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## **Spotting the Science Culture - Integrating Gender Perspectives into Science Courses**

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### **ABSTRACT**

Teaching about gender theories as well as highlighting science as culture has been integrated into science courses within teacher education programs (early childhood education to lower secondary) in Sweden, in order to increase the understanding of what may contribute to the emergence of students' negative attitudes towards science and to the attitude differences between girls and boys. The underlying feminist starting point was the theoretical assumption that such an expansion of the ordinary course content may lead to prospective teachers working with natural sciences in new ways. Thus, gender theories and analyses, critiques from feminist science philosophers, the use of cases and reflection tasks, and mandatory written assignments are some of the additions to the courses, along with the ordinary concepts and phenomena-oriented content. The students were urged to assume a position where they examined the subject and the activities they took part in from an external perspective while studying the subject. This case study discusses experiences from the project and illustrates what a widened critical perspective can bring to higher education. The practical implementation is described and exemplified. Finally, some conclusions and implications for teacher education are presented.

### **KEYWORDS**

culture of science; gender; teacher education; integrating gender perspectives

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## **Spotting the Science Culture - Integrating Gender Perspectives into Science Courses**

### **INTRODUCTION**

This case study describes experiences from a research and intervention project within teacher education programmes at two universities in Sweden, where gender issues and a problematizing of science as culture were integrated into natural science courses. The underlying idea behind this expansion of the ordinary science course content is that making the culture of natural sciences visible, while at the same time teaching its contents, may provide students with wider perspectives and theoretical tools that help them understand important aspects of different emerging attitudes towards science and technology. We will briefly describe the motives and theoretical underpinnings of this study and then detail how we proceeded in practice, illustrating this with a few examples. Finally, we also present some conclusions.

We have followed a cohort of approximately 120 pre-service teachers (early childhood education to lower secondary) from two universities in Sweden. The project was conducted during two semesters of distance learning when students first study natural sciences in their education programmes. In Sweden teacher education (early years to lower secondary) includes compulsory science courses, which means that all pre-service teachers to some extent receive instruction in science. The proportion may vary, but at the time of the implementation of the project a minimum of 30 credits science courses (corresponding to 20 weeks full-time studies) were mandatory. In addition, there were opportunities to read additional science within an educational block of optional courses, or to choose to have a specialization of the whole teacher education with a focus on science. Students who chose such a specialization read a total of at least 90 credits of science. Recently, the teacher education programmes in Sweden have been reformed which has resulted in limited optional choices, but mandatory science courses are still included for preschool and primary school teacher students.

Within the actual group of pre-service teachers, composed of a majority of female students, negative attitudes towards science subjects are quite common, as are negative experiences from their own schooling (Appleton, 2006; Fler, 2009; Sundberg & Ottander, 2009). Furthermore, many of them attest to feelings of stupidity connected to teaching in these subjects (Andersson, 2011). Previous studies have shown that teachers with negative experiences in science and technology avoid teaching these topics (Appleton, 2006), and when they are forced to teach such topics, their negative experiences or low self-confidence affects their students' learning. Whether a child's learning will be stimulated or inhibited is influenced by teachers' attitudes towards a subject but also by teachers' beliefs about a child's 'ability' to develop skills in that specific subject area (Andersson, 2010). For education students to avoid consciously or unconsciously transferring negative attitudes to pupils in their future profession, they need an opportunity to scrutinize, reflect on and try to understand the cause of their potential negative feelings.

This project has its starting point in the feminist assumption that knowledge of natural science culture and power structures and of how women historically have been marginalized in this area may, together with gender theories, lead to prospective teachers working with natural sciences in new ways. We have been inspired by, for example, Jill C. Sible, Dayna E. Wilhelm, and Muriel Lederman (2006) who, in their study, integrated feminist perspectives into a course in cellular and molecular biology. The researchers found that the increased knowledge of cultural aspects favourably affected the acquisition of knowledge and subject contents, and that the female students especially performed better when compared to performances in a traditionally conducted course.

