the data.

An example of what we do find is that the teachers' vision of high quality math instruction appears to be a leading indicator of improvement in practice. This appeared, looking at the relationship longitudinally between changes in their visions and the practice over time. In other words: Teachers view of what counts as high quality math instruction appears to be developing and it influences how they make sense of improvement and how they actually teach.

Interviewer M: *So, they are kind of exemplary teachers?*

Paul Cobb: Yes, or, so these are regular teachers in our data, there were not many of them, but there were some.

Interviewer A: *And can you maybe say a little bit more about what characterizes those teachers. What they were doing?*

Paul Cobb: Yes. We have a little paper and it was written for teachers. I actually use this in my teaching future teachers. And one of these teachers was very kind and gave us permission to use one of these video recordings in my class. And so, what I do in there, I can tell you the whole activity, although it is more than you need to know, but I think it is an eight grade class and he happens to have chosen a problem which he is using on the particular day, it is about a dance marathon, where people dance for a long time to earn money for charity or to raise funds or whatever. But you know, a lot of these kids had no idea what a dance marathon was, but the teacher sticks with this context. The math he is aiming for is linear equations, and he is particular interested in the relation between graphs equations and tables. And this is the first problem, these kids would have to hit with a non-zero y-intersect. So there is math in here as well as issues of context. So what would an exemplary launch be? There are also issues of language? So what the teacher did first of all was to spend some time making what a dance marathon is, real for the kids. This particular fellow does not give the kids the problem. He actually projects an image or a whole bunch of images taken from google of people dancing, and he asks the kids what these are doing, and then they talk about what a dance marathon is. And he does it a lot from listening to the kids' ideas, having other kids reword and revoice, calling of kids he is not sure if they understand. So it is very interactive. Then, the other thing I felt was important – this is my contribution – was the math. What is happening in a dance marathon? It is not just that people dance for a long time. As time passes, money accumulates. And kids having that image is critical, if they can engage in the problem. This relationship between these changes in quantities, because that is what is going to get mathematized. And so if that also gets attended to explicitly and in the problem you get three kids with three plans, one just gets given five bucks or whatever, it is for participating in the marathon, somebody else gets two dollars up front and maybe a dollar for every hour they dance, and a third kid gets nothing up front and 15 cents per hour. Different graphs, different slopes. It is not teaching them or showing them how to solve it. It is focusing on how they interpret and understand the problem, so they can begin to engage with it. So the additional supports we would see important for all kids, is addressing or clarifying the context, clarifying mathematical ideas, explicitly talking about any terms or words that

might not be relevant, sometimes by using a picture to help kids to understand those terms. And this came out in a very interactive way where you are drawing on kid's ideas and language, and these kids would explain it, you know, one kid said, that you have to work for it. So he recasts it in kids language. Notice, this does not mean you have to align tasks with kids out of school experiences. You do not have to. But what you have to do is to make whatever the context is, real for the students. Otherwise it is inequitable. So that is where it came from.

Teacher professionalization

Interviewer A: *Could you maybe also say a little bit more about this professionalization? What characterizes a professional teacher? And how do you use your knowledge of good teaching to qualify teachers in other schools or districts?*

Paul Cobb: What we try to do, it did not entirely work in one of our districts, in addition to our two-hour feedback meetings, we also for three years organized and led day-and-a-half long district leadership institute with district leaders about 15 of them, from across all over the main unit and we could show them coding of what launches currently look like in their district. They are not pretty and also went through this sort of activity with them with the video. To have this as a focus, that would be good. What we then did, we had the main math people there and everybody was hot to trot. The idea was that they would work with their math coaches on the launch and they could work with teachers. Sadly what happened, which we could not believe, the math people assigned the people to work with the coaches who had not been at the session, so they had no idea what a launch was. So it got mistaken. But our plan was to make this a focus of work and also to work with principles on this. It is about the importance of coordination professional development across groups. For us the problem is not us going into a teacher professional development, we are arrogant enough to think we know how to do that, it is how can we support them in doing it. This is a challenge. It is how can you support others in supporting teachers? And so, what we did the following year, this was specifically on the launch, we ourselves worked with the coaches, as a design experiment,

to explore conjectures about supporting coaches learning. So we are trying to work out an experiment with designs where we purposely avoid doing teacher professional development ourselves, because that is not what we think the problem is. We think it is about building their capacity to support teachers' learning.

