Different habitus – different strategies in teaching physics? Relationships between teachers' social, economic and cultural capital and strategies in teaching physics in upper secondary school.

Accepted for publication in *Cultural Studies of Science Education*

Susanne Engström · Carina Carlhed

Abstract
With environmental awareness in the societies of today, political steering documents emphasize that all education should include sustainable development. But it seems to be others competing ideals for teaching physics, or why do the physics teachers teach as they do? Physics teachers in secondary school in Sweden have generally, been focused on facts and a strong link with scientific theories and concepts. In general, the curriculum sway the teaching, a standard text book in physics is used, the teaching is organized according to the book and the teacher deals with and demonstrates typical tasks on the whiteboard and group work is common for special issues related to tasks from the textbook or elaborating. The aim with this study is to analyze why physics teachers in upper secondary school choose to teach energy as they do. Data emerging from a questionnaire focused on indicators of the teachers' cultural and economic assets, or capital, according to the work of Pierre Bourdieu´s sociology. Especially his concept on life styles and habitus provide a tool for analysis. We focus on physics teachers' positions in the social space, dispositions and standpoints towards the ideal way to teach physics in upper secondary school (n=268). Our response rate is 29 % and due to the low response rate a non response bias analysis was made. In our analysis we primarily sought for groups, with a cluster analysis based on the teaching practice, revealed common features for both what and how they teach and three different teaching types emerged. Then we reconstructed the group habitus of the teachers by analyzing dispositions and standpoints and related those to the specific polarization of sacred values, that is struggles about the natural order (doxa) in the social space of science education, which is a part of and has boundaries to dominating fields like the natural sciences and the political fields (curriculum etc.). Three teacher-groups' habituses are described and analyzed; 1. The Manager of the Traditional, 2. The Challenger for Technology and 3. The Challenger for Citizenship. By constructing the habitus of the teachers in the different groups we can explain why teachers teach as they do and thereby make a contribution to both science education research and to teaching training, whereas reflective approach which also includes the individual dispositions and representations are paramount. In our paper we elaborate the grounds and implications of these findings further.

Keywords
Physics teachers · Physic teaching · upper secondary school · habitus · life styles

S. Engström (✉)
School of Education, Culture and Communication, Mälardalen University, Västerås, Sweden
e-mail: susanne.engstrom@mdh.se

C. Carlhed
Department of Education, Uppsala University, Sweden

Sammanfattning
Med den miljömedvetenhet som råder i samhället i dag och de politiska styrdokument som finns för skolan, betonas att all utbildning bör omfatta hållbar utveckling. Det gäller även fysikämnet. Men det verkar trots det finnas andra ideal för skolfysikens innehåll, eller varför skulle annars fysiklärare undervisa som de gör? Fysiklärare i gymnasiet i Sverige har generellt sett varit inriktade på fakta och undervisat med en stark koppling till vetenskapliga teorier, begrepp och arbetssätt. Visserligen styr kursplanen undervisningen men oftast används en lärobok i fysik utifrån vilken även undervisningen organiseras. Fysikläraren väljer ofta innehåll och arbetssätt enligt läroboken och erbjuder därför typiska uppgifter som gås igenom på tavlan som inledning varefter elever enskilt genomför beräkningar. När laborationer utförs är grupparbeten vanliga men de utgår ofta ifrån specifika moment kopplade till läroboken och dess struktur. Syftet med denna studie är att analysera *varför* fysiklärare i gymnasieskolan väljer att undervisa *energi* som de gör. Ett ytterligare syfte är att finna vilka ”ideala” fysikundervisningsmetoder och vilket ”bästa” ämnesinnehåll som finns inom skolfysiken som praktik. Genom att analysera svaren som framkommit i en enkät som behandlar indikatorer på lärarnas livsstil, deras kulturella och ekonomiska kapital enligt Pierre Bourdieus sociologi och speciellt hans begrepp *habitus*, skapas ett analysverktyg för. Vi fokuserar därigenom på fysiklärarnas olika positioner i det sociala rummet, i skolfysiken. Vi speglar lärarnas dispositioner och ställningstaganden mot det ”rätta” sättet att lära fysik i gymnasieskolan. En webenkät sändes till de fysiklärare som undervisade fysik A-kursen vid samtliga gymnasieskolor i Sverige, (n=913). Svarsfrekvensen uppgick till 29% varför en bortfallsanalys genomfördes.