### **CONSTITUTION OF GENDER AT DIFFERENT LEVELS IN SOCIETY**

As an integral part of the science courses, our intervention introduced critical perspectives on gender and science as related to the culture of science and a feminist critique of the sciences. We wanted the students to observe the culture of natural sciences and the ways in which the historical gender codings of the subjects are visible today; we wanted them to assume a position so as to examine the subject and the activities they took part in from an external perspective, at the same time as they studied the subject. Through the course literature and teaching, they were introduced to and applied the gender theories of Sandra Harding and Yvonne Hirdman (Harding, 1986; Hirdman, 1990). The choice of gender theories was determined on the basis of competences which are important in terms of the students' future professional roles. According to Harding's and Hirdman's theories, gender is constituted at different levels in society – on a symbolic, a structural, and an individual level. For example, the symbolic values attributed to different science subjects give rise to different statuses, thus contributing to a hierarchical order, of which gender is an integral part. The more a subject is associated with rationality, logic, objectivity, 'pure thinking' and mathematics, the higher its status and the more it is perceived as masculine. A teacher must be able to reflect on different levels, see structures and understand what it means to be a girl or a boy in the various contexts that exist in parallel within the school environment. For example, there is much research that just adopts an individual perspective on the performances and the abilities of students to succeed in a subject, where their difficulties in assimilating a subject's content are viewed as problems on the individual level. One problem with science education research, dominated by this constructivist perspective, is that it does not take the culture of science education into account (Fleer, 2009; Jane, 2006). We believe that when the individual perspective is allowed to dominate as a model of explaining the actions and performances of students as well as the (re-)actions of teachers, individual factors become a smoke screen that prevents factors that exist on a structural or symbolic level – for example, factors related to gender – from being observed.

### **AIMS**

The aim of integrating gender perspectives and problematizing the science culture was to increase student "teachers'" awareness about subject-related gender issues; for example, how ideas and images of science may influence their own and their future pupils' emotional experiences in science. A recent published study in

*Science* by Sarah-Jane Leslie, Andrei Cimpian, Meredith Meyer, and Edward Freeland (2015) illustrates the potential importance in a longer term of such a widening of ordinary course content. In a large-scale, US nationwide study of academics from 30 disciplines they found that women are underrepresented in fields whose practitioners believe that raw, innate talent is the main requirement for success, because women are stereotyped as not possessing such talent (Leslie et al. 2015).

The purpose of this paper is to illustrate what a widened critical perspective can bring to higher education, where *widened* in this context means going beyond the limits usually restricting what can be considered as part of science courses.

### **EMPIRICAL DATA AND ANALYSIS**

The project consists of two phases, - the first phase being the intervention where also the majority of the data collection took place. The next section describes and exemplifies this intervention, which is the main objective of the present text. The second phase of the project consisted of analysis of the collected empirical data and interpretation of the results.

The empirical material consists of students' assignments and written reflections during teaching sessions, audio-recorded group discussions totalling approximately 10 hours, and field notes from seminars. We have used Braun & Clarke's thematic analysis (2006) as a fundamental analytical tool and the software package QSR NVivo 9 to tag, mark and group the material in nodes, categories and themes. The empirically driven coding provided an overview of the extensive material and served as the foundation for next rounds of more focused and theoretically guided analysis. Finally, in-depth thematic analyses of different emerging strands were conducted drawing on, inter alia, Edward Relph's (1976) concepts of insiderness and outsiderness, and Cathrine Hasse's and Stine Trentemøller's (2009) method of culture contrast. The analysis is still ongoing, and so far some of the outcomes are reported in submitted articles (Danielsson, et al., 2014; Gullberg et al., 2014).

### **INTEGRATED ELEMENTS**

An overview of different teaching elements and mandatory assignments integrated into the science courses during two semesters is given in Figure 1.

