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Abstract. As one of the so-called basic skills, 'mathematics' or 'numeracy' is at the top of the list of subjects in adult education programmes. Together with political investment in general and further education, practitioners and theoreticians focus on 'knowing and learning in different contexts'. Jean Lave's theory about 'situated learning' may be regarded as a confrontation with the idea of learning as acquisition of propositional knowledge. One characteristic of adult education in mathematics is that the participants bring with them adult life experience from their everyday and work. Another characteristic is their perspective in educating themselves. There is an apparent contradiction between many adults being blocked in relation to mathematics in formal settings and being competent in their everyday life. It is possible to make sense of this contradiction by analytically expanding the context for knowing and learning mathematics from the participants' experiences and perspectives to also include the adults' dispositions, cf. Pierre Bourdieu's concept of 'habitus' as a guiding principle for practice. By interpreting the account of her life by a 75 year old woman concerning her attitudes to mathematics, the author illustrates and discusses the two analytical concepts ('situated learning' and 'habitus') and their suitability for analysing adults knowing or not-knowing mathematics in different situation contexts.

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1. INTRODUCTION

"Are you good at maths?". When a schoolchild or a young person is asked this question it usually means, "Are you good at maths in school?". When an adult is asked the same question the first reaction may be, "What do you mean?". In the adult world mathematics and mathematical knowledge are relative notions, the meaning of which depends on the individual, the situation and the context. In the context of mathematics education the question may be perceived in the same way as by the schoolchild. If the question is asked by a workmate at a metal workshop it may be due to the questioner's uncertainty when converting a working sketch with 1:5 measurements, and the question may only have to do with one specific skill. In general conversation among friends, the question may have to do with general everyday competence and mean, "Are you numerate?", which is a question with both a subjective and an objective dimension. It is subjective because the question has to do with individual perceptions and needs. It is objective

because perceptions and needs depend on the social and historical context. The need for numeracy in early industrialised society was quite different from the need in today's democratic information society.

By this I mean that I regard 'adults and mathematics' as a complex subject for mathematics education, whether the focus be on teaching, learning, or knowledge. Thus delimiting the field of study is a central part of the research. In my view the complexity is based on at least three vital, inter-connected conditions which have to do with knowing, learning and teaching of adults:

(1) Knowing mathematics is a contextually determined and thus relational concept in the adult world. Whether or not an adult knows mathematics can only be answered after the questions such as who, where, when, what and related to what.
(2) The situation for learning mathematics depends on the experience of the individual adult with mathematics in school and everyday practice and their individual perspectives for learning. Emotional factors are just as important as cognitive ones in the psychological learning process.
3) Adults have a range of different opportunities to learn (or not to learn) maths in adult or further educational systems and/or in everyday practice. There is a large variety of formal adult education programmes where mathematics is taught as a separate subject or integrated in other subjects, and where the objectives are either mathematical, general or specific vocational competence.

I regard mathematics as a contextualised activity, i.e. there is no such thing as context-free mathematics. For ease of reference to the use of the word 'context' by other researchers in mathematics education, I shall make a distinction between two types of meaning and term them, respectively, 'task context' and 'situation context'. According to the dictionaries, the English (French, German, Danish ...) word 'context' has two fundamental meanings. The one is linguistic meaning words that come before and after a word, phrase, statement etc., helping to show what the meaning is. The other meaning has to do with historical. social, psychological etc. circumstances in which, a) something happens, or, b) something is to be considered. Mathematical didacticians use the term 'context' in both fundamental meanings. 'Context' representing reality in tasks, word problems, examples, textbooks, teaching materials, is closest to the linguistic fundamental meaning (Forman & Steen, 1995; Helme, 1995; Unenge, 1995). I call this type *task-context*. In this sense the word is often normatively employed, e.g. in curriculum documents as a requirement that teaching and materials shall contain 'real-life context' or 'meaningful and authentic contexts'. Freudenthal distinguishes between the two meanings of what I call 'task-context'. He uses the term 'text', meaning a linguistic vehicle, in particular for word problems or text problems, and the term 'context' meaning "that domain of reality, which in some particular learning process *is disclosed to the learner* in order to be mathematised." (Freudentahl, 1991, p. 73, my italics). He illus-

trates the difference with a problem about the butcher, Smith, who has 26 kilos of ham in his shop and orders 10 kilos more. The question is how much he has now. But, in reality, when the ham arrives some of the 26 kg has been sold. The context of this problem is not the butcher's reality but the textbook. In the textbook context each problem has one solution and only one.

In the other fundamental meaning, which has to do with historical, social, psychological etc. matters and relations, researcher in mathematics education speak of a context for learning, using and knowing mathematics (school, everyday life, place of work etc.), or context of mathematics education (educational system, educational policies etc.). (Christiansen & Walter, 1986; Mellin-Olsen, 1987; Lave, 1988 & 1992; Harris, 1991; Strässer et al., 1991; Niss, 1994; Strässer & Zevenbergen, 1996). I call this type *situation context*. An illustration of the two terms can be found in an empirical Swedish study of the school as context for cognitive action. Students worked, in two different settings, on the everyday problem of establishing what it would cost to send a letter: a mathematics lesson and in a social studies lesson. (Säljö & Wyndhamn, 1993) The task-context is the same but the problem is solved in two different situation contexts.

In both connections a central didactic question has been formulated in terms of transfer of learning and in particular concerning the application of knowledge from school contexts to work or everyday activities and vice versa. (Schliemann & Acioly, 1989; Nunes et al., 1993; Noss & Hoyles, 1996; Strässer, 1996; Evans, 1996).

'Adults knowing and learning mathematics in different situation-contexts' is the subject of this article. The '*adults*' I am speaking of are those with brief schooling whose perspective with regard to education is about training themselves for the job on hand or for skilled work. At no point in history have so many adults taken part in formal education. Many of them have difficulty and/or blocks with regard to learning mathematics in formal settings, despite the fact that they are competent problemsolvers in their daily lives. My approach is a pedagogical-sociological one; adults' learning processes are regarded and analyzed as social processes and not as cognitive ones. The main objective of the article is to construct a tool by combining the two concepts of 'situated learning' and 'habitus' and illustrating their usefulness for shedding light on the complex of problems by analysing a single qualitative interview in order to construct the meaning of mathematics in a woman's life.

2. LIFELONG LEARNING AND ADULT EDUCATION

"You live and learn" as the old saying goes. It is about the school of life where fresh experience can change the foundation of our thoughts, actions and how we perceive ourselves. Formerly, the institutionalised framework of education (in the sense of

formation) was only applied to children and young people. Now the right and the obligation concerning education does not stop with childhood and youth but also includes adult life. The idea of lifelong learning was introduced by UNESCO in the late 1960s. The concept disappeared from the policy debate but reappeared in a different context and a different form in the late 1980s. In the meantime lifelong learning as a guiding principle for restructuring education had changed from a utopian idea to an economic imperative. (Rubenson, 1995) Adult education programmes are highly prioritised in educational and labour market policy in the European Union, primarily with reference to technological development on the labour market. Concerns about people who are illprepared for the work-places of the future have resulted in various policy reports identifying 'basic skills' and 'key competencies' and postulating appropriate educational responses. As one of the basic skills, 'mathematics' or 'numeracy' is at the top of the list of subjects in the educational programmes available. In Denmark more than 100,000 semi-skilled workers participate every year in mathematics education and even more in teaching that contains mathematical elements.

As in the area of adult education, research into adult education is a growth area. However, 'adults and mathematics' is a relatively uncultivated area of research on mathematics education, but it is also an area with increasing activity. (Wedege, 1998) In 1994 Helga Jungwirth, Jürgen Maass and Wolfgang Schlöglmann advertised for other researchers in this field in the ICMI Bulletin (Jungwirth et al., 1994). Also in 1994, at the initiative of Diana Coben, inter alia, the first international forum for research, Adults Learning Mathematics (ALM), was formed. (Coben & O'Hagan, 1993). At the 8th International Congress on Mathematical Education, in Seville 1996 (ICME 8), for the first time one of the groups was organised around the theme of 'Adults returning to mathematics education' (Working Group 18) with Gail FitzSimons as chief organiser. In the international handbook, also from 1996, there is an entry for 'adults' for the first time ever in a reference work on research on mathematics education. And it did not stop there: there is a whole chapter devoted to the theme of 'adults and mathematics'. The authors of the chapter characterise the research field as one showing "great heterogeneity" (FitzSimons et al. 1996, p.755). While I agree that the area would seem to show heterogeneity, in my opinion this has to do with, firstly, the great complexity of the subject and secondly, the fact that there does not exist a total paradigm or a 'grand narrative' concerning adults and mathematics.

