At the present time reports from most parts of the world indicate that students are opting away from education containing a substantial component of mathematics or physics. In many countries this happens not only as far as post-secondary studies are concerned but pertains to school education as well. At closer analysis this enrolment problem seems to be intimately connected to the roles that mathematics and physics play in society and culture in general and in relation to the individual in particular. In other words, the enrolment problem and the justification problem of education involving mathematics or physics are linked so as to constitute a common problem field of an international nature. This implies that any deeper understanding of the problem will have to be based on analyses which go beyond simplistic national explanations.

The present book approaches this problem field from a variety of different perspectives, including historical, sociological, educational, geographical and philosophical ones. In principle, all types of educational programmes from school to university in which mathematics or physics occupy a marked position are considered.

The book contains 23 chapters written by a total of 29 scholars from 16 different countries in Africa, Europe, and USA. They cover a range of issues such as the roles of physics and mathematics education in society in the present and in the past; relations with gender; images of mathematics and physics; the relevance paradox; problems of communication in and with mathematics and physics; all addressing, directly or indirectly, the question 'why teach and learn mathematics or physics?'
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Learning to Pattern Physicist Virtues: 
- Male and Female Dissimilarities

Abstract. In this paper I shall argue from my fieldwork at the Niels Bohr Institute in Copenhagen that male and female physics students adjust differently to the learning of social codes that express what is considered virtuous in the larger group of physicists at the institute. We can learn these virtues from the way our own bodies move and place themselves in space. As especially women do not seem to engage in the same activities as most male students they do not seem to learn the physicists' student virtues shared by most male students and teachers. This might affect their sense of belonging in a physicists' community of practice at university level. I propose that this gendered dissimilarity may be due to former gendered experiences that is arising to a conflict in this new community of practice.

Introduction

Why do some people apparently have difficulty fitting into the physicists' community — although they have been motivated enough to embark on a physicist's education? Are women in excess in the group of apostates and misfits and if this is the case, why?

Physics studies not only seem to have problems in attracting new students, male as well as female, these years in the western world. Many physics students leave their studies at some point or another and do not pursue further careers, (Ferdinande, 1995). Especially female physicists seem absent when it comes to academic careers in physics. The closer you get to academic top-positions, the higher the female drop-out level — especially in western industrialized countries, (Science, 1994, 1468). Denmark is no exception in this dismaying picture.

In 1995 the Danish Research Councils decided to make a major effort to reveal reasons for the absence in Denmark of women with academic careers in general, and launched a project running till year 2001 with the general aim of looking into possible social, psychological, cultural and institutional gender barriers. My project is placed under this umbrella and looks especially into implicit cultural impediments that might keep female or male physics students from pursuing academic careers.

In the project I am undertaking for the Danish Research Councils I made a survey among the first year students at the Niels Bohr Institute for Physics in Copenhagen. It showed among other things that no female students planned to get a career as a Ph.D. when they began studying. After three months of study even fewer female students planned on finishing as Master's graduates. In contrast, three months of study increased the number of male students going for an academic career to a little over one third.

Much later when I presented these and other results at the Niels Bohr Institute the women (researchers, teachers, Ph.D. students) present, with few exceptions, expressed negative feelings towards pursuing further careers as physicists. Even though I addressed women (and men) who stayed in the system, the women still expressed a sense of "non-membership" in the physics community.2

A research into this matter could take as a starting point that women have difficulties learning the teachers' curriculum. This would imply looking into the learner's capacity for learning physics, teachers' capacity for teaching, the demanding curriculum and the like. Many teachers at the Niels Bohr Institute have assured me, though, that female students do very well in general in exams and frequently better than the average male student.

Recent research by Jean Lave and Etienne Wenger have made us aware that this is not the only kind of learning we do in school. Learning in school not only involves learning the teachers' curriculum. We have to learn a learner's curriculum as well. A learner's curriculum is a field of learning resources in everyday practice viewed from the perspective of the learner, in contrast to the teacher's curriculum constructed for the instruction of newcomers (Lave & Wenger, 1991, 97).

The learner's curriculum evolves out of participation in a specific community of practice. It is essentially situated and tied up to what Lave and Wenger terms LPP (legitimate peripheral participation) where a newcomer gradually becomes involved in membership by participating in a community of practice.3 Along the way we learn to become different persons while learning what is important to know in this community (Lave & Wenger, 1991).