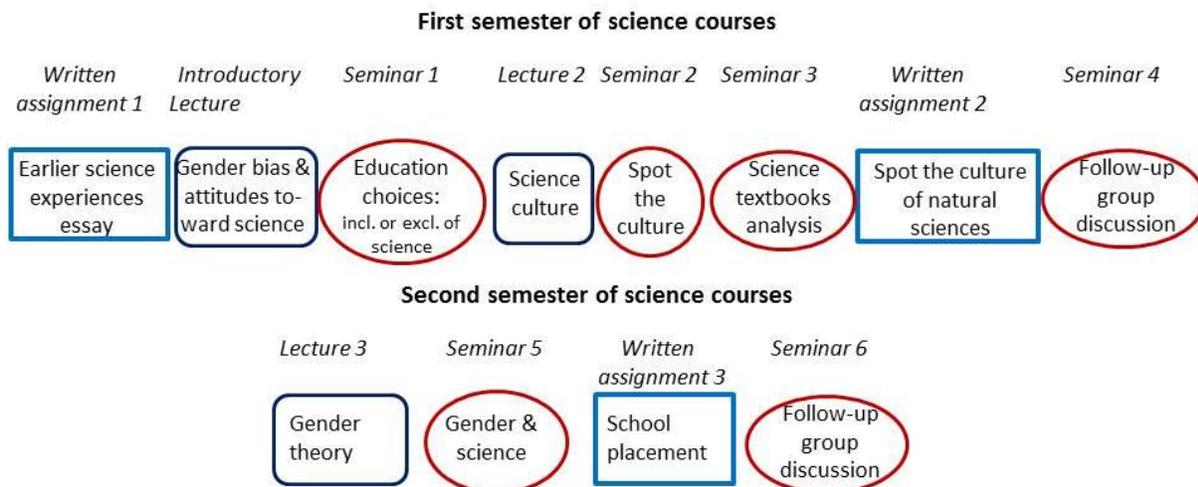


Figure 1. Integrated teaching elements

Based on previous research that demonstrates the presence of negative attitudes towards science subjects among preschool and primary education students (Andersson, 2011; Appleton, 2006; Fler, 2009; Sundberg & Ottander, 2009), we wanted the students' own experiences and ideas to be central. Initially, before the science portion of teacher education had started, the students were asked to write an essay on their memories of the natural sciences, in and out of school (written assignment 1). In this assignment the students were encouraged to remember their own experiences of science and school science teaching and reflect upon how it had affected their views of science. Another important element of the project was the use of 'cases' (Andersson, Hussenius & Gustafsson, 2009), often in the form of descriptions of real teaching situations, articles in a newspaper, pictures or something similar. These 'cases' could be presented during a lecture to illustrate the topic and engage the students, or they could be used in seminars. The students reflected individually on the case and wrote down their spontaneous reflections. Since they had no time for preparation, these tasks in a sense resemble real situations: something happens in a classroom and the teacher needs to respond and handle the situation immediately. Afterwards the case was discussed in class or in smaller groups and also was analyzed from a gender-theoretical perspective.

The first integrated lecture gave an introduction covering both gender and cultural aspects of science and science teaching, especially addressing gender biases in student educational choices and gender differences in attitudes. The lecture included the case given below, which is a real event that occurred at a school in Sweden.

In an upper secondary school, students in the final year of the science program have had a written test in physics. This day, they get their graded tests back. One of the students, we can call her Sandra, becomes very happy when she notices that she has scored full points. However, her feelings of happiness just

last a fraction of a second, because on the test the teacher has written: "Perfect score! Get a life."

The short sequence described exemplifies how implicit messages about physics and implicit values of young high-performing women are conveyed, and it was used to illustrate how such views and values can be expressed. The teacher's written comment can be interpreted as related to a fairly common picture of physics as a difficult topic that not everyone can engage in. Prominent figures in physics, both historically and today, are almost exclusively male, with an aura of genius status. A young woman who earns a perfect score on a test in this 'difficult' subject is not regarded as (potentially) genius but must then, according to such logic, have spent considerable time and effort in studying. Thereby, she would have missed things that are seen as essential components of a 'real' female's life.

