
‘Let’s Dance!’ Theorising Alternative Mathematical Practices in Early Childhood Teacher Education

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ABSTRACT In light of the contemporary discussions on the biased relationship between gender and mathematical teaching and learning in the Western world, can we, by means of a reconceptualised early childhood education, influence how young children construct their gendered subjectivities in relation to mathematics? This project has been carried out with the aim of challenging the taken-for-granted mathematical teaching discourse and to produce more creative, in-depth and gender-sensitive mathematical learning situations for student teachers and their subsequent students in early childhood teacher education practices. To exemplify such work, from a data collection of 75 student reports, this article investigates and analyses documentation collected from a maths project undertaken by an early childhood education student teacher. The poststructural and material feminist analysis performed shows that the material-discursive intra-actions taking place are conceivable to have both expected and unexpected gendered impacts on children’s ongoing subjectivity constructions. It also shows that it is difficult but possible to change taken-for-granted mathematical teaching practice as well as student teachers’ understandings of maths teaching.

Introduction

Why does it seem as though school mathematics is simply about following determined rules and procedures rather than using philosophical, artistic and bodily languages to achieve deep understanding? According to a recent governmental report, *To Enhance the Status of Mathematics*, written by the Swedish Delegation of Mathematics [1], most Swedes seem to think that the subject of mathematics is connected to a repetition of skills, the use of textbooks, teachers’ hieroglyphics on the blackboard, working silently and alone and doing homework based on a textbook (SOU 2004:97). This notion of doing maths is also present in early childhood teacher education (hereafter referred to as ECE). Before taking the compulsory maths course, very few student teachers seem to think that maths is something other than what can be referred to as ‘school mathematics’ and a more traditional textbook-oriented approach (e.g. Sinclair, 2004; Brown et al, 2004; Skovsmose, 2006). In my own survey of female early childhood teacher education students’ attitudes and notions about mathematics, the image of textbook-driven teaching and negative feelings was strikingly dominant (Palmer, 2010). In this article I will show how it is possible to challenge this everyday and taken-for-granted view of mathematics by using alternative teaching and learning discourses and paying specific attention to gender as a significant force in learning.

In our work as teacher educators, my colleagues and I have tried to dislodge and disturb the solid discourse of school mathematics that seems to have become firmly rooted in the population at large. The aim of this work has been to perform alternative ways of teaching that help students to understand maths in more creative and embodied ways and still follow the Swedish National Agency for Education’s guidelines (2006). In this article I refer to this thinking about maths as *an alternative in-depth understanding discourse*. This discourse challenges the instrumental use of textbooks and instead promotes a creative investigation that uses the body, alternative materials and artistic means of expression with the aim to do interdisciplinary work that goes beyond

science/art and mind/body binary divides (Palmer, 2009; Lenz Taguchi, 2010). It also challenges the dominant Western view that mathematics is simply 'brain-work', i.e. what can be understood as masculine, rational thinking; instead it points to the importance of working simultaneously with body *and* mind and to reach a deep understanding of mathematics by the use of bodily and creative expressions such as dance, music or drawing (e.g. Sinclair, 2004).

Aim, Data Collection and Outline of the Article

The aim of this article is to analyse one example – out of 75 student reports – in order to demonstrate how different discursive understandings of teaching practices, learning maths, gender and popular culture not only relate to, intersect and support each other, but also relate to the materiality of children's bodies, material objects and artefacts.

The example describes how a group of 6-year-old children, one boy and four girls, created a break-dance choreography using mathematical concepts. This example has been selected from a total of 75 reports from three different cohorts, all written by ECE students during a 10-week reconceptualised maths course. During this course the student teachers took part both in 'regular' maths teaching, in order to learn and practice basic mathematical ideas and concepts, and in investigational maths in smaller groups (Palmer, 2009). During a 5-week vocational training period the student teachers also planned, carried out, documented and analysed an investigational project of their own. Their learning processes from these three major sites of learning were weaved together into a written report containing pedagogical documentation, theoretical reflections and analysis (these writing processes are described in Lenz Taguchi, 2009, 2010).

The course is a part of a 1-year programme, 'Investigative Pedagogy – Dialogue Reggio Emilia', offered by Stockholm University.[2] The course literature represents the discourse of feminist poststructural pedagogy (Lather, 1991, 2007; Davies, 2000; Lenz Taguchi, 2005, 2006, 2007), the Swedish field of early mathematics (Doverborg & Pramling-Samuelsson, 1999; Ahlberg, 2000; Höines-Johnsen, 2000; Skolverket, 2000) and literature corresponding to the Reggio Emilia early childhood context (Project Zero and Reggio Children, 2001; Åberg & Lenz Taguchi, 2005; Dahlberg & Moss, 2005; Reggio Children, 2005; Dahlberg & Bloch, 2006; Rinaldi, 2006; Dahlberg et al, [1999] 2007).

