

Chapter 7

“Significant Matter” in Sociomaterial Analysis of Educational Choices



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7.1 Gaining New Insights into Educational Choices

“Something happens when the human and the material aspects meet that is important to understand”, says physicist Karen Barad (1999, p. 2). Barad advocates including the physical, material reality when analysing phenomena that we normally tend to interpret as social and psychological. We term this a sociomaterial perspective (Løken and Serder 2018). In this chapter, we take up this perspective in order to better understand the reasons why three particular women chose to study STEM subjects, and consider the significance of *materiality* in their descriptions about their choices.

This study (which is taken from a more extensive qualitative study of atypical educational choices) explores how a sociomaterial perspective can provide a broader understanding of women’s educational choices in general – and atypical educational choices in particular. The work demonstrates how gender and materiality are woven together in ways that are not generally revealed in sociocultural research about gender and educational choices. The chapter provides a necessary perspective to the debate on the recruitment of women to physics/STEM through its assertion that sociomaterial gender perspectives provide new angles for understanding educational choices.¹

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Despite decades of strategies to even out gender differences men still dominate in many of the sciences, including physics (NOU 2012, p. 15). Many attempts to understand the stubbornness of the gender divide in science look either at exclusion mechanisms or at individual choices. Researchers frequently explain the gender imbalance by reinforcing gender-stereotyped differences in interests, or by blaming gendered attitudes in the sciences (Adolfsson et al. 2011; Björkholm 2010). Gendered attitudes and differences in interests are also often discussed as being inherent to society and culture (Regan and De Witt 2015). In this chapter, we argue that seeing the gendering of educational choices as something that is constructed by sociomaterial practices and experiences provides greater opportunities for insight into how to recruit girls to STEM subjects, and to physics in particular. This view posits materiality as constitutive of everyday life, inherently entangled with its social dimensions. As Barad (2003) relates, “matter matters” and this obliges us as education researchers to consider the effects of materiality alongside considerations of language, discourse and culture.

When we examine educational choices as being situated, sociomaterial practices, we include people’s relations to materiality in order to better understand *how* their interests and choices are formed. Sociomaterial approaches emphasise relationships that are established between human and *non*-human actors (Serder 2015). In physics, (one of the subjects of focus in this chapter) matter is inextricably linked to the subject both in practice and on a symbolic level. Not only is matter the research object of physics, physicists are symbolically bound to matter by its materials and artefacts: Atoms and sound are examples of materiality, but also physicists’ laboratories, clothes and bodies. It is therefore natural to point to an interest in materiality as a potential reason for choosing a physics education. By stressing the importance of materiality, and of the interaction between human and non-human actors, these sociomaterial perspectives must be examined as a contributing factor when someone chooses their educational path.

In this chapter, we extend the argument to include materiality in the examination of psychosocial and sociocultural processes to interpretations of gender as developed in the field of Science and Technology Studies (Asberg and Lykke 2010; Fox et al. 2006; Lie 2003; Wajcman 2007). We highlight this connection to argue that analyses that emphasise the influence of sociomateriality on educational choices can generate new perspectives on the recruitment and inclusion of women in physics. In this chapter, we develop this argument by discussing empirical examples from three narratives taken from a larger qualitative study into women’s atypical educational choices in Norway (Løken 2017). From close readings of these women’s stories we developed the following questions: Which experiences and socio-material practices do these women deem to be relevant when deciding on an education? How does an atypical educational choice begin to take shape, and of what significance is gender in this process? For context on the importance of adopting a sociomaterial gender perspective on educational choices, we begin by examining recent research into educational choices in Norway and similar Nordic countries.

7.2 Interests, Identity and Gender

Studies about educational choices carried out in Norway and in comparable Nordic nations often identify one’s personal interest in a subject as a significant factor (Jensen and Henriksen 2015) in one’s educational choices. Personal interest as a driving force in educational choice is reflected visually in recruitment campaigns, in the rhetoric used in information materials, and is evident in education policies. Indeed, one’s choice of study in education can be said to represent one of the most dominant narratives in the discourse concerning educational choices (e.g. Bøe 2012; Løken 2015; Sinnes and Løken 2014). Additional research surveying recruitment to the sciences has found that personal interest, choice, and participation in the sciences are also closely linked to identity construction and socioeconomic background (Hazari et al. 2010; Holmegaard et al. 2014; Schreiner and Sjøberg 2007).