For the last seven years I have been participating in educational planning and development in the area of 'general qualification of semi-skilled workers' in the Danish adult vocational training system, with special responsibility for arithmetic and mathematics teaching. Two of the most central questions in planning and development are: What qualifications are needed and how can they be translated to education? In the two simple questions about knowledge, learning and teaching lies the assumption that formal education could be an appropriate answer to semi-skilled workers' need for general qualification. There is also an implicit assumption in the work of all educators that, after

all, there is a certain connection between 'the matter meant', 'the matter taught' and 'the matter learnt'. There are, in addition, some difficulties in translating qualification analyses into vocational education having to do with the context-determination of qualifications. a. The general categories of qualifications are described in isolation from the technological contexts of workplaces. b. The conditions for transfer between school and workplace are unclear. c. The knowledge of adults' actual qualifications in a new technological context is uncertain. (Darrah, 1992, Wedege, 1995 a & b; Strässer, 1996). My interest in 'adults and mathematics' is that of the educational planner, but my point of departure is that educational reforms must address the social nature of work, including the capacity to understand and modify technology and organisation.

3. KNOWING AND LEARNING MATHEMATICS IN PRACTICE

There is a broad range of positions for understanding learning processes today. From one perspective learning as a psychological process (cognition) is being investigated, and from another learning as a process of interaction (social learning). The traditional psychological theories of learning share important features. They are based on a number of dichotomies between inner and outer, knowledge is considered as exclusively something to do with the brain, and the individual is taken as the unproblematic point of departure for learning processes. Throughout the 1980s there was increasing interest in learning in practice in psychological and pedagogical research. A central figure is Californian anthropologist Jean Lave who formulates her project thus:

> I have tried to move the investigation of "cognition" outdoors in several senses: out of the laboratory, out of the head, out of the confusion with a rationalistic "culture", out of conflation with conventional "knowledge structures" and out of the role of orderproducing, primary constraint on activity in the world." (Lave, 1988, 189-90)

As is well-known, in the "Adult Math Project", Lave conducted a comparison of adults' arithmetical procedures in two different kinds of situation context: everyday life and in school-like situations. Experiments were carried out with adults solving problems with three different kinds of task-context: 1) a supermarket, 2) a 'school-supermarket', and 3) school mathematics. It proved to be the case that the adults participating in the investigation had a hidden mathematical competence which showed itself in the supermarket, but was not applied without problems in the school situation. (Lave 1988) These two points are exemplified in these experiments: the one has to do with the difference between the world of practice and school knowledge, the other with different settings. The meaning varies as the situation-context varies. In everyday life people use their own methods and we know from a large-scale English investigation that adults, in particular university graduate, often get a guilty conscience because their methods are different

from the 'correct methods' they learned at school. (Cockcroft, 1982)

Some years later Lave and Wenger formulated a theory of situated learning by constructing the analytical concept of 'legitimate peripheral participation' as a generalisation of the idea of apprenticeship. They emphasise regarding the agent (the learner), the activity and the world as being mutually constituted and thus provide the possibility of circumventing the view based on an assumption that learning is internalisation of factual knowledge or information. (Lave & Wenger, 1991) According to L&W the concept of 'situated learning' (learning as an integral part of generative social practice in the lived-in-world) bridges the two different views of learning: learning processes as cognitive processes or as social practice. Learning viewed as situated activity has as its central defining characteristic a process that they call *legitimate peripheral participation* (LPP). They construct this analytical concept of learning processes by using the term 'apprenticeship' as a metaphor when analysing anthropological studies , inter alia of training of tailors in Liberia and 'non-drinking alcoholics'. The concept of LPP provides the possibility of expanding the learning context with relations between beginners and experienced people, activities, identities, techniques and communities of knowledge and practice. Learning is described as a process with participation in communities of practice, participation which at first is legitimately peripheral but which gradually increases in engagement and complexity. The objective of the learning process is described as 'full participation'. LPP is ambiguous as learning is described as a process that points to a stronger position while still being a position where one is kept away from full participation. Here 'peripheral' is a positive term the antonymous concepts of which are 'non-related' or 'irrelevant'. The connection to social practice is present. 'Legitimate' indicates that there exists a written or unwritten agreement about the learning relation. LPP is neither a form of education, a pedagogical strategy, nor a teaching strategy. It is an analytical view of learning - a way of understanding learning (Lave & Wenger, 1991). The concept of LPP makes it possible to undertake the important distinction between learning and goal-oriented instruction/teaching. Jean Lave points out that the theory is not a theory of universal learning mechanisms, and researchers would have to explore each practice to understand what is being learned and how (Lave, 1996).

Jean Lave has a position in activity theory on the basis of which "the central theoretical relation is historically constituted between persons engaged in socio-culturally constructed activity and the world with which they are engaged." (Lave, 1993, p. 17). From this point of view, meaning is not created through individual intentions but has a relational character, and the analysis of the immediate situation cannot account for the concrete connectedness and meaning of the activity. In their presentation of the relational view (and integration in practice) of persons, their actions and the world in a theory of social practice, Lave and Wenger (1991) criticize a phenomenological position which implies that social activity is its own context. They point to French sociologist Pierre Bourdieu's critique of structural and phenomenological theory in his "Outline of a

Theory of Practice", with its vision of regulations without rules, embodied practices and cultural dispositions concerted in class habitus. (Bourdieu, 1977).

4. HABITUS - AS A CONDITION FOR LEARNING MATHEMATICS

At a course for sewing machine operators a participant had to divide 100 cm. by four, but her reaction was: "No, I can't. I've never been good at mathematics." It might come as a surprise that anyone could react to this sum in this way in a country where the unit of currency, the krone, is 100 øre or 4 x 25 øre; the story serves to illustrate the complicated and often emotional relationship of adults to mathematics. This relationship has been the subject of a number of investigations. (Buxton, 1981, Cockcroft, 1982, Burton, 1987, Frankenstein, 1989) And it has been shown that adults' attitudes to mathematics cannot be called simply 'positive' or 'negative'. (Jungwirth, 1994) From practice, interviews and questionnaire surveys we know that many participants in adult education are blocked in relation to numbers, figures and mathematics. (Jungwirth et al., 1995; Wedege, 1997) Participants' resistance to learning is another recognised issue in adult education in general and specifically in mathematics instruction (Lindenskov, 1996).

In a development project in the Danish Adult Education System (Wedege, 1997), we have defined three analytical levels of adult participants' experiences with mathematics. The basic level of experience (a judicious mixture of incorporated skills and understanding (mathematical thinking, tacit knowledge) and attitudes, feelings and motives) can be summed up in adults' relationship to mathematics, mathematics in the world surrounding us and ourselves; one could say, subjective dispositions to mathematics which generate actions and attitudes in interaction with personal understanding and skills.