Seen from this angle the problem is not so much the teacher's curriculum, but how to characterize and deal with the learner's curriculum. To Lave & Wenger the learners curriculum is mainly about positioning yourself so you get access to knowledge. This knowledge is not restricted to textbook knowledge or knowledge taught by teachers. You learn from your peers as well as from textbooks and teachers, and what you learn is not only scientific knowledge, but how to belong in a community of practice. In the examples scaffolding their argument, Lave and Wenger seem to treat newcomer as a homogeneous group. Learning or exclusion from learning is viewed as a conflict between structural constraints and the group of newcomers. For the group as a whole it can go smoothly or not so smoothly. An example of the latter is butcher apprentices excluded from learning by 'old-timers'. In this particular setting all newcomers seem to be excluded from membership and thereby fail to learn, (Lave & Wenger, 1991, 76). In this perspective membership of a community requires access to a wide range of ongoing activity, and to old-timers and other members of the community (Lave & Wenger, 1991, 101).

Challenging Lave's and Wenger's argument a little, we could ask if this kind
of learning, even though newcomers apparently all get the same kind of access, is not just as heterogeneously learned within a group of newcomers as is textbook learning? If this is the case, this could imply that not everyone learns to reach the center of a community of practice as old-timers — even if the newcomers start on an equal base.

It might be worthwhile probing into what is actually learned in a learner’s curriculum, and how and by whom. To the question of what is learned, I shall limit myself to some aspects of what is implicitly learned as virtues in social interaction.

I propose from my fieldwork at the Niels Bohr Institute that certain virtues are taught as part of a learner’s curriculum in this community of practice. As goes for all learning not everyone learns these virtues equally well even though they might be aware that they exist as social codes — and in this differentiated learning we might find a gender bias.

Fieldwork embodied

When it comes to getting scientific insight into what counts as virtues in any group of people one approach could be to make interviews. Asking questions of what is considered to be virtuous, comparing answers, eliciting consensus from interviews transformed into written statements. One limit of this approach lies in the imagination of the researcher regarding what questions to ask, and how to elicit implicit cultural understandings of virtues as played out in real life from spoken words in the interview situation. In my case, even though informants might have surprised me with unexpected answers, not even the informants themselves might be aware of what they regard as virtuous in everyday life at the Niels Bohr Institute. Language provides no direct way to culture (Hastrup, 1995, 42); let alone implicit culture; let alone implicit cultural virtues. This is partly due to the special character of virtues as connected to bodies (Biagioli, 1994). Even though virtues can be explicitly stated in words they can only be experienced and learned by physical presence.

To look into the problématique of the female drop-out rate in physics, I therefore undertook the task of looking into the matter from another angle. Using my own body to get access to this particular kind of knowledge with the aid of the method that characterizes, above all, the specific anthropological craft — the fieldwork. Anthropological fieldwork seemed to be a way to get access to some of the aspects of student life that is rarely stated in words.

Experiencing the students’ daily life myself as a kind of hybrid “student/anthropologist” might give access to direct, and maybe even embodied, knowledge of what it was like to be a female student in this ambiance. My view as an anthropologists is thus not a bird’s view giving a total picture of what it is like to be a student at the Niels Bohr Institute. Nor is it the Superman X-ray view probing into other people’s heads. It is a particular view seen from my position as a practitioner in the field. The traditional mise-en-scène of anthropology, in terms of fieldwork as observation of the closest possible distance, and of the anthropological monograph reflecting an objective and total world, has broken down in the 1990-ties. To create general anthropological knowledge, we must take our point of departure in the realities of particular people. We must share their experiences (Hastrup, 1996, 161). This conception of anthropological fieldwork goes beyond what has, in anthropological terms, been described as participant-observation. It goes beyond mere presence as a platform for direct observation. This understanding of anthropological fieldwork requires active participation or, put a little different, participation in activity.

This implied that I would have to enter the world of physics students, researchers and teachers as a physics student myself as well as an anthropologist. I wanted to take part in the process of learning what student life at the Institute level was all about from a participant’s point of view. Thereby I could get an idea of the implicit learner’s curriculum and, as it turned out, of what was implicitly held to be virtues in this community of practice.

Following this method I enrolled myself as a first-year student at the Niels Bohr Institute for Physics in Copenhagen and followed the 1996 cohort in their first year of study.

I was in many ways limited in this task. To mention a few impediments I was not a mathematics student at high school and also my knowledge of physics is limited. I was older than most of the students around me and I was known to be an anthropologist. Even so my impression was that I was more or less accepted along the way. The more actively I participated, the more accepted I was. I followed classes, tried to do homework, tried to solve exercises with the others and participated in many social arrangements. This way I gained what literally can be described as “embodied knowledge” of the, often not explicitly stated, social codes that constituted part of the learner’s curriculum among the students. This also, from time to time, made it possible to experience some of the unstated virtues played out in social relations.

