Motivations and meanings of students' actions in six classrooms from Germany, Hong Kong and the United States

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Abstract: This article presents an analysis of about 100 interviews with students from eight-grade classrooms in Berlin, Hong Kong and San Diego that reconstructs student motivations and the meanings they attribute to classroom activities. The data of the six classrooms were produced in the Learner's Perspective Study (LPS). The LPS is an international collaboration of researchers investigating practices in eighth-grade mathematics classrooms in 13 countries. Although not the central focus of the research, the case study of six classrooms revealed a variety of students' beliefs and perceptions, which are the focus of this article. These correspond to the possibilities the classroom practices offer. The study also reveals some similarities among student motives and concerns across classrooms. The findings are an important reminder that basing a curriculum upon an alternative vision calls for changing mathematical content as well as the social relations that are established through teaching methods and principles of evaluation.

Kurzreferat: Grundlage der Analyse sind Interviews mit ca. 100 Schülerinnen und Schülern, die im Rahmen der "Learner's Perspective Study" (LPS) durchgeführt worden sind. Die LPS untersucht den Mathematikunterricht in achten Klassen in 13 Ländern. Der Artikel präsentiert Ergebnisse einer Analyse der Bedeutungen, die Schüler/innen den Tätigkeiten im Mathematikunterricht in sechs Klassen aus Berlin, Hongkong und San Diego zuschreiben. In den Interviews wird deutlich, dass die Erwartungen und Vorstellungen der Schüler/innen mit den Möglichkeiten korrespondieren, die ihnen die Unterrichtspraxis bietet. Es zeigen sich auch Gemeinsamkeiten in den Anliegen der Schüler/innen aus den drei Ländern. Die Sozialisation im Unterricht schließt – neben den beabsichtigten Effekten, Phänomene ein, die weder von den Lehrerinnen noch von Lehrplanentwicklern beabsichtigt sind.

ZDM-Classification: C63, C23, C90, D70

1. Introduction

In the course of the discussion of curriculum in terms of standardized out-put, it is important not to loose sight of the social processes by which mathematical knowledge is constructed in the classroom. The enacted and the attained curriculum might differ substantially from goals, content, competencies and activities described in curriculum documents. How students view their learning environment and why they chose to (or not to) participate in classroom activities has an impact on knowledge development. The article reports upon an analysis of students' motivations and concerns and of the meanings they attribute to classroom activities.

A couple of studies are devoted to students' learning approaches, views of the nature of mathematics and mathematics learning, goals and motives (e.g. Goodchild, 2001; Hoyles, 1982; Klosterman, 1996; Schoenfeld, 1989; Pehkonen & Törner, 1998; Wong et al, 2001). Schoenfeld (1989) attributes students' underdeveloped abilities to solve problems to their beliefs about mathematics. His study of the problem solving behaviour of 230 upper secondary students revealed that many were searching for rules and held the view that on principle problems should be solvable by a distinct rule within a relatively short time and have only one answer. Wong et al (2001) report investigations of students' conceptions of mathematics as a curriculum issue in which the conception of mathematics is taken as part of the "attained curriculum" (Travers & Westbury, 1989) mediated by the teachers' conceptions of mathematics, assuming that their conceptions play an important role in their teaching. The studies reported by Pehkonen and Törner (1998) are predicated on the view that the students' beliefs about mathematics are linked to their beliefs about mathematics learning and teaching, which have an impact on students' motives. The motives influence participation, which in turn influences achievement, and vice versa. Hoyle's (1982) study of students' school experiences revealed that many were concerned with their level of ability after they had experienced difficulties in mathematics. Goodchild (2001) reports an exploration of activity in regular mathematics lessons in a year ten class in the UK in order to contribute to a theory of classroom activity. He points out that goals are not to be seen as fixed targets but rather arise dialectically in the relationship between the acting person and the arena of her activity and assumes that classroom culture exerts a considerable influence on students' perceptions of school mathematics. The expectations the students hold correspond to the possibilities the classroom practice offers. Classroom practices obviously shape behaviour and thought and can be taken as the premises on which the students' (and the teachers') ways of trying to succeed are based.