In Lave's theory where communities of practice function as situation context for learning, a concept is missing which makes it possible at once to understand the subjective and objective conditions of the learners' dispositions for learning, or in other words, the objectively determined subjective conditions for learning. Lave is "taking learning to be a matter of changing participation in ongoing, changing social practice." (Lave, 1997) Her theory fits perfectly with the idea of lifelong learning, but within her theoretical framework. Why does someone learn in a given situation context while other do not? In his critique of the phenomenological biographical method, Bourdieu expresses it thus:

> Essayer de comprendre une vie comme une série unique et à soi suffisante d'évènements successifs sans autre lien que l'association à un "sujet" dont la constance n'est sans doute que celle d'un nom propre, est à peu près aussi absurde que d'essayer de rendre raison d'un trajet dans le métro sans prendre en compte la structure du réseau, c'est-à-dire la matrice de relations objective entre les différentes stations. (Bourdieu, 1986)[8]

Having established the blind spot in Lave together with our preliminary formulations about subjective dispositions as a basic level in adults' experience with mathematics, leads me to *habitus*, the concept employed Bourdieu for a system of dispositions which allow the individual to act, think and orient him or herself in the social world.[1] People's habitus is incorporated in the life they have lived up to the present and consists of systems of durable, transposable dispositions as principles of generating and structuring practices and representations:

> Les conditionnements associés à une classe particulière de conditions d'existence produisent des *habitus*, systèmes de *dispositions* durables et transposables, structures structurées prédiposées à fonctionner comme structures structurantes, c'est-à-dire en tant que principes générateurs et organisateurs de pratiques et de représentations qui peuvent être objectivement adaptées à leur but sans supposer la visée consciente de fins et la maîtrise expresse des opérations nécessaires pour les atteindre, objectivement "réglées" et "régulières" sans être en rien le produit de l'obéissance à des règles, et, étant tout cela, collectivement orchestrées sans être le produit de l'action organisatrice d'un chef d'orchestre. (Bourdieu, 1980 pp. 88-89)[b]

Bourdieu only defines the term 'dispositions' implicitly. It means 'ability to', 'instinct', 'taste' 'orientation' etc., but, as appears from the definition of habitus, it is not a case of innate, inherited or natural abilities. The term 'system' stands for a structured amount which constitutes a whole. Habitus (as a system of dispositions) contributes to the social world being recreated or changed from time to time when there is disagreement between the people's habitus and the social world. The dispositions which constitute habitus are durable ('durables'). This means that although they are tenacious, they are not permanent. Bourdieu has discussed precisely these two matters in an answer to attacks on him by critics for determinism in his theories (Bourdieu, 1994) The relation between individual habitus and class habitus is described by Bordieu as a homology that unites the individual habitus in the different members of the same class. Each of the structural systems of dispositions is a structural variant of the others: variations on the same theme. (Bourdieu, 1980)

While people's relationship to mathematics has not been on Bourdieu's agenda in any of his empirical work, there are several reasons why it seems fruitful to attempt to employ habitus as an analytical concept when working with adults and mathematics.

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[1] Like Lave, it is Bordieu's ambition to escape the dichotomy of objectivism vs. subjectivism, inner vs. outer, actor vs. structure. Many theories of socialization are based on a fundamental dichotomy: out there in society there are norms which are internalized in the individual. Instead Bourdieu employs the term *incorporation*, and the theory of habitus is incompatible with the idea of people as 'bearers' of social structures and norms. There is no direct, unmediated influence from social structures and norms to individuals. In Bourdieu's sociology people are most often *agents* in the etymological meaning of the word (agens, agere = act).

* The theory of habitus has to do with other than rational, conscious considerations as a basis of actions and perceptions. Dispositions and emotions are important factors when adults are learning - or not learning - mathematics.
* Habitus is durable but it undergoes transformations. Dispositions point both backwards and forwards in the current situation of the adult learning mathematics.
* The concept of habitus aims at an action-orientation anchored in the individual and can simultaneously explain non-action i.e. not learning mathematics.

I would claim that the concept of habitus, developed and belonging in a sociological problematique, can be combined in a problematique of mathematics education together with Lave's concept of situated learning. In the first place, Bourdieu emphasises that the theory of habitus is not 'a grand theory', but merely a theory of action or practice. (Bourdieu, 1994). The habitus theory has to do with why we act and think as we do. It does not answer the question of how the system of dispositions is created, and how habitus could be changed in a (pedagogical) practice.[2] In her previous work Lave refers to the theorizing of Bourdieu and social practice theory of the relational interdependency of agent and world, activity, meaning, cognition, learning and knowing, but in a new article she points at Bourdieu's silence about the nature of learning: "Every time it would be reasonable to address learning directly Bourdieu either switches to discussing educational institutions, or shifts his focus to teaching ... rather than learning, or he relegates learning to an individual, ahistorical, mental-process psychology that is inconsistent with the rest of his theoretical position." (Lave 1997)

Lave's own theory about situated learning is also a partial theory, a theory of learning as an integral part of social practice. She is trying to find an answer to the question of how people's dispositions are created and changed through legitimate peripheral participation. The two theories reject the idea of internalisation of knowledge and attitudes/norms, respectively. They mention instead active incorporation. The theory of habitus, as a social practice theory, doesn't encompass the theory of situated learning, but I would claim that the two theories are compatible and complementary. Lave's view of context as the concrete relations within and between situations in societally and historically generated systems of activity (1993) is compatible with Bourdieu's relationism and both challenge the dichotomy inner/outer, subject/object.

There is no sense in seeing habitus as the result of an isolated pedagogical activity (a product of learning). But it would be fruitful to employ the concept of habitus in the work of interpreting the conditions for adults learning mathematics, precisely because

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[2] Note, however, that at the end of the 60s the term achieved a central place in Bourdieu's terminology, where it is presented as product in the pedagogical activity in "La Reproduction" from 1970 is being about the function of the educational system in social reproduction. Here "une formation durable" and "habitus" achieve equal status. (Bourdieu & Passeron, 1970, 46-47) Many references in pedagogical/didactical literature refer to this work and thus deal with habitus as a result of education.

habitus is formed through impressions and acquisition, either directly where the objective structures are experienced and leave traces, or indirectly when we are exposed to activities that make impressions. This means that the concept of habitus can be used in interpretations of the conditions for adults learning as legitimate peripheral participation.

5. THE MEANING OF MATHEMATICS IN A WOMAN'S LIFE

Ruth is an active, out-going woman of 75. She has lived for 23 years on a small island in the North Sea, the last 9 years as a widow. Bridge is what she is mainly engaged in, apart from friends, family, and everyday life; she is also the cashier in the local gymnastics club. Last summer I asked Ruth if I might interview her about her relationship to mathematics during her life. She agreed, but somewhat hesitantly. Ruth is my mother: I am her daughter. This means that I had dual roles during the interview: one as 'the daughter' and actor in this history interested in the human being and individual, and one as 'the researcher' with a specific interest in her as a subject. My knowledge of Ruth's life and idea about the part played by mathematics in this life functioned as my interview guide, but in the interpretation of the text I only include general knowledge of the societal and historical context as well as concrete knowledge, i.e. about her parents-in-law playing bridge.

I got the idea of interviewing my mother because she has always been coquettish at home about how bad she was at mathematics while simultaneously being conscious of her ability at arithmetic. I had seen a contradiction between her bad maths grades at the lower secondary school leaving examination, her competent way with figures in daily life and at high-level bridge, and her function as tournament leader. I had also regarded her high grades in mathematics at the Technical School later in her life as a sign and I thought that it had changed her view of mathematics. Before the interview, before my interpretation and construction, as a researcher, of the meaning of mathematics in Ruth's life, I had an idea, as a daughter, of the meaning of mathematics in my mother's life.

The interview was taped and I have analyzed and interpreted it on the basis of a print-out of the tape. Various communities of practice were identified during the first editing and analysis of the print-out, and the text is organised according to four types of situation context for math-containing knowing and learning: school, work, family, and leisure-time (her passion). I have retained the original chronology in the interview within each section. In the final version the text has been adjusted to the written language at some places and its length cut down.[3]

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[3] Where one or more words are underlined in the text, this indicates that R. is particularly emphasising these words. The sign .. immediately following a word indicates that the speaker interrupts herself. The sign ... indicates hesitation, while (...) indicates a pause of some length. I

School

Ruth started school in 1928. She achieved high grades in the primary and lower secondary school and at the lower secondary school leaving examination, apart from in mathematics where her grades were very low. She has always described herself as having a "flypaper memory". Her teachers recommended that she continue into upper secondary school, but her parents left it up to her to make the choice, and she stopped when she had passed the lower secondary school leaving examination in 1938.

T: How far back can you remember from your time at school?