The virtues, although rarely explicitly stated as such, were expressed in words and through bodies in space. I shall extract some of my own experiences and some gender dissimilarities in the patterning of these virtues as they manifested themselves to me by the way bodies (including my own) placed themselves in space. Before I give a more specific definition of what is meant by virtues, I would like to present an empirical example of such expressions of virtuous behaviour — and the opposite.
Alice, John and Mildred

In the following I start by describing a situation involving three Ph.D. students and myself as I experienced it. My interpretation of it comes from having participated in somewhat similar situations and thereby having embodied some of the virtues that seem to matter in the episode. Therefore, the interpretation is partly based on how I interpreted my own participation. Finally I describe how my active participation gives me a new insight into the above-mentioned situation—that gives access to learning virtuous behavior in the group. To narrow down the argument I have chosen only situations where the computer functions as a mediating device for the expression of virtues. As we shall see, showing a lack of understanding for these virtues gives a lot of problems.

Let's start with the example of Alice.

At the Physics Winterschool I participated in a week-long course with some of the Ph.D. students. During an exercise a group of three Ph.D. students, two females and one male, we can call them Alice, Mildred and John, came into a room with a computer to solve an exercise in chaos theory. The male student John tried to reach the seat in front of the keyboard, but the female student Alice ran a little faster to the computer and addressed John in a more aggressive way, slapping his hands away from the keyboard, saying that now she wanted to write on the keyboard. John shrugged his shoulders and remarked, "Oh, well. If you think you can manage." From my own fieldwork experiences I did understand Alice very well. I had myself been in the periphery when we made group work among the first-year students. Often with one or two other female students, getting annoyed because I could not see, and thereby not follow, what went on at the screen. I had even discussed with a female first-year student how it could make you angry always to have to stand in the back. But at this point I had also learned that being aggressive is not part of the virtuous behavior for a good scientist. Fighting over keyboards goes against the unspoken virtues. Aggression shows lack of control. When the women fight they are positioned as fighters. Not as good scientists. Their approach to doing science does not lean on acceptance in the group, as should be the case in order to live up to the virtues. By defining the situation as a fight Alice excluded herself from the joint enterprise and put herself in a position where she can easily risk personal failure.

After some minutes Alice ran into some problems. In this world it's normal to have problems. Nobody solves an exercise smoothly—neither male nor female students—but if you have an established authority and a good contact with the rest of the group, it will let you work in peace and be happy to help you out with comments or casual scientific questions. In this case John immediately was ready to take over and Alice again had to slap his fingers away from the keyboard. Soon after a male teacher came into the room—smiling when he saw Alice's problems. "Let me show you," he said pushing her away, as John made him way with his body, so he could sit next to the computer. Soon after Alice and Mildred were in the periphery while the teacher and John were eagerly bending over the screen engaged in solving the problem. John did not, in scientific terms, know better than Alice. He did not acknowledge her authority at the keyboard as she did not acknowledge his. Neither of them knew how to solve the problem on the computer. Being aggressive, though, did not help Alice get authority. When the teacher came Alice was already on guard—defining the situation as a fight for the machine. Not a problem that had to be solved by a group. She did not engage the teacher (or John) with comments nor did she in other ways take control of the teacher's (or John's) presence. Instead, she shrugged her shoulders and gave up the fight. John did not shrug his shoulders. Instead, he moved his body in a subtle way "inviting the teacher in." He slid his body to the side where Alice was placed in front of the keyboard, pointing to a specific problematic point on the screen and commenting on it. This whole maneuvering, less than ten seconds, made it possible for John to squeeze Alice out and invite the teacher in. Thereby John could take the "natural" position as the teacher's aid by moving to the front of the keyboard next to the teacher, engaging him as a valuable member of the group. The teacher seemed to accept this whole procedure and John as his natural collaborator. Alice, just as "naturally", moved back without objections. For the rest of the exercise she shared the more inactive position in the back with Mildred and myself and her engagement in the exercise at issue fell noticeably.

Virtues in Communities

Before I venture into an analysis of this episode a couple of definitions are necessary. My analysis centers on two central concepts: virtues and communities of practice.