The students' written reflections and the following discussion show an outrage at the teacher's comment, but generally they are not able to make a link between stereotypical views of both gender and science. During the lecture, this linkage was highlighted by referring to a study by cultural anthropologist Cathrine Hasse, where university physics teachers and students were asked to describe a successful physics student. When a student was described as ambitious and studious, it was a description of a woman, but when described as smart and intelligent, the description was of a man (Hasse, 2002). The choice of words indicates clear value differences, which reflect how women and men are viewed in different ways. The Swedish historian Hirdman (1990) described two aspects of this pattern: first, the separation of the two sexes and second, the superior status of the male standard. The formation of gender consolidates differences between the sexes, and the female gender is always subordinate to the male one, independent of status, class, time, and space.

At a seminar following the introductory lecture, the students discussed reasons for the emergence of gendered attitudes and careers, with the starting point as the experiences they had written about in their essays. Although many students in their essays described negative memories of school science, there were also examples of the opposite. The following quote is taken from one of the audio-recorded group discussions:

I found it very easy, like chemistry, math, and things like that. But that wasn't something you'd say in the last few years at school. You would moan more about it being difficult, even though it wasn't. Because that's what the culture was like.

One way to interpret this statement from a female education student is that when she pretended that studying natural sciences in school was difficult, she did that in order to fit into the norm of being a girl. In doing so, she adapted to the expected identity for a girl, where finding mathematics, physics and chemistry easy is not included. Rather than opposing and criticizing the prevalent image of natural sciences, she avoided doing anything that would be viewed as different. During the seminar, when she as an adult looks back on and problematizes her school

experiences, she pays attention to the cultural coding of the natural sciences, something which may also affect her feelings for the subjects and her future role as a teacher. In group discussions when students in this way shared experiences or observations, analyses and interpretations of real situations, the shared sequences became 'micro cases' which added to the cases chosen by the researchers. These 'micro cases' thus contributed to a broader understanding of possible feelings in connection to science learning.

The second integrated lecture gave a theoretical overview of natural science history and culture, which included critiques by feminist science philosophers. At the seminars following this lecture the students were given several individual and group tasks, all aimed at "spotting" the culture of natural sciences and interpreting stories conveyed in parallel to the subject content. In one such reflection task, a picture from a university science program advertisement was used (Fig. 2). The students also performed analyses of texts and pictures in school science textbooks, starting with questions like these: What epistemological view is mediated? What is the relationship of humans and nature? Is nature portrayed from an androcentric perspective or does it show an intrinsic value of the subject? Is the text formal, factual, and does it put facts into context? Is the text relational or distanced? How do the texts and images connect to each other? Are there gender issues? Who/what is included or excluded?



*Figure 2. Picture from a university science program advertisement*

At the end of the first science semester the students completed an individual written assignment analyzing science as culture, an individual analysis task (written assignment 2). They were free to choose to review science teaching in the course

they took part in (including lectures, labs and field trips), review a passage from a university or school textbook or other instructional materials, or observe science lessons or activities at a school or preschool. When one of the student groups consisting of prospective preschool teachers realized that they could write about their experiences from the ongoing course, they showed a strong emotional reaction that can be characterized as liberation. It was like opening a bottle of champagne in the way the students embraced the task - it was clear that these students recently experienced negative feelings and emotions, and now they had an opportunity to scrutinize, analyze and write about such episodes. Of the preschool student teachers, 60% (28 of 47) chose to review the ongoing course, and a majority of their written assignments reported situations that led to feelings of stupidity, exclusion, being ignored and the like in the context of science education. For many of them this was a repeat of emotions associated with science teaching from their own school days, but this time they had a tool to deal with these feelings.