R: I can't really remember anything from the primary school. I can simply remember nothing at all about arithmetic, nothing. There wasn't anything that made a particularly deep impression on me. But then we got into higher classes in the lower secondary school and the lower secondary school leaving examination, and I was very bad there. I had a very bad relationship to maths. In fact I got quite low grades at the leaving examination ... in written mathematics. /.../

Ruth tells me that, in school, she didn't have any problems with her low grades. She didn't experience it as a catastrophe and was never teased by her schoolmates for a reason like that. After the lower secondary school leaving examination, Ruth wanted to earn money. She got a job at the railway and attended evening school for two years where she had accounts and book-keeping. More than 30 years later, when her own daughters had moved away from home in 1971 she decided to attend a Technical School to be trained as a draughtsman. At the final examination the following year she, a 50 year old woman, got the top grades in mathematics.

R: Yes..yes.. and then I wanted to get some kind of education. "Well, that's fine", Daddy said. "Do it if you want to." And I thought," Oh, I've always loved drawing", I said. I wanted to be trained as a draughtsman. /.../

T: So you had no problems with mathematics there?

R: No, because I was determined to learn it now, right? And Daddy helped me (laughter)./.../ I also learned how to use the logarithm tables and things like that, and square roots. But all of that has disappeared from my brain now. After all, I don't use it. I don't need it.

While she can vividly remember her mathematics teachers at primary and lower secondary school and at her evening school, Ruth has no memory of her teacher at the Technical School.

R: No, I don't remember him so I can't remember the teaching either. I just remember that we had an instrument that you learn to do sums on. /.../ Yes. a slide rule. Yes, we had to learn to

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have indicated where I have reduced the text of the print-out by /.../. <---> contains my explanation or comments.

use that. But I worked everything, everything out manually. I multiplied six figure numbers and there were six rows of them under that. (T: laughs) I finished it before the others had finished pushing this ruler around. It was my brain that was working.

T: But you looked up the logarithm tables. You didn't just work it out yourself, did you?

R: Yes, .. No, well, but mathematics has never meant anything to me (...)

T: As far as I remember, you got good grades in mathematics at the Technical School?

R: Yes, I got a good grade <grade A>, ... Yes. I must have recovered there.

T: But maybe it made a greater impression on me than on you?

R: Yes, yes, (laughs) but then you were a mathematician. (...) Yes.

T: But you don't remember anything about that teaching. You remember the logarithm tables but nothing else?

R: No, I don't remember anything at all about the teaching in maths. It's strange. After all, there wasn't that either. We didn't have very much maths. There were mostly drawing lessons. After all, we were attending a draughtsman school.

In the community of practice at lower secondary school, Ruth learned that she was stupid at mathematics. From the teaching she received at school, Ruth had incorporated the basic notion that mathematics was not relevant for her, was not a tool she could use, and her explanation of this is, "I wasn't interested in it". At that time it was quite in order for girls not to like mathematics. In the lower secondary school there was a subject entitled 'girls maths'. I would claim that the habitus of a young woman i Denmark in the 30-40s does not automatically encompass a disposition for learning maths, or generate a conception of mathematics as a relevant subject. In order to understand Ruth's perception, one should also be aware of the fact that at that time arithmetic and mathematics were two separate subjects in the Danish school. All pupils had the subject of arithmetics (the four basic arithmetical operations, simple fractions, conversion etc.) from first grade, while the 'academic' pupils had the subject of mathematics (algebra and geometry) from eighth or ninth grade. It was only twenty years later, not in school but in her family, that her low maths grades gave her an inferiority complex.

At the beginning of the 1970s she took the decision to get some more education. That was before cyclical and structural unemployment started and before adult education was upgraded. It was unusual for a woman of that age to start on an education programme. At the Technical School she was determined to learn because she wanted to achieve something. She wanted to be a draughtsman. But her dispositions for having to do with mathematics did not change. Also there, she experienced mathematics as a necessary evil and still somewhat irrelevant. The teaching at the Technical School was relevant for Ruth to the extent that it was aimed at a job as a draughtsman. She was there to learn to draw, not to learn mathematics. It should be added here that the training for draughtsman was a youth education programme and the subject of mathematics was a general subject which also qualified pupils for further studies. It was apparently the case that in the concrete teaching no lines were drawn between this subject and mathematics as part of the draughtsman programme. Her good mathematics grades were only

an interlude. and, despite her good grades at the examination, Ruth's attitude is still the same: mathematics is not me and anyway I can't use it. In addition, her great arithmetical ability, built up through a whole life with sums, gave her the impression that the aids that they had at their disposal (the slide rule) were no use either.

Work

After the lower secondary school leaving examination, she got engaged to the eldest son of the bank manager and worked at the Lolland railway until they got married in 1945 and moved to Copenhagen, where she got a job at the main office of the Landmands Bank.

T: What did you do after your lower secondary school leaving examination?

R: Well, I wanted to earn money and I was lucky enough to get a job at the main office of the Lolland railway. And then I attended evening school ... But I don't think .. I can't remember what maths I learned there, not much. I wasn't interested.

T: What did you do at the main office?

R: I was calculating ... for example, if a package was sent from one place in the country, such as from Skagen and down to Rødby, then it went through a whole lot of small private railways. We had a network of small private railways over the whole country then, and when they crossed each other and came in there, then I sat and divided and worked out their financial share. What each small railway should have, and then I sent them a message.[4]

T: (Laughs) That sounds difficult, doesn't it?

R: Yes, but .. it was ..

T: /.../ Did you ever get complaints?

R: *No!* (T: laughs) And it included the Southern Funen steam-ship companies, if you were sending a package to Svendborg, they were involved. And ... Varde-Nørre Nebel railways .. all the small different .. small railways that existed all over the country. /.../ I can still remember all those small stations today. After so many years. Harpelund and Købelev, Onsevig, Kastager, Horselund and Svinsbjerg (T: laughs) and Kragenæs. It must be almost ... 50 years ago. It's incredible what you have in ... at the back of your brain. What you carry around. (Laughter) Memories. It's just there without you knowing. /.../

T: Then <after seven years> you got married and moved to Copenhagen and worked in a bank, didn't you?

R: Yes, as I said at the beginning when we were newly married /.../ I got a job at the main office of Landsmands Bank in the cheque clearing department And I sat the whole day and entered cheques on huge, old-fashioned machines. And when you pushed the button they shook and made an awful noise, and I was sitting in an office where there were at least 15 of those big machines. It wasn't a very pleasant place to work. /.../ And we had this completely crazy chief clerk. He scolded us if our slips didn't add up. When we had counted many

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[4] In the studies of Forman and Steen concerning mathematics for work and life in USA, they conclude that mathematics at work is "concrete mathematics built on advanced applications of elementary mathematics rather than on elementary applications of advanced mathematics." (Forman & Steen, 1995, p.228)

thousands of cheques. And then one day I wasn't going to put up with it any longer and I said: "From now on I would like to ask you if I could enter my cheques alone. I promise you, I guarantee, that my slips will be correct this afternoon at four o'clock." And I got permission. And they did. Every single day.

Ruth was working with figures at both the railway and the bank, but they never asked if she was good at arithmetic. She tells that her father-in-law simply rang a colleague in the bank. She has never shown certificates of any kind to her employers.

T: Yes, but, what did you think yourself? /.../ You got low grades at school, (R: Yes) and there you're out there with all those big sums of money (R: Yes) and figures. Did you ever think .. were you afraid of making mistakes when you ..
R: No, and that's what was strange. "I have never been afraid of throwing myself into new jobs. Never ... I just didn't think about it - that I could make mistakes. Not at all. There's nothing about geometry in a bank, is there?"

After being trained as a draughtsman, Ruth got a job at the Directorate of General Planning in Copenhagen. In 1974, when she moved with her husband to Western Jutland, she got a job in the regional harbour office.

T: What sorts of jobs did you have to do in the Directorate of General Planning?
R: Well, I drew maps of Zealand and dotted in the various measurements they had made of maps and alterations and ... things like that. And I also made statistics of different things, and I drew curves ... of how many roads which had so much traffic and how many cyclists .. /.../
T: As a draughtsman you must have had to do measurements at your job. What did you feel about that?
R: (...) Yes, well it went fine, That went fine.
T: With increasing and decreasing and ...
R: Well I didn't do so much about that. No. (...) I mostly did drawing for the architects. They came into the studio and said," We want this done in this and this way on this scale and with this and this thickness, and it has to be ready by tomorrow at noon!" (laughter)

Earning money. That was the meaning of the first part of Ruth's paid labour. Paradoxically enough, most of her working day was filled with figures. In the bank, big figures and small figures, but many. At the railway she also had to do calculations on the basis of models and distributional figures. But the figures had a meaning; it was not just problem solving like at school but solving dilemmas with consequences in real life. When after seven years of independent calculation work, she got a job where the only measure of quality was that the slips should add up, she knew it was wrong. She demonstrated her consciousness of self by expressing a wish to work alone. She isolated herself and made a competent contribution to the only objective of this community: to

make the cash add up.