The analysis is part of larger study that rests on data from the Learner's Perspective Study (LPS), an international collaboration of researchers investigating practices in eighth-grade mathematics classrooms in 13 countries (for further information and references visit the website http://www.edfac.unimelb.edu.au/DSME/lps/). The data of the six classrooms were produced in the LPS.

Although not the central focus of the research, the study revealed a variety of students' beliefs and perceptions, which are the focus of this article. Other features of the practices in the six classrooms, such as the structure of mathematical content, the forms of interaction and talk across ten lessons, the mathematical meanings as intended to develop by the teachers, students' perception of classroom atmosphere and pedagogy are documented elsewhere (Jablonka, 2004; see also Jablonka and Keitel, in print).

2. Research Methods

The techniques of data collection in the LPS were developed in the course of the Classroom Learning Project undertaken at the University of Melbourne and culminating in the development of "Complementary Accounts Methodology" (Clarke, 1998). In the LPS, in each classroom sequences of at least ten consecutive lessons in three urban public schools were documented. The data related to each lesson comprise classroom videotapes, teacher questionnaires, teacher interviews, field notes from classroom observation, students' productions, resources used by the teacher and post lesson video-stimulated recall interviews with students. A "familiarization period" of up to one week was included for each classroom being videotaped. In the classrooms, three cameras were used: Teacher Camera, Student Camera, and Whole Class Camera. In each lesson a different group of four students who consistently sit near each other was videotaped with the Student Camera. Two students from this group were interviewed after the lesson. Images from the Teacher and Student Cameras were mixed on-site to provide a split-screen record of both teacher and student actions in the lesson. This split-screen video was used in the post lesson interviews. The students were given control of the video replay and asked to identify and comment upon classroom events of personal importance. The interviews were semi structured. On occasion, the interviewer started a conversation about the ways the students engage with mathematics at school and at home, about the meanings and relevance they attribute to the topics under consideration and to mathematics in general, about their identity as learners of mathematics and about their feelings in mathematics lessons. The circumstances under which such accounts may provide legitimate data, have been detailed, for example, by Ericsson and Simon (1980). The transcripts from the student interviews in Hong Kong and Germany were translated into English by the local research teams. All names used in this article are pseudonyms.

The student interviews provide rich information about their perspectives on classroom practice. Some students might have identified the researcher with the official side of the school, though they had been promised that there would be no information given to their teacher. In the interviews it was guaranteed that the teacher would not be shown the video from the student focus camera or the mixed video and would not have access to the interview data.

The strategies of analysis and categories for interpretation that emerged from the data of the first classroom analysed were checked against the data from the next one, which was chosen to be from a different cultural context in order to develop codes and theoretical constructs that could be identified in all six classrooms. In the course of this activity many categories had to be revised because of a cultural bias.

The selection of the six classrooms is based on the principle of maximising contrast but at the same time keeping a reasonable basis for any study of variations, which presupposes a similarity in at least some aspects. The study is conceptualised as a multi-case study. In the original study design from the LPS, eight-grade mathematics teachers have been selected according to local criteria of competency. In the present study, the classroom communities as groups and as organisational units are the cases. The contrasts refer to different dimensions of the cases, such as location, ethnic and socio-economic background of students, language, type of school and achievement distribution. Because of the complexity of these cases, some are similar in a couple of dimensions, others only in one. The table below shows the numbers of students interviewed; some were interviewed ingroups.

Classroom	Students interviewed	Interviews	Class Size
G1	22	11	27
G3	10	8	12
HK1	19	19	35
HK3	18	18	39
US1	20	20	29
US2	20	20	33
	109	**96**	**175**

3. Findings

Although the interviews had as the main purpose eliciting students' interpretations of classroom events, a number of issues emerged that centred about students' motivations, beliefs, attitudes and expectations. From the data obtained, it is not always possible to identify whether the students' statements and comments refer to a certain task, to the lesson, to mathematics learning in general or whether they expressed wishes rather than interpretations of reality; it is equally hard to classify the findings as expressions of either beliefs or motivations or purposes etc. However, the following themes emerged from the data and deserve documentation and discussion.