Interviewer M: *And the coaches, are they teachers?*

Paul Cobb: There are different designs. Some of them are district based, some of them are school based. But these are people whose charge is to work with teachers in the school buildings to support their learning and get better on the job. And sometimes that involves working with groups of teachers, they might be, I do not know, the eighth grade math teachers, meeting twice a week, and they would lead and be in those meetings. Sometimes it means they go into individual teacher's classrooms and work with them in their classrooms

Interviewer M: *Are they trained teachers, these coaches?*

Paul Cobb: Ideally, they should be at minimum pretty sophisticated teachers themselves. But that is not enough, right? Because coaching is different from teaching. You do not just have to be good at supporting kids learning. You also have to be good at supporting teachers learning. And the literature on coaching is really astonishingly thin and awful. That is why we view it as we are having to experiment, because there are no really good designs on which to build. So we view it as probing around, trying to come up with tests, revise and prove designs for supporting coaches or school leaders' learning. So that is why we work more closely with two districts, so that we can do that.

Interviewer P: *How do you go about using knowledge on examples of good teaching in professional development of teachers, because sometimes the trainee teachers cannot see themselves in such examples.*

Paul Cobb: I see it as a trajectory. There have to be a lot of things as a basis before you get to that point. They read an article and then they have to do an assignment. I think you should plan for something, you should think about this, before you actually go into the classroom. So

we then give them some other tasks. Suppose you are a fifth grade teacher and you are going to use these.

Knowledge about learning

Interviewer M: *This instruction thing, could you say something about how we should understand instruction in terms of theories of learning.*

Paul Cobb: The best I can tell you is, I used to – I come from that background – but my position has evolved and to be honest I do not think so much about theories of learning anymore, but if you would have gone into my head: When I say instruction I do not mean teacher performance, I mean teacher's interacting with kids to support their learning, and if you ask me to think about this learning, the best thing I can say – and this is not an ideological point – I am more on a socio cultural orientation, not the broad activity theory, which I do not find helpful at all, but more at the level of practice and I think to address this I have to say something about how we think about the relation between knowledge and practice. And I think so often, or the default is to think of knowledge as prior to driving practice and we see that as a very problematic way of thinking about it, but I think it is quite common. Can I tell a story, give an example? Take this construct of mathematical knowledge for teaching. I know the people very well that developed that, and I am pretty sure that the way they go into it is from a background not in math but a teaching background, and they view their own math background as quite weak, and that is why that became a focus for them. What they did to develop that measure was to really reflect and think hard about their own practice, both the planning, the doing, the actual interacting with the kids in the classroom and the reflection back on it afterwards, and they were able to identify some key moments, where particular forms of math knowledge were important. The reason why I am saying this, is that I think it is a nice example if you want to use the term knowledge at all, and I used to get hung up on this. I usually do not want to use it, and I say, you have to talk about knowing. And I guess I have given up on those issues. I think they are part of the world of academia, but my position is: let us think about how we want to use the word. It is a form of knowledge

that is operative in practice, it is an aspect. Practice is not something where you go in with an empty head. You are thinking and reasoning, and it is the reasoning that is in the practice. And what they then did up in Michigan – they are very clever people up there – they then developed this paper and pencil multiple choice assessment, which we think is a good assessment, precisely they are thinking about teaching when they respond to those items. That is why it is a good assessment. Then so many people, because it is a paper and pencil assessment, then one thinks about it, then we are just going to boost their mathematical knowledge for teachers, then their teaching will get better. No! You have now separated it out of practice. Teachers, when you are working with them on math and not doing that in the context of practice, they will not relate. It will be this separate, academic exercise I do in this college class or I do in this professional development session. It will not influence or affect. They have to be – from their point of view – working on the practice.