Ruth associates her exam grades with school, not with real life, and the low grades in mathematics left no mark on her. Neither does she think that knowledge of geometry would be of any use in a bank, a comment that also shows that mathematics is primarily connected to geometry which was a central topic in teaching at school. Her function in the cheque clearing department did not challenge her mathematical knowledge either; it only posed challenges to her data discipline, assurance and endurance. There was no need for independence and creativity.

Problems to do with figures from tables and statistics that are converted into graphs and curves. This is applied mathematics but as a draughtsman Ruth did not experience it as such. It would almost seem that her perception was: what can be used in practice is not mathematics. In the mathematics lesson it is called "measurements": at the studio it is called "scale" and is connected to a specific problem which she solves in her firmly defined place in the hierarchy of the community of practice. In her perception, mathematics is needed by the architects, not by the draughtsmen.[5] Every adult who left the Danish lower primary school before 1958 has experienced mathematics as a subject that divided in two different ways: in primary and lower secondary school, arithmetic and mathematics were two different subjects and in lower secondary, only the academically oriented classes had mathematics.

The family

Ruth was born in 1922, the daughter of the saddler/upholsterer in a medium-size provincial town.

T: What did your father and mother say ... when you weren't getting on so well <at mathematics>?

R: They didn't say anything at all - they didn't get involved in any way. School was just something ... Ruth went to school and they didn't get involved in it at all. And there certainly was nothing called parent-teacher meetings or anything ... either. But all my other grades were so good, but they made no comments on my bad maths grades. /.../

Both at work and at home in her own family, Ruth had to do with figures . It was she who was in charge of the household and family budgets. Her husband had graduated from upper secondary school with mathematics as a speciality. He became an officer but decided to educate himself further and graduated as a geodesist at the beginning of the 1950s. Throughout their whole life together he was often away from home on business. They had a daughter in 1947 and another two years later. Ruth was a housewife from

[5] In an inteview survey with 45 participants in Adult Vocational Training conducted by Lena Lindenskov, many of interviewees have a perception of mathematics as "we" - the semi-skilled workers not using mathematics versus "the others" - the engineers, the foremen etc. (Lindenskov, 1996)

1947 to 1971 and during the last fifteen years of this period she worked parttime in a dress shop.

T: You were responsible for the household budget. I remember you had an accounts book?
R: I still have because I always kept accounts. And it was always me who was responsible for keeping all the accounts in our marriage because I very soon discovered that Daddy wasn't interested in money. And he didn't understand it either. /.../ And I could spend all the money I wanted to, because Daddy knew that I didn't spend too much. He knew that I understood money and only spent it when it was necessary. So I never had any difficulty with .., we have never had any financial problems. It was really Daddy who .. got allotted money from me. (Laughter)

Ruth's eldest daughter graduated from upper secondary school with a speciality in mathematics and read French and mathematics at university. The youngest graduated from upper secondary with languages as a specialty and trained to be an actress, but she was also good at mathematics. Although Ruth was by far the best in the family at arithmetic, she always said that she was no good at mathematics.

T: When we started having maths in school you told us about the low grades you got at the lower secondary school leaving examination. How did you feel about that /.../ when you had two mathematicians in the house?
R: Well I had a constant inferiority complex.
T: You did?
R: Yes, I did. And that was because I was so stupid at solving problems. When a pound of butter costs so and so much - and the highest mountain in Spain is so high, how fast can an elephant run? (laughter) I can't work that out, and I can still not solve simple problems like that, puzzles. Not at all. /.../)

Ruth grew up in a lower middle class family where education was not a matter of course. As her grades were so good, it was obvious that she should take the lower secondary school leaving examination. With regard to upper secondary school, all that was actually said by her parents was that she could make up her own mind; so she chose to go out to work. I would claim that the habitus of a young woman from the lower middle class in the 30-40s did not automatically encompass dispositions for an academic education. Ruth entered a higher social group, not through formal education but becoming engaged to the oldest son of the bank manager in town. In the new family, she learnt through legitimate peripheral participation until they got married seven years later. In Ruth's own family, and in the case of her own daughters, education was a matter of course, and mathematics was regarded as an important subject, and not just a school subject on a line with others where one could get good or bad grades. In the discussions about mathematics around the diner table, Ruth was a peripheral participant but in the sens of 'non-relating' not in the sense of 'relevant'. It was not in school but in

her family twenty years later, that her not-knowing maths gave her an inferiority complex.

For most of their life together it was Ruth's husband alone who supported the family. But because of her financial sense Ruth soon took over both responsibility and control, so it was not she who was given housekeeping money but he who was given 'pocket money'. She was once more calculating figures in columns; they were, however, not just figures but accounts and figures for the family budget. She experienced autonomy and some possibilities. The perspective was saving for a car, a summer cottage. Although the salary was low they never "had any financial problems". Ruth said: ".. and I can still not solve simple problems like that, puzzles." But real dilemmas like controlling a budget are no problem to her. One of Ruth's basic perceptions is that there is no link between being a mathematician and understanding financial matters.

Leisure-time

Ruth and her husband shared a passion: bridge. They played at home, at the club a couple of times a week, and in tournaments. Bridge has played a central role in most of Ruth's adult life, for herself and her social relations. When Ruth and her husband in 1974 moved to a little island off the coast of Western Jutland, nobody played bridge. They formed a club and started to teach bridge and, after a couple of years, organised summer tournaments. When her husband died in 1988, Ruth continued on her own. Last summer a newspaper published a full-page feature article about her entitled, "The Bridge Queen".

T: Can you remember when you started playing bridge?

R: Yes! I can. It was in 1939, Daddy was taking his upper secondary school leaving examination and, oh, there were three of them who were studying for it, and they were completely exhausted and they were relaxing with a game of bridge. "Ruth, just come here and hold the cards". No, I said, I don't want to, I can't play bridge. I don't know what bridge is. "Oh, you only have to hold the cards". And that's actually the way it started. When we had got married and moved to Copenhagen then I discovered that I had to be taught properly /.../

Ruth tells me how they started with the Culbertson system and later went over to a "very difficult, complicated" system called Precision Club, a system they learned and played for very many years. But then it became "very modern to play Standard Bridge" which they learnt, and she has been playing it since then. I ask her about the difference between the two systems and she gives examples of artificial bids and more natural bids.

It was always Ruth who calculated the bridge accounts (scores), mentally and very quickly. Even today when she runs her own bridge tournaments and has a lot to calculate after 30-35 guests, she never uses a pocket calculator. "It's too slow," as she says.

T: Have you never been on a tournament leader course?

R: Absolutely not. When I took over the summer bridge tournament from Daddy I really had

butterflies in my tummy. Adding and dividing - it's also a question of arithmetic to place so and so many players at so and so many tables, with so and so many games, and none of them may play the same cards twice ... to be able to make the plans so that people move in the right direction at the tables and .. not everyone can do .. /.../

T: How many <players> did you have last year?

R: Well, nine tables, 36 people. The most I want to have is 10 tables. I don't want more. Because then I would have to have the big hall over there. Up to now - I've managed with two smaller rooms. That's nicer. /.../

T: How do you plan a tournament, for example with 9 tables?

R: Oh, that's quite difficult. 5 tables are a minimum. You have to make a table plan and plan how you are going to move around. 5 tables, that's 10 pairs, and they have to play 9 rounds if everyone is to play against everyone. 3 games at each table, that is 27 games, and that's enough for one evening. But if there are 6 tables, that's an even number, then the cards have to be put over to tables 3 and 4. They are not played. That's called a relay - in order to make everything work out. Tables 1 and 6 share cards.

T: What does that mean?