In Norway and other Nordic countries research demonstrates that girls more often choose career tracks related to biology or medicine, rather than to technology or physics – because (or partly because) these choices are more in line with their desired identities (Schreiner and Sjøberg 2007). Recruitment campaigns and products are designed with explicit connotations to femininity with a view to “selling” the message or product to women (Lagesen 2005; Lie 2003). However, a systematic review of the effects of management tools on influencing educational choices has concluded that it is difficult to isolate measures that boost the proportion of women in the sciences (Damvad 2015, 2016). The literature on educational choices includes research results that suggest girls feel alienated by the sciences, but also that such notions can be challenged (Løken 2015). Young women admit to many of the stereotypes that exist in the field, but also contest these in the narratives they provided for this study on their educational choices (Henriksen, Dillon and Ryder 2015; Løken 2015). As gendered recruitment campaigns appear to have a limited effect in terms of changing practices and opinions, we read our study participants’ responses as a persuasive argument for exploring new perspectives on educational choice. Could there not be other ways of thinking about how a choice of education is shaped and gendered that could researchers with a deeper understanding of subject interest and identity construction? In this chapter, rather than try to find explanations for educational choices, we seek to deepen the understanding of how personal interests are constituted in sociomaterial practices.

The dominant perspective in the field of didactic research is the sociocultural perspective which is primarily about the interaction *between* human beings, and artefacts are primarily viewed as mediating instruments and not as active agents (Lenz Taguchi 2012). As mentioned earlier, the sociomaterial stance stresses that there is more to these interactions than mediation. In the next section we will provide a more detailed account of how a sociomaterial perspective can be used to identify experiences and practices that are relevant to the educational choices we make.

7.3 Educational Choices as Sociomaterial, Situated Practices

In post-humanist theory (e.g. Alaimo and Hekman 2008; Barad 2007; Solbrække 2011) materiality is used as an umbrella term for non-human actors. In short, it includes anything from technology, machines, artefacts, animals, texts and objects, or bodies and natural phenomena. Human actions are seen as mutually dependent on the material and social contexts in which they take place (Lenz Taguchi 2012), or as Tobias Roehl (2012) states: “Human actors and material objects are closely interwoven and transform each other in socio-material practice” (p. 110). To explain why educational choice can be identified as a sociomaterial practice it is relevant to study which material and human elements appear in individual stories about educational choices.

The significance of the material aspect to social life should not be taken to mean that “things” have agency in the sense of intention, but that the interweaving of the human being and the material object “does something” which in combination becomes something more than just the sum of the two. In sociocultural theory, objects, often referred to as artefacts, are seen as tools for human action. The sociomaterial approach instead emphasises how the presence of things and their availability determine what we can do – and how (Pickering 1995). According to Pickering (1995) human actions are the effects of the human and non-human actors’ constant resistance and accommodation to each other, and to the sociomaterial conditions surrounding them. “Things” and “practices” can therefore be considered two sides of the same coin. Barad describes the output from the encounter with materiality as *intra-action*, and in this intra-action agency appears. Building on the works of Judith Butler, Michel Foucault, Bruno Latour and Donna Haraway (Hekman 2010), Barad writes that “*agential intra-actions are specific causal material enactments that may or may not involve humans*”, and that “*the world is intra-activity in its differential mattering*” (Barad 2003, p. 817). A sociomaterial approach directs the attention to what emerges from the encounter, the relationship entangling the human and non-human. We could therefore envisage a choice of education as an effect of such interweaving.

According to Ninni Sandvik (2015) the post-humanist question about which social and material relations link up to spark an action is an empirical one. A post-humanist, sociomaterial approach to empirical material challenges the way we understand actions, such as choosing an education. This does not necessarily mean that (all) relations are equal but that “it is not entirely clear who and what initiates, controls, prevents and is of significance” (2015, p. 52). Sandvik also suggests that neither is it clear “how the events occur or with which force the actors’ agents for action negotiate for influence” (p. 52). Having acknowledged this, we will use a sociomaterial approach to examine *how* material experiences and practices have an impact on educational choices.