3.1 Passing tests

> *I was focusing really hard on the ... like, on the whole entire thing. Cuz, I consider it as like a test- another test ( ) ... Another ... day at school.* (Noah, US1)

In total, 52 students talked about passing tests and examinations or about their grades at some stage in the interviews. These comprise more than half of the students interviewed from the two German classrooms (G1, G3) and from US1, but only a couple of students from the other classrooms (HK1, HK3 and US2). A total of 23 students (six from G1, three from G3, two from HK1, one from HK3, eight from US1 and three from US2)

immediately referred to passing tests and examinations when asked about the purpose of the mathematical activities in their classrooms. Four of them talk about the advantage of knowing specific algebraic techniques in written tests:

Birgit and Arabella, G1, refer to purpose of learning binomial formulas:
Birgit: *Well ... probably so that you also learn to calculate more quickly ... that you become quicker somehow*. Int: *Is that how you see it?* Arabella: *Well yeah ... right. I definitely see it like that. Because when there's a test ... you've only got an hour and if there are nine questions ... and you have to answer all of them ... then it's really difficult then.*
Olivia, HK1, refers to solving linear equations in two unknowns by Gaussian elimination:
The most important thing is to learn a faster method. When you learn a quick method, we can save lots of time in examinations and tests.
Alfonso, US1, refers to alternative procedures his mother showed him:
I like, because um, I like when you can have different options, because if you like, like if you like um, solving a problem one way and you, you understand it but you kinda don't ... um, I don't really like that because sometimes you can get those wrong on tests and stuff but, if you like, like if you do one- one problem, and you did it one way and you think you might got it wrong, you could do it another way to see if you um, got it right.

Diana (G3) justifies the need to get good grades in tests and to pass examinations by an anticipated gain in employment, Lonna (US1) and Stefan A. (G1) mention progress into further education, Alfonso (US1) reasons: "It'll make my mom proud". All other students do not expand further on the purpose of passing mathematics tests.

The majority of the 52 students who made statements about tests, examinations and grades take test scores as a true and fair measure of their mathematical competency. However, nine of the German and three of the Hong Kong students who chose to talk about tests do not think their competence is estimated correctly by their marks. All but two of these students explain that they make "careless mistakes or "stress mistakes" because of a lack of concentration during tests, but do not view this as a failure because they know they "can do it". However, one German and one Hong Kong student (Albert Me. From G1 and Jessica from HK3) assert that their competence is overestimated in the tests:

Jessica (HK3): *Sorry? Um … just work hard before examinations, then the result seems to be quite good, I don't quite understand usually.*
Albert Me (G1): *I have got a two, yes … is good as well.* Int: *As well, yes, of course it is good, too, and, so do you rate yourselves good or.* Albert Me.: *Yes, in a TEST I do.*
Gordon (G1): *Hm, the difficulties that I have are always with this, when we do a test then I calculate everything through really sort of scatterbrained, and then always put a minus in instead of a plus or something like that, and then it always ends up just ends up wrong ... Because I - I can do it really - but then when I do the test – I'm always worked up and then I think I have - I'm always thinking, oh I hope I can manage to do all this and then I do it all quickly, and then I don't check it through, well ... and then ... I usually get a bad grade.*
Selin (G3): *Yes, because I can do it. That is why it is fun.* Int: *You can do it, it is fun but you are a 'four'?* [The best German mark is 'one', the worst is 'six'.] Selin: *Yes.* Int: *That is.* Selin: *Yes. Now. I don't know. ... Four. But I can do it.* Int: *Mhm*. Selin: *In the tests it's somehow strange … then I can't do it.*
Int: *Mm-hm. Like this, what about your own math performance? Math subject …* Joyce (HK3): *Not as good as before.* Int: *Not as good as before. Why is it like that?* Joyce: *Very careless.* Int: *Very careless. Careless of what?* Joyce: *Like … I know it, I know it should be separated into two equations, but A and B are related, have to use the answer of A to get the answer of B, but I don't know why I copy B wrong, when I calculate the answer of A, it is wrong. So I loose a few marks.* Int: *Copying things wrong*// Joyce: *//Yes, but everytime (…) I don't know what I have done wrong, (I am) very angry.*
Jane (HK3): *According to the academic results from exams, according to the question papers … usually I am careless … um missing … careless, make … make some mistakes.* Int: *Mm, is it what you did wrongly are usually not too …* Jane: *Too serious? It won't be, that is unless I don't know how to do the question … yes.*