Det första steget i analysen gjordes med klusteranalys (Engström och Gustafsson 2010). I klusteranalysen eftersöktes mönster i hur lärare säger sig undervisa och välja ämnesinnehåll. Klusteranalysen och fortsatt bearbetning avslöjade gemensamma drag av *vad* och *hur* lärare undervisar och tre olika undervisningstyper utkristalliserades. Som ett nästa analyssteg rekonstruerades de tre undervisningstypernas grupphabitus. Detta analyssteg redovisas i denna artikel. Rekonstruktionen av grupphabitus gjordes genom att dispositioner och ställningstaganden analyserades för respektive undervisningstyp. Likheter och olikheter inom undervisningstypen jämfördes. Specifika ställningstaganden, livsstilar, sociala bakgrunder etc. kunde hänföras till de olika undervisningstyperna och utgjorde delvis grund för habitusrekonstruktionerna. Dispositionerna och ställningstagandena relaterades även till polariseringar av ”heliga värden” och den ”rådande kulturen” som framkommer i kampen om den naturliga ordningen (doxa) i det sociala rummet inom naturvetenskaplig utbildning. Naturvetenskaplig utbildning, däribland fysikämnet i skolan, är en del av och gränsar mot större dominerande områden inom samhället såsom naturvetenskap som vetenskapsområde och även det politiska fältet. Ställningstagandena har således olika legitimitet beroende på vilken pol man väljer att ansluta sig till värderingsmässigt. Konstruktionen av tre lärargruppshabitus beskrivs och analyseras: Den traditionelle med ämnesfokus, Utmanaren med teknikfokus och Utmanaren med fokus på medborgarskap. Genom att rekonstruera grupphabitus kan vi förklara varför lärare undervisar som de gör och därmed kan vi lämna ett bidrag till forskning om naturvetenskaplig utbildning. Vi ser i resultatet att ett reflekterande förhållningssätt hos en lärare är av största vikt och då specifikt att reflektera över sina egna ställningstaganden, sin egen bakgrund i relation till sin undervisning.

The subject of physics is considered difficult (Ford 1989), highly mathematical (de Souza Barros and Elia 1998), and largely influenced by the ontology and scientific approach born from natural sciences (Wertheim 1997). In Western societies natural science has received high status (Myrdal 2005), a view that is also found in school practice and in professional life (Berner 2004). The physics patents on explaining how our world works are based on investigations carried out with scientific instruments, current theories and concepts. It is considered as the foremost subject for understanding life on our planet. Knowledge is analytical, based on derivatives of fixed principles that are considered laws (von Wright 1986). Physics teachers in secondary school in Sweden have generally embraced these features. Thus teaching is characterized by a focus on facts and a strong link with scientific theories and concepts (Gyberg 2003). In general, the syllabus influences teaching, a standard textbook in physics is used, the teaching is organized according to the book, and the teacher deals with and demonstrates typical tasks on the whiteboard. Group work is only common for special issues related to tasks from the textbook or for elaborating (Engström and Gustafsson 2010).

In societies around the world today, environmental awareness and political engagement have changed political governance towards documents highlighting that education in general should adopt messages of environmental responsibility and include sustainable development (Government Communication 2005/06:126). For example, the goal of the United Nations Decade of Education for Sustainable Development (2005-2014 DESD), for which UNESCO is the lead agency, is to integrate the principles, values, and practices of sustainable development *into all aspects of education and learning:*

> This educational effort will encourage changes in behaviour that will create a more sustainable future in terms of environmental integrity, economic viability, and a just society for present and future generations. (www.unesco.org)

Has the implementation of these values into education been successful? In Sweden for example, energy teaching in physics in upper secondary schools lacks content that includes environmental relations, in contrast to biology teaching, for example. If physics teaching does include more evaluative issues such as environmental problems and students' own energy use, it is expressed very objectively and precisely and thus appeals to the spirit of scientific knowledge (Gyberg 2003). But an appropriate subject content in energy teaching in physics would, in accordance with international and national environmental policies, potentially raise more political issues, more environmental and efficiency problems, more future energy solutions and opportunities for students to obtain insights into sustainable energy practices (UNECE 2005) and (UN 2003). Although the syllabus emphasises such content (SKOLFS 2000:49) it is absent from upper secondary physics textbooks, especially in the content dealing with heat and energy (Engström, Niedderer and Gustafsson 2011). The previous study mentioned above focused on content in teaching practices in the first physics course, Physics A, that students encounter in the science program in secondary school in Sweden. The Swedish curriculum, including physics teaching, emphasizes a democratic perspective. Teaching should for example enable students to examine their own energy use in discussions, in calculations and in concrete issues. The students' own use of energy may be a starting point in that, to let students think about their own situation and compare it with the situation on other continents. The Swedish curriculum for Physics A (SKOLFS 2000:49) also states the objective that the student should be able to discuss ethical issues related to physics.
"The aim is also to contribute to the pupils' knowledge of the natural sciences so that they can take part in the public debate on issues related to the natural sciences. This covers analyzing and developing their views on questions, which are important for both the individual and

society, such as energy and environmental issues, as well as ethical issues related to physics, technology and society." (SKOLFS 2000:49, English translation, se also Table 3 in Appendix for more details).

The teaching practices investigated in a study by Susanne Engström (2008b) were based largely on the textbook in physics and had a focus on problem solving. Teaching materials had a stronger impact on teaching practices than policy documents and syllabi. Great attention was also paid to selected objectives in the syllabus, such as more specifically conceptual understanding and computational skills (Swedish National Agency of Education 2003). Engström (2008a) found that physics teaching was occasionally characterized by examples in limited contexts, and only in rare cases were put into larger contexts or were complex problems touched upon. Teaching never included strategies for sustainable energy use or future technology, or the reasons for a shift to renewable sources of energy, despite the fact that the curriculum emphasizes skills to participate in discussions in society about current energy issues. A tentative conclusion would thereby imply that the natural sciences serve as an ideal in teaching physics. If teaching were to follow the political ambitions in the national curriculum, teaching would aim to educate competent citizens, who can participate in shaping a sustainable society. Ideally physics education should comprise obvious and long-term themes. Several studies have shown that it is possible to work with advanced studies in long-term themes by relating the physical notions to technological applications in a chain of energy, where both environmental problems and future solutions are exemplified (Engström et al. 2011). In these themes, aspects like pricing of energy and political values can be incorporated (Space 2007). With a change in the content of teaching as described above, a change in the teaching practices, i.e. methods, would also follow.