The first part of the article contextualises the study by giving an overview of the Swedish political context of mathematics in order to provide a background to the example described. In subsequent sections I outline the dominant discursive context of mathematics education in Sweden and introduce my theoretical understanding of the constitution of mathematical and gendered subjectivity in relation to discourse and language (Butler, 1993, 1997, 1999, 2004) and to a material-discursive and agential realist approach where the concept of 'intra-activity' is central, a concept I will define in the theory section (Barad, 2007, 2008). The second part of the article illustrates the example of alternative maths, my analysis and a discussion.

The Political Context of the Study

Mathematics is a highly disputed item on the Swedish educational and political agenda. Students' mathematical performances are rated as relatively poor and general student interest in the subject is low (Skolverket, 2003; SOU 2004:97). In comparison with students in other Western countries, for example Finland, Swedish students do not perform well in mathematics (PISA, 2000). This has led to several swift measures implemented by the Swedish government with the aim of improving the level of performance. One proposal given by the Swedish Delegation of Mathematics, mentioned earlier, is to support research into attitudes towards maths in order to enrich the subject's image in society, particularly in the education sector (SOU 2004:97). Improving early childhood teacher training is another urgent priority, and since 2005 mathematics has been compulsory in ECE programmes.

The delegates of the Swedish Delegation of Mathematics declare in their state report (*To Enhance the Status of Mathematics*, mentioned in the Introduction), that instrumental work based on maths books must be challenged by 'aesthetic means of expression' and 'cooperative investigative approaches to learning' in order to widen children's understandings of maths (p. 172). They point

out that young children should have opportunities to work with elaborative, communicative and hands-on mathematics together with engaged teachers and thereby gain a deeper mathematical understanding.[3] The delegation describes mathematics as art; a beautiful and insightful subject that provides an aesthetic dimension to life in the same way as dance, music and other artistic expressions (p. 50). They also use words like 'creativity', 'beauty' and 'cultural heritage' to paint a picture of the fascinating art they consider mathematics to be (p. 131). This way of describing maths corresponds to what we have chosen to call the *alternative in-depth understanding discourse*, described above. In addition, the Swedish pre-school curriculum explicitly states that learning mathematics in pre-schools should be investigative and playful (Swedish National Agency for Education, 2006). The Swedish pre-school curriculum also relates to gender and states that teachers should work to prevent the formation of stereotyped gender roles and patterns among pre-school children.

Theory

Mathematics and Gender ...

The strong gender bias of mathematics in Western societies is of great importance in the field of ECE, in that 99% of the pre-school workforce consists of women (SOU 2004:125). As scholars like Walkerdine (1991, 1998), Ernest (2004), Mendick (2006) and de Freitas (2008) have clarified, in the Western world (defined here as Western Europe, the USA, Canada, New Zealand and Australia) mathematics is understood as a masculine subject and related to specifically male traits like rationality, objectiveness and logical thinking. The above-mentioned scholars have shown that females don't believe in their own ability to succeed in maths to the same extent as males.[4] My own survey confirmed that the understanding of oneself as mathematically competent and confident has little to do with actual performance and outcome but much with feelings of confidence and self-esteem, which are often connected to gendered notions and attitudes (Palmer, 2010). Our memories from school are weaved into subjectivities and produce power in relation to our life choices and self-understanding in relation to maths.

As Walkerdine (1998) has shown, girls are frequently understood by teachers as good 'rote-learners' who are willing to follow instrumental guides and rules, whereas boys are considered to be better at 'deep understanding' and problem solving. When it comes to mathematical performance, however, recent research shows that gender differences do not exist (Hyde et al, 2008). According to a large US study – including SAT results and maths scores from seven million students tested in accordance with the No Child Left Behind Act – boys and girls are equally good at maths (Hyde et al, 2008). The study shows that cultural beliefs and gendered attitudes, communicated by teachers and parents alike, are crucial when it comes to whether boys and girls regard themselves as 'maths smart' or not, and also affect their choice of career and higher education. According to Hyde et al's study, teachers' stereotypes about boys' and girls' respective mathematical performances are old-fashioned but still prevalent among teachers; hence a revision of these stereotypes seems mandatory. For example, Hyde et al's study shows that girls' success in mathematics is downgraded (by teachers) and thought of as rule-following, and that the image of the ideal pupil is still one of a boy who can reason and be inventive and creative. Hyde et al's investigation shows that cultural beliefs are incredibly influential; through encounters with educational practices boys and girls come to understand themselves as more or less mathematically oriented, gifted or skilled. Accordingly, we know that teachers' attitudes towards maths and the organisation of mathematical teaching practices have a significant impact on how children construct their gendered and mathematical subjectivities as learners in school (Walkerdine, 1998; Hyde et al, 2008).[5]

... and Material-Discursive Intra-actions

In line with Judith Butler's theory (1999), teachers', as well as children's, discursively informed thinking about learning and teaching mathematics *materialises performatively* into embodied practices of moving, talking and doing (Butler, 1999, p. 179). Just as children learn to pick up proper ways of performing female and male gender through discursive practices and subject positions

available to them, it's possible to understand how girls and boys constitute subjectivities in relation to maths.