Six students (from G1 and US1) expanded on their emotions before, during or after a class test, including an "uneasy feeling", "being nervous", "driving myself mad" and disliking teachers who "try to smack you in the face with the same test over and over again". Most of the students report that they do not spend a lot of time at home studying mathematics except when they prepare for tests and examinations. Many want to do well and at the same time minimize the effort for doing so, as expresses for example by Albert Mu. (G1): "Before written tests I usually go through all the rules, but otherwise not so much really", or Janet (HK3): "Huh? Do mathematics? No, (I) will do some before the examinations." A couple of students from each Hong Kong classroom report that they have hired a private tutor or attend classes in tutorial centres. Comparatively many students from US1 are concerned with getting good grades. Examples of typical statements are given below:

Roberto (US1): *I just like want to ... GET the lesson. Know how to do it and stuff.* Int: *//Ah. Okay.* Roberto: *//So I can like do my homework and ... G- d- go- do good on quizes and tests.* Int: *Oh, okay. Can you tell me a little bit about that "GET the lesson." What i- what is that? What helps you to do well on quizes and tests?*
Roberto: *Um ... practice- like problems. Like I was out for a couple of days and Mr. Anderson just told me to- that the homework I had to do was like ... practice problems- practice, like make up- I had to make up my own problems. And practice and practice until I get it.*

Alfonso (US1): *And like last week when he was doing that thing with the calculator, he really confused me, so I was thinking about what I would do to get a good grade on that quiz.*
Int: *Oh, so you like to have quizzes?* Esperanza (US1): *Yeah.* Int: *Yeah?* Esperanza: *Because of them, I like to have uh, good grades.* Int*: Oh.* Esperanza: *But I was-I was get bored because I was getting A- ... Yeah, I was ... I-I Today, I was in the career center and I have-I don't have um, uh ... I think it's not a good grade. Like ... I have to have a ten.*

The relative importance students attribute to passing tests could be due to differences in what Doyle (1983) calls the "evaluative culture" of the classroom, of which students are more or less permanently aware. Indeed, the teachers in the two classrooms (G1, US1) in which a majority of students talk about tests, spent a couple of lessons during the period of videotaping preparing for tests. In the interviews after these lessons, the students did not refer to the topic when asked what the lessons were about, but to "test preparation" as the main point. However, only a couple of the Hong Kong students mentioned high achievement in examinations and tests as a motivation in the interviews, seemingly a contradiction to Chinese "examination culture" (Wong and Wong, 2002) and a cult of efficiency prevalent in the Hong Kong society (Leung, 1995), which are assumed responsible for achievement orientation. However, the omnipresence of examinations might be too familiar in classroom practice to be reflected upon by the students. In one lesson, the teacher in HK1 actually justified the advantage of Gaussian elimination by pointing to the advantage of saving time in examinations.

The purpose of passing tests commonly is linked to extrinsic motivation that is evaluated as less conducive to learning than intrinsic interest in a problem or topic. In this six classrooms, this motive is not linked to the achievement level, neither of the class nor or of individual students.

3.2 Acquiring relevant competencies

Several interview prompts referred to the goals and the main point of the lessons, to the reasons why students thought it important to deal with the topic, to what they actually learnt from the lesson and what had to happen so that the lesson was perceived as a "good" lesson. In their answers the students frequently expanded on other topics than those of the lesson and on the relevance they attributed to them. Some students did not refer to mathematical knowledge but to generic competencies.

3.2.1 Thinking

A total of 13 students made statements in which they associated mathematical activities with "thinking". Eight of these students are from HK1, three from HK3; one is from US1 and one from G3. The following conversations are typical:

Int: *That is for example you have joined the mathematics class, do you think it can help you? That is for yourself.*
Michael (HK1): *I have learnt more knowledge and my brain … brain can run faster.*
Int: *What's the most important thing you want to learn from math lessons?* Patrick (HK1): *It's important to learn … how to think.*
Int*: Is that a hard question? I'm looking for what were your goals for the lesson? What were the th- when you go in to the class, what- what do you want to do when you go into class?* Leon (US1): *Learn- learn more.* Int: *Oh, okay. Alright. And ho- what does learning mean for you?* Leon: [thinks about it] Int: *Does it mean that you can just remember what someone said and copy the same things down?* Leon: *No.* Int: *No? Tell me what it means.*
Leon: *Get smarter.*