There seem to be competing ideals for teaching physics, i.e. the political will to develop skills and knowledge for *change* versus the scientific will to *explain* phenomena. But why do physics teachers teach as they do? How do these two competing ideals impact actual teaching practice? What are the relationships between teachers' practices and these ideals? Can different teaching methods be explained in relation to these ideals?

The aim of the study

In order to explore the questions above, we started from the hypothesis that there are relationships between aspects of teachers' lifestyles and their choices concerning teaching goals, methods, subject content and practices in upper secondary school. We found support for that idea in Pierre Bourdieu's sociology, in particular through the concepts of habitus and cultural capital. An assumption in the theoretical framework is that (teaching) practices are closely related to teachers' lifestyles, which in turn have been shaped through different life conditions and experiences, historically and in the present.

We analyzed data from a questionnaire (Engström and Gustafsson 2010), which focuses on indicators of teachers' cultural and economic capital (Bourdieu 1996). We focus on physics teachers' positions in school physics, dispositions, teaching practices and standpoints towards the ideal way to teach physics, especially energy issues in upper secondary school. By using the concept of habitus from Bourdieu's sociology, we explore teachers' practice and the reasons why teachers teach as they do. Thus, our research question can be framed as: How do teachers' practices and standpoints relate to the polarization of competing ideals?

Habitus and the social space

Depending on the life paths and life conditions of the teachers, different kinds of lifestyles evolve. If a group of people share the same life conditions, they also share similar features in their habitus (Charlesworth 2000). Accordingly, through the variation of lifestyles, reality is perceived differently, which influences teachers' choices of doing "the right thing" – guided

by a practical sense, closely related to specific life conditions. Theoretically, we can understand this practical sense through the concept of habitus, see Figure 1.

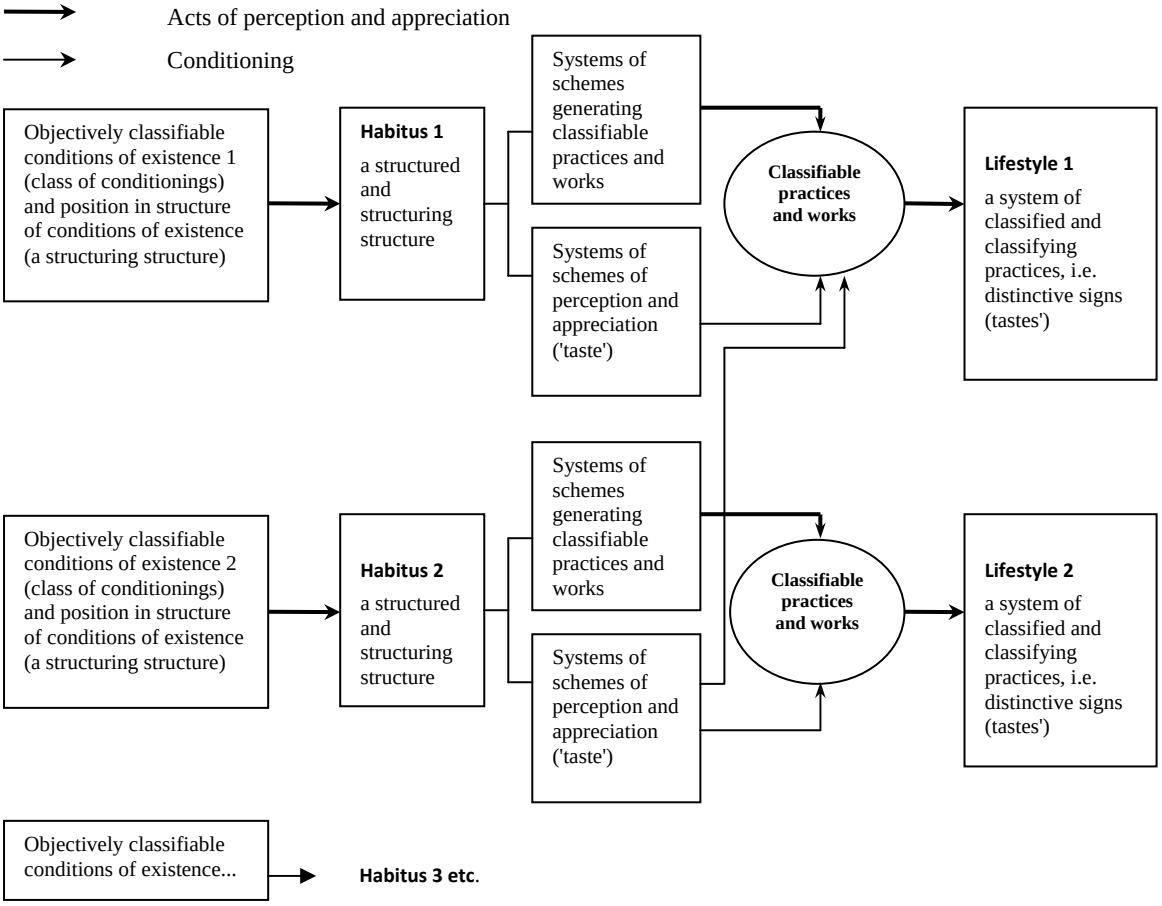

Figure 1. Conditions of existence, habitus and lifestyle (Bourdieu 1984, p. 171)