Interviewer M: *Then these teachers, they are instructing. Do you think that they should consider how the children do learn? And how should they conceptualize it?*

Paul Cobb: I think so. I want to take it even a step before that, as this is telling a story. This is from my prior life, where we were with this group of teachers. We worked with these teachers for about two years, and we were really trying to orient these teachers not to focus on learning but just to focus on the kids mathematical thinking, a step in the right direction, right. That does mean you have to de-center and look at what is going on from their point of view to figure out their thinking. So we had the teachers bring sets of student work from their own classrooms and they looked at it and they were quite happy to do this and to identify different types of solutions and sort them into levels of sophistication. The wheels came off, because the teachers saw this as pointless, as no relevance to planning on what they do next. Afterwards we actually went back to the schools and observed the teachers' instruction and started questioning them, did interviews immediately afterwards about what they had seen in their lesson, and what came out was that any time they looked at student work or anything, it was always to assess or to check: Did they get it? It was

never prospective to plan for the future. And so when they were looking at student work, they were figuring out what the students got, not that this is going to inform my future plan. So once we figured this out, we came up with a whole new design, and we had a summer session, and we said let's start with something that is a real problem. And what was a real problem in their language was motivating students. And a lot of the students did not really care – and if you saw the instruction you could understand why – so we said: Let us focus on motivation, but we wanted to recast it in terms of supporting the development of kids mathematical interest. And we were able to do that. We had a design and we had a successful three days with them. The thing is, if you begin to understand, it is not just something inherent in your students, they are not just unmotivated people – they are not motivated because they do not understand what is happening in my class and therefore it is really boring and pointless from their point of view –an initial decentering. That was the first time and the first step and then we build from that over time to also focusing on mathematical reasoning. So the thing we learned from this story is that even for these teachers in the US who teach secondary, even decentering to focus on trying to figure out what their kids are thinking is a huge achievement.

Interviewer A: *Earlier, you talked about the difference between knowledge and knowing. And my question is related to the teachers: Can one say that it is not about teacher knowledge, but about changing their minds about their teaching? Because, what I hear is that they have to think about teaching in another way?*

Paul Cobb: I like that image, but they also have to change their knowledge. It is not this separate thing. It is knowledge *in* practice. And if they change their knowledge in practice, their practice changes. It is an aspect of practice. Practice is both knowing and doing. It is not one or the other.

The other thing I was going to say was, when you asked about learning - it is a thing I have thought about for a long time: I maybe talk about a specific aspect of teaching, so like – one of the things we now and then think about, is teachers' understanding of what kids might be learning in a whole class discussion. So, we think about very specific things. We do not think about learning by and large. What was interesting in that

study was the default whole class discussion, then and also now looks like the following. The kids have worked in groups and the first group gets up and presents, and they just present, whatever they present, and the teachers say: Thank you very much. And then the kids sit down. We call it show and tell. And then the next group and the next group. If you analyze that from a kids learning opportunity point of view, there is very little going on. So my assumption was that the teachers did this because they have other goals like self-esteem or, whatever it is. So we actually asked the teachers about this, and yes they had those goals but they also thought their kids were learning. Somehow they had this theory that the kids were picking out the good mathematical pieces, all on their own. And they might ask: Does it involve a change in learning? I would say: Do we want to teach teachers learning theories in general? No. Do we want to profoundly influence, how teachers think about, how kids learn from each other in classrooms, whether it is in small groups or in whole classes? I believe it. But not first. As part of the process, not apart from practice. So, how we think about it. We think about what should be happening in a whole class discussion, and what are the teachers attempting to achieve is number one. Seeing how kids solve a problem, looking at the kids solution, we think it is really important that there has been a good launch, so that everybody is engaged in the problem, so that they have a basis from which to understand each other. If they haven't been engaged in the problem, then they are not going to keep up when the whole class discussion begins. A big part of the teacher's role is number one: to make sure that they are drawing on kids' solutions. And then they have to think about: if I am explaining, and you are a student, how might you be understanding me? And their role is then to mediate the communication between the kids on important issues, so they might be using alternative representations in presenting the picture or diagram of my solution to help you understand it. Because it is worth to understand mathematically.

Interviewer M: *In some of your papers, you write about cognitive constructivist theories of learning. My question is whether these theories contribute to teaching practice in mathematics?*