The process of materialisation is, however, as the physicist and philosopher Karen Barad (2007) shows, a process where discourse and the material world mutually and agentially inter-connect and *intra-act*, which takes Butler's concept of materialisation a step further. The concept of intra-activity should not be confused with the modernist notion of *inter-activity* which often is used to describe interpersonal relations. Moreover, inter-activity refers to interaction between clearly separated objects or organisms, whereas intra-activity refers to interactivities between matter and organisms that, according to the laws of quantum physics that Barad draws from, are not understood to have clearly defined borders (2001, 2007, 2008). The notion of intra-activity turns our attention to the agency of the environments, things, materials and places in the ongoing interrelations and mutual processes of transformation taking place between human organisms and matter and between different matters irrespective of human intervention. This concept provides an understanding of how bodies and things mutually inter-connect in repetitive intra-active relations and affect learning and the production of knowledge. Following Barad, the discourse and the material are inter-dependent and are mutually caught up in the dynamics of intra-activity. Barad explains that:

Neither discursive practices nor materials are prior. Neither can be explained in terms of the other. Neither is reducible to the other. Neither has privileged status in determining the other. Neither is articulated or articulable in the absence of the other; matter and meaning are mutually articulated. (Barad, 2007, p. 152)

In Barad's thinking, discourses, (human) organisms and matter are all understood as *performative agents* (Barad, 2008). Hence, discourse intra-acts with the agency of all other bodies, materials and artefacts in the pedagogical spaces of early childhood and teacher education in the construction of learning and the learner. In Barad's understanding, the concept of materialisation is not only about discourses coming to matter, as we have learnt to understand the concept in Butler's thinking (1999), but also about matter coming to matter in the process of ongoing transformation and becoming a subject (Barad, 2001, p. 108). Knowledge (in this case mathematical knowledge) can consequently be understood as something that is produced through complex intra-actions of multiple material-discursive learning events (Lenz Taguchi, 2010).

To summarise how Barad develops Butler's concepts of performativity, it is possible to say that performative processes are not limited to repetitive acts and movements of the human body, but do also include the intra-activity between non-human material objects and the body. It can be understood as a mutual process of material-discursive intra-activity, where matter matters just as much as discourse (Barad, 2007, p. 392).

Methodology

My analysis is based on feminist poststructuralist discourse analysis (Burman & MacLure, 2005; Somekh & Lewin, 2005; Lather, 2007), with a special focus on material-discursive intra-actions (Barad, 2007, 2008) and how to understand this in relation to children's learning processes (Lenz Taguchi, 2010). A discourse, in this study, isn't understood as something that is said (as signifying system, grammars, speech acts or conversations) but rather, as specific practices that enable or define what can be said (Barad, 2008, p. 137). In this context discourses are, according to Barad and as already shown in the Theory section, understood as performative agents.

Working with *material-discursive interaction analysis* as a methodological strategy, based on Barad's agential realism, can be seen as an extension of a feminist poststructural discourse analysis. This strategy has facilitated the identification of dominant and resistance discourses and power play in the investigated project *as well as* material-discursive intra-actions. In the material-discursive interaction analyses I have focused on the intra-activity in-between the subjects, the discourses and the learning environments and materials (Barad, 2007, 2008). I have tried to rethink matter as activity rather than passive substance, and have read the data as 'flattened out' and non-hierarchical (Alaimo & Hekman, 2008, Lenz Taguchi, 2010). This means that I have included that which we understand as material and seen it as agential and power producing, for example: physical environments, teaching aids and the media, e.g. TV shows (e.g. Palmer, forthcoming).

The analysis performed for this article does not only facilitate the identification of material-discursive interactions and power play but also processes of subjectification. Here I rely on feminist poststructural theory (Davies & Gannon, 2005). Subjectification can be understood as the historically specific processes whereby one is subjected to the discursive regimes and regulatory frameworks through which gendered individuals and their social contexts are also, and through the same processes, constructed (Foucault, 1978; Butler, 1997). Through examining how discourses work and intersect, feminist poststructural analysis makes visible that power does not only force us into particular ways of being, but makes these ways of being desirable in ways that encourage us to adopt them as our own. For example (and as I will give examples of in the analysis), when discourses from popular culture powerfully intersect with gender discourses – in processes of subjectification – specific gendered and mathematical subjectivities are made available (and become desirable) for the children (Davies & Gannon, 2005, p. 318).