The majority of the students who refer to "thinking" or "using the brain" describe activities in mathematics lessons in contrast to those in other subjects, for example, Chinese and Chinese History or English, subjects they associate with memorizing of facts. For them, a feeling of being mentally engaged makes mathematics lessons less boring:

Polly (HK1): *No. It is just mathematics lessons uh … no, because in other lessons such as Chinese and Chinese History you do not need to use the brain, no, only listening to Miss talking … so it is boring.*
Rachel (HK1): *Well, because, I do not know how to tell you. But I think that Mathematics can make me think faster.* Int: *Yep.* Rachel: *That is I need not use my brain to think in lessons usually. That is I only need to memorize all, the information in books. Also, it can- that is I can find the answer when I see the question, so there is no need to find the information in books.*
Jennifer (HK3): *And it's easy to make mistakes during calculations, so if um…if um…you will know it when you learn something by heart, but for mathematics, mathematics, it doesn't mean you can do it even you have memorized it.*
Osbert (HK3): *He teaches us something. For in the other lessons, the teachers talk about … the texts. But he teaches us, math.* Int: *I don't understand. Mr. Tang also talks about the texts.* Osbert: *He teaches us what to do and we're thinking at the same time. We merely listen in other lessons.*
Bekant (G3): *With German and English you do not have to think as much, with English all you have to do actually is learn. Words or usually speaking. And with mathematics you have to calculate you know, think and all.*

The following statements suggest the students use „thinking" and "using the brain" in the sense of concentrating:

Int: *Have you learnt something that makes you think faster?* Polly (HK1): *Yep.* Int: *What is it?* Polly: *For*

example, that parenthesis, I forget to write it and I could think of it.
Katherine (HK3): *Um … um … I have to keep my mind clear when doing calculations, I mean day dreaming this and that.*

These findings are partly in contrast to what Boaler (2000) reports. Students from the UK compared mathematics lessons with other lessons they perceived as less boring. This is an important reminder of the fact that students' perceptions of mathematical activity are also related to their experience of classroom practices in other subjects.

3.2.2 Knowledge for everyday and professional practices

The practices students referred to in the interviews comprise managing a bank account, shopping, dealing with rents, salaries, fees, taxes, or buying and renovating a house. Jeannine (G3) explains that a computer user still has to have some mathematical knowledge in order to operate it, Mona (G3) and Albert Mu. (G1) think that mathematical knowledge can be useful for uncovering cheats. Seyfettin (G3) draws a distinction between mathematics and calculating and thinks the latter is important for everybody. However, these examples do not refer to the topics of the lessons videotaped. Two students from G3 suppose that linear functions are useful for graphic designers. Other professions named in the interviews include: mathematician, bank employee, revenue officer, computer specialist, businessman, worker in chemistry and physics.

A couple of Hong Kong students make general statements about the importance of connections to daily life, though it is not clear whether they talk about their experience or rather express an ideal:

Gordon (HK3): [the most important things to learn in mathematics lessons are] *those which can be applied in mathematics and to the daily life .*
Joyce (HK3): *The most important thing to learn in math is … um … something that you can't find the answer in your daily life.*

Four students draw attention to mathematical abstraction and argue that anything could be modelled by variables and equations:

Albert Mu (G1): *Yeah, and then he told me um ... to calculate how much money you have to pay when you go shopping um ... and then you can tell um ... whether they've taken you for a ride, yeah, and then you need it ... well for your income, when you eventually go to work, in order to manage your income properly ... mm you need math everyday then.* Int: *Yeah, but perhaps not the As and Bs and the Xs and Ys, do you?* Albert Mu.: *Yeah, but the As and Es will become proper figures then. Later on in life.*
Thorben (G1): *Is actually – actually it is logical with the – that with the variables, that is always A, B and things like that, that are equations actually. Int: Yes, that are () equations.* Thorben: *Actually all problems are equations.*
Olaf (G1): *Even though it's not really my cup of tea, it's still important.* Int: *Mm, mm.* Markus: *That's my opinion as well because um the X can stand for anything at all.*
Rose (HK1) [takes a task from the lesson as an example]: *To learn…the things in our daily lives…but we're not using simple arithmetic to solve them. For example, in this question, we learnt that this can help me to…hey man, when you're talking about a sum of money, I…I may put my money into my bank account, I may spilt that sum of money into two. I may mix up two sums of money and forget about the amounts of money. If I apply this equation, I'll know how much money is put into Bank A and how much is put…em… into Bank B. This is practical in our daily lives.*