As formerly stated virtues cannot be taught and learnt without physical presence. The human body has received increased attention in the study of scientific practice. The historian Mario Biagioli has directly credited Kuhn and Feyerabend for bringing the importance of the scientist's body for the production of science to our attention, Kuhn by pointing to the importance of directing science students' attention to specific paradigmatic exemplars when they learn to apply theories, and Feyerabend by introducing the notion of natural interpretations. Recent lab studies following this line of thought have led to an awareness that it is not rules but ostensions (something that escapes complete formalization) that guide scientific endeavours. Physical presence seems to be a condition for this learning process. It is through practice that students are taught how to do science (Biagioli, 1993, 70).
The problem with realising this is that it raises a number of methodological problems. As Biagioli puts it: it is impossible to trace the changes in the scientists' methods and mental categories in their tacit knowledge by the methods normally used by historians and social scientists — texts and quantitative interpretative tools. He solves this dilemma by looking at a period in history where the scientists and courtiers cultural practices — namely the 17th/18th century. There scientists and courtiers had skills considered as virtues at court (Biagioli, 1993, 74). These virtues included, among other things, elegant demeanour and conversation. This courtliness should be seen against the background of what at court was considered uncourteous. Badly dressed persons who displayed inegalitarian demeanour and conversation were expected to be pedants. Biagioli argues that Galileo's ideas and his telescope were accepted at court without proper evidence leaning on correspondence rules were accepted — one of the gang” by the courtiers.

Today you might still have to walk, talk and dress in particular ways to be accepted by the larger group of scientists — only the way you walk, talk and dress have changed over the years. Though scientists and courtiers no longer share membership of the same community, some embodied virtues still can be found, most likely, in scientific community, even though Lave and W. can see them as “one-of-the-gang” by the courtiers.

The underlying importance of practice and of the active body in science studies, found in works by (among others) Biagioli, is perfectly in line with recent years' practice theories of learning in activity in communities of practice as described by Lave & Wenger.

Although Lave & Wenger are never too precise about what is actually meant by a community of practice they offer this definition: communities of practice “impl[y] a situation in which participants share understandings concerning what they are doing and what that means in their lives” (Lave & Wenger, 1991, 98).

Here I follow Lave and Wenger in their description of communities of practice as an intrinsic condition for the existence of knowledge, not least because the community itself provides the interpretive support necessary for making sense of its heritage (Lave & Wenger, 1991, 98). Compared to an idea of a mere internalization of knowledge, learning from the perspective of communities of practice is understood as involving the whole person acting in the world (Lave & Wenger 1991, 53). The term ‘community’ does, however, not imply co-presence, a well-defined identifiable group, or socially visible boundaries.

Communities of practice can rather be seen as reproduction cycles where newcomers — or apprentices — enter to find positions and are positioned in a way that affects their identity, the social possibility of negotiation of meaning, and the learner's curriculum itself in the meeting with old-timers and masters. In this process they learn to define the situation and to see from what platform a possible negotiation should begin. Learning in such a community implies becoming a different person with respect to the possibilities offered by these systems of relations. Identity, knowing, and social membership condition and entail one another (Lave & Wenger, 1991, 53).

Communities of practice embody certain beliefs and behaviour to be acquired, and social interaction is a crucial component of this situated learning of values, beliefs and actions in practical activity. This kind of learning is not based on a curriculum. It is often unintentional and a product of social interaction in particular settings and thus this situated learning can be seen as a historical production of persons. Lave and Wenger conclude, that the learning of the newcomers seems to intensify when they learn from interaction with other newcomers. “It seems typical of apprenticeship that apprentices learn mostly in relation with other apprentices” (Lave & Wenger, 1991, 93).

In these communities newcomers go through a process of experiencing learning as peripheral participants in a particular activity and context. Gradually we move from the periphery to the center as we assume the role of old-timers. Along the way — in this very process — we become more engaged in, motivated by, and identifying ourselves with the activities in the community. So, learning is not only a condition for membership, but is in itself an evolving form of membership in communities of practice (Wenger and Lave, 1991, 93).

This again implies, even though Lave and Wenger do not explicitly develop this point, that learning is situated in activity and that constraints to learning may not only be structural but also a question of the actual level of physical participation.

When it comes to the learning of implicit virtues it is this physical involvement in social activity that gives rise to understanding. This points to the importance of physical active participation to learn and understand the shared virtues and their meaning in a community of practice. At the same time it points to the problem of not engaging in active participation, thereby not learning and understanding the
virtues. This, finally, could be used to explain differences within a social group, normally considered to be alike, such as a group of students. It also gives a tool for how to identify these dissimilarities. Members of the (apparently homogeneous) group who do not participate actively in the same activities do not learn and understand the virtues shared by the rest of the group. Thereby we find dissimilarities between members of the group. In the cases I have sketched, these dissimilarities seemed to have a gender aspect.