When one shifts from a sociocultural perspective to a sociomaterial perspective our understanding of the role of gender in educational choice changes. In both approaches gender is viewed as a practice and not as a distribution pattern of

characteristics, a background variable or a biological or identity category. As Donna Haraway (2004) relates: “Gender is a verb. Not a noun. Gender is always about the production of subjects in relation to other subjects, and in relation to artifacts” (p. 329). In other words, gender is seen as something which involves *doing* and which is produced through relationships with the social and material world. In the following section, we use examples from our participants’ narratives to demonstrate how gender gains agency in the sociomaterial experiences and practices referred to in their stories. We suggest that happens as participants constructed their identities and develop subject interests. This strategy offers a more nuanced view of the relationship between educational choice and gender, which in turn affects how we think about the recruitment of women and their inclusion in the sciences.

This research suggests that a sociomaterial perspective on educational choices recognizes the ways material experiences and practices construct or form *part* of Norwegian women’s educational choices. The analysis of the empirical material does not seek to interpret descriptions of material experiences and practices as representations or expressions of subjective interests. Rather the point is to use intra-action as an analytical tool to investigate what is being produced by these experiences and practices. Thus, we are able to elaborate on the open empirical questions we formulated at the beginning of this chapter about: the ways an atypical educational choice takes shape; which experiences and practices are seen as relevant; and the significance of gender as a starting point for the analysis.

7.4 Narrative Analysis of Stories about Educational Choices as Material Practices and Experiences

Narrative analysis is an interpretive, hermeneutic methodology based on a review of qualitative data (Dauite and Lightfoot 2004). The empirical material that forms the basis for the analysis in this chapter is comprised of texts that describe Norwegian women’s personal stories about their educational choices. The stories were collected over a three-year period (2009–2012) by the first author of this chapter (Løken 2017). The accounts were written in 2009 by 17 girls aged between 18 and 22 who entered higher education science programs with few female students, in the autumn of 2008 or 2009. The participants were all in the same age group and shared certain social patterns typical of their generation (Almås 1997). The informants were recruited through an open invitation. The invitation to participate in the study was published on a website, and the link was sent to Norwegian universities and university colleges where women were under-represented in science programmes. The young women were asked about: what or who inspired them to choose STEM; whether particular experiences, persons or other factors influenced their choice; how they felt about being one of just a few girls in their chosen study program; what they expected from their time as a student; their thoughts on future job and career prospects, etc. The website also contained information about the study’s selection

and participation criteria, information about how their stories would be used, and details concerning consent and anonymity. The researchers consciously opted to take what the informants had written at face value and did not conduct further investigations into the girls' backgrounds and social lives. The point was to study the factors that the informants themselves chose to present as being relevant to their educational choices.

A follow-up interview with the informants was carried out via email in 2011 and 2012. In the two follow-up interviews the participants were asked to reflect on stories about girls in the sciences, about whether recruitment drives such as bonus admission credits for girls have had any impact, about whether their expectations and study plans had changed, and about any advice they would give to young women wanting to study the same subject. The women were also asked why they think so few girls choose to study STEM subjects, about their take on gendered subject interests and educational choices, whether they would have chosen differently had they been born a boy, and more generally, their experiences as young women in a male-dominated academic environment.

The 17 submitted texts (130 pages) and transcriptions of the follow-up interviews were uploaded to the data analysis programme NVivo to structure and categorise the content. Examples of categories included: interests, identity, experiences and expectations. These categories provided a starting point for our theme-centred analyses of the empirical material as a whole (Thagaard 1998). All mentions of "material experiences," such as references to objects, sensations/emotions and relations to the non-human world, were thematised in the narratives. That very category formed the basis for the selection of the three stories used in the empirical analysis in this chapter.