The beginning of the second semester of science courses included a course segment covering in-depth gender theories and a number of in-class tasks, most of them but not all relating gender issues to science. An important element was the use of cases (see above) through which the students trained their ability to bridge theory and practice and to use gender theories to analyse situations with relevance for their future professional life. Among other tools, we used materials from articles in research journals to give students insight into research that explores the social context impact for the emergence of gender differences, and we used research that shatters common myths about biological differences concerning, for example, mathematics performances (Hyde & Mertz, 2009). We took a study on gender biases in mothers' expectations about infant crawling (Mondschein, Adolph & Tamis-LeMonda, 2000) and used it as one of several cases for preschool education students. The study illustrates the importance of the social context for the acquisition of motor skills. The preschool education students were informed about the study design, that the mothers had been asked to estimate their 11-month-old infants' *crawling ability* ("What is the steepest slope your baby can really crawl down successfully, without any help and without falling or sliding?") and *crawling attempts* ("What is the steepest slope your baby will attempt to crawl down, regardless of whether he/she will fall or require assistance?"). In group discussions the students predicted the outcomes of the study, whether they expected gender differences in crawling abilities and attempts, and what they thought about the mothers' expectations. After being presented with the results of the study, the students continued discussing more generally the consequences of gender-biased expectations.

Later on, the same semester was embedded with an extended, practical six-week placement at a preschool or a school. During this internship the students were given assignments and one of those was to carry out an observation study with the purpose of discovering situations where gender was of significance. They should recognize situations or conversations where gender mattered by observing interactions between children, between children and adults and/or between children and materials but also between adults. Specifically, they were told to look for

situations connected to science and technology activities or activities that could be regarded as *emerging* science/technology (Siraj-Blatchford, 2001). Unlike introducing the task of spotting the science culture, this task was met by resistance from some students. These students perceived that an excessive focus was put on girls and openly protested what they perceived as being too feminist, most often in the form of comments such as "it is just as bad for boys". However, since the assignment was mandatory they had to fulfil it anyway. In some instances, the resistance was broken during their school placements when they, despite their preconceived notions of students/children being treated equally, observed several examples that contradicted this. They observed how teachers consciously or unconsciously presented, expanded or made subject areas invisible to children based on gender stereotypes, and the student teachers reflected on the consequences of this.

The education students summarized their results in a written report (Written assignment 3; see Fig. 1), in which they also reflected on the situations described and analysed them using gender theories (Gullberg et al., 2014). At the final seminar, in close connection with the end of the school placement period, the students shared examples of observed situations, their reflections and their analyses. In their reports and at the seminars some students claimed that they had not found any examples where gender mattered, but upon being presented with such observations and analyses by their fellow students, they realised that similar events had also taken place during their own placement. Still others stuck with the notion that children were not treated differently depending on whether they were girls or boys.

## **RESULTS FROM THE GENDER ASSIGNMENT**

Two different main views about children emerged from our analysis of the students' assignments carried through during their school placements: children as *versatile* with potential interests in a variety of subject matter topics, or children as having stable core identities and the need to *be who they are*. These entail different tendencies for acting and reacting in situations and activities. According to the *versatile* view, teachers have agency to offer and stimulate children in different kinds of activities, thereby opening up possible new interests. Education students with this view of children were able to *detect* situations where they thought children were treated differently according to their gender. Some of them described situations where they, or an in-service teacher, *counteracted* to prevent traditional and stereotypical gender patterns. Still others also showed how they were able to *reflect* upon their own stereotyping behaviours or thoughts. Within the other view of children, the student teachers argued that children have stable core identities and need to 'be who they are', with the consequence that stereotypical gender behaviours within science activities were seen as natural (Gullberg et al., 2014). They held the view that children should be allowed to *be who they are*, and for them it was difficult to look beyond the individual level and understand influences mediated on structural and symbolic levels.