Paul Cobb: Let us say this. Yes and no is the decision I have come to over the years. What I take and still hang on to from those days is *the* central

idea to focus on the individual kid for example, or it could be individual teachers and assume that what they do is rational, and our job is to figure out that rationality. A lot of people are willing to do that with students and we see an increasing will to do it with teachers. This was not the case twenty years ago. I always assume that they are doing their best, or what they think is best for their students. And I am just trying to figure out why they are doing what they are doing as a starting point, before we even develop the initial design or supporting their learning or whatever it is. And then: where I think that cognitive approaches are not useful is when you try to come up with models, cognitive models, schema theory, or whatever else it is. I see absolutely *no* pay off in that, at least in the work we do. It is not saying it is wrong. There might be other purposes, like knowledge engineers do that to develop computer systems that simulate human activity. It could be very useful for that, just for what *we* do, and I would say for profession developers in general, it is really not helpful. It does not help you develop better disciplines, whereas I gave you the example before, where we were in the class with the teachers we are working with, and it was absolutely critical we understood why they had the reaction they had when they were working with us. We did not know why they were doing what they were doing when they saw no point or even the relevance of looking at kids' work in order to plan future instruction. The golden rule to me is to always assume it is a design failure rather than a person failure. That is incredibly helpful for me and my crew when we use to work in the classroom with classroom design experiments – and the kids were doing some bizarre things – we think: How did we teach them to do that? Where did we go wrong? And we go back to the tapes every time and then you can improve the design and make a better choice. Do you see what I mean? So that is the golden rule.

Interviewer M: *Teachers should ask themselves that question very often. That would be nice.*

Paul Cobb: That's part of equity, if you think about it. Rather than saying there is something wrong with the students. I got stupid students or lazy students or their parents do not care. No, it is your problem as a teacher or instructional designer.

Interviewer P: *Can you talk a bit about, if we kind of transfer that way of thinking to the professional development discussions, because I see a lot of resistance from teachers to professional development or to the things they are taught at these courses we have. So I am interested in hearing if you, in these designs you make, have seen some kind of resistance, and maybe how come.*

Paul Cobb: We see it from the districts. And we try to learn from it. What we have been doing, the group of us, the last few months, we have had periodic meetings where we say: What would we do differently, if we should do this over again? If we were, what would we do differently? What are some of the epic mistakes? And I would say that one of them is not to attend to what some would talk about as motivation. I would prefer to renounce that in terms of development of personal identity, but without going down the black whole of identity, but just refer to the minimum we can get away with to come up with a reason for operationalisation of identity. It is, I would say, it has been very striking in all this work, there has never been an instance I can recall – I do not think there *have* been any – of any district level people attending in supporting developmental reason, motivation, will agency and that sort of terrain of the folks they are working with, whether they are teachers or whatever, someone put into work to change their practice. And it is a hell of a commitment. I work with practicing teachers, so that is my world, mainly, rather than preservice. But the person I am thinking about – it is usually a she, but that is because I am sexist, who is a really accomplished teacher, really well regarded by his or her peers, been teaching like, I would say, 15 years, highly regarded in the school, has very good classroom management, has very good test scores, teaches mainly procedures or whatever, regarded well by the school leader and so on. You are asking that person to change how they teach. Wow! That person has so much to give up. If you know what I mean? So much is invested in it. And so, that is the person I think about. And so, what would a design look like? You must not only focus on their practice, but on supporting them in developing reason and motivation or will agency to change. And it has to be *their* will and *their* agency. This has to go back to themselves. Ultimately they have to be the one investing the effort to make the change. You cannot do that for anybody. That is part of the design. And I would say that

this is a limitation I see in what we have been doing. I want to say, I kind of understand why we did that. There is so much else to focus on, but what is bizarre is, we use to go and work with groups of teachers ourselves. We used to have any design attend to that. I do when I teach my classes here. It is problematic in some way, really problematic, they have no reason to want to change. And so going forward, that is one of the things we want to make an explicit focus on in our future work. Now, that is the best I can say. I wrote a little paper about this. Because that group of teachers we work with ourselves, this was a district, which was attempting to change math teaching and we were given the teachers who were resisting by the district. We did not know that. Initially it was very hard, but by the end of the first year we just met them three times this year in the summer session. By the end of the second year they were volunteering to work through their lunch breaks to keep going. And they ended up being designated leaders of their district. Charged with developing units supporting the other teachers learning. So we went back and said: How the hell did that happen? And that is what the paper is about: Their development of human agency to want to change their work. And it is identity, I think. They develop an image of a new form of practice, but it is not just about that. It is what they identify with. They want to become that kind of teacher. Then they were really willing to put in the extra effort. They were trying to set up teacher groups to work with other teachers in their schools on their own initiative. So, trying to understand that process. That is what we try to do.