The analysis below is organised to follow the learning events taking place in the chronological order that Helen – the student teacher – has described them. It also includes an analysis of Helen's thinking and of her own analysis. My analysis focuses on the intra-activities taking place between discourses and materials, and on identifying how gender can be understood as a productive force in relation to different mathematical and popular culture discourses.

An Introduction to the Mathematical Dance Project 'Let's Dance!'

The chosen project to be analysed in this article was carried out in the school in which Helen did her vocational training. Helen had decided to be open to the children's own interests in popular culture and leisure pursuits, pick up what was 'going on' among the children and start a maths project about something that the children were engaged in. After only a few days she understood that the children in the class were very interested in break-dance and street music. They constantly talked about different 'moves', song titles such as *Bad Guy* and *My Girl* and break-dance performers called 'Rain' and 'Bang'. Subsequently, Helen decided to start a project about dance and maths. She was eager to investigate the relationship and inter-connections between bodily movements (dance) and mathematics, inspired by her own investigational processes with her fellow students in teacher education, which have been described and analysed elsewhere (Palmer, 2009).

Helen had prepared by studying different mathematical spheres in depth to be able to follow and challenge the children's explorative work. Foremost she studied the subject area of mathematical symbolic thinking and language, and about mathematical transferences from real situations to symbols, words and signs (Doverborg & Pramling-Samuelsson, 1999; Ahlberg, 2000; Höines-Johnsen, 2000; Skolverket, 2000). She also studied theories about how children invent and use mathematical patterns to understand mathematical structures and relations (Skolverket, 2000). Helen's learning objectives were to allow the children to investigate the connections between symbolic mathematical languages and dance and the body and to use pedagogical documentation as a tool that moved the project forward *and* clarified mathematical concepts and relations to the group of children. When Helen asked Lisa, Victor, Sara, Sofia and Maria if they wanted to work with her in this dance/maths project, and to create a dance choreography of their own, they all accepted.

The Project and the Analysis

When the group gathers for their first session they start with a discussion about what music they will use for the creation of the dance choreography. The children have brought a bunch of CDs. They listen to the music together and discuss the different tracks; they all push their favourite songs. They finally agree to decide on the music by voting. The children now show Helen how a voting process is carried out. They all know how to do this; they have seen it on the *Eurovision Song Contest*, *American Idol*, *Let's Dance* and on other TV shows. Maria keeps the record by drawing one stroke for each vote on a piece of paper. They all make their choices and – through Maria's hand – the votes are materialised as strokes in groups of five on the piece of paper, as they have learnt to do in their 'fill-in-books' in maths class.

Since the children already seem to be familiar with how a voting session is supposed to be carried out they do not discuss how to do this; instead they immediately start to talk and act in ways that they have seen on *American Idol* and the other TV shows. The TV programmes that inspire the children provide a particular way of carrying out a voting procedure and all the children performatively follow these unspoken but current rules. The media discourse and its regulations – together with the material objects at hand in this situation: the paper and the pen, the CD player and the CDs – can be identified as forceful agents already in this first session. The well-known *discourse of school mathematics* works in a similar way. The mathematical method that the children use for counting the votes is already familiar to the whole group, and since everyone knows this strategy (drawing strokes in groups of five) no alternatives seem to be available to them. The pencil and the piece of paper encourage – as performative agents – Maria and the other children in the group to give their votes, wait for their turn, sit still and look at Maria's hand scratching with the pen across the paper. Brian Massumi (2002) uses a football game to study how a collective is created around the ball and writes that 'the ball moves the player' (p. 72). Similarly, the pen in the voting session moves the children in specific ways. The pen, as well as dominant discourses from TV and school, encourage Maria to draw strokes on the paper, to have eye contact with the other children, to keep track of the strokes expanding as a mathematical pattern. Mathematical knowledge can here be understood as a result of something that emerges in the spaces in-between the material and the discursive; between Maria's hand, the pen and the paper on the side, and discursively informed thinking and social relations on the other (Lenz Taguchi, 2010).

The project moves on. The song *Black and White* wins. The children move on to a discussion about finding a proper name for the dance group. These are some of the proposals the children came up with:

- 'Four girls and only one boy'
- 'Victor and the four girls'
- 'The cool girls and the cool boy'

They decide on a name for the group by following the same voting procedure as before. 'The Cool Girls and the Cool Boy' is the winner and everyone seems happy with it. However, at this point new discourses can be identified. The difference between the boy and the girls suddenly appears to be more important than in the previous voting session; gender discourses seem to become increasingly more relevant for the production of power. All the suggestions of names for the dance group focus on Victor as the only boy. The performative effects of language are evident in this situation. The language that is used by the children is informed by gendered and media discourses as well as from mathematical thinking. When the children say 'Four girls and only one boy' the actual, material bodies of four girls and one boy intra-act with the words they use to describe their dance group. The children's utterances, informed by gender and media discourses, *and* the material circumstances (the actual bodies of four girls and one boy) together constitute the children's gendered subjectivities. This dynamic intra-activity produces 'four girls and only one boy' instead of just a group of children. With Judith Butler we can say that gender difference is materialised in the children's conversation and is performatively installed as a social and cultural practice (2004). Being a girl or a boy can be understood as an effect of the powerful intra-action between discourses, language and the materiality of the children's bodies (Barad, 2001, p. 109). In the next part of the project this becomes clearer.