Some students from US2 had been wondering about the meaning of algebraic expressions and report that they gained some insight in the lessons:

Chelsa (US2): [Pointing to different equations and graphs written in columns in her notebook] *So I had this* [points to fourth column in notebook of math phrases]. *And then I kind of built from here and then I went to the equations* [points to a column of equations]. *Then the hardest part for me was ... I'm thinking ... okay, how can words suddenly turn into numbers* [pointing at both columns at the same time].
Lindsey (US2): *It helps me learn by like, sort of thinking about what I would use it for and using just real live objects in my head ... and think about it from another perspective.*
Letitia (US2): *Yeah. That I never had- I knew that like, pi was um, like about circles, like that's how we … Yeah but like I never knew that if you like take things away from a math problem you can get pi.*

Examples of typical statements of students who complain about a lack of relatedness to "real life" are given below:

Andi (US2): *Um, just ... well, I don't really understand how I'm gonna use it in real life, but ... but, I- I really like graphing; um, using problems and graphing them. Um, and using the T- um, T-charts and stuff.* Int: *Now when you say um, "real life", what does that mean to you?*
Andi: *I don't know what like, I'm gonna use it for ... like when I'm gonna use it ... and how it's gonna take part in my life.*
Int: *Um, what do you think is the most important thing to learn from mathematics lessons?* Jessica HK3): *Sorry? Mathematics? Not at all, how important can it be?* Int: *What can you learn from mathematics lessons?* Jessica: *I can't think of any, I always wonder what's the point of teaching those stuff … The teacher won't need to use that in his daily life … I don't understand why he is teaching that.*
Int: *Do you think that you have to know these things? Is*

it important? Peer (G3): *Actually, I don't think so. ... If you have to know these things later or no idea (...).* Int: *That was what you also asked once today (...) during the lesson.* Peer: *Yes, I asked her whether this is important at all for you jobs later on, but I don't understand it either.*

Altogether, just a few students thought that the mathematics they were about to learn could be of use in everyday situations. Some explicitly complained about the seemingly useless nature of the content, some others tried to make informed guesses after being prompted by the interviewer. There are no statements of students from US1 about a relation of classroom activities to everyday or professional practices. In all classrooms except in US1, there appear word problems in at least some of the ten lessons videotaped. In HK1, HK3 and G1, classical algebraic text problems for setting up equations are introduced together with "steps" for solving these problems. However, in the post lesson interviews the students refer to these problems as *mathematical* problems. It is only one problem that deals with money in a bank account (HK1) that convinces the students that equations might be useful (see the conversation with Rose, above). In US2 a professional context is indexed in the tenth lesson when the students experiment with paper bridges and pennies in order to find data for the relationship between length of bridge and supporting capacity. In G3 an everyday context is used in geometry word problems.

3.2.3 Understand why, see connections

Much more students from US2 than from the five other classrooms (that is 11 compared to one to three) make reference to understanding why, finding patterns and establishing connections. This is entirely in accordance with the teacher's goals. Naomi's (US2) statement is typical:

Int: *What were your goals for the lesson on Friday?*
Naomi (US2): *I think my goal was to understand how ... all of this works out.* Int: *When you say, "all of this works out," can you tell me more about that?* Naomi: *Of how all the graphs are related to each other and how all the representations are related.*

However, some of the students in this classroom seem to struggle because of conflicting messages they gained from their prior experiences with mathematics tasks that showed different features. Goodchild (2001, p.78-79) briefly discusses such a situation as "double-bind".The statements below is exemplary of this situation.