Thus, habitus is both a product of the past and active in the present, by its capacity to structure action in the present, like a compass. In Bourdieu's terminology “the mental structures, through which they apprehend the social world, are essentially the product of the internalization of the structures of that world” (Bourdieu 1989, p. 18). The habitus, defined by practical logic is, according to Bourdieu (1984), essentially internalized and converted into a disposition that generates meaning-giving standpoints. Bourdieu (1989) explains this as meaning that dispositions tend to be adjusted to standpoints, the *agent* tends to perceive the world as natural and accept it. Because habitus is a transposable system of dispositions that provides the individual meaningful practices and is implemented as universal applications that could be used by the agent in new practices, it lead to systematics in all practices (Bourdieu 1984). Habitus thus shapes strategies to cope with social situations. Strategies can be described as the relationship between an individual's habitus and structures of the social world. In practice, strategies make it possible for individuals to deal with unpredictable and constantly changing situations. The choices, both preconscious and conscious, may indeed appear to be objective, but they are determined by the conditions that prevailed when production principles of the strategy were formed. Therefore, the strategies (choices) tend to reproduce the structures from which they result (Bourdieu 2005).

Using Bourdieu’s theory to understand the structures in the social world wherein the teachers are immersed, we maintain that they occupy a position in a social space and exercise

social practice, which determines, for example, classification schemes of social distinction, for instance in judgments about what is considered “good” or “bad,” or what is valuable/necessary, or who is “of our kind” or not. The specific positions focused on in our study are the physics teacher positions in secondary schools in Sweden and especially the teaching of Physics A courses. Being a teacher basically means communicating valuable content to young people within a school system. In other words, the teacher is not producing any content him/herself, but reproducing content that is mainly produced by science and transformed into text books and school subjects. Hence, the teachers’ “free” choices in designing their teaching content are limited in at least two ways: 1) through the government and supervision of national curricula/syllabi and 2) their emphasis on developing specific skills per se that are negotiated and the products of struggles between experts and dominating agents in science and policy/state bureaucracy.

The teachers in our study are recognized as agents, holding positions in a social subspace within the reproductive field, here referred to as *the social space of school physics*, with accompanying standpoints and sets of strategies/choices in maneuvering their teacher intentions. In order to understand how teaching practices are related to present “ideal” teaching practices, we have to reconstruct the different symbolic values and the polarizations that recognize each teaching practice as valuable. Teachers have resources, which are symbolic goods that are recognized as having a difference in degree depending on which value system is present. Bourdieu’s general term for the resources is capital, which has a symbolic value in a specific social space (practice). It illuminates the relationship between teachers' dispositions, their strategies as standpoints or symbolic acts, and their recognition within a social practice. The term *cultural capital* implies being recognized as capital in a specific society, i.e. economic, scientific and educational capital, by which it is possible to understand the social space of positions and aspects of dominance and its hierarchies. Depending on the amount of and the sort of capital a person has, it provides a basis for determining his/her relative position and activates the habitus in relation to the specific field. Bourdieu suggests a formula for the logic of practice in *Distinction* "(Habitus x Capital) + Field = Practice" (Bourdieu 1984, p. 101). But he also stresses that the same habitus can express different standpoints and practices depending on the particular field status and dominant culture; thus practices guided by habitus are not static. There are no explicit rules or principles that determine behavior; it is rather an implicit, vague and undetermined stance towards to the social world (Bourdieu 1990). However, we want to stress that our use of collective habitus in this article does not explore a collection of individual habituses and their relation to the social space. As a first step toward understanding the practices of physics teachers sociologically, it rather deals with the features of a range of collective habitus types, and tracks of practices and standpoints emerging from them. A second step would be to explore collections of individual habituses of physics teachers, using qualitative methods in order to capture the dynamics, variation and ambiguities within a collective habitus.

Now, returning to the notion of collective habitus and our data. All physics teachers have a similar amount and sort of educational capital as physics teachers, but they may have different amounts of social, economic or scientific capital. Differences could then be observed, especially if we also take into account parental/family background in terms of the amount and composition of their parents’ cultural capital.