The group now start to develop their choreography. All five children dance freely to the music. They count their steps, copy each other's moves, and repeat the sequences over and over again. Helen brings a digital camera. The children start to take photos of each other's dance moves; they move to the loud music and repeat the moves over and over again to get good pictures. They are getting warm, they laugh a lot and they have intense discussions, both with the person behind the camera and with the camera itself. The camera is not a passive instrument that is brought into the group. Instead it can be seen as an active material object – a performative agent – that makes new questions emerge in the intra-actions with the children (Barad, 2001). The camera doesn't simply map the children's bodily movements; it also maps intensity in the room, gender, affects, feelings, vision and touch – a myriad of sensibilities and intra-activities. The camera encourages the children to move and talk in specific ways, intrinsically informed by what is produced in the intersection between the gender and media discourses that the children bring with them to school.

Imitating videos seen on MTV, these discourses inform them how to stand and move as boy or girl. The children dance 'freely' to the music but at the same time they are governed by powerful gender discourses – the movements they 'choose' in their 'free' dance are performed in accordance with gendered images from MTV and TV shows. When the children 'hook up' with the camera and start to perform in front of the camera lens they all become part of a productive event. It is not possible to say where the camera 'ends' or where the children's bodies 'begin' – everything becomes fused together in this specific practice (Barad, 2001, p. 98). The performative production of the dance choreography can here be understood as a dynamic intra-activity between human and non-human performative agents (Barad, 2008): the camera, all the organisms that the children's bodies consists of, the light and temperature in the room, the rhythmic mathematical beat of the music, the smooth linoleum floor on which the children are dancing and so on.

Next day: With support of the computer and the laser printer it's easy to develop the digital pictures and to put them on the wall. Helen gathers the children in front of the wall and starts a discussion about the materialised, 'frozen' movements in the pictures. The children decide to organise the work by naming the different moves. These are the names they decide on:

- 'Twist, stand still, twist, wave and role; Victor's break-dance.'
- 'Everybody stands in a circle and does the "king's chair" with Victor.'
- 'The girls do the movements that we have decided on and Victor can do what he likes in the middle.'
- 'Victor is the king and two of us (the two stronger girls) lift him into the "king's chair"'

The girls and the boy repeat the moves they have seen on MTV and recognise them as typically girlish ('Twist, stand still, twist, wave and roll') or boyish ('Victor's break-dance').

The children's movements are now, with the support of technology, materialised as photos, which give the children the opportunity to revisit the event and to intra-act with the images (which here become important performative agents). The children study the photos on the wall carefully, compare the different moves, and have a lively discussion about whether the moves are suitable for boys or girls. Once again, it seems as if everything that is said and done in the group revolves around Victor as 'the only boy'. It's obvious that Victor is positioned, and positions himself, as different from the girls (Davies, 2000). As the documentation illustrates, the girls and the boy seem to work hard to fit in and act and talk in ways deemed appropriate in this specific context, for example when the girls tell Victor to stand in the middle or when they lift him into the 'king's chair'. They seem to actualise the twists and rolls they have seen on MTV, and in turn they construct, perform and iterate 'proper' gender as well as gendered subjectivities as cool 'break-dancers'. This process of gender production can be understood as an improvisation within a clearly limited field (Butler, 2004). When reading this documentation in the light of Butler's theories, the boy and the girls can be understood as two different gender categories produced within a binary frame; they are linguistically constructed as *different from each other* (Butler, 1999, p. 31). Moreover, this powerful relationship is an asymmetrical construction in which the boy and boyish movements are given a higher value than girlish actions. Still, the subordinated positions that are actively taken up by the girls nonetheless seem to be desirable and popular among the girls (Davies & Gannon, 2005, p. 318). This is even more apparent in the next section of the documentation.