R: If we play 3, maybe 4, rounds, then table 1 plays first. ... A tournament with 6 tables is called a Howell tournament. 7 tables and it's a Mitchell. (...) At the tables you sit east-west and north-south. The tables are numbered. When the guests arrive each pair gets a number: table 2, north-south, or table 4, east-west. North-south remain at the tables. East-west go to a table with a higher number. The cards go to a table with a lower number. It's all calculated very mathematically, so that everyone plays with everyone else and nobody plays the same cards.

Ruth's passion for bridge did not develop during her childhood: bridge was not played in the saddler's home. But it was in the home of the bank manager? and at the upper secondary school which her boyfriend attended.[6] The way Ruth was drawn into the world of bridge is a clear example of situated learning as 'legitimate peripheral participation'. It was her boyfriend who invited her, and bridge developed into a passion for Ruth From being the one who held the cards, by participating in the communities of practice of the clubs combined with a basic course at the beginning, she reached a position as a competent player and later a teacher and tournament leader. On her way to a higher position in the social hierachy, she starts playing bridge. The legitimacy for her peripheral participation was provided by her relation to the boyfriend.

When Ruth speaks about leading a bridge tournament she says, "It's also a question about arithmetic". It is only later when I ask her to explain the principles for planning a tournament, she says, "It's all calculated very mathematically". This was the first and only time during the interview that Ruth linked her own competence in everyday life

[6] According to Bourdieu the practice of bridge is growing up through the social hierachy. The practice of bridge also varies greatly among students at "les grands écoles" according to social background - especially the intensive activity of tournaments. (Bourdieu, 1979, p.240)

with mathematics. But her first reaction to the question was that this was difficult. [7] The way she explained to an uninitiated person the way a tournament leader plans is evidence of classical mathematical thinking when solving problems: she starts with a simple example in order to explain what is more complicated. To her mathematics knowing is practice.[8]

Jean Lave's theory about situated learning is about learning as a goal-oriented process described as a sequence from legitimate peripheral participation to full participation. She sees learning as a social practice and the context of her analysis of learning processes is the current communities of practice. Lave is "taking learning to be a matter of changing participation in ongoing, changing social practice." (Lave, 1997) Throughout her life Ruth has participated in a number of different communities of practice. Some have been simultaneous (family, bridge, education), while others have followed one another (school, work). Because of the way the school divided subjects, she learned that arithmetic and mathematics were two quite different types of practice. She had achieved a competence at arithmetic through the teaching she received in this discipline which, combined with her consciousness of self, gave her a competence that proved to be relevant in other forms of social practice. She learned a number of things in her mathematics lessons: that she was stupid at maths, that she was not interested in it, and that in any case mathematics had no relevance for her life. She was confirmed in this by never having failed in practical situations due to a lack of mathematics knowledge. When, much later in her life, she got the highest grade in the subject of mathematics when being trained as a draughtsman, this did not change her idea of mathematics, the world around her, or herself. An explanation as to why she still had an image of mathematics as only being relevant for others (architects and mathematicians) may be the division of subjects that was also found in her technical training programme where mathematics was isolated from vocational training. But the theory of situated learning does not present a possibility to explain why her perception of herself had not changed, and why she never got 'the taste for mathematics'.

Ruth's motivation to be a draughtsman made her overcome her blocks, but not her resistance against learning mathematics as with bridge. Instead of using the slide rule she multiplied the six figure numbers and finished before the others. Her intentions had

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[7] In London D. Coben and G. Thumpston have conducted a series of research interviews about adults experiences of maths in their life histories. The importance of mathematics and success in math examinations has been remarked by almost all the interviewees. On the other hand it appears that once people have succeeded in applying a piece of mathematics, it becomes 'non-mathematics' or 'common-sense'. Thus they never perceive themselves as succesful: mathematics is always what they cannot do. (Coben & Thumpston, 1995)

[8] Whether she calculates probabilities or learns them by heart when she is playing a hand, we do not no. A similar issue can be raised for Schliemann and Acioly's bookies (1989).

changed but not her dispositions to mathematics incorporated through her lived life. According to the theory of Bourdieu habitus of a girl born 1922 in a provincial town as a saddler's daughter, of a pupil in a school where arithmetic and mathematics were two different subjects at a time where it was "OK for a girl not to know mathematics", and habitus of a wife and mother staying home with her two daughters is a basis of actions (and non-actions) and perceptions. Habitus as a system of dispositions generating practices and representation undergoes transformations but otherwise durability is the main characteristic.

6. CONCLUSION

While some adults change their attitude to mathematics during a training course, others fail to do so. For some people, this means something for their image of themselves and their life project, for others not. I would claim that these differences cannot be explained solely within a context that consists of the teaching and the participants' current situation, their perspectives and their qualifications. In order to expand the context for analysing learning processes and drawing a link to the life lived by participants, I have attempted to combine Jean Lave's concept of situated learning (as legitimate peripheral participation) with Pierre Bourdieu's concept of habitus (systems of durable, transposable dispositions as principles of the generating and structuring of practices and representations). I have argued that it is possible to combine the concepts of LPP and habitus in a theory of adults learning mathematics through teaching and everyday practice.

In a number of experiments with mathematics teaching in 'Access' courses leading to specific professional training, such as teaching, it has proved possible to change adult learners' image of mathematics and of their own relationship to it. To change their image of mathematics as something mysterious and arbitrary and the experience of their own inability to understand, mathematics was encountered as an active, investigational discipline, built upon conjectures. (Burton, 1987). In these experimental courses, called 'from failure to success', the participants were 'return-to-study' adults, and their aim was to pass the test in order to be admitted to higher education. This means that their rationale for learning mathematics was instrumental. We do not know whether they experienced a change in their experience of or attitude to mathematics as something relevant to their lives, or if they have developed a social rationale for learning mathematics in the future, i.e. a rationale which relates to knowledge as such - having a value to the individual as a social subject, besides its importance for the external examination. "A rationale which says that knowledge has an importance beyond its status as school knowledge." (Mellin-Olsen, 1987, p.158).

Blocks and resistance are two central phenomena in adults learning mathematics. The two types of reaction in adults may be described as having been generated by

habitus. Participants in the experimental courses mentioned above will probably not block in future, formalised, learning situations. This is an important result in itself for although one cannot say that there is 'typical' participant in further education, a significant number of the participants have negative perceptions of themselves, the institutions and mathematics (Strässer & Zevenbergen, 1996). But what about resistance? Many adults who start on vocational education are surprised that the programme includes teaching in mathematics. One of their reactions may be resistance in the learning situation which has to do with the fact that they have experienced themselves as competent persons without mathematics and that mathematics has not been perceived as relevant to their life project (Wedege, 1995a). This perception stems from their experience in various communities of practice (work, family, leisure), where basic arithmetical skills have perhaps been sufficient to manage the challenges, or where mathematics has been hidden in techniques and technologies. In other words, in communities with different practices - as contexts for knowing and learning mathematics.

When considering eventual consequences for educational planning, I agree with Christine Keitel when she writes that

> teaching mathematics as such (...) is not the solution of the problem and does not even address it. The problem is that of *making implicit mathematics explicit* and elucidating the significance of its application. (Keitel, 1989, p.12)

This can be realised by, for instance integrating mathematics teaching in vocational training in such a way as to make the mathematical knowing explicit. A successful learning process in mathematics may be described as a process where the relevance paradox (the contradiction between the objective relevance of mathematics and its subjective irrelevance) (Niss, 1994) is resolved at the level of the individual from peripheral to full participation. I regard the individual consciousness of the subjective relevance of mathematics as an important result of a habitus that in practice at the workplace may enable the development of the worker's technological competence. (Wedege, 1995 a&b) This can in turn mean that even though lifelong learning is a purely economic imperative (qualification of the labour force), participation in education can result in liberation at the subjective level.

On the basis of a cognitive view of learning processes and knowledge, the title of this article must naturally be, 'To know or not to know mathematics - that is also a question of context'. However, my concern here has been only to illustrate 1) mathematics knowing as a relational and context-dependent practice, and 2) the conditions for adults' changing attitudes to learning mathematics.