Virtues in activity

The embodied virtues can be observed as patterns of repeated activities in different local spaces within the general frame of the Niels Bohr Institute. Seen from an outside perspective they appear to be social codes shared by some, not by others. Understanding the virtues (thus giving rise to membership in a community of practice) is only learned by active participation, though.

As seen from the outside the virtues are felt from individual or group reactions such as verbal utterings, silence or bodily postures like frowning brows, shrugged shoulders, a certain regard or tone of voice. During my fieldwork I saw, and felt, many times positive and negative reactions when it came to participating in group work around computers. It took a while, and specific movements of my own body, before I began to understand these reactions.

Computers are very important tools in the physics community and also at the Niels Bohr Institute. They are at the center of many of my fieldwork events. In most physics problem solving exercises at undergraduate or Ph.D. level the computer plays a central role. Since there are never enough computers physics students often work around the computer in groups where the computer then becomes a mediating device for, among other things, social conduct in the group and the learning of virtues.

The male students are learning from each other by commenting rather than directly asking for help. When they do not understand what goes on at the screen they never ask “What is going on?” They rather lean over the keyboard, pointing, and form sentences like “You move this one over here to change the array?” – or at least ask questions in a very casual way. They often point physically to something on the screen and make the question a sort of comment and never ask questions revealing fundamental ignorance. If there are women present who have not explicitly asked for help they most often stand up or sit in the outer periphery of the group. They rarely make comments and seldom ask questions as participants in a joint enterprise. If they address the group directly they rarely physically join the circle by leaning in over the shoulders of the others, commenting, pointing to the screen etc.

One thing I experienced many times, without understanding it, was the occurrence of negative attitudes when women (sometimes myself) placed behind the person at the keyboard asked questions about what was going on on the screen. Or when two women working together put up their fingers to ask questions about how to solve an exercise. Even though the women were often (but not always) helped with a smile, by teachers or peers, it felt as if we had exposed ourselves as “stupid” by asking directly for help. I saw, on the other hand, how male students were greeted when they sat down to work at computers with male friends – and how they moved around in the room going from one computer to the other. Just as the teacher often did. They often joked with each other and with the teacher, and I confess I often found them a bit childish. Judged from statements made by the women I worked with, they shared this perception. I felt more at ease with these women that seemed to be hardworking; never leaving their seats to run around; asking questions when they did not understand the given exercise. Whether the female students were working alone, standing in the periphery in mixed groups, or together two and two with another woman, they never engaging in the running around between groups. As a woman and an anthropologist I often sat a bit away from the screen in mixed groups. Often I became a bit annoyed when I could not follow what went on. No one seemed aggressive – but I could feel a little aggression because I sometimes felt secluded in mixed groups. Only did I not know what to do about it.12

These experiences later gave me an ample background for understanding why Alice became aggressive in the episode with Alice, John and Mildred.

Then one day I began to understand why the male students acted as they did. I began myself to move between the groups, looking over the other students’ shoulders to see what went on. This I did, even though no other female student did this, because I was an anthropologist and wanted to make comparisons. If I had been a full time student, I guess I would have preferred to get the work done as best as possible. At that time I was not aware that I also imitated the male students’ behaviour. They greeted me, though, inviting me to participate in solving the problems (though they knew I would not be of much help). I began pointing at the screen, making comments from my very limited knowledge. To my surprise they did not treat me superciliously. Gradually it dawned on me that I must have been doing something right. More right than the other women, who were frowned at when they asked questions from their seats. I learned a lot more about how to solve certain exercises when I approached the groups this way.

By moving my own body in space in a new way I gradually learned to understand why the women were frowned at by the male students and the male students greeted when they engaged in the running between groups. They were not childish. The activity now made sense to me in (at least) three ways:
1) By moving between groups the male students repeated the activity system in the group in front of the computer. Here the most important virtue was to consider the group work a joint enterprise, but at the same time a competitive situation. You did not compete by being aggressive, but by being best at using the group as a whole to get results. By running between groups the male students did not engage in play. For one thing they showed physically that they perceived group work in a wider sense than did the female students, by engaging people from other groups in their own work. Not by asking for help, but by behaving as if solving the exercise was a joint enterprise. Just as the work within the group around the computer was to be considered a joint enterprise.