Now and then the girls form a circle with their bodies and instruct Victor to dance in the middle, as they have seen break-dancers do on MTV. When Helen asks the girls whether one of them would like to change places with Victor, stand in the middle and be lifted into the king's chair, they all respond by saying: 'No! That would be odd! He is the only boy and therefore he must be in the middle!' It is certainly not easy for Helen to break with the dominant gender norms that inform the children in their dance creation. The intra-action between dominant gender discourses, the influential discourses of MTV and the bodily repetitions of movements provide positions as a girl or a boy (discursive as well as physical positions) that seem to be so attractive and desirable that the children come to see them as their own. There seem to be no alternatives available neither for the girls nor for the boy. At this point of the project Helen could have invited the children to revisit the documentation and to discuss the gendered codes from the media that obviously informed the group. However, Helen doesn't challenge the children at this point (which she later regrets). Still, she is preoccupied by the complex stereotyped gender relations apparent in the group, and writes in her report:

It appeared as though they almost revelled in the differences they experienced. To me it seemed very difficult to challenge the children to break with the discourses producing gendered norms in the sense that they always instantly tried to re-establish these differences.

Helen seems to wrestle with how to challenge the children to resist and displace discourses that produce gendered norms, but doesn't seem to know how to do this.

Bodily Movements and Graphical Signs Intra-act with Mathematical Concepts

In the following session Helen unrolls a large sheet of paper on the floor and invites the group to draw the choreography of the dance on it, assisted by the photos from their last session. The girls immediately start to draw images with thin ink pens, alternately looking at the photos and practising the moves while listening to *Black and White*. They draw detailed pictures of themselves in the different dance positions, with eyelashes, earrings, necklaces and different cool hairstyles. The girls work really hard on the documentation. They make drawings and write numbers beside each picture to remind them of how many times to do each twist or spin. Helen discusses every image carefully with the girls and then asks them if they can simplify the symbols and rationalise the work so that everything can be photocopied and multiplied. Lisa draws a circle with lines and says: 'This can be the symbol for the wheel and the splits'. Sofia says: 'Yes, and this can be the symbol for Victor's break-dance in the middle!' The choreography is now slowly transforming from photos and drawings into a symbolic language that the girls can 'read' from the paper on the floor while dancing through it. Each symbol can be seen as a materialisation of a bodily movement concretised as materialised images. Hundreds of photocopies with symbols are now spread out on the floor. The large-scale production of documentation has expanded rapidly in a flow of intense cooperative work. Helen and the girls sit on the floor in the middle of the 'sea' of documentation. The girls work really hard to find the symbols they need, to put them in order and to then reorganise them on a new sheet of paper.

A lot of things are happening at the same time now: the girls are drawing, listening to the music, counting their steps, negotiating the meaning of the symbols, having a discussion about the documentation with Helen. The girls' affective connections to music, drawing and working together in this investigative fashion are very powerful. Their bodies and discursive understandings (of maths, popular culture, etc.) are mutually entangled with the material: the photocopies on the floor and the sheets of paper. It is consequently possible to identify that the work follows *an in-depth understanding discourse* rather than a traditional school discourse. Hence, it is important to note that the girls in the project transgressed the taken-for-granted (Western) idea; the project succeeded in producing joyful, in-depth mathematical learning for the girls, which in itself challenges the taken-for-granted way of understanding mathematical learning in terms of gender (compare Hyde et al, 2008). The girls owned the project and pushed it forward in a forceful manner, their constitution of mathematical subjectivity going against common expectations, while being supported by material and social circumstances.[6]

What happened to Victor? It is fascinating that Victor, as the only boy in the group, withdraws from the group when the project shifts from dancing freely to the music to drawing, counting and writing. Helen writes in her report that 'he starts playing with gadgets in the corner of the room, crawls under a table and finally he sneaks into the janitor's room (next door) to chat with him'. She tries to motivate Victor to come back to the group and engage in the cooperative work again, but without success. One way of understanding this is to connect this observation to contemporary research on masculinity theory. Victor's performance can be analysed in the context of the 'anti-study culture' that exists among boys in Scandinavian and Western European schools (Epstein & Elwood, 1998; Drudy et al, 2005; Boaler, 2002). Victor's way of acting can also be connected to research about girls' and boys' respective performance in school. Victor's disappearance from the group created much consternation particularly on the part of Helen and one of the girls, Sofia. It's apparent that boys get a lot more attention than girls in maths education at all educational levels in Europe and the USA, in spite of the fact that girls achieve similar or higher grades than boys (Skolverket, 2003).[7]

Finally: The project finishes with a dance performance. All five children, including Victor, take part in it. Afterwards the girls tell the rest of the class about their work, show the

documentation and explain the meaning of the mathematical symbolic language they have created for the choreography. Helen also tells the class about what she has learnt. She explains that the girls' symbolic language can be understood as 'pre-algebra' (Skolverket, 2000). This is a new concept for the children but it isn't hard for them to understand when she shows them. Helen writes and draws with coloured pens on the white board, demonstrates dance moves and explains that algebra is the name of a mathematical language, just like the one the girls had invented, that can be used to create models of real-life situations. Instead of using words, algebra uses symbols or drawings to communicate with others. All the symbols drawn by the girls can be exchanged by, for example, X, Y or Z or other mathematical symbols, and thereby transformed to a more abstract level (Höines-Johnsen, 2000). This started an entirely new learning process that Helen didn't take part in since her vocational training period was completed.