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tlf. 46 74 22 63

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by: Mogens Niss

218/92 "A Three-Square Theorem"

by: Lars Kadison

219/92 "RUPNOK - stationær strømning i elastiske rør"

af: Anja Boisen, Karen Birkelund, Mette Olufsen

Vejleder: Jesper Larsen

220/92 "Automatisk diagnosticering i digitale kredsløb"

af: Bjørn Christensen, Ole Møller Nielsen

Vejleder: Stig Andur Pedersen

221/92 "A BUNDLE VALUED RADON TRANSFORM, WITH APPLICATIONS TO INVARIANT WAVE EQUATIONS"

by: Thomas P. Branson, Gestur Olafsson and Henrik Schlichtkrull

222/92 On the Representations of some Infinite Dimensional Groups and Algebras Related to Quantum Physics

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224/92 *UNIVERSAL AC CONDUCTIVITY OF NON-METALLIC SOLIDS AT LOW TEMPERATURES*

by: Jeppe C. Dyre

225/92 *"HATMODELLEN" Impedansspektroskopi i ultrarent en-krystallinsk silicium*

af: Anja Boisen, Anders Gorm Larsen, Jesper Varmer, Johannes K. Nielsen, Kit R. Hansen, Peter Bøggild og Thomas Hougaard

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226/92 *"METHODS AND MODELS FOR ESTIMATING THE GLOBAL CIRCULATION OF SELECTED EMISSIONS FROM ENERGY CONVERSION"*

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Vejleder: Peder Voetmann Christiansen

228/92 "Teknologi og historie"

Fire artikler af:

Mogens Niss, Jens Høyrup, Ib Thiersen, Hans Hedal

229/92 "Masser af information uden betydning"

En diskussion af informationsteorien i Tor Nørretranders' "Mærk Verden" og en skitse til et alternativ basseret på andenordens kybernetik og semiotik.

af: Søren Brier

230/92 "Vinklens tredeling - et klassisk problem"

et matematisk projekt af

Karen Birkelund, Bjørn Christensen

Vejleder: Johnny Ottesen

231A/92 "Elektrondiffusion i silicium - en matematisk model"

af: Jesper Voetmann, Karen Birkelund, Mette Olufsen, Ole Møller Nielsen

Vejledere: Johnny Ottesen, H.B.Hansen

231B/92 "Elektrondiffusion i silicium - en matematisk model" Kildetekster

af: Jesper Voetmann, Karen Birkelund, Mette Olufsen, Ole Møller Nielsen

Vejledere: Johnny Ottesen, H.B.Hansen

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- Modul 3 fysik projekt -

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af: Bent Sørensen

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Et 1.modul fysikprojekt

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Projektrapport

af: Trine Andreasen, Tine Guldager Christiansen, Nina Skov Hansen og Christine Iversen

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Specialerapport

af: Linda Szkotak Jensen og Lise Odgaard Gade

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Projektrapport af: Birthe Friis, Lisbeth Helmgaard, Kristina Charlotte Jakobsen, Marina Mosbæk Johannessen, Lotte Ludvigsen, Mette Hass Nielsen

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af: Lise Arleth, Kåre Fundal, Nils Kruse

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Eksamensopgaver fra 1976-93

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To Sigurdur Helgason on his sixtyfifth birthday
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Opdaget eller opfundet
NAT-BAS-projekt
vejleder: Jens Højgaard Jensen

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Det praktiske elevarbejde i gymnasiets fysikundervisning, 1907-1988
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Vejleder: Jens Højgaard Jensen

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Projektrapport udarbejdet af:
Stefan Frello, Runa Ulsøe Johansen, Michael Poul Curt Hansen, Klaus Dahl Jensen
Vejleder: Viggo Andreasen

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af: Erwin Dan Nielsen, Jan Danielsen, Niels Bo Johansen

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(en kaotisk talgenerator)
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Gymnasiematematikkens begrundelsesproblem
En specialerapport af Peter Hauge Jensen
og Linda Kyndlev
Vejleder: Mogens Niss

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by: Viggo Andreasen and Freddy B. Christiansen

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by: Jeppe C. Dyre and Jacob Jacobsen

290/95 Modellering af uregelmæssige bølger
Et 3.modul matematik projekt
af: Anders Marcussen, Anne Charlotte Nilsson, Lone Michelsen, Per Mørkegaard Hansen
Vejleder: Jesper Larsen

291/95 1st Annual Report from the project
LIFE-CYCLE ANALYSIS OF THE TOTAL DANISH ENERGY SYSTEM
an example of using methods developed for the OECD/IEA and the US/EU fuel cycle externality study
by: Bent Sørensen

292/95 Fotovoltaisk Statusnotat 3
af: Bent Sørensen

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af: Lotte Ludvigsen & Jens Frandsen
Vejleder: Anders Madsen

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Af: Jesper Duelund og Birthe Friis
Vejleder: Ib Lundgaard Rasmussen

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by: Mette Olufsen and Johnny Ottesen

298/95 Mordet på Schrödingers kat - et metaprojekt om to fortolkninger af kvantemekanikken
af: Maria Hermannsson, Sebastian Horst, Christina Specht
Vejledere: Jeppe Dyre og Peder Voetmann Christiansen

299/95 ADAM under figenbladet - et kig på en samfundsvidenskabelig matematisk model
Et matematisk modelprojekt
af: Claus Dræby, Michael Hansen, Tomas Højgård Jensen
Vejleder: Jørgen Larsen

300/95 Scenarios for Greenhouse Warming Mitigation
by: Bent Sørensen

301/95 TOK Modellering af træers vækst under påvirkning af ozon
af: Glenn Møller-Holst, Marina Johannessen, Birthe Nielsen og Bettina Sørensen
Vejleder: Jesper Larsen

302/95 KOMPRESSORER - Analyse af en matematisk model for aksialkompressorer
Projektrapport sf: Stine Bøggild, Jakob Hilmer, Pernille Postgaard
Vejleder: Viggo Andreasen

303/95 Masterlignings-modeller af Glasovergangen
Termisk-Mekanisk Relaksation
Specialerapport udarbejdet af:
Johannes K. Nielsen, Klaus Dahl Jensen
Vejledere: Jeppe C. Dyre, Jørgen Larsen

304a/95 STATISTIKNOTER Simple binomialfordelingsmodeller
af: Jørgen Larsen

304b/95 STATISTIKNOTER Simple normalfordelingsmodeller
af: Jørgen Larsen

304c/95 STATISTIKNOTER Simple Poissonfordelingsmodeller
af: Jørgen Larsen

304d/95 STATISTIKNOTER Simple multinomialfordelingsmodeller
af: Jørgen Larsen

304e/95 STATISTIKNOTER Mindre matematisk-statistisk opslagsværk indeholdende bl.a. ordforklaringer, resuméer og tabeller
af: Jørgen Larsen

305/95 The Maslov Index:
A Functional Analytical Definition
And The Spectral Flow Formula

By: B. Booss-Bavnbek, K. Furutani

306/95 Goals of mathematics teaching

Preprint of a chapter for the forth-comming International Handbook of Mathematics Education (Alan J.Bishop, ed)

By: Mogens Niss

307/95 Habit Formation and the Thirdness of Signs

Presented at the semiotic symposium

The Emergence of Codes and Intensions as a Basis of Sign Processes

By: Peder Voetmann Christiansen

308/95 Metaforer i Fysikken

af: Marianne Wilcken Bjerregaard, Frederik Voetmann Christiansen, Jørn Skov Hansen, Klaus Dahl Jensen Ole Schmidt

Vejledere: Peder Voetmann Christiansen og Petr Viscor

309/95 Tiden og Tanken
En undersøgelse af begrebsverdenen Matematik udført ved hjælp af en analogi med tid

af: Anita Stark og Randi Petersen

Vejleder: Bernhelm Booss-Bavnbek

310/96 Kursusmateriale til "Lineære strukturer fra algebra og analyse" (E1)

af: Mogens Brun Heefelt

311/96 2nd Annual Report from the project
LIFE-CYCLE ANALYSIS OF THE TOTAL DANISH ENERGY SYSTEM

by: Hélène Connor-Lajambe, Bernd Kuemmel, Stefan Krüger Nielsen, Bent Sørensen

312/96 Grassmannian and Chiral Anomaly

by: B. Booss-Bavnbek, K.P.Wojciechowski

313/96 THE IRREDUCIBILITY OF CHANCE AND THE OPENNESS OF THE FUTURE
The Logical Function of Idealism in Peirce's Philosophy of Nature