2) By moving between groups the male students got access to comparing results from other groups which could they make use of in their own work. Even though the notion of solving problems as a joint enterprise was very important, there could at the same time be a very competitive atmosphere, both between groups and within groups. But it never manifested itself as aggressiveness—rather cleverness to get the others to work for you.

3) Moving between groups, leaning over shoulders, commenting while pointing at the screen, etc. All this made it possible to avoid asking for help directly, and thereby the male students avoided to become regarded ignorant by teachers and peers. It made it possible not to reveal fundamental ignorance, in contrast to the female students who asked direct and general questions.

This could be understood by me only by engaging myself physically in the same activity as the male students. What I learned was that for the three above-mentioned reasons, “childish” behaviour was in fact considered virtuous by the larger group of male students. Together they constituted, in this particular situation, a community of joint practice. The better you were at engaging others in your own problems the more virtuous you were considered to be. Some male students and all the female students did not seem to express the virtues that gave access to membership. The same members of the (granted very small) community of practice jointed forces regarding asking for help directly, whereas revealing fundamental ignorance was a marker of non-membership.¹³

Compressed, the virtues shared by the male students, as an ideal type of a physicist, could be described as follows: “A scientist, working in a group with other scientists on a joint venture, who is clever enough to make the group work for him, brave enough to venture into open competition with other members of the group and helping the group in competition with other groups, making comments rather than asking for help, never revealing lack of prestigious knowledge and never revealing fundamental ignorance.”

In the 18th century pedants and country people, wanting to be taken seriously at court, could read handbooks on courtly etiquette that dealt with how courtiers should dress, behave, talk, walk and stand, (Biagioli, 1993). Put on a list, the above mentioned embodied virtues could in an ideal (extracted) form be expressed as a sort of handbook for physics students:

**The ideal physicist’s virtues**

- You are a scientist¹⁴.
- You are engaged in the quest for truth
- You are burning for science (passionate)
- You are working for mankind (not for money or fame)
- Your aim is to answer the biggest and most fundamental questions (first)
- You are intuitive
- You regard science as joint enterprise
- You are working in a group
- You engage other in your work
- You learn from group-peers
- You never reveal aggression
- You never reveal (fundamental) ignorance
- You never asking for (fundamental) help
- You are working in open competition (within your group and with competing groups)

**Past experiences**

In the computer examples we have seen that not only scientific knowledge but also virtues are learned in practice as mediated by the computer. Male and female physics students seem to learn to value these virtues differently, and show dissimi-
larities in patterning what can be identified as some of the physicist’s virtues in the larger group of students and teachers.

Only by active participation in practice, using your own body in the process, it becomes apparent that moving your body in a certain way makes sense. From apparently childish behaviour, when seen from a non-participant, point of view of females (working hard in the same place), the male students’ behaviour reveals a shared understanding of group work based on certain virtues as seen from a participant’s point of view. This understanding seems close to male teacher’s understanding of what is considered virtuous in this community of practice. In contrast, female students — even at Ph.D. level — express that they do not feel quite at home in the physicists’ community, and some even react to it with aggression.

My example with the computers is just one small example of what is considered virtuous by the larger group, but is ignored or misinterpreted by others. Not all examples are divided along the gender line — and the examples given here, it must be remembered, tell nothing of female students’ scientific capacities as compared to those of male students. Many women in this world are fully capable of working effectively with computers. And some men are not. Still women and men with the same capacity for solving exercises on computers behave very differently when it comes to group work around computers. Some men will not participate in the “childish” behaviour and, just as most women, stay in their seats. Only, these men rarely reveal ignorance by asking direct questions.

This heterogeneity within the same group of students gives rise to a number of questions concerning how we learn implicit cultural (or as Kuhn and Biagioi would put it “tacit”) knowledge of what is virtuous in a new community of practice. As I have argued the understanding of virtues must be connected to active participation, as a physics student as well as an anthropologist. This only points to new problems, though.

Why do the women (myself included) not participate the same way as male students when they begin their freshman year? If they cannot see the screen, why not lean over and participate like most male students? Why ask questions revealing ignorance instead of pointing and commenting? The answer could lie in the past experiences, even quite embodied physical ones, that we bring with us to university.

In my field-work it was obvious that into this community of physics students enter newcomers of all kinds (even one anthropologist). We all tote our former experiences with us (body-experiences, dreams, nightmares, thoughts and knowledge). We carry our past with us, whether we are aware of it or not. The present into which we enter offers new possibilities — but also new and often unforeseen impediments. Not the least so when it comes to learning new implicit cultural virtues.