Again, the documentation is used to make the event material and thus becomes an important performative agent in relation to the students in the class (Lenz Taguchi, 2010). This enables the children to understand the relationship between the movements and the symbols. Moreover, and as Watson (2005) also describes in her previous study, the symbolic language invented by the girls is used to communicate with the other students in the class (p. 21). The documentation and the dance performance encouraged the children in the class to have a discussion and to further explore the relations between bodily movements and symbols. By way of a summary, this project can be seen as an investigation of how the mutual relationship between the body, matter, gender and powerful discourses from popular culture and school affects explorative work with children, dance and mathematics and the constitution of gendered and mathematical subjectivity.

Discussion

This project is an example of an interdisciplinary work in mathematics that challenges traditional school work. It is an illustration of how children cooperatively produce mathematical knowledge using aesthetic means of expression and the body, in line with ideas put forward by the Swedish Delegation of Mathematics. However, the experiences from this project also show that it isn't always easy for teachers and student teachers to become aware of the powerful material-discursive intra-activities taking place in children's work and to understand gender as a productive force in relation to school discourses, learning and teaching discourses, and discourses of popular culture. In the next section I discuss the possibilities of using pedagogical documentation to better understand the norms that have the power to install us all, children as well as teachers, as recognisable gendered subjects and how we can we dis-install ourselves and hopefully allow alternative subjectivity constitutions in school.

A Pedagogical 'Teaching Methodology': using pedagogical documentation to understand pedagogical situations in alternative ways

In this kind of open-ended investigational project the work is developed step by step in often unpredictable ways. This requires that the teacher, or in this case the student teacher, makes decisions about how to move on and identifies which questions and subject matter should be given attention and how power works in the collaborations. The responsibility of the teacher is to pick up the children's ideas, questions and interests, introduce new material into the group work and – via the documentation – clarify mathematical ideas and relations and elucidate and interfere with the power production in the cooperative work. An important pedagogical 'teaching methodology' is to examine the pedagogical documentation more deeply and to confront situations and questions that arise during the learning processes. A starting point in this work is to consider and discuss evident questions seriously in an intellectually rigorous way, together with others during ECE or at schools and pre-schools. Sharing perspectives and investigating the micro-empirical questions that can be identified in the documentation might provide new insights about each and every situation, and might also open up new understandings about what to do next time or how to go back and re-create a situation from a completely new perspective (Project Zero and Reggio Children, 2001; Åberg & Lenz Taguchi, 2005; Dahlberg & Moss, 2005; Rinaldi, 2006; Lenz Taguchi, 2010). Pedagogical documentation will then be somewhat of a main character and take the lead role in

projects, as Lenz Taguchi has previously shown (2010). It is to be understood as a *performative agent* in itself and as such also a 'methodological' tool for learning and change in pedagogical practice.

The process of gathering the documentation and examining it together with others is important if we want to learn more about the work we have carried out and more about ourselves as teachers. 'Reading' the pedagogical documentation together with others can be seen as a *slowing down movement* (Lenz Taguchi, 2010). In a slowing down movement the work process is decelerated and allows us to re-enact the pedagogical documentation. In a slowing down movement we can create a space for reflection, discussion and consideration. Lenz Taguchi (2010) describes this movement as a possibility for the teacher (and the children) to 're-install themselves in the learning-event' and to understand what happened from a different perspective (p. 172). A slowing down movement is about temporarily 'freezing' situations so that we can go *into* the work again, relive the situation and understand it in alternative ways.

This, for example, would have been one way of enabling Helen to understand the different discourses of gender, power, masculinity, popular culture and mathematical learning at work in this specific project, and the intra-action between the children and the materials within the pedagogical space that was arranged for them. Importantly, as Lenz Taguchi writes (2010), the slowing down movement enables us to then be creative and inventive – a transformation she describes as a *speeding up movement*. A speeding up movement can be understood as a space that is free from taken-for-granted habits that can be identified when the work suddenly changes direction or moves into a completely new problem area. This movement might break with stereotyped gendered norms and help us plan the next step of the project.