## **CONCLUSIONS**

The intervention briefly discussed in this case study is an example of feminist

gender pedagogy, where gender theories are applied to subject contents and activities in the teaching of science subjects. The interventions trained students to spot hierarchies, adopt power perspectives and, most of all, to analyse and understand situations from a gender perspective. The pedagogy means moving alternately between different viewing perspectives: the distanced and more impersonal versus the close and personal points of observation. The culture of the natural sciences was presented to the students based on both historical understandings (impersonal) and on the students' previous experiences (personal), mainly from their years in school. The teaching of natural sciences has been studied partly by using descriptions of real situations in the form of "cases" (impersonal), which are engaging but distanced from the students' personal experiences, and partly by engaging them in observations of activities they themselves are part of (personal). Through the distanced perspective students analysed cases on the structural and symbolic levels, which thereby functioned as a bridge for understanding the effects on the individual (personal) level.

The underlying idea of the implementation of the intervention was that integrated cases, tasks and theoretical sections would stimulate students' awarenesses of aspects relevant to whether students feel included or excluded in science teaching. For many students, highlighting the natural science culture became a way of confirming their own experiences and the feelings they had in relation to the subjects during their school years. In essays and seminars, many claimed to have felt stupid, mainly during physics and chemistry lessons, which resulted in low self-confidence and a negative attitude towards the subjects. Our conclusion is that when these students managed to spot the subject culture, they could externalize these feelings; instead of blaming themselves they could see other reasons for their failures. From here, students with negative memories of science teaching may reappraise the cause of negative feelings, a shift that can be described as a process of empowerment. Thus, the students had an opportunity to relate to the subjects in different ways, which might be of importance in their future professions.

To integrate knowledge of gender into science discipline courses is a special challenge for the teacher. Such knowledge can challenge stereotypical notions, of which many students are carriers. Making the gender codings of natural science subjects visible and highlighting their effects, specifically on women, were experiences that many students were uncomfortable with and not used to. This also created more resistance. Some of our students perceived and expressed a feeling of being forced into something they did not consider relevant for the actual courses they were taking. A quite common idea among students, as well as academic scholars, is that issues of gender are not relevant for certain subjects, regardless of whether the subject is taught at pre-school, primary school, secondary school, upper-secondary school or at university. Mathematics, chemistry and physics are subjects where it is not rare to hear such arguments; according to this type of argumentation, there are no gender aspects to study at the molecular level, quantum physics is gender neutral, and the solution to a mathematical problem has nothing to do with gender, etc. Our aim was to increase "student teachers'" awareness about science subject related gender issues and although this extension of the course content was accepted by many and even embraced by some students,

the resistance from others was more concrete. In retrospect we can conclude that we should have put more emphasis on informing and motivating the students of what was to come, before they entered the science courses. The integrated elements of cultural aspects and gender issues were non-traditional and nothing they expected. Their resistance probably would not have occurred or at least would have been easier to overcome, if the students had been prepared in advance and realized that the courses did not solely consist of ordinary traditional science subject content. Another aspect to be aware of is eventual resistance from colleagues, namely other academic science teachers. Although those responsible for teacher education programmes at the two universities involved and those responsible for the science courses in these programmes were informed and had approved the project, that is not the same as having gained acceptance among all of the faculty. It came to our knowledge that someone voiced to the students and other colleagues his/her scepticism and critically commented on the integration of gender issues. For some students this critique from a science teacher confirmed and strengthened them in their right to show resistance. Again, we believe that more detailed information and anchoring of the project before it was implemented could have prevented the emergence of such resistance.

Finally, gender concerns issues of the personal and private. Being forced to pay attention to gender-stereotyped views and actions, may open up recognition of such situations within the private sphere, experiences that might be painful. Thus, resistance is not surprising. Nevertheless, all teaching, regardless of subject, contains gender aspects. To avoid addressing gender solely on a general level and possibly being reduced to merely trying to ensure that the opportunity to contribute is divided up somewhat fairly between students, it is necessary to visualize gender aspects connected to the subject content and its culture.

The methods described in this case study, which included elements where the subject content was scrutinized from a gender perspective, contribute an example of how teacher education programmes can work to train and encourage gender-conscious science teachers. An interesting follow-up of the present study would be to interview a number of the participants some years after their graduation, to find out if and how this intervention has influenced their science teaching.

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