Interviewer P: *But then, one of the starting points for a development like that, is that they are actually able to see the picture that you are giving them of another kind of teaching. That it is kind of relevant to them?*

Paul Cobb. Yes, that is right. But this is over a period of time. This was not day one: Here is an image of teaching, do you like it or not? The other thing we had to do was, they were used to professional development, where somebody goes in for two days and tells them what to do. And we had envisioned a different type of relationship, where it really was a collaboration. And you cannot tell people, what to do – or you can, but they will not understand. And they cannot. It

is not their fault. They have to have those kinds of experiences. So we have a negotiated way of working.

Interviewer A: *Now we are talking a lot about this teacher development. Could you talk a little bit about teacher education? Teachers who are going teach?*

Paul Cobb: I do think about it. Let me tell you the context. I have to draw a circle, so I am not getting into organizing entire programs and we have people who are supposed to do that anyway and it is their specialties. So I can only tell you about my class and about what I try to do. In my class, many of the students are going to work soon and they say: I want to be an elementary teacher. A lot of these people, you know they are bright people, they are very articulated, they write well. But a lot of them had very bad experiences as math students to start with. I do not know if that is the same in Denmark, but it is here, they do not like math, they would rather not be with me. So the first thing is to get that out on the table and to try and convince them that it is not their fault, it is the way they were taught. And the initial thing I do is I have an old piece of video from back in the days where I had hair and everything. It is very representative of second graders. And basically, what it prints out for these kids is that there are two different worlds in math. There is the world of quantism and relationships between them. And there is the real world. And these kids know some math. They have dealt with quantism to some extent. And then there is the stuff they do in school, which is some kind of symbolic hieroglyph. And the two have no relations. And so you can show them. You switch from one class to the other, and you can flip them from one room to the other in the interview they are operating in. At that time when I did that work, I were a constructivist, so I would say different cognitive contexts, and I would now broaden that account. But it makes the point: this is very typical. And for most people in my class, this is also very undesirable, so there is a reason, a motivation to want to work to begin to develop an alternative way of teaching. And then I had some videos we put together, modules of kids that my students do serious assignments on, where we try to edit down just a few segments of classroom teaching experiment. We took it from one of those, where I got interviews before and after, and these kids get really, their thinking really develops in like three months. Quite dramatically. So we have to look at

them before and after and analyze the kids thinking. And they analyze classroom clips to begin to figure out what the teacher did. Just as an initial entry. And they seem to want to do that. They seem to find that as a worthwhile activity. That is just the start of the class and then, if we are looking at particular content strands, we do not for instance just focus on it is a very good idea to have a discussion, but what is a key characteristic of productive discussions and what is the teacher's role in making that happen? One thing I have learned from this work is the phrase I now use: fighting our way up to the level of concrete practice. And I put it that way on purpose to be provocative, because in the academia we have abstracts up here and highfalutin language and concrete practice is down here. And if you actually read a lot of stuff it is always abstract stuff. It sounds very good until you actually think about doing it and realize, it does not achieve contact. And our fight is the struggle up to specific learnable practices. It is getting to the specifics. And the specific is not the same for us as the procedure. It always involves wisdom and judgement. Invokes forms of knowing. And so part of what we have been trying to do to achieve success, is to begin to try to identify what we think might be productive. The launch would be an example of a teacher practice but also interesting in coach practices and school leadership practices and district practices. And the criterion we have is that you can envision someone actually practicing practice. So if you asked about metaphors for learning I would say graduated series for apprenticeship experiences, at least for professional learning, whether it is with teachers work or with somebody who is already a pretty sophisticated teacher. So if I am trying to figure out how to launch a task, I have an image of what a launch might look like and then I might try launching a task perhaps with a small group of teachers playing students and you are the coach and you give me feedback on my launch or even if you were the coach, you ask a question or do something kids might do, and I should try to handle that. That sort of thing. We have been influenced by Pam Grossmanns' work and she makes a really important distinction in professional development between pedagogies of investigation and pedagogies of enactment. So pedagogies of investigation, that is what we do a lot in professional development, analyzing classroom videos, investigating it, looking at student's work, records of practice. And that is really important, but our argument is that it is not enough. We also need to be trying to enact these things ourselves with somebody who is more advanced and could

scaffold. So that is the way I see apprenticeship. So when we did our coaching design, the coaches would actually go out and do professional development sessions. Ideally we should have been there, but we could not so that would be videos, we analyze with them. We have something to work on. I think we talk a lot about the complexity of things and the messiness and I think a lot of it is. It is swampy and it is complex.