Based on our interpretations of the material experiences in the preliminary analysis, we created condensed portraits of three stories. This reduction was an analytical strategy that helped elucidate and illustrate key aspects relevant to the problem posed in the chapter. Names and places cited in the excerpts were changed to ensure anonymity. We used excerpts from the accounts of Violet and Mia, who both studied physics at Norwegian higher education institutions, and also from Mona, who studied technical cybernetics at the university. Each account, in its own way, describes their educational choices as sociomaterial practices.

The analysis presented in this chapter examines the tension between a deconstructionist framework (in which the human being is seen to be positioned in and through competing discourses on the one hand) and a humanistic framework (in which the being's integrity is considered both the start and end point for the analysis). The deconstructionist framework allowed us to critique the idea of meaning as rational and straightforward. At the same time we strove to maintain a close eye on the significance of the material aspect in the analyses without giving preference to either the human subject or the material objects. The analysis of the three narratives did not allow for generalisation on statistical grounds. The point was, rather, to ascertain whether the interpretations we made could add more nuanced meaning to previous knowledge of young women's atypical educational choices, thus giving the reader new knowledge and insight.

7.5 Objectification and Embodiment in Narratives about Educational Choices

In the following analysis we look at the informants’ observations about issues that often play a part in the recruitment of girls to the sciences: past experiences of science and of affectivity, technology in childhood, special treatment and school experiences – and we demonstrate how we interpret these themes using a sociomaterial approach.

The Sciences and Affectivity The sociomaterial approach to our data suggested that rather than look at past experiences of science or the conditioning of the informants’ interest in science, we could interpret such experiences as sociomaterial *intra-actions*: experiences that could be linked to material and bodily aspects. While “interest” could be observed analytically through self-reports in questionnaires or interviews with informants and be reported as a thing in itself (“an interest”), the challenge for us became how to grasp signs of intra-actions, and how to understand what they had changed. Interest, in this analysis, was understood to be a transformation due to non-human (or sometimes human) agency.

In their responses, the informants suggested that playing with objects, building things, and solving tasks were an important factor that drove their interest in science. For example, Mia “couldn’t get enough maths exercises in primary school,” and described herself as someone who “loved playing with Lego, building things by following the manual, building playhouses and playing with toy cars.” When we interpreted Mia’s story in a sociomaterial perspective, the significance of materiality became conspicuous. Mia described how the challenges she confronted as a child constituted a significant part of the objectified experiences that she linked to her later choice of education. These challenges and their achievements, in turn, resulted in a sensation of excitement that she still remembered: “Especially as a child, it is very exciting to be set new challenges as a result of having achieved something,” she wrote, also referring to how important it was to be set “additional exercises and extra material to work with.” If, through a sociomaterial lens, we see objects as having agency, we can understand these experiences as moments where these materials and tasks moved something *within* Mia. Not only did she enjoy interacting with them, but they acted upon, and in some sense, changed her. This is why we interpreted this experience as an intra-action. In another example, Violet, responding to a question about an experience that motivated her educational choice, recalled a school trip in which the students were to build and launch a rocket.

Violet suggested that her experience of building a rocket launch on the school trip was a key factor in her motivation to study physics. It is not hard to imagine the thrill she experienced in this event—in being invited to connect with space itself. Taking this perspective in the analysis opened up the notion that the rocket, the space – or the place where this launch was taking place, changed Violet. Not only did she interact with the material while building the rocket, but the material world acted upon her. Do we know this for sure? No. Just as we cannot be certain about

how the social or the cultural shape actions, we cannot know how the material informs them. However, to draw on Barad (2003), we cannot deny that “matter matters.” In this analysis we suggest, therefore, that Violet’s building of the rocket to launch was an experience wherein non-humans shaped humans, as an intra-action. The scientific artefacts’ encounter with Violet sowed a seed that later informed her choice to study science.

When Mia and Violet described the factors that made them take an early interest in science, they spoke of their emotional experiences with material content. While an analysis from a sociocultural perspective would have stressed signs of (human) socialisation and enculturation in Mia’s story, our sociomaterial approach instead focused on the agency of non-humans (e.g. the Lego bricks). A sociocultural analysis of our data would have put human interaction with the objects in the fore and focus, for instance, on the ways a child mimicks adults’ actions in their interaction with these objects. However, if we interpret the Lego bricks as something that the informant forged important sociomaterial connections with (instead of, for example, attributing her interest in them to her parents’ intentions and/or socioeconomic background) we can understand that the exposure to the material itself was an important experience for her.