In short, we do not enter communities of practice with the same past experiences and therefore not with the same potentials for development. Lack of certain former experiences can be a serious impediment in learning social membership — including learning the virtues inherent in this community of practice.

Problems of access to learning resources, adult guidance and peer collaboration reveal a conflict between the individual entering as a newcomer with a particular background of experiences, and the relations built up between newcomers and old-timers of the community. These experiences can be of a similar kind — insofar as we may share a certain kind of experiences with a larger group — or we may share the absence of a certain kind of experience with a group of people.

The fact that we have an area of potential conflict between the individual person, the experiential background and the virtues upheld in the communities of practice, and that this conflict also to some extent can be seen as a gender conflict, are part of my deliberations concerning my empirical material from the Niels Bohr Institute.

Although we, as freshmen, all appear to be newcomers and therefore are understood as being on equal terms, some students apparently have a greater ability to learn implicit virtues than others. One explanation could be that they bring with them greater potentials for learning. It is clear from this that we must look for what kind of potentials people bring into this new setting. Here the most obvious answer I could find from field-work conversations with male and female students, is the lack of former experiences with computer games among female students. In contrast, most male students seem to not only have played computer games but to have played in groups around computers. These former experiences might have meant little or nothing for many other kinds of academic studies, but particularly in physics not only knowledge of how to solve exercises on computers but also of how to behave around them seem to matter.

Experience, or lack of experience, with computers as joint enterprises from computer games takes on a new meaning when the students enter the university setting.

As we saw in the example with Alice, John and Mildred, this is not a question of scientific knowledge but of agreement (or the opposite) with prevalent virtues. By defining the situation as a joint enterprise John gets authority to invite the teacher to the seat in front of the computer and himself to move closer to the keyboard center. He can drag in the teacher by giving him the place close to the screen, by pointing to the problem that now is to be solved collectively by the group with the teacher in front of the screen and John next to him. By defining the situation as a fight Alice is bound to loose because this is not part of the scientific virtues that are shared by the teacher. She might be aware that her behaviour is not in accordance with virtues shared by the larger group (including the teacher). In any case she literally moves her chair back to give room for John and the teacher and keeps silent — at least for some time — while the two in front of the screen work on the problem.
Women seem to be placed in this position more often than male students in the physics students' community. Even the women ending up as scientists or teachers. One explanation could be that the women do not carry with them the experiences that make it easier for male students to learn and accept the implicit virtues encountered. Since the virtues are implicit and only learned in activity, most women never get around to learning them. Instead they develop other strategies to be able to see the computer screen, such as aggressive behaviour, which might make it even more difficult for them to become accepted. Another explanation - and the two of them might be connected - may be that women simply have no desire to learn these virtues, neither before nor after entering the Niels Bohr Institute. They regard the male students' behaviour as childish and prefer other ways of solving problems. In other words: even though implicit virtues were made explicit, by active participation, the women might want to solve their problems in their own way. Not following the “virtuous” behaviour of the larger group, women might have other standards for what is considered virtuous. Standards that perhaps better fit their own past experiences. This opens up for a whole lot of new questions about more or less fundamental gendered differences in the directed (by past experiences) sense of what is considered virtues by females and males – which goes far beyond the scope of this article. The physics community is not a static one, though. Sometimes change involves fighting over keyboards. Sometimes dissimilarities are dissolved in the course of time. In any case my anthropological field study was a particular experience in a much larger world of experience, and a small peep into a much larger field of inquiry.

Notes

1 It was a very small questionnaire sent out to first year students in physics, astro-physics, geophysics and bio-physics the year I initiated my fieldwork. 68 students participated. 53 males (out of 95 possible answers) and 15 females (out of 23 possible) answered.

2 During my fieldwork, to my knowledge only one woman tried to get a university job and she failed. In the same period the number of women employed at the Institute went from 4 1/2 female scientific staff to 3 1/2. The number of male scientific staff is, according to the internal telephone book, 19 full professors (no women professors) and 68 associate/assistant professors.

3 There are of course many more aspects to this interesting concept but it will take the argument too far to go into all of them here.

4 Probably certain virtues, differing from community to community, are always taught as part of a learner's curriculum that any newcomer has to learn. Entering a new workplace you might make a fool of yourself by sitting at the wrong table, or by going through the wrong door thereby breaking the social codes for virtuous behaviour.

5 The distinction I make here between social codes and virtues is as follows: you might be aware of a social code, but you do not necessarily regard it as virtuous. You can see other people behave in a certain way, but you do not understand why it is good (virtuous) to behave in this way.

6 The university administration and most of the students were aware that I was an anthropologist. I began my fieldwork August 1996 at the introduction course by making a small speech about my project for the new students. I've, during my fieldwork, given a talk for Ph.D. students, teachers and “Women in Physics” at the Niels Bohr Institute about my findings. I also conducted interviews with elder students and participated in arrangements for Master's graduates and Ph.D. students.

7 Even though my main place in the hierarchy was among the first year students my position as an anthropologist also made it possible for me to move around in the system. My active participation became more limited when I moved “upwards”, but I could still use a lot of my experiences as a first-year student.

8 Biagioli considers the courtly virtues as a type of tacit knowledge. Even though he does not go much further into the discussion, he points out that these virtues may differ from other kinds of tacit knowledge. He also point out that tacit knowledge has political implications - something I quite agree on also in the study presented here. Only time and space prevents me from going further into this discussion.

9 Although it is not part of my present study I take it that these learning processes continue endlessly, far into the scientific practice in labs - but starts at latest at university level. This is after all what all the scientist in the labs has in common. Not every university student of physics gets to work in a lab but all scientific physicists working in a lab have a university degree.

10 As I use the concept of “learning in activity” here, it gives room for a wider perspective than “learning by doing” since activity here refers to all sorts of activity in the community of practice - not only a specific task that has to be learned explicitly.

11 The American educator and pragmatic philosopher John Dewey has, though, in the same line of thought, underlined the cognizance of how membership in groups is actually obtained: not only by participating in activity, but by learning and understanding only through participation (Dewey, 1916, 30).

12 Much later, when I presented my results at the Niels Bohr Institute December 4, 1997, many of the women present made it clear that they recognized many of the aggressive feelings I had experienced and for the same reasons.

13 In Biagioli's case, the courtiers regarded what was called "pedants" this way and despised them for their shabby clothes, and their rude, inelegant manners and talk.

14 Not a college teacher teaching physics, and the like, as many of the students eventually become - but a person working with scientific research.
References


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Piagetian Formal Level Attainment and Physical Science Option in the Second Level School

Abstract. Irish second level educational statistics show a low and decreasing uptake of Physics; uptake is lower amongst girls but is not decreasing as rapidly as it is with boys. Chemistry is similar but has suffered a very steep decline in the proportion of the available boys it has attracted. Biology, the other pure science subject offered in the senior cycle of Irish second level schools, differs from the physical science subjects; the level of uptake is high, and highest amongst girls, and is not showing a decrease.

Physical science opting pupils, aged 16+, were found to have more of their members at the Piagetian formal operational level than those who had not so opted. This was true of both girls and boys but stronger amongst the latter. Where limited or minimal support can be expected from the teacher almost all below formal boys and some at the formal level do not opt; again this effect was also found amongst girls but to a lesser extreme. The differences between the girls and boys responses are explored.

Some possible remedial strategies relevant to the aspects of the problem touched on are considered; of these intervention in the pupils' earlier education to foster cognitive development, as exemplified by the CASE programme (which is described) is concluded to be the most promising.

Because of a widespread belief that too few pupils, and in particular too few girls are leaving school without experience of and qualifications in physics, a study was made of some relevant issues. The current level of uptake of Physics in Irish second level education, in total and for boys and for girls, at present and over a ten year period, and in comparison to the other pure science subjects offered (Chemistry and Biology), was investigated; Irish National education statistics for 1994/5, (the most recent published at the time of writing), and for the nine previous academic years were consulted. (Eíre 1987 to 1996).1

The lower second level school (junior cycle), offers, during the first three years, a general science programme which in the latest year reviewed was being studied by some 84% of girls and 92% of boys. To the level to which Physics, (and the other constituent disciplines, Chemistry and Biology), can be taught in these early years this would appear to be a reasonable satisfactory situation; however even at this early stage a loss of potential Physics pupils has taken place.

Following a transition year, (a recent introduction), in which they can sample the subjects on offer in the upper school (senior cycle), pupils at 16+ opt for any one, two, all or none of Chemistry, Physics and Biology for the two year Leaving Certificate programme. Further losses of potential Physics pupils occur here; not all pupils are retained in school; not all pupils follow the academic Leaving Certificate programme; not all schools offer Physics; not all timetable alternatives involving Physics suit all pupils. Pupils are not constrained in their choice of the