Interviewer M: *And it should not be a swampy lowland?*

Paul Cobb: We just do not have a good way of conceptually handle it in a way that is productive for practice. I also think, this is a big issue for me. I have come to see most educational research as pretty irrelevant, at least in math education and particularly the learning sciences – this relates to the abstract-concrete issue – because I think what goes on in most educational research is groups of researchers in quite small cliques studying, I do not know, kids and discourse learning, and what counts as an important problem to study is defined by the other researchers. So I think of it as kind of this sort of hole of mirrors, just a group of researchers refracting each other and their views and there is no reality, there is no practice, no reality of school in it at all. And I think, we, to understand, at least in this country and in a research university like this one, to understand the institutional setting which encourages this pathological behavior in terms of what it rewards. If you are interested in actually, ultimately it is about the quality of kid's education, that is not there. So you have to be aware of the reward structures and the norms in the places where you work – it is in the water we swim every day – and to decide if you will play that game or not. So I have made the decision that I don't want to play that game.

Interviewer P: *Do you remember we talked about our thinking about these small measures that you were working on developing? And we also talked about this with the professional teacher who was a bit like you when you are doing these research designs where you always analyze a situation, then use that knowledge to improve practices. Is that really – of course in a minor scale – the picture of a good teacher?*

Paul Cobb: In part. In big part. There are a lot of analogies.

Interviewer P: *Am I right, when I see these small measures as a part of it?*

Paul Cobb: Surely, that would be part of what we want to feed them back on. The other thing I will say is the difference between research and teaching. They should be in contact right. For most teachers their work for improving, their practice if it is a group of teachers and what they do collectively together in their school, that is their focus. That is not only my focus. That is my focus – if I am not doing that, it is not ethical – but I am also interested in generating knowledge that is relevant to other people in other schools, but it is still about improving practice. That is the difference, I see that as a big part of the difference between design research and action research.

Interviewer P: *But could we also imagine it as the teacher, the way he is looking at his or her teaching?*

Paul Cobb: Yes. And I want to take it up a little bit through the system. So if we could dream: What becomes interesting in this country with its high stake accountability? For district leaders there is this huge sense of agency, so they keep coming up with ideas and want to roll it out across the system immediately, and it fails. It will fail. Your initial design is always broad. You are doing stuff that we do not know how to do. Otherwise you would not be working on it. If we knew, what to do, then why...? Do you see what I mean? So. Part of what I want to do when going forward is to see if it is possible – I do not know if it is – to negotiate a way of working at the district level parallel to this, where you start very small, suppose we were working with teachers, it will be one or two teachers, only, to have them as partners working out the design. And then maybe go to one school and then two. But no, you want to do it quickly, you know. Does that make sense?

Interviewer M: *All the methods you have developed, can they be transferred to other discipline areas?*

Paul Cobb: I think so. But you need people with that disciplinary expertise. Because they have to be adaptable. What we do is not generic. I should explain the position we have come to. It does not

just matter that we work in math. It is not just math. It is what is the specific vision of high quality math instruction. We start in the classroom with kids and their learning and how do you support that learning and so on. And that has implications throughout the system. But rather than starting with the policy and seeing if it goes down, we try to create policy by starting with the kids and the teacher and going up. And if that is where you start, your visions of high quality math instruction have implications for the policy, and so it could be that the policy in English art would be different if you have a different vision in relation to teachers current practice. But I think the heuristics is probably transferable.

Interviewer M: *You talk in some papers about this emergent perspective. What is that? It is a theory or is it just to understand emergence?*

Paul Cobb: It is a way of looking at things. I don't want to use the word theory because that seems very grand. We have a phrase. "Self-made grand iceman". You're building yourself up and making yourself look important and that is what it smacks off for me. So, I would not call it a theory. It is a way of looking. It is a lens. It relates to what we were talking about earlier, that classrooms are complex and messy. When we were doing classroom design experiments they were complex and messy, so what should we really be attending to, be focusing on? It is a way of looking on what is happening in the classroom and what the kids are up to and what the teachers are up to. A way of looking that could inform the revision and improvement of your design. So it is an attempt to develop that, and make the classroom appear less messy.

Notes

1 http://peabody.vanderbilt.edu/departments/tl/teaching_and_learning_research/mist/index.php