Shannon: *Hm, I'd prefer to be in my old math class cuz that was easy.*
Lindsey: *Sometimes, it just depends on what it's about, on like- solving things to solve for a variable, I liked that, I like to solve for things, but if it's something- I- I don't know. I like things that I can do, and I don't like things I can't do.*
Int: *Um, do you like math?* Ashley: *Well, um, yeah, it's- it's okay, except um, I like actually solving the problems instead of like um, making the graph or um, making tables. I like equations better.* Int: [Laughing] *You like equations better, why do you like equations better?*
Ashley: *Because um, like if you solve it and then like you could- you could sometimes just, you know that you're right-* Int: *Uh-huh.* Ashley: *And it's like there's only one answer.*
Hannah*: I get confused because they do it differently than I used to- Than I used to learn.*
Int: *She used the word undefined, what did- do- did you- what was going through your mind when she said undefined?* Miguel: *I just thought that um, how can it be that there's no answer for it. How can it be undefined? That there should be an answer.*

3.2.4 Learn "how to get the answer"

A total of 35 students from all six classrooms, including the classroom (US2), in which the teacher tries to stress relationships across topics or between tasks (see above), employ the metaphor of carrying out steps, 'doing things' and obtaining results. Many students talk about their wish of being able to produce a valid answer in an efficient way. "Understanding how" is an important goal, as conveyed in the following typical conversations and statements:

Int: *Um, what does understand mean then? You know what the rule is or what?* Chantal (G1): *Yeah and how I have to work it out.* Int: *And do you know why the rule is valid?* Chantal: *Umm, no.*
Anna (G1): *Well it just belongs to basic knowledge. You just have to be able to do it, and then you're allowed to forget it.*
Albert Mu.(G1): *Well now, the most important thing, that was mm ... was mm knowing how, how you change the, what's it called? Bi - binomial formula um ... well ...mm in a normal ... well ... problem. And, yeah that was really - the most important thing.* Int: *Why are binomial formulas important?* Albert Mu.: *Well mm, so that you don't have to write so much ... in the math lesson.*
Int: *Only these things are important? Why are they important? What did you learn?* Osbert (HK1): *Use … Mn … modifies the equations so that it's easier for me to get the answer. Same here.*
Int: *That means er ... what would you like to learn in this lesson, but you have just said er ... you would like to learn how to ...* Nina (HK1): *Er ... calculate- calculate.*
Int: *Um … what do you think is the most important thing to learn in mathematics lessons?* Janice (HK3): *Learn how to do the calculation. Calculate …. Have to get the answer, this is the most important.*
Int: *What do you think is the most important thing to learn in mathematics lessons?* Jason (HK3): *To learn the expressions and the ways to calculate them.*
Alfonso (US1*): I want- wanted to hope that I understanded all of it and that I would be able to do it*

like that [snaps fingers]. *Like not have to think about it, just I would know it. Like, cuz uh, some problems you know you know, but like one they add a new number and you might not know how to do it so, I want to be able to get it fast.*
Int: *Okay, and what does understand mean for you? When do you know you understand?* Autumn (US1): *When I can- I can like, go up to the board and do a problem and get it right.*
Amy (US2): *He's amazed that I come in and right away I just start the warm up, because he thinks that I like it or something, and I just- like one time I saw the warm up and I'm like "oh that's easy," and so I just wanted to like get it done as fast as I could ...*

The goal of generating a product dominates many of the students' activities. This is also manifested in the ways students co-operate on tasks. The most efficient way is checking the results and entering a discussion only in the case of a mismatch, as observed in the German and the Hong Kong classrooms. In US1 students did not work in pairs or groups. In group work in US2, some adopted the strategy of employing majority rules, of dividing the task into sub-tasks or of copying from the ones who are quick. Apart from the fact that an output has to be produced, the content of the tasks often did not afford co-operation and discussion. This makes the students' strategies even more reasonable.

The following comment is exemplary of the experience shared by many students. It is reminiscent of Doyle's (1983) observation that academic tasks are presented as work:

Hannah (US2): *It's well I know it is, but more of a duty to get it done, instead of just have fun, and do something with it.* Int: *Do you think it's important for- for her that you just get things done?* Hannah: [Nodding] *Yeah, get things done because that's one of our major requirements, to have all your work completed.*

3.4 Behave according to expectations

There are a couple of students who did not express motives or goals. They seem to assume that the classroom activity is necessary for their learning and want to do what is required. This is expressed by statements which do not include any reasons for their participation in the classroom or reference to any particular content they expect to learn. All comments suggesting this interpretation are made by students from HK1, HK3 and US1. However, students from US1 frequently said they just wanted to learn more or "harder stuff", whereas many of the Hong Kong students concede that they have never asked themselves what they expected or wanted to achieve in mathematics lessons:

Int: *Have you ever thought about what you want to learn in this lesson?* Gordon (HK3): *What?* Int: *Have you ever thought about what you want to learn in this lesson?*
Gordon: *No, I learn what he taught.*
Int: *Mm … have you ever thought about what to learn?*
Janet (HK3): *No.* Int: *Mm … like this for every lesson? That is, you never thought about what to learn.* Janet: *I listen to what he talks about.*
Int*: Okay. When you went into that lesson, was there something you wanted to have got out of that lesson? So by the end of it?* Shauna (US1): *No. No.* [Shauna shakes her head] *Nope.* Int: *Not or nothing?* Shauna: *Nothing.*
Int: *Why…is it* [equations] *important? You say it's important* Raymond (HK1): *Because it's written on the blackboard. Usually, the things that the teacher writes on the blackboard are important.*

Many of the conversations in this category resemble Goodchild's (2001) description of a rationale for engaging in classroom activities that is not linked to any sense of the value of the tasks. However this cannot be concluded from the statements in which students assert that it is important to learn more mathematics in the mathematics lesson, an obvious fact, as obvious as that it is the teacher who sets the goals.

4. Discussion

Some of the findings resemble outcomes of studies that deal with students' conceptions or beliefs about mathematics. For example, in a study with 29 Hong Kong students Wong, Lam, and Wong (1998) confronted students with ten hypothetical situations and asked whether these situations involve "doing mathematics". Their study revealed that the students recognise mathematics by the use of terminology and content and perceive mathematics as a set of rules, but also maintain that mathematics is closely related to thinking. This is similar to the descriptions of many students from the two Hong Kong classrooms, though what they describe as thinking is very close to concentrating and focussing on a task and does not necessarily involve decision-making. One of the teachers participating in Wong's study observes: "The working steps are not mathematics but just a way of presentation. Real mathematics involves thinking procedures rather" (Wong et al., 2001, p. 12). However, this form of representation seems to be predominant in the six classrooms. For example, when dealing with "word problems" in HK1, G1 and G3, or when careful consideration of single steps in algebraic transformations is given in US1, HK1 and G1. The students appreciate this form of representation and otherwise feel lost, as some in US2. The students' comments quoted by Wong and Marton (2002) are in line with those from this study, not only in the Hong Kong schools HK1 and HK3. The authors point out that the problem solving procedures adopted by the students are influenced by the practice of examinations. Some students employ a strategy of writing down only the formal solution to the problems because they are used to a deduction of marks for wrong statements in primary education. In the exit examination at grade 11, marks are given for any correct response in the answer box, which makes a guessing strategy reasonable. Similar practices might be found when students are used to solve multiple-choice tasks.

The students' statements are linked to different levels of the curriculum and not mutually exclusive. Some communicated their views as assumptions about the purpose rather than as expressions of personal goals, some as experiences with tasks or as comments about school mathematics. There are important differences between the six classrooms, although the two classrooms from Hong Kong appear more similar to each other than any other two. However, there are also some similarities in student perceptions and themes that emerged in the interviews. This suggests that there are general principles in operation that limit the scope of mathematical activity in all six classrooms, independent of curriculum tradition, achievement level and cultural affiliation. These structural similarities are embodied in a variation of physical settings, forms of interaction and talk, habits and rituals. Differences can be attributed to culturally specific solutions of the *same* problems. In all classrooms, the participants cannot interpret and redefine their social relations, as they like. Hess and Azuma (1991) observe, for example, that when dealing with this situation, Japanese teachers tend to stress the development of adaptive dispositions, whereas U.S. teachers seek to make the learning context more attractive for students.

From the perspective of the students, the teacher is the only one who endues the constellation of a problem, the goals, the division into tasks and sub-tasks and the way(s) of solving them. However, the students are still expected to be mentally engaged in the development of the solution. Some findings of this study suggest that the students adopt culturally specific solutions to this problem.

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Keys used in transcripts:
S Unidentified student
// Overlapping talk
... Pause of three or less seconds, respectively where it would be in the English version of the original transcript
(…) Indecipherable words
(text) A 'best guess' from transcriber

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