Using the two examples from Mia’s and Violet’s stories about their educational choices, we have argued that the Lego bricks and rocket equipment had agency in the sense that they helped forged connections between the material and the human subject, and that these interactions were important enough to be mentioned in their women’s narratives. A didactic consequence of these events suggests that such connections could be encouraged by exposing girls to material objects in different educational settings. While girls’ educational choices are traditionally understood to be a consequence of their socioeconomic status, acknowledging the significance of affording them with material experiences can help researchers and policy makers move past an impossible problem: that schools cannot change their students’ socioeconomic status.

7.6 Technology in Childhood

Technology is often defined as a masculine subject in literature, where the feminine and the masculine are pitted against each other (Lie 2003). To resolve this problem, technology is often reconstructed in feminine ways in order to encourage women to feel at home with the subject (Lie 2003.). These perspectives can also be found in the literature addressing so-called “girl-friendly” initiatives (Sinnes and Løken 2014). Donna Haraway (1991) challenges this viewpoint, stressing how technology has become an important part of our lives. By examining how the human subject intra-acts with technologies, we therefore also need to deconstruct the link between technology and masculinity. By looking at how materiality is given agency in our informants narratives, we can understand the subject matter as part of the subject’s

lived experience without cultural dichotomies dictating how gender plays a part in the educational choice.

The next example details Mona’s material experiences with technology. Mona grew up in an industrial town and attended the company crèche of the biggest local employer. Here, she often heard about the rocket-making factory: “Big influences have been the place I grew up and my family. Where I come from there are a lot of civil engineers working for the big tech companies [...] These businesses specialise in weapons systems, marine technology, defence technology, offshore technology, gas turbines, car parts, oil and gas and aviation [...] And these companies are highly noticeable in the local community since they sponsor sports clubs, arts projects and events, and they donate technology aids to schools and hold various family days, open days and school trips where you get to see what they do. Through the years I’ve been on many such days, and since several members of my family work for some of these companies, I’ve got an insight into the technologies they develop. That has always interested me [...] I have also had the opportunity to work in several of the companies. This has only been part-time jobs.” These experiences gave Mona a “...positive impression of those who work there, the social environment and what they work with.” From a sociomaterial approach, Mona’s experiences can be viewed as an example of intra-action between the human and material – her play with technology and the practical experiences that the local employer represented. Her story excerpts reveal material experiences and practices that have been present since her childhood. Seeing, hearing about and experiencing a highly technological world filled with material artifacts captured Mona’s imagination. Remembering these objects and the excitement they offered remain with her.

What can we glean from this memory? We suggest that Mona’s material experiences tell us something about the importance of being a participating actor in an environment that has an expansive technological repertoire. However, the different technologies she described require knowledge of how to use them. Technology is, therefore, a combination of objects, practice and knowledge that Mona encountered in various settings throughout her childhood. The narrative demonstrated how the technology she grew up with contributed to her identity construction and influenced her decision to study technology.

7.7 From the Significant Other to Significant Matter

In the study, the informants described themselves as being free, independent decision-makers who ultimately act in accordance with their subject interests and aspirations. By “degendering” their bodies, presenting them as gender-neutral in their descriptions, distancing themselves from symbols and identity markers associated with the female and feminine, describing themselves as “tomboys” who have “always” been interested in science they took control of their bodies so that being/having a female body did not come into conflict with their educational choices. In these responses we see these young women distancing themselves from cultural

conceptions of womanhood by rejecting feminine norms and values and by choosing an educational path that demonstrates more traditionally masculine ideals. In this way, we suggest, they create opportunities for practising gender outside stereotypical gender discourses. We assert that, even though the informants identified opportunities and limitations that directed their choices, they were deeply rooted in the material world. In the final section we highlight some implications of using a sociomaterial, theoretical approach when examining educational choice based on the insights we have gained through our analyses. But first, a few more reflections on how material experiences and practices have an impact on educational choices.

