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Learning and transition in a culture of playful physicists

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It has been argued that in higher education academic disciplines can be seen as communities of practices. This implies a focus on what constitutes identities in academic culture. In this article I argue that the transition from newcomer to a full participant in a community of practice of physicists entails a focus on how identities emerge in learning how to highlight certain aspects of personal life histories. The analysis of interviews with 55 physicists shows that physicists often perceive experiences in their childhood as the first step into their professional identities as physicists. These experiences involve recollections of the ability to think scientifically (e.g., 'go beyond the surface'), and the ability to play with toys which can be connected to the practical life of physics. The process of identity formation can be described as developing in a relational zone of proximal development, where old-timers recognize particular playful qualities in newcomers as a legitimate access to a physicist identity. The article discusses how play which physicists connects with a scientific mind can constitute a relational zone of proximal developments in a community of practice as a particular "space of authoring" in a physicist culture, which cut across other cultural differences.

Identity in communities of practice

Learning in communities of practice implies a transition where identities are redefined in a process where "identity, knowing, and social membership entail one another" (Lave & Wenger, 1991, p. 53). This transition takes place when newcomers enter communities of practices defined as "a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice" (Lave & Wenger, 1991, p. 98)[1]. In the examples mentioned by Jean Lave and Etienne Wenger, who introduced the term community of practice in 1991, a newcomer can be a young Maya girl learning the practice of being a midwife. She is not learning to boil water and clean instruments through theoretical training but rather by watching, listening to and helping the more experienced

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women, gradually learning the practice through participation. Another example is the more officially selected apprentices of tailors in Liberia where young men are chosen to learn the trade of sowing. First they are learning by watching, and helping masters. Gradually they are accepted as cutters of fabric and dressmakers and finally as professional tailors. In these everyday processes newcomers achieve a status as legitimate peripheral participants who over time can become recognized as "*master practitioners*". Though they might learn in a particular community learners are whole persons acting in the world with multiple possibilities for identification. Within the community newcomers gradually find positions and are positioned in ways which affects their social possibility for negotiation of identity and meaning in the meeting with old-timers and masters. In this process they learn to define the possible cultural resources which could become part of possible negotiations for the constitution of professional identities.

The authors make a clear distinction between the traditional teacher's curriculum to be found in schools and the learner's curriculum to be found in any community of practice. A teacher's curriculum involves the old-timer's explicit instruction of newcomers. What is to be learned is to be mediated by an instructor's intervention and an old-timer's view on what is to be known. A learning curriculum "is a field of learning resources in everyday practice viewed from the perspective of learners... [and it] is essentially situated" (Lave & Wenger, 1991, p. 97). Etienne Wenger has in an indebt discussion of communities of practices underlined that learning, in whatever form it takes, changes who we are by changing our ability to participate, to belong, and to negotiate meaning. And this ability is configured socially with respect to "practices, communities, and economies of meaning where it shapes our identities" (Wenger, 1998, p. 226).

An illustration of how identities more precisely are negotiated in communities of practices is given by Lave and Wenger with reference to Carol Cain's study of how alcoholics, as newcomers to the society, learn new identities in the community of "Alcoholics Anonymous". Through participation in weekly meetings where former alcoholics give testimony on their transition from "non-alcoholic drinkers" to "non-drinking alcoholics" they gradually learn what elements in life stories can be included in new identities as non-drinking members of the community (Cain, 1991; Lave & Wenger, 1991; Peacock & Holland, 1993).

Apart from these examples Lave and Wenger also analyze the communities of practices around the professional identities of American butchers and U.S. Navy quartermasters. They deliberately avoid including schools and higher educational institutions as examples of communities of practices. The taken-for-granted notion that schools are privileged arenas for learning is countered as the authors claim schools primarily teach students to be students and not about actual practice. They describe how butchers apprentices rather than learning how to cut meat are sequestered to a world of theory on the school bench with no bearing on the real needs of butchers" apprentices for learning in practice what meat cutting is.

The authors mentions the community of physicists as an example of higher education as a community of practice, but claim that the reproduction cycle of the community does not begin in school, but much later, possibly only in graduate school (Lave & Wenger, 1991, pp. 99-100). They do not attempt to describe this higher education community of academic physicists as a community with its own inherent practice, and a cycle of reproduction where old-timers gradually teach newcomers to take their place.

Other have, though, taken up this challenge and argued that higher education can be seen as a multitude of communities of practices (Knight & Trowler, 2001). Academics can achieve membership at different levels, where full participation entails shared understandings of core meanings and in these academic communities of practices (as in any other) the community culture is "both enacted and constructed and where personal identity coalesces, is shaped and re-shaped" (Trowler & Knight, 2000, p. 30).

I shall take this challenge one step further and from an analysis of empirical material gathered at physics institutes in 9 countries (primarily Denmark, Italy and Great Britain) try to identify specific elements in a learner's curriculum which can coalesce in shared physicists professional identities (Hasse, in press). I argue that some of new coming students who learn

the learners' curriculum will identify these possible resources and thereby have eased their transition into the community of practice of physicists.

Authoring in social space

In *"Anonymous Alcoholics"* we can follow a direct transformation of identities as narratives take form (Cain, 1991). In the community of academic physicists the process is not so direct and professional identities are formed over a much larger time span. In my analysis, I do not have access to data material showing changes in how identities are constructed in narratives before and after entering academic physicists" communities of practices. I shall try to elicit what old-timers underline when they reconstruct what in their professional life stories gave access to a career in physics and oppose it to what newcomers are taught about possible elements in a professional physicist identity. Since 1996 throughout three research projects, I have been conducting 55 semi-structured interviews with physicists and physicist students besides a number of focus group interviews with Danish and Italian physicist students[2]. That the interviews are semi structured means it is a scheduled activity, open ended but follows a general script and covers a list of topics (Russell, 2002, p. 203). In these interviews I have been developing the questionnaire according to the specific research project at hand, but many questions have remained the same in all three projects. One of the consistently repeated questions is: Why did you study physics? 53 out of 55 physicists and physicists' students have answered this rather open question, 28 males and 25 females[3]. The physicists are either full professor, associate professors, in a few cases long time researchers who never obtained a permanent position, Ph.D. students and in three cases students[4]. In the following I shall concentrate on an analysis of thematic elements relating to early childhood or school experiences which are highlighted by physicists as important for the transition to science and an identity as a physicist. I shall only refer to national identity and position when it is directly relevant for the analysis though the interviews took place at different physics institutes in different countries. All names are fabricated to preserve anonymity.

The reason why I have posed so open and non-directive a question has been to avoid closure on what could be mentioned as sources of inspiration. The question invites a free narrative of what forms an early identification with being a scientist[5]. The answers can lead in many directions in relation to what is perceived as relevant for a motivation to become a professional in physicists own biographical narratives. In my analysis of these answers I do not believe them to have a privileged or especially truthful quality. I take these narratives to be a particular feature of a given cultural milieu, dependent of cultural conventions and shared formats as "instances of social action" (Atkinson, 2005). I take them to be as much about how particular elements in life stories can be connected with professional identities in physics as referring to any private experience.

The argument made by Lave and Wenger, that identities are situated and (re) negotiated in a newcomers meeting with a community of practice, can be deepened if we dive into the relation between identity and narrative. Following Jerome Bruner (1991, 1990) identity is created by a self-narrative and its reception and acceptability is judged rather by verisimilitude than by verifiability. From a methodological point of view these narratives create a whole of separable event – as an act of emplotment (Ricoeur, 1984, p. 65). Narratives are plots in the sense that they not only order events in space and time, they also convey schemes and traditions and include taken-for-granted cultural organizations of perception and thinking about the world. Personal stories are not only acts of telling someone about one's life but also means by which identities can be fashioned. In the words of Nigel Rapport narratives "represent a primary engagement of our understanding of the world, of experience, and ultimately of ourselves" (Rapport, 2000, pp. 75-76).

For Dorothy Holland and her colleagues William Lachicotte, Debra Skinner, and Carole Cain the concept of identity is tied to Lev Vygotskys notion of a zone of proximal

development. They argue that identity can be defined in this way: "People tell others who they are, but even more important, they tell themselves and then try to act as though they are who they say they are. These self-understandings, especially those with strong emotional resonance for the teller, are what we refer to as identities" (Holland, Lachicotte, Skinner, & Cain, 1998, p. 3). These "tellings" they call "*spaces of authoring*", inspired by Bakhtin's discussion on dialogic selves and Vygotsky's discussion of inner speech (Holland, Lachicotte, Skinner, & Cain, 1998, p.169). In Vygotsky's original notion of the zone of proximal development he was concerned with school children's achievement in schools. In his own example some children who formerly performed just as poorly as other classmates have the potential to move further ahead than the others, when they receive help from a teacher. These particular children, Vygotsky argues, has a more advanced zone of proximal development which facilitates learning how to solve the posed problems under "adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). In the argument made by Holland et al. the space of authoring become a zone of proximal development, where the teachers" "adult guidance" is replaces by social internalized "voices", who tells the person what identities are preferable in a particular figured world, which the authors themselves in many ways find comparable to a community of practice (Holland et al., 1998, p. 57). In this space of authoring neither deterministic culture, nor positioning in situated practice in themselves creates identities. Identities do not belong to the single individual but are formed relationally in a constant evolving process in the meeting between a community and persons. Therefore identities are never to be found as end-products.

Following a distinction made by Vygotsky in his discussion of psychology of art the question of professional identities is not so much one of the difference of individual versus social, but the difference between collective and social (Vygotsky, 1971, p.17). Everything about a professional identity is social, but that does not imply that all properties of the psyche of an individual are inherent in all the other members of the group as well. What we can hope to identify are not "cultural dopes" with completely alike identities, but certain social elements of identity formation prevailing in particular communities of practices.

The answers to the question "Why did you study physics?" contain a number of identifiable social elements in what the physicists perceive as the motivational prime mover into the professional identity as a physicist. These can roughly be divided into two groups (with some overlap): references to school experiences (especially teachers) as sources of inspiration (20 in all) and references to the identity of a physicist as stemming from early childhood – in some cases as hereditary or natural motivation (33 in all). In the first group we find the *"doubters*", who might have considered becoming something else. In the second group we find the "*child" physicists*" with references to very early transitions: "parental influence", childhood "play" and reading of popular science books as sources of inspiration but also the scientific mind as inborn.

Scientific minds at play

The 20 people referring to teachers or the time in high school as the time when transition to physics took place mention that teachers were "funny", "lively", "ability to create a passion" and good at making excursions. In this group many also express that they were in doubt fluctuating between physics and other subjects. Several have considered kindred subjects like mathematics, engineering or medicine. Others (especially among the Italian women) have considered careers in the humanities as for example archaeologists or in one case a career as an opera singer, which she only gave up because her brother became a physicist and urged her to do the same[6]. In general people seem rather pragmatic about why they came to study physics in this group. As one Italian physicist explains: even though he had a very good mathematic and physics teacher in school, his decision to study physics was more about economy. He might have wanted to study other things, but he could not afford to move away from his hometown and here studying physics was the most likely option. In general

these physicists praise what could be called *scientific minds* and the teachers who could open their minds to scientific thinking.

An important element of a scientific mind is to question the present state of affairs. Thus the ability to open up for new questions was one of the key constituents of what the philosopher Gaston Bachelard (1938/2002) called "the scientific mind"

In the other group of early transition we not only find less doubt about the choice of physics, but also some indications that a scientific mind can be an inborn quality thus described by a female physicist, who met a physicists who helped her get a job:

> I believe that no matter what person I had met, I would have worked with science. I believe you have a searching soul as a scientist – you are born with it. If you are not born with a searching mind, you cannot do research. One cannot learn to have a searching critical mind. You might learn to be critical, but to really do research you have to be very critical, analytic – and you have to be curious – and wish to explore every possibility which opens up.

In this case, the transition into an identity as a physicist is eased by having been born with the "right scientific mind". The ability to "think as physicists" is something, which other physicists also acknowledge. However, whereas the first group gives examples of how this ability is taught, in the latter group teachers are not accentuated as the most suitable transition makers. On the contrary – several mention that the physics teachers were directly counter-productive. In one case a physicist relates this to teachers irritating habit of having ready-made answers. In a couple of other cases the teachers almost can destroy a budding interest in physics, because they do not take the students serious as competent scientists-to-be themselves.

As one physicist explains: "Because it was very frustrating to argue with your teacher when you are in seventh grade about something related to physics. And usually the teacher did not necessarily understand the point I was trying to make". What helped this physicists, as many other we find in this group, is that they had a father (or in one case a mother) who was a physicist, who, as the same physicist continue, "was able to explain, to say 'yes, you are actually right', and there is the other thing, and this kind of thing opened up a world for me which was good, because I was actually frustrated with my physics teacher".

To "learn how to think" as a physicists is to think for yourself and this goes through several of the statements, which is found in biographies.

It is inherent in the professional identity as a physicist to look at the physical world in a skeptical manner. In the narratives, it is this skeptic attitude that in the end can make you challenge your own teacher. This is an aspect of physicist identity which is found in many other statements than in my interviews. To be skeptical is an important feature of the scientific mind, which means not to take the world as we learn it to be in other parts of life for granted. On the contrary – even as children physicists-to-be must learn to be skeptical about the world around us. They cannot just marvel over beautiful birds, and flowers. They learn to be critical of any perception.

Processes of transition into the culture of physics

The famous physicists Richard Feynman (1999) recalls how his father used to take him for walks in the woodlands of the Catskills Mountains and point out small riddles of nature, which forced the child to reflect on possible answers. During these walks with his father, the young Richard learned a great deal about the deception of first hand perceptions, which later helped him as a physicist. On one occasion, his father taught him about how perception and knowledge of birds could change with a careful examination of the perceived. Instead of for example naming the birds they saw along the way, that father would say: "Look, notice that the bird is always pecking in its feathers. It pecks a lot in its feathers. Why do you think it pecks the feathers?" Richard guessed it's because the feathers are ruffled, and that the bird is trying to straighten them out. The father then said: "Okay, when would the feathers get ruffled,

or how would they get ruffled?" The boy answered: "When he flies. When he walks around, its okay; but when he flies it ruffles the feathers". Then the father would say, "You would guess then when the bird just landed he would have to peck more at his feathers than after he has straightened them out and has been walking around the ground for a while. Okay; let's look". "So we would look", Mr. Feynman remembers, "And we would watch, and it turned out, as far as I could make out, that the bird pecked as much and as often no matter how long he was walking on the ground and not just directly after flight. So my guess was wrong, and I couldn't guess the right reason". Then his father tells him, that the pecking is connected to an ecological food chain of lice, mites and birds. The birds peck their feathers to get the lice (Feynman, 1999, p. 181).

The father also teaches Richard not to believe he knows anything about birds, just because he knows their names. By looking at the bird Feynman learns that changes in his understanding of what a bird is, is possible even if the words remain the same. What the words "brown throated thrush" can mean, can in other words change with perception. A perception can be changed, when a new theory is brought forth changing the meaning of the category. This relation between perception and categories as something, which should not be taken for granted, has always been a hallmark for natural science. The scientists must go beyond the apparently accepted understanding of categories and perceive the world in new and more profound ways. Physicists question established representations, "look for themselves", and test what they perceive instead of taking it for granted.

The children in the second group have, according to their own narratives, caught onto a fundamental skepticism shared by the members of this particular community already in childhood.

A very successful female physicist underlines the logical thinking she learned at home:

> And you know they both [her parents] had a very logical – you know... if you have an issue or problem in an observation, you observe, you formulate a hypothesis, you test that hypothesis. It was never said like that – it was just the way I think.

Another female physicist refers to her father as the decisive figure who taught her to probe into nature.

> He gave me a love for nature, for knowledge, for never stopping up at the superficial level – all this I owe to him [...] he has been a great source of inspiration to me; he created a great enthusiasm [for physics] in me.

Play – Going below surfaces

In this group, many refer to how they learn the social element of skepticism in early childhood because they learn from their scientifically oriented parents. Of the 55 physicists eight had a parent (in one case a mother otherwise fathers) who was also a physicist. Others had cousins, brothers and in one case a grandmother who influenced them.

But the most outstanding feature in the group of 33 answers is that 13 refer to childhood play as the decisive transition into physics. This play could be inspired by parents or not, but as a general feature it is play which give new insight in how to perceive the world.

The lice on the brown-throated thrush were not to be seen with the naked eye. Feynman also learned from his father that perceptions can deceive, but deception can be corrected with the right equipment. Galilee could not have seen the moons of Jupiter without his 98mm long blue and gold cartoon and telescope, now on exhibit at the museum of Science in Florence. Newton could not have made new insight to our understanding of light without his prisms. The physicists-to-be learn already in childhood to appreciate playing with instruments, which can change perceptions of the surface of things[7]. These instruments, whether they are made for children or not, is considered a playful activity, which opened their minds for a professional identity as physicists.

When Alice, one of my interviewees, went out on the balcony with her father whatever romantic relationship she had with the stars were changed forever.

> Yes, I watched the stars. My father is a physicist. He was very... it was not because he gave me allot of books, but we lived in a town and so we could not see the stars clearly, but we went out on the balcony anyway to look for specific star objects. And I became interested. How big is it? What is really going on up there?

From being the small yellow dots we all see above our heads, which we can perceive as "Orion's belt" and mythological figures, Alice learned, through her fathers skilled guidance that the instrument showed her that the stars are not just equivalent dots – but stars come in many sizes and colours and that you through instruments which cover their spectres can say something about not only their composition but also they distance and movements in relation to earth. Already as a girl she learned that a lot about the stars we can immediately perceive is hidden for our human eyes – and that it can only be reached through instruments.

This is a learning process she shares with many of the physicists, who has been brought up learning that there is more to nature than what meets the eye.

Apart from the skeptical perception and the use of instruments, physicists also refer to a more direct play with children's toys, which can have the same mind-opening function.

One of these is the physicist is Walt, who remembers his childhood play with Lego as a source of inspiration, which continues to this day.

In his narrative the child Walt plays with his big box of Lego on the carpet of his parents' house. He has red, yellow and white Lego-bricks of different sizes and shapes. They all have little dots on one side and little wholes on the other and fit into each other. He is building a tower putting brick upon brick, making choices all the time of which brick to chose; nothing mechanical here. Nothing natural either in the sense of nature as not fabricated by humans. Lego is a Danish trademark – thought up and set into production in t he Danish town Billund by a Danish businessman. It consists of colored plastic toy bricks, which can be built on top of each other. Thirty years later, Walt is still playing. He is studying physics of electro deposition – electric chemical plating. He is having fun and combines his experience as a grown up physicists directly with his childhood experiences.

> It is the same process you would use to chrome plates like the bumper on the car – something like that, but looking at it on an atomic scale. It has turned out to be absolutely fascinating – I haven't enjoyed myself so much for a long time, and yes, it really has a strong connection to my play with Lego.

Walt tries to explain what he is actually doing:

> You have a solution, say of cobber ions in a liquid and you pass a current through them and electrons are passed from an electrode into the solution, it goes to the ion and the ions then become metal-ions. So you initially have cobber ions in a blue solution, but when you pass a current through you have cobber metal forming at the surface and by using certain tricks you can form that cobber metal or whatever metal you are interested in into particular structures. You can layer materials on an atomic scale by using a current. I mean, it's very much like playing with Lego.

This is what Walt perceives every day through the electron microscope, watching as blue turns red, layers and fractals grow in spiral patterns. For an outsider these patters are beautiful but meaningless. How do human beings come to perceive the world as physicists? Is there a straight line from Lego to playing with building layers of cobber ions? For Walt, Lego and physics have been joined in a narrative giving his life an unbroken direction from childhood till his present work in the laboratory. In that sense there is almost no transition – he began as a child playing with Lego bricks and a grown up physicists he is doing almost the same. It is only when Walt's narrative is compared to other physicists we see a persistent pattern in the narratives. In this narrative, the social element of the scientific mind is present in so far Walt learns that the things

that meet us with a smooth surface (a wall of Lego or a layer of lacquer) can always be broken down to smaller elements and that smooth surfaces are built from such small elements.

Several male physicists tell about playing with electricity, making chemical experiments or taking things apart in childhood. As one explains:

> I did things at home that I was not supposed to do, dangerous things. I played with the electrical currents [...] and I always tried to take the transistor radio apart to see how it functioned. And once, I remember, I did it so effectively that I could not put it together again.

These examples can also be analysed as referring to the *scientific mind* and the notion of going below the surface. Once the transistor is taken apart, it appears that it consists of many small elements.

There might be a gendered aspect in how physicists relate to the scientific mind in so far women refer to ways of getting below surfaces in different ways than males. Three female physicists (only one of whom is today an astronomer) remember how they in childhood explored the sky with telescopes or binoculars, whereas the male physicists seem to refer more to hands-on experiences of how they would play with objects found in nature or the home taking them apart and scrutinizing their inner parts. This gendered aspect might be related to what kind of playful activities, which are considered appropriate for boys or girls. One of the female physicists in group two for example remembers with regret how she was barred from playing with her brothers tempting Mekano set (which might have had the same function as Lego in enhancing the scientific mind).

In general the childhood activities the physicists remembers as important for their transition into physics are in this group often connected to play with instruments like telescopes or toys like Lego which open up a new understanding in the child's mind of space, time and relations. Some, mainly boys, play with play sets of chemistry, electrical circuit's boards, or take a transistor radio apart and the like. Though there are differences in the particular types of playful childhood activities, I suggest that what the physicists' statements have in common is that they see their childhood activities as zones of proximal development, which ease the transition into the professional identity as physicists. It was through these activities that they developed a scientific mind, which does not take the world for granted, but takes it apart to look for oneself.

The play the physicists accentuate in the interviews is of a particular kind. They do not refer to playing with dolls, animals or social group games. The particularity of the physicist-to-be's game is that it concerns a sceptic scrutiny of the world that we normally take for granted. The playful physicists-to-be challenge the world as it appears. Training telescopes on stars and pulling transistor radios apart have this in common: the acts reveal the invisible parts of objects. Stars appear difference once perceived through a telescope and the surface of a transistor.

Through these activities the children are prepared for the life as physicists as they have learned to act out what is considered an important social element in constituting a professional identity: the scientific mind. This might not only be reconstructions of childhood experiences, but might also point to the role of play in development as proposed by Vygotsky. Play is not just about giving pleasure, but a serious activity full of hidden rules preparing the child for the grown-up world. In play it become a desire to act out what the child has perceived as important rules guiding adult behaviour and its needs and motives for action (Vygotsky, 1978, p. 92). What the children are not able to do in reality (being taken serious as scientists for example) they can fulfil in imagination. Vygotsky's examples concern small children, where the child is acting out the rules they believe to belong to the adult world. The childrens' rudimentary understanding of what guide adult behaviour determine what is accepted or is discarded in a game. Through play as a leading activity in development, children gradually learn to be adults. The play with invisible parts of objects and the professional identity as a physicists do not develop as an isolated string of mental processes, though, but involve "an element of reconstruction, reorganization of personality structure and consciousness as a whole, which Vygotsky called the systemic structure of consciousness" (Veresov, 2005). The

leading activity of physics does not emerge directly from the activity of play, but emerges with the whole situation of learning to become a professional physicist. It is the relational zone of professional identities meeting childhood recognitions of a particular kind of play, which from the scientific minds point of view is still allowed long after childhood (Hasse, 2002b).

Enrolled as a physicist

In the group of *child physicists* we find the strongest identification with the profession of physics and many statements like "I was never in doubt", "I always knew I would be a scientist" and "I have always wanted to do it. That has been my dream since I was a little kid; basically, since I was ten years old I wanted to be a scientist." In this group of child 'physicists', teachers are not credited for being transitional figures helping in becoming physicists – sometimes the contrary. Through an analysis of the answers, I contend we might not only elicit what originally spurred the interest in physics, but also what legitimately constitutes an identity as physicists. The same social elements found in interviews with physicists are also found at physics institutes. Here teachers play an active part when they teach physicists students about important elements of professional physics.

In 1996, I enrolled myself as a physicist student at a physics institute in Denmark to study in- and exclusions of physicists' students and especially why it was difficult to keep female students on a career track as physicist scientists. Here I was confronted with a lot of new understandings of what could be included in an identity as a physicist. These understandings are identified in a "cultural learning process" where surprises in the culture of the community develops as the participant observer learns deeper meanings behind words and actions and increasingly can perform what Clifford Geertz (1973) termed *thick description*.

In this process the cultural learning of the researcher is not that much different from the learning of other participants as she learns by doing and following the practice of other newcomers (Hasse, 2002a,c). This focus on cultural learning processes implies changing basis of reflection that gradually make way for new kinds of surprises (Hasse, 2002a, pp. 122-123). To be able to experience these cultural surprises as a researcher you must position yourself so that you can be exposed to surprises. One of the most effective ways of doing this is through participation in the same activities as the other participants. This approach is an enhanced understanding of the definition of participant observation given by Martin Hammersley and Paul Atkinson when they defined ethnography as "a particular method or set of methods" that "involves the ethnographer participating, overtly or covertly, in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are the focus of the research" (Hammersley & Atkinson, 1995). In my case, I officially enrolled as a physicist students acknowledged as both an anthropologist at work and a new student by the other participats. The ethnographer's cultural learning in the community contextualizes the analysis of the narratives and all other data material gathered in the field.

In my daily dealings with the physicist students in- and outside of classrooms I found to my surprise that the physicists students, whom I had envisioned as "nerdy" and dry people were in fact very playful. Especially a particular group of male students seemed to play with whatever objects at had, the huge window glasses in the cantina, slices of pizza, a box of sweets. Through these playful acts, they tested out certain physics theories as the theory of gravity, which was tested through fierce jumping in a downward-headed elevator or Brownian motions where round candy was dropped in a glass of coke. For some of the other students, especially the conscientious female students, this conduct could be quite annoying especially when it interrupted classes or ongoing experiments initiated by the teachers. My next surprise came when I found that the teachers instead of scolding the playful male students backed them up and praised them for fooling around. When I later addressed the community of physicists with these findings I was told not to be surprised that playful acts were rewarded even when they disturbed classes. One of the external examiners connected with the Niels Bohr Institute

explained: “I get so happy when I see what they do in physics exercise class. Half of them are playing around and we reward that. The playful students get rewarded for being creative and showing initiative!” (Hasse 2002b, p. 260)

Playful activity was considered an asset. Although not explicitly expressed as such in the teachers curriculum is could be learned in the learners’ curriculum as an important social element in physicists’ professional identity. In this community of practice life stories and identities are negotiated and reconstructed to fit with the general understanding of what are valued qualities in the practice of physics. In the space of authoring in academic physics we find voices advocating for scientific minds, but also play as an element of the scientific mind.

Other cultural elements in professional identities as physicists could have been explored further – for example, religion and science fiction, which can be important elements in physicists and physicists own discussions of science (Hasse, 2002a). Religion was mentioned to me by some physicists when they tried to explain the deeper meaning with their science[8]. But as none of the physicists explicitly mentioned it as an answer to my open question I have elicited it from my discussion here. Science fiction was spontaneously mentioned by one of the two male students in the sample, but not by any professional physicists, so I have also left this aspect out here. When explicitly asked about science fiction many physicists admit that it did constitute a motivation of sorts to read about especially the technical fantasies in hard science fiction literature, but they also stress that science fiction is a child disease in physics[9].

Gender is also an issue in the institutional learner’s curriculum. Women and men show different attitudes to play in physics as students, but in the professional physicists answer to my open question I found no gender differences within the two groups with half the women in the first group and half the women in the second. Therefore I have not gone deeper into this problematic here. Only if we subdivide the group of *child physicists*, we find that the women do not play in the same way as male physicists (with electrical circuits, taking transistor radios apart etc.) but rather use instruments like the telescope. A further probe into the material show that in the group of child physicists we find an overweight of female physicists who have been inspired by a parent (6 women and two men have a father or a mother who are physicists).

In relation to position we find students, PhD. students and professors in both groups. As for national cultures, the physicists in the child physicists group come from Denmark, Italy, Great Britain and the Netherlands. The cultural elements of play seem to cut across national cultures just as in the *school* group. The only salient difference here is that among the doubters we find more Italian physicists who had considered a career in the humanities. This is probably due to the fact, that national cultures also influence what kind of elements can be included in a professional identity as physicists (Hasse 2001a). In Italy, many physicists have studied classical languages before entering the study of physics[10]. These doubting physicists have had a vaster array of possibilities for professional identities, due to they background in classical studies.

Discussion

A community of practice does not necessarily imply co-presence, a well-defined identifiable group, or socially visible boundaries. It does imply participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their communities (Lave & Wenger, 1991, p. 98). In this sense the physicists coming from very different national contexts could be said to belong to a transnational community of practice which support the professional identity formation with some of the same constituting social elements. Others have spoken about these similarities in professional physicists lives as a “culture of no culture”, where scientific minds “longs passionately for a world without loose ends, without temperament, gender, nationalism or other sources of disorder – for a world outside human space and time” (Traweek, 1988, p. 162). In other respects we would rather see the physicists as belonging to different but overlapping communities, but when it comes to the acknowledgement of play as an actual zone of development of the established practitioners it seems an integral part of physics culture.

There are many ways to achieve membership of the community of academic physicists. By recognizing the playful activity of some male students it can be argued that the teachers ease these students transition to the community as students learn that play is considered an asset, This learning later become part of their own life story as professional physicists.

Identities are formed in relational zones between established old timers acknowledgement of certain constituting social elements in identity formation and newcomers, who have their own actual development enhanced in the meeting with the old timers. The old timers recognise the desired social elements the newcomers, bring with them into a community of practice. Through their recognition newcomer learn that the posses the desired elements.

I have proposed an addition to Vygotsky's model of a zone of proximal development, namely that the teacher also himself has an actual and a potential developmental zone. What is recognized as potentially worth developing is relational with respect to what the old-timers in the community are capable of recognizing. Zones of proximal development are always relational (Hasse, 2002b). Sometimes bright students or physicists are misunderstood because their actual zone of development is actually the proximal zone of development for the teachers around them, which they only later came to understand (Einstein is an example of this). In other cases, some students' proximal zones of development make a perfect fit with the teacher's actual development. In the physics institute where I was a participant observer for more than a year, the teachers and elder peers recognized play as a potential asset in physics (Hasse, 2001b, 2002b). Play connected with scientific minds thus functions a zone of proximal development in two ways: a) For the children the playful activity might open their minds to the critical scientific thinking later to be appreciated by professional physicists and b) For the teachers a students playful activity might open for a recognition of particularly gifted students, who are then asked to continue a career as professional physicists.

This does not mean that all physicists play, but they know they would be better of if they did. Though you can definitely become a successful physicist without this social element playful activities can be seen as excluding physicists who do not play around. This might especially concern women, who consider play an opposite of more meticulous work (Hasse, 2002b). This is recognized in this interview with a female American physicist:

Interviewer: Ok. One thing, I have been studying the young physicist students and the one thing that struck med was that in Denmark there was a group of very playful students. And they were almost everyone male students. Playing around with equipment to make exercises, throwing things around. Is that something you can remember?

Mary: Oh yes, this is part of a whole trend I can see in retrospective. I can see this made you feel unwelcome in physics or not a part. As I said I was very smart, I was doing well and I would go to physics labs and we would have an assignment to do something to put together an electric circuit or something and these were totally foreign to me totally unfamiliar. And I would perhaps be a bit slower than my lab partner who was unbearable male, because there were not many women. And he would just go "chum-chum-chum" and put together the circuit and go there, there we are done... And at first I deferred to them because in my world you would not barge in and insist on that you knew what you were doing unless you did. And I would not do that. And I shortly discovered that in fact they indeed would do that even though they did not know what they were doing. [...] And I actually found that he had made mistakes and indeed the instructor had made mistakes which I found by looking very carefully trough instruction and the ships. But it was not – it was against the grain it was against the – In order for me to learn something they had to be warm on me. And that is not a very effective way to learn anything so yes I was very uncomfortable at the lab [...] I have to say it was not smooth sailing.

The playful student might make mistakes, but he is still acknowledged and encouraged by the instructor who himself makes mistakes, but accept play. This is probably because through play we can open for new questions to ask – one of the main constituents of the scientific mind. The person who comes to doubt if she belongs in physics is Mary, who, even though she according to her own story, is smart, she is not meeting the colleague's actual zone of proximal development, which praise careless play over meticulousness. On the contrary – she becomes disillusioned and almost leaves physics. Through play, the students and physicists might make mistakes, but they also challenge the establishment and pave the way for new insight according to what is considered constitutive for scientific minds.

Conclusion

I have argued that physicists underlining of childhood play as the first transition to professional physics, as diverse as these childhood recollections may seem, all point to the same inclusion in a scientific mind, which does not take the world for granted. The physicists belonging to the group of child physicists seem to have gotten physics in with the mother's milk and are, maybe for that reason, much less in doubt about their professional identity than the group of physicists in the group of doubters. In the childhood games of scrutinizing nature, looking closer at the stars in the sky, taking transistors apart and building up or tearing down bricks the children can be said to learn not to take the world for granted, and to scrutinize it and think for yourself.

Neither identities nor communities of practices are reifiable closed and unchanging entities. Community of practice is a heuristic device for capturing common ground, constitutive relations, their entailments, and effects in a framework of social practice theory, in which the production, transformation, and change in the identities of persons, knowledgeable skill in practice, and communities of practice are realized in the lived-in world of engagement in everyday activity (Lave & Wenger, 1991, p. 47). Newcomers to a community have to learn new identities in the communities learning curriculum. In this process identities are constantly in the making through what Holland and her colleagues called a space of authoring voices. There is nothing essential about these spaces in academic culture, but I have argued we can find certain elements in physics culture, which cuts across nationality, gender and position. Play is such an element, which can be tied to the greater constituent of physicists' professional identities: The Scientific Mind. Professional identities belong to cultural communities of practice, which emphasize particular social elements in constituting membership identities. Childhood experiences can be a social element, which can ease transition into a professional identity together with certain acts, which can be recognized by old timers as access to membership. In the case of physicists it is for example childhood experiences with play, and the subsequent recognition of play with physics as an asset by old timers as both these elements open the scientific mind to new questions in physics. The playing child discovers that the world can be perceived in a critical manner. Adults (like fathers or teachers) help many to this understanding. Then children begin to play games, which open the world up for critical scrutiny. At some point, the physicist discovers that the leading activity of play in childhood has been transformed into the everyday life of a physicist. The young physicists-to-be, which has discovered the critical scrutiny of the world in play, can develop into the professional activity of a physicist if their zones of proximal developments meet with actual zone of development of old timers, scaffolding their scientific mind. The voices of old timers become part of professional physicists' space of authoring.

Professional identities are not collective but they are social. Many physicists do not recollect play as their first development into a professional identity as a physicist. They accentuate other social elements such as teachers opening their scientific minds. Even though many differences can be identified (for example in some cases between Danish and Italian physicists and between male and female) – these differences can be analyzed as patterns of elements. In these patterns, we find clues as to how particular childhood experiences can ease

the transition into identification with the physicist community of practice. These findings do not exclude very personal constructions of professional identities, but highlight the social elements forming common ground.

The internalized voices in social authoring thus do not determine identities but provide a cultural reservoir from where such elements can be drawn. In a community of practice of professionals, identity formation is not only related to the peripheral learning through participation in the actual practice, but to the self understandings newcomers learn it is acceptable to recount as narratives of professional life stories. In this sense the zone of proximal development of identity becomes a development relative to the values learned in a social community. In the culture of physics play can become an element in life stories to be included in the new identities formed in the community of practice and as newcomers learn identities across nationality, gender and position to a certain extent coalesces.

Notes

1 The concept of Lave and Wenger (1991) has since been developed from a general heuristic device to a more instrumental theory by Etienne Wenger (1998) and Wenger, McDermott, and Snyder (2002). For my purpose here, the original definition is sufficient for my discussion of learning physicist's identity.

2 The titles of the three research projects are (1) 'A good natural scientists m/f?' dealing with in- and exclusion processes of male and female physicists students from higher education, and (2). 'The cultural dimension of science' and (3) 'Understanding Puzzles in the Gendered European Map' both dealing with gender and cultural differences in the practice of physics. The projects have been financed by the Danish Research Foundation and the European Framework Programme. 27 of the interviewees work in the same international particle physics project, Atlas. The rest work in different fields of physics. The main part of physicists comes from Denmark, Italy and Great Britain (45). The remaining 10 from Senegal, Romania, Netherlands, Sweden and the United States.

3 In two cases the question was not formulated so it did not invited reflection, so these cases were omitted.

4 Where it is relevant for the analysis I shall make a distinction between students and physicists. I could also make distinctions in relation to gender and nationality, but in this context, national cultural differences and gender are not as relevant as they are for my analysis in general (see Hasse 2000a,b, 2001b, 2002a,b,).

5 In their narratives the physicists themselves sometimes note that they knew very early they wanted to become scientists and work with nature, but that the profession of physicists was not known to them by then. So in the interviews they both refer to the becoming of a 'scientific mind' and of becoming a physicist interchangeable. Some also mention though, that they might have become other types of scientists. In some cases, reference to play in childhood came in answers to other questions, and in some cases, the open question was followed by a follow-up question.

6 In Italy, it is not unusual to study physics after having chosen the line of classical studies in high school and in general, many women with this particular background become physicists. This combination is quite unusual from a Danish point of view, where physicist all come from a background in a mathematical-physical or technical high school (Hasse 2000a, in press. See also www.upgem.dk.)

7 This finding has been confirmed by the UPGEM Study. See www.upgem.dk

8 See Hasse 2000a,b for a more thorough discussion of this subject.

9 Elsewhere I have argued that for physicists students science fiction, just as well as play, constitutes a scientific zone of proximal development (Hasse, 2001b, 2002b).

10 As mentioned before it is possible in Italy to combine physics with a background in classical languages and philosophy and students with these backgrounds has traditionally been considered the best (Hasse, in press).

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Il a été admis que les disciplines de l'éducation supérieure peuvent être considérées comme des communautés de pratique. Cela pose la question de savoir comment se constituent les identités dans la culture académique. Dans cet article, pour mettre en évidence la transition de nouveau venu à participant à part entière dans une communauté de pratique de physiciens, j'examine non seulement la manière dont des identités émergent au travers des pratiques, mais aussi les aspects biographiques que les participants identifient comme ayant facilité leur transition. Une cohorte de 55 physiciens a été interviewée et leurs analyses ont été comparées à des données supplémentaires, notamment tirées d'une observation participante d'étudiants en physique. Les physiciens identifient souvent des expériences de leur enfance comme premiers pas vers leur identité professionnelle de physiciens. Ces expériences requièrent une pensée de type scientifique et une capacité à jouer liée avec les pratiques de la physique. Le processus de formation identitaire peut être décrit comme se développant dans une zone relationnelle de développement proximal, dans laquelle les aînés reconnaissent les qualités ludiques des nouveaux venus comme légitimant leur accès à l'identité de physicien. L'article discute la manière dont le jeu, que les physiciens associent à l'esprit scientifique, constitue une zone de développement proximal dans une communauté de pratique, comme «espace d'auteur» dans la culture des physiciens – laquelle peut par ailleurs dépasser d'autres différences culturelles.

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Current theme of research:

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