By: Helmut Pape, University of Hannover

314/96 Feedback Regulation of Mammalian Cardiovascular System

By: Johnny T. Ottesen

315/96 a + b "Rejsen til tidens indre" - Udarbejdelse af et manuskript til en fjernsynsudsendelse + manuskript

af: Gunhild Hune og Karina Goyle

Vejledere: Peder Voetmann Christiansen og Bruno Ingemann

316/96 Plasmaoscillation i natriumklynger

Specialerapport af: Peter Meibom, Mikko Østergård

Vejledere: Jeppe Dyre & Jørn Borggreen

317/96 Poincaré og symplektiske algoritmer

af: Ulla Rasmussen

Vejleder: Anders Madsen

318/96 Modelling the Respiratory System

by: Tine Guldager Christiansen, Claus Dræby

Supervisors: Viggo Andreasen, Michael Danielsen

319/96 Externality Estimation of Greenhouse Warming Impacts

by: Bent Sørensen

320/96 Grassmannian and Boundary Contribution to the -Determinant

by: K.P.Wojciechowski et al.

321/96 Modelkompetencer - udvikling og afprøvning af et begrebsapparat

Specialerapport af: Nina Skov Hansen, Christine Iversen, Kristin Troels-Smith

Vejleder: Morten Blomhøj

322/96 OPGAVESAMLING

Bredde-Kursus i Fysik 1976 - 1996

323/96 Structure and Dynamics of Symmetric Diblock Copolymers

PhD Thesis

by: Christine Maria Papadakis

324/96 Non-linearity of Baroreceptor Nerves

by: Johnny T. Ottesen

325/96 Retorik eller realitet ?

Anvendelser af matematik i det danske Gymnasiums matematikundervisning i perioden 1903 - 88

Specialerapport af Helle Pilemann

Vejleder: Mogens Niss

326/96 Bevisteori
Eksemplificeret ved Gentzens bevis for konsistensen af teorien om de naturlige tal

af: Gitte Andersen, Lise Mariane Jeppesen, Klaus Frovin Jørgensen, Ivar Peter Zeck

Vejledere: Bernhelm Booss-Bavnbek og Stig Andur Pedersen

327/96 NON-LINEAR MODELLING OF INTEGRATED ENERGY SUPPLY AND DEMAND MATCHING SYSTEMS

by: Bent Sørensen

328/96 Calculating Fuel Transport Emissions

by: Bernd Kuemmel

329/96 The dynamics of cocirculating influenza strains conferring partial cross-immunity
and
A model of influenza A drift evolution
by: Viggo Andreasen, Juan Lin and Simon Levin

330/96 LONG-TERM INTEGRATION OF PHOTOVOLTAICS INTO THE GLOBAL ENERGY SYSTEM
by: Bent Sørensen

331/96 Viskøse fingre
Specialerapport af:
Vibeke Orlien og Christina Specht
Vejledere: Jacob M. Jacobsen og Jesper Larsen

332/97 ANOMAL SWELLING AF LIPIDE DOBBELTLAG
Specialerapport af:
Stine Sofia Korremann
Vejleder: Dorthe Posselt

333/97 Biodiversity Matters
an extension of methods found in the literature on monetisation of biodiversity
by: Bernd Kuemmel

334/97 LIFE-CYCLE ANALYSIS OF THE TOTAL DANISH ENERGY SYSTEM
by: Bernd Kuemmel and Bent Sørensen

335/97 Dynamics of Amorphous Solids and Viscous Liquids
by: Jeppe C. Dyre

336/97 PROBLEM-ORIENTATED GROUP PROJECT WORK AT ROSKILDE UNIVERSITY
by: Kathrine Legge

337/97 Verdensbankens globale befolkningsprognose
- et projekt om matematisk modellering
af: Jørn Chr. Bendtsen, Kurt Jensen, Per Pauli Petersen
Vejleder: Jørgen Larsen

338/97 Kvantisering af nanolederes elektriske ledningsevne
Første modul fysikprojekt
af: Søren Dam, Esben Danielsen, Martin Niss, Esben Friis Pedersen, Frederik Resen Steenstrup
Vejleder: Tage Christensen

339/97 Defining Discipline
by: Wolfgang Coy

340/97 Prime ends revisited - a geometric point of view -
by: Carsten Lunde Petersen

341/97 Two chapters on the teaching, learning and aassessment of geometry
by Mogens Niss

342/97 LONG-TERM SCENARIOS FOR GLOBAL ENERGY DEMAND AND SUPPLY
A global clean fossil scenario discussion paper
prepared by Bernd Kuemmel
Project leader: Bent Sørensen

343/97 IMPORT/EKSPORT-POLITIK SOM REDSKAB TIL OPTIMERET UDNYTTELSE AF EL PRODUCERET PÅ VE-ANLÆG
af: Peter Meibom, Torben Svendsen, Bent Sørensen

344/97 Puzzles and Siegel disks
by Carsten Lunde Petersen

345/98 Modeling the Arterial System with Reference to an Anestesia Simulator
Ph.D. Thesis
by: Mette Sofie Olufsen

346/98 Klyngedannelse i en hulkatode-forstøvningsproces
af: Sebastian Horst
Vejledere: Jørn Borggren, NBI, Niels Boye Olsen

347/98 Verificering af Matematiske Modeller
- en analyse af Den Danske Eulerske Model
af: Jonas Blomqvist, Tom Pedersen, Karen Timmermann, Lisbet Øhlenschlæger
Vejleder: Bernhelm Booss-Bavnbek

348/98 Case study of the environmental permission procedure and the environmental impact assessment for power plants in Denmark
by: Stefan Krüger Nielsen
Project leader: Bent Sørensen

349/98 Tre rapporter fra FAGMAT - et projekt om tal og faglig matematik i arbejdsmarkedsuddannelserne
af: Lena Lindenskov og Tine Wedege

350/98 OPGAVESAMLING - Bredde-Kursus i Fysik 1976 - 1998
Erstatter teksterne 3/78, 261/93 og 322/96

351/98 Aspects of the Nature and State of Research in Mathematics Education
by: Mogens Niss

352/98 The Herman-Swiatec Theorem with applications

by: Carsten Lunde Petersen

353/98 Problemløsning og modellering i en almendannende matematikundervisning

Specialerapport af: Per Gregersen og Tomas Højgaard Jensen

Vejleder: Morten Blomhøj

354/98 A GLOBAL RENEWABLE ENERGY SCENARIO

by: Bent Sørensen and Peter Meibom

355/98 Convergence of rational rays in parameter spaces

by: Carsten Lunde Petersen and Gustav Ryd

356/98 Terrænmodellering

Analyse af en matematisk model til konstruktion af terrænmodeller

Modelprojekt af: Thomas Frommelt, Hans Ravnkjær Larsen og Arnold Skimminge

Vejleder: Johnny Ottesen

357/98 Cayleys Problem

En historisk analyse af arbejdet med Cayley problem fra 1870 til 1918

Et matematisk videnskabsfagsprojekt af: Rikke Degn, Bo Jakobsen, Bjarke K.W. Hansen, Jesper S. Hansen, Jesper Udesen, Peter C. Wulff

Vejleder: Jesper Larsen

358/98 Modeling of Feedback Mechanisms which Control the Heart Function in a View to an Implementation in Cardiovascular Models

Ph.D. Thesis by: Michael Danielsen

359/99 Long-Term Scenarios for Global Energy Demand and Supply Four Global Greenhouse Mitigation Scenarios

by: Bent Sørensen

360/99 SYMMETRI I FYSIK

En Meta-projektrapport af: Martin Niss, Bo Jakobsen & Tune Bjarke Bonné

Vejleder: Peder Voetmann Christiansen

361/99 Symplectic Functional Analysis and Spectral Invariants

by: Bernhelm Booss-Bavnbek, Kenro Furutani

362/99 Er matematik en naturvidenskab? - en udspænding af diskussionen

En videnskabsfagsprojekt-rapport af Martin Niss

Vejleder: Mogens Nørgaard Olesen

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