In the introduction section we suggested that the natural science ideal in teaching physics, with its aim to educate skilled (math) problem solvers who can explain physical phenomena, may be dominant. Nevertheless, there are other ways of teaching physics, which have been influenced by education policy and environmental policy and are mainly mediated through the national syllabus. This means that there are competing ideals for teaching physics, i.e. the political will to develop skills for *changing* society versus the scientific will to develop skills

to *explain* phenomena. In sum, *school physics,* placed at the intersection of natural science, the educational policy field and the reproductive field, with its core function to reproduce knowledge, is influenced by the other larger social fields mentioned above, where specific kinds of capital are appraised and certain standpoints are recognized in different degrees. The social world is largely structured with social spaces inside fields, placed inside larger fields like a Russian doll (Bourdieu 2004). Thus a social practice has a dual structure: it is structured not only by the lifestyles and properties attributed to agents but also by a system of symbolic power from larger social spaces, and both of these mechanisms act to produce the social space (Bourdieu 1989).

By investigating different teachers' lifestyles through the questionnaire mentioned earlier we can thereby understand the dynamics and variation within the teachers' collective habitus and their teaching practices. However, habitus is a theoretical concept, not an empirical and descriptive one (Callewaert 2003). Therefore, in this study we reconstruct teachers' habitus from information about their positions as physics teachers in secondary school, their dispositions (capital) and their standpoints on content and methods in teaching, which are related to symbolic capital in larger social fields.

Methods

Analysis – collective habitus

A person's history is constitutive of individual habitus. For a collective habitus, the collective history of a group of which the individual is a member is constitutive. In this study we focus on teachers as a group and reconstruct their collective habitus. This means that we emphasize their middle-class positions as physics teachers in secondary school and their educational trajectories as an important basis of their habitus. We will thus see habitus as both individualized and collective, as in Bourdieu's book *Distinction* (1984), which presents a study of habitus that underlies cluster in sectors (social classes) in social spaces. But, as mentioned earlier, even within a group habitus there can be variations.

In an earlier study (Engström and Gustafsson 2010), which was based on the same questionnaire as is dealt with here, three different types of physics teaching emerged through a cluster analysis. The cluster analysis was based on teachers' position-takings about their teaching, how they related physics concepts to different contexts and to what extent they did so. A large group of teaching strategies were interpreted and labeled into three groups of teaching strategies; 1. *The Mainstream Group*, 2. *The Future Solution Group*, and 3 *The Challenger Group*. For example, the latter group consisted of teaching strategies that, in addition to basic concepts and relationships, also showed teaching with a more valuing content, allowing sustainable development to characterize the content and using a variety of teaching methods and material (Engström and Gustafsson 2010). In this present article we continue to elaborate the three teaching types and go further with analyses of teaching types and their relation to the teachers' positions in school physics, teachers' compositions and amount of social, economic and cultural capital into a final synthetic analysis.

In this article we frequently use the term reconstruction, and there is a reason for that. Bourdieu discusses misunderstandings with translating the scientific discourse to the social world. He distinguishes between empirical persons and constructed, epistemic individuals (1996, p. 53-67). The epistemic individual is defined by a distinct set of characteristics that differ systematically from other properties that are also constructed the same way. These constructed individuals or classes/groups on paper are to be made, to be (re)constructed, by the researcher. In sum, from the self-reported questionnaire data collected from the teachers of flesh and blood, we reconstruct epistemic individuals (on paper) and three different collective habituses. In order to reconstruct habitus and lifestyles we used the concept of capital, for

example cultural capital (education etc.), economic capital (income, type of house, car etc.) and social capital (married, not married, friends etc.) as well as symbolic capital to systemize their standpoints regarding how to teach energy issues in physics and what content that they chose. Due to the sort and amount of capital the teacher holds a specific position within the social space of *school physics*, which is also an analytical construct. Thus, the specific position and the teacher's standing points are of relative value, depending on what is appraised in the social space of *school physics* at the intersection of natural science, the educational policy field and the reproductive field.

An empirical base from a previous study - sample and the questionnaire

Our empirical material for this article was collected in a previous study (Engström and Gustafsson 2010). As a first step in designing a population, schools were located that offered the course Physics A during the academic year (2008-2009). The population frame included all upper secondary schools in Sweden (1025 schools). Questions were posed to the schools about information on the present physics teachers who taught the course Physics A including their e-mail addresses. The respondent list ultimately contained e-mails to 913 physics teachers, who are considered as the total population. No sampling was done.

As a survey tool a web-based survey system was used that distributed e-mails to the 913 teachers with a link to the survey. The survey questionnaire consisted of seven sections with mixed open-ended questions and closed-answer questions. Response alternatives consisted of actual responses/opinions or of claims such as to a high degree/low degree and never/seldom/often, etc.

Section 1 was headed by questions about the energy teaching used in the course Physics A. The section included 12 questions on *teaching activities* such as subject content (86 closed-answer items in total). Questions in part 1 were based on content for teaching about sustainable energy in the Physics A course (Engström 2008a). The questions aimed at capturing what was taught in terms of energy in Physics A and at how teaching was carried out. Sections 2 to 7 were designed with inspiration from both Bourdieu (1984) and other studies that also used Bourdieu-inspired questionnaires, (for example Calander et al. 2003).

Sections 2 and 3 contained questions about *the teacher's current job and workplace and his/her views of the physics topic*. The section included 33 questions and a total of 151 items. The issues included current occupation, the work team, the teacher's specific professional function and the present working environment, which magazines and journals they read. In addition, there were questions about their previous work and choice of profession. Finally, we asked about their vision of the physics subject, on grades and school and how skills are taught etc.

Section 4, was titled *issues concerning the teachers growing up and studies*. Questions were intended to explore the teachers' sort and amount of cultural capital. It included questions about the region they grew up in, education, institutions and current type of residence. This part contained 20 questions and a total of 72 items.

Section 5 was headed *questions about the origin of the family*. The part included 18 questions, with 49 items covering the country of origin, parents' country of origin, parents' occupations, family composition and parents' education.

Section 6 consisted of *questions about the current family situation*, for example partner's education and occupation, children's education and children's leisure activities. The part included 12 questions with a total of 89 statements.

Section 7 concerned *questions about lifestyle*. This section included 23 questions and 240 statements about choice of television programs, leisure activities, choice of travel, accommodation and clothing tastes, the working share in the home, taste of furniture, annual income, favorite film, favorite author, etc.

After the questionnaire had been constructed it was piloted by four physics teachers (one female, three males) who recently taught the course Physics A. Some adjustments to the questions were made based on their comments.

When the email survey ended after six weeks, the response rate had only reached 29 % in spite of three reminders, with elaborated information accompanying the final reminder. The email-survey was answered by 268 teachers. The link to the email survey was opened by another 222 teachers, but no final submission was made in these cases. 423 teachers did not open the link at all. The 29 % response rate was relatively low, but very similar to contemporary studies using surveys, probably due to survey fatigue (Bosnjak and Tuten 2001).

In order to examine nonresponse bias between our sample and the population we collected information about our population from official registers at Statistics Sweden; *Higher Education database* (HREG) and *The Employment Register* (SREG). We found 1,423 individuals that worked as upper secondary teachers in 2008 and had a relevant education in physics or other subjects that are closely related. The comparison was made in relation to the proportions of the population in term of age, gender, work experience, profession, the school's mandatorship (private or state/community governed) and the teachers' place of residence in the population and in our sample (Appendix, table 2).

Regarding the proportion of men and women in our sample, it seems that we have a slight deficit of responses from men of 6 %. Our deficit is larger (12.5 %) regarding the responses from women compared to the ratio in the population. When it comes to age it seems that we have reached the youngest and the oldest teachers compared to the population, while we have the largest deficits among the middle groups (17% and 18 %). These conditions are reflected also regarding work experience, since these factors are interrelated for natural reasons. The teachers' responses about their current position show that we could expect 98 % to be primarily upper secondary teachers but we reached 77 % in this category. But if we add responses (15 %) in the category lecturer in physics, who normally teach at universities, we end up with 95 %. They are probably working on the side, parallel with their work at a university. In comparing the proportions of responses from teachers at schools with either municipal, county, or private control, it shows that we have a perfect fit from the two latter categories. Thus, the deficit in responses is from schools with municipal control. However, we have 61 % of the teachers working within municipalities, and we conclude that there are sufficient data on this category. Comparing the residential locality of the teachers we found small differences between our sample and the population (7% at the most).

In our understanding, the response bias could be due to primarily age/work experience and to gender. It is hard to say whether the youngest and/or the oldest teachers are more conservative or progressive in their teaching, but it may be reasonable to say that the conservative side dominates. The youngest teachers have less experience and could hold on more firmly to conservative teaching values and regulated forms of teaching (lectures, laboratory work) than teaching methods that may demand more experience of group dynamics, i.e. group work. The oldest teachers would probably hold on to teaching methods they learned in their early carriers, which also could be seen as more conservative teaching. Regarding gender, it could be assumed that non-responses from women also belonged to the middle age groups from which we had a larger deficit. In sum, we can conclude that we have probably more data on teachers who might prefer conservative teaching methods. It is also in line with the majority of respondents in the *Mainstream* teaching type (see below).

In general, we conclude that there is a rather fair concordance between the population and our sample. But our main concern is not to compare frequencies between teaching types but rather to explore qualitative differences between them. In conclusion, we argue that our

sample is adequate and our results show trustworthiness and can contribute to a tenable explanation of the divergence in self-reported teaching practices.

A previous study – our first step in the analysis

The first step in the analysis was done in a previous study (Engström and Gustafsson 2010). The free text answers from the open-ended questions were categorized and coded into new variables using the SPSS data sheet for use in subsequent statistical processing. Primarily, we sought groups or clusters using those variables (both open- and closed-answer) that comprised the choice of teaching more of content dealing with environmental issues, future technology and more evaluating content. This was done through a hierarchical cluster analysis using Ward's method by SPSS, where we look for teachers' choice of the same subject content (Field 2000). The basic idea of clustering is to measure the "distance" between objects and find the objects that are closest to each other. When using cluster analysis (presented in Engström and Gustafsson 2010) we detected groups of objects in the data (20 variables). In the study we measured the similarity of teachers' teaching practices in terms of whether they choose a more evaluative and society-related content in their teaching. Cluster analysis resulted in three main clusters with eight sub-clusters. Subsequently, profiles for each of the eight clusters were created. Profiles correspond to patterns of responses given to a total of 34 other questions from the questionnaire that deal with questions of "what" and "how" (i.e. content in teaching and teaching methods). The three main clusters were compared with the eight sub-clusters and were then merged into three physics teaching types with similar response patterns to questions about content in teaching and teaching methods (Engström and Gustafsson 2010).

Thus the previous study revealed common features for both *what* and *how* teachers taught. *Three* different teaching types with distinctive teaching strategies emerged: *The Mainstream Group, The Future Solution Group and The Challenger Group* (Engström and Gustafsson 2010). Generally, the three teaching types diverge most about *what* they teach and have more in common with respect to *how* they teach. For example, a common feature was that the teachers more or less appreciated group work and discussions that involved the students' own discussions in the classroom. The *Mainstream* group (corresponding to 46 % of the teachers in the sample) comprised strategies that had the students discuss only tasks from the textbook about how they understand basic concepts and laws in physics. This teaching practice, as other researchers also found for example Pamela Mulhall and Richard Gunstone (2008), focuses on conceptual understanding and conceptual change, which are explained as features from scientific culture. According to Douglas Roberts (2007), focusing on conceptual understanding means understanding the physical concepts in the "right" way and understanding the scientific way of thinking/working, and it is thereby *not* focused on understanding the situations and contexts where the concepts can be applied. According to Roberts (ibid.) it is unusual that teachers focus on students' own contributions to determine the content of teaching, to address current environmental and political issues and have students discuss different energy solutions. The two other teaching types *The Future Solution Group* (corresponding to 39 % of the teachers in the sample) *and The Challenger Group (*corresponding to 14 % of the teachers in the sample) comprised different teaching strategies in the sense of selection of different subject content compared to the *Mainstream* group, and teaching methods that also deviate from ordinary practices.

Analytical procedures – the present study

In the following section we report how we have taken the analysis further by relating the empirical teaching types based on their teaching strategies to the specific social space that physics teachers in general are embedded within, that is, analyzing the teaching strategies in

relation to different bases of cultural legitimacy. In general, teachers choose their teaching practices in relation to certain self-acknowledged values, which reflect a form of rationality that is both cognitive and cultural. Naturally, they choose what they think is the best way to teach physics. The specific social space surrounding teaching practices offers a set of different bases of cultural legitimacy – to do right in the eyes of others. For example, following the curricula that emphasize sustainable development issues could be seen as seeking legitimacy from the educational policy field. On the other hand, the natural science field could offer legitimacy to a strong emphasis in teaching how to search for truths, explanations and definitions of physical concepts, primarily using formulas for solving physical problems and tasks.

We analyzed teachers dispositions (cultural, social and economic capital) and representations about teaching strategies (teaching types from the previous study) and related these to the specific polarization of values in specific social space such as school physics, which is considered here as an intersection between the reproductive field, the scientific field and the educational policy field. Depending on the specific doxa within the fields of interest, the teachers' standpoints about their teaching practices could be understood as orthodox positions or a heterodox positions, inspired by Bourdieu's work (for example Bourdieu 2005, 2000).

In other words, we reconstructed the teachers' collective habituses, by integrating their positions (as upper secondary teachers), dispositions (capitals) and representations (teaching strategies) in the analysis. The different kinds of collective habitus are thus compositions of schemes for actions, especially the teachers' views of the "appropriate" action that is in accordance with their embodied history, their present life situation and their current position in the social space. These distinctive kinds of collective habitus reconstructions are used here to pursue an exploration of the rationality, which can explain why a teacher does as he/she does in relation to his/her position in the social space.

In short, we sought the three teaching types and their social and cultural features as such were evident from the data. Cross tabulation analyses in SPSS was the main statistical method to achieve this aim. The teaching types were analyzed in cross tabulations versus teacher groups' dispositions (different forms of cultural, social and economic capital, see examples in Table 1, Appendix). We analyzed tendencies in the sense of which teaching type had the majority of answers to a specific question or statement, which means that there were some overlaps in the teaching types. This implies that we were interested in relations of the answers and differences of emphasis *between* the different teaching types. The collective habituses are constructions that sum up characteristics and elements from reality into analytical products, which can be used in reflections on teaching practice in relation to teachers' life styles and positions in the social space. The habituses are thus not empirical categories with strict borders for inclusion/exclusion of certain criteria from the questionnaire, whereas the teaching types that emerged from cluster analysis in the previous study are, on the contrary, strictly empirical. The collective habituses are results of iterative, theoretical and interpreting quantitative and qualitative acts that sought a broader understanding of how teaching practices were related to lifestyles, socio-economic and cultural dispositions and altogether the embedded existence of practices in the social world. Teaching practices and teachers' standpoints on content and methods in teaching were related to symbolic values in larger fields. In order to grasp symbolic values in the different fields we leaned on results from other studies (Gunstone and White, 1998 concerning the reproduction of the physics teachers own view on science; Gyberg, 2003 about the impact of scientific discourse on the physics subject; Aikenhead, 1996 which writes about the specific sub culture of science in the physics classroom; Cross & Ormiston-Smith, 1996 concerning strong socialization forces steering the physics subject; De Souza Barros, and Elia, 1998 meaning that the physics subject is highly

mathematical; Mulhall and Gunstone, 2008 regarding how the physics subject is valued as the most important in science and at last Myrdal, 2005 who states the importance of the nature science is in society) to support knowledge about the specificity of core values in the fields. In Susanne Engström (2011) political documents, physics textbooks, and research production from science education have been analyzed. Educational policy texts and curricula reveal for example what is considered important from the state's point of view; textbooks, written by researchers, focus on certain content (problem solving, laboratory work, formulas), which also shows a prioritization of what is considered fundamental from another point of view etc.

The physics teachers' collective habituses

On one hand, one can say that the habituses are somewhat homogeneous, because they all are *teachers in upper secondary school*; the teachers are all qualified as physics and mathematics teachers, and due to their position as physics teachers, the level of income is similar according to our data. Socializing practices tend to involve friends within the same occupation, many read the same science journals and socialize within the same social strata concerning amount of educational capital etc. Their positions demand a high investment of educational capital, which is at least 4.5 or 5 years of tertiary education, mathematics and physics or 5 years of studying engineering, plus at least one year of educational studies at university. In relation to other teachers in secondary school they have a high status owing to the status of the physics subject (Bertilsson 2009). But in relation to physics teachers at universities, they have lower status (Ulfsdotter-Eriksson 2006).

However, among the physics teachers there are differences due to different amounts of economic capital. This entails consequences in activities and lifestyles, such as vacation activities, housing conditions and choices of leisure activities. According to Bourdieu, economic capital is a dominating capital, i.e. it dominates over cultural capital (Bourdieu 1996). Thus, habitus is largely dependent on economic opportunities, and income plays an important part in studying and understanding lifestyles and taste. Consequently we propose the teachers' standpoints and choices should be seen as "a virtue made of necessity" (Bourdieu 1984, p. 177).

In the following description of the reconstruction of the teachers' collective habituses, the distinctive features are stressed. The earlier empirical teaching types from the previous study, which were based on teaching strategies are now transformed into habituses and renamed due to the additional new analytical dimensions of dispositions and teaching practice relating to specific values within different fields (i.e. the reproductive field, the scientific field and the educational policy field). The habituses' names are *The Manager of the Traditional* (based on teaching strategies from the earlier Mainstream Group), *The Challenger for Technology (*based on The Future Solution Group) *, and The Challenger for Citizenship (*based on The Challenger Group).

The Manager of the Traditional

This habitus seems to function as a faithful manager of the natural science heritage. The habitus is characterized primarily as being an outsider, a parvenu, due to the lack of higher education experience among his/her parents, i.e. no inherited educational capital. Faithfulness to the natural science core values tends to be combined with some lack of self-confidence and with timidity, which comes along with the parvenu position. This shapes a trustee position, such as a guardian of the "land in-between" where the status quo rules. An example of this is a prevailing lack of concern for improving and developing his/her teaching skills, or the content in the physics course. The habitus seems to be fuelled by respectfulness for, in this case, mathematical skills in physics and for physical science in itself. The parvenu position means that only an education can enable a social ascent. This creates loyalty towards the

education system that made a class journey possible (also described by Bourdieu 1996, p. 101, 114).

As defenders of the views that the physics subject is the most difficult subject to understand, the standpoints tend to emphasize that physics is not the most important subject for everyone to learn, it is something for those who are *chosen and have talent* (see other examples in for example Bourdieu and Passeron 2008). Thus, knowledge of the subject of physics is not needed to solve the problems of mankind or for developing all students into scientifically literate individuals. The standpoints emphasized in accordance with this habitus imply that the physics subject is an old and traditional subject that very few are skilled in and that it is not necessary to connect the subject to other broader, cultural or societal contexts.

We observed that the standpoints revealed from the specific teaching strategies show sympathy towards the natural scientific ideals obtained by their university education. The answers display a reverence for physics and mathematics, visible in the reproduction in the teachers' self-reports on their own teaching, what content they focus on and how they teach. It seems that there is no urgent need and/or self-confidence to change the teaching of physics according to political documents, i.e. towards sustainable development. Society itself, with its political battles, tends to lack any attraction. For example the standpoints show no political engagement in society-related issues outside work. It seems that the horizon includes no incentives or even opportunities to change the natural social order, at least those not meaningful for them, which could explain the lack of political interest. As a striving parvenu, he/she has to balance the strategies emerging from working class culture and the new habitat that entails new challenges. The expressed sympathy towards reproduction activities could be seen as gratitude towards the education system, a conclusion which has been supported in earlier research i.e. on elementary school teachers (Muel-Dreyfus 1987) and boys from poor families and their career-making in church – the "oblates" (Bourdieu 1996).

From the teachers' statements, it seems that there was an initial wish to become mathematics teachers, but they needed to study one additional subject, so they chose physics, even if they really did not like the subject, and were only to a low extent impressed by their own physics teachers. In conclusion, it was a secondary choice of profession. Their choice of educational path and profession had nevertheless opened up for their own children to embark on the natural science path and into higher education at university. Choosing a natural science secondary school program is considered the "royal road" to university education in Sweden (Broady et al 2009). There was a strong concordance between the educational background of the teachers and that of their spouse (a matrimonial pattern among professions also found by Bihagen 2000). Many have a spouse with a university degree, and if they have children of secondary school age, they tend to pursue natural science programs. The teachers have a relatively high amount of educational capital in terms of a university degree, like their sisters and brothers, but their parents have no university degree. The