To aid in our empirical analysis, we asked the informants questions about how material experiences and practices intra-act, and about how body and gender represent materiality in their educational choices. To arrive at our study's conclusion, we have studied narratives about educational choices to identify what is given agency in the narratives. By interpreting stories of Norwegian women who have opted to study science in a male-dominated field, we have argued that a sociomaterial perspective (following Barad's (2007) concept of intra-action) can be used to understand how material experiences and practices may influence educational choices. We suggest that it may be useful to pursue this approach in order to gain a broader understanding of gendered educational choices. It might also be useful to analyse other kinds of data about women's educational choices from this analytical point of view. In a sociomaterial perspective gender does not serve as a cause but is negotiated as part of one's educational choice.

Rather than dismiss educational choices as the result of an intentional choice according to interests or cognitive, rational processes and a consequence of socioeconomic background, we have also shown that material forms of agency come into play when women who have chosen a science in which they are a minority tell their stories. Our interpretations of the stories about their choices reveal how embodied, sensory experiences and intra-actions with concrete things are understood as key components in the formation of the decision to study science: in Mia's case her experiences with building blocks and construction games in childhood were key, while Violet pointed to factbooks and films as important artefacts in the story about her choice, in addition to recounting her material experiences of rocket-building and launching. In Mona's narrative her encounter with technology in the local community came to have a major impact on her interests and choices. From these stories we see that the things that surround us, the experiences we have with them, and our bodily situation in the world critically inform our interests, aspirations, and educational choices.

In a sociomaterial approach, the human species is not considered to be superior to other subjects, nor is it believed to be the only subject endowed with agency. This means that the material object has a natural and equal place on par with the human subject in analyses of complex, social processes and practices – such as educational choices. According to Lenz Taguchi (2012), a sociomaterial approach to learning enables us to create a language that better describes the significance of the material

aspect, because this approach involves utilising differences, diversity and complexity in relation to learning. We believe that this is valuable knowledge when it comes to studying educational choices. It means that learning – such as choosing an education – becomes a bodily and material question along the same lines as questions about thinking and cognition based on language and discourse (Lenz Taguchi 2012).

Estrid Sørensen (2009) argues that in education research there “is a blindness toward the question of how educational practice is affected by materials” (p. 2). We believe the same can be said about our understanding of educational choices as a sociomaterial practice. These are perspectives that challenge the ideas about the consequences of material forms of agency (Barad 1998). In a discourse about educational choices this can be taken to mean that the material objects we surround ourselves with form part of those choices – and that the subject is undergoing a continual, constitutive process (Braidotti 1994). Thus the informants’ continual identity construction is closely interwoven with the materials in their surroundings— what we identify as “significant matter” in the stories about educational choice. Existing research has long identified “the significant other,” such as a teacher, family member or peer, and shown how they can all exert influence over educational choices (Danielsson 2013; Sjaastad 2011). In this chapter we have demonstrated how material experiences and practices also impact educational choice, and suggest that this non-human and material aspect, the “significant matter” must also be accounted for in further studies on educational choices.

7.8 Educational Choices as Sociomaterial Intra-Actions

This chapter can be read as an argument for the interpretation of educational choice as a sociomaterial intra-action (Barad 2007). This analysis both challenges and supplements the more traditional sociocultural approaches to choosing an education in which the decision is seen primarily as an individual choice based on interests formed by the social environment. The key difference between the sociocultural and sociomaterial approaches is how the human subject is understood and positioned. As we have shown, a sociomaterial analysis implies that the human subject is no longer at the centre of the analysis (Løken and Serder 2018). We conclude with the assertion that “significant matter” must be included when analysing educational choices on a level footing with “the significant other.” And if we want to influence women’s educational choices through different forms of practice such as recruitment drives, teaching practices and careers advice/guidance, we would do well to explore how material practices and experiences impact individual choices. Or, using post-humanist terminology, we must acknowledge that the material object “kicks back” (Løken and Oyselbø Sørensen 2018) in studies on educational choices, in teaching, and in initiatives aimed at recruiting more girls to the sciences.

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