In the case of the example I have presented here it is possible to re-install ourselves through the pedagogical documentation, different discourses, the camera or the ink pen, or relive the event from the perspective of the floor; i.e. to see the event from a completely different material angle and thereby understand how it could develop in a different direction. In such a process it will be easier to break with stereotypical gender norms, and to help us to go against related and taken-for-granted forms of power production. It will also be easier to plan our next steps as teachers carefully. For instance, a slowing down movement and a re-enactment of the pedagogical documentation might have allowed Helen to understand the dynamics of the project's micro-empirical situations, and to add new, alternative performative agents to the group. What would have happened if the group had been assigned completely different materials, or different music, or if the work had been moved into a new room or outdoors? We don't know which intra-activities might have emerged in the work then, and we don't know what discourses would have been activated when the work was to accelerate again – in a speeding up movement – together with these new performative agents. All we know is that the slowing down movement would have helped Helen to navigate the project in alternative directions and that new material-discursive intra-actions probably would have emerged in-between those new performative agents. This, in turn, would have affected the constitutions of (gendered) subjectivity and the social dynamics of the group, thereby interrupting the reproduction of gender norms.

Theoretical displacements like these may change the concrete pedagogical practices, the way we talk and act as teachers, how we work with gender issues, how we understand and interpret and use pedagogical documentation, how we choose to furnish our classrooms, and how we plan and evaluate mathematical learning projects (e.g. Palmer, 2010). The new co-members (the things and the environment) propose alternative options for the constitution of subjectivities, as a girl, boy, woman, or man, and new discursive understandings of how to plan, carry out and evaluate mathematical projects. This might also *change ourselves*, how we understand our own (gendered) subjectivity as teachers and student teachers in *specific contextual situations*, how we relate to the subject of mathematics, gender and popular culture, and how we think about the pedagogical work we perform.

To Conclude

In a time when mathematics is a subject matter in crisis, I would like to enhance the importance of getting involved in alternative teaching and learning discourses and to experiment with alternative learning strategies (SOU 2004:97). In the study presented here, an intra-active perspective has

equipped teacher educators, ECE students and children with new understandings of teaching and learning mathematics, and of the constitution and reconstitution of gender and subjectivity in relation to mathematics. It has also allowed us to consider power as dynamic relations – not only relations between humans but also in-between matter, things and the environment – that have effects on the production of bodies and subjectivities (Barad, 2007; Palmer, 2010, forthcoming). Perhaps most importantly it has changed our personal attitudes towards mathematics. If the desire to work with mathematics has been awakened here in Swedish ECE, I cannot see why this shouldn't be possible elsewhere. It is in this sense that I hope that this article will be a source of inspiration.

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I would like to thank my student, Helen, for inviting me to share her learning process during this fascinating project. Without you and the children, this article would not have been possible.

Notes

- [1] The report's main purpose was to suggest efforts and measures that would enhance interest in mathematics and improve the subject's image in the country, from pre-schools to universities. The commission called for a general overhaul of teaching methods (SOU 2004:97, pp. 5-17).
- [2] All the 120 students taking part in this programme between 2004 and 2007 were invited to participate in an ongoing research project on learning processes. They signed a document which gave the project permission to use all their written material, but allowed for the possibility of withdrawal during the year and up to 1 year after the conclusion of the programme. The students were guaranteed full anonymity and the opportunity to read the research analyses before publication. The project has been featured in several reports (Lenz Taguchi, 2005, 2006, 2007, 2009, 2010; Palmer, 2009, 2010, forthcoming).
- [3] This is similar to educational standards in several other countries; see, for example, the National Council of Teachers of Mathematics in the USA and their document *Principles and Standards for School Mathematics* (2007).
- [4] These observations are confirmed by the study of the Swedish GeMa group, 'Gender and Mathematics' (Brandell et al, 2005; Brandell & Staberg, 2008). The study investigated 1200 high school students' attitudes towards mathematics and concluded that female students do not believe in their own mathematical skills in the same way as male students do, even though they generally receive better grades.
- [5] Ethnicity, age, class, and religion are other important power-producing aspects that intersect with gender in pedagogical practices. In this article, however, I limit my analysis to gender.
- [6] An interesting parallel is Boaler's 4-year study from 2002 that shows that when girls in the age range of 13 to 16 years have an opportunity to work with investigative mathematics, they don't want to go back to procedural 'following steps' mathematics education (p. 136). The girls in her study talked about the quest for understanding maths in depth and said that they didn't want to go back to 'copying down endless formulas and procedures from chalk boards' (p. 138). The study was carried out with 300 girls in two secondary schools in England, which taught mathematics in completely different ways.
- [7] Other projects included in the data collection of 75 reports from the 1-year programme ('Investigative Pedagogy – Dialogue Reggio Emilia') indicate similar tendencies. Several students (15 out of 75) documented afterwards that they were surprised that they had given the participating boys so much attention, despite their attempts to be as gender neutral as possible. In more than 70% of the investigative projects described, the student teachers began their mathematical investigations starting with the boys' interests. This indicates that the taken-for-granted discourse that over-estimates boys' performances and gives them more attention (Walkerdine, 1998; Hyde et al, 2008), is strong and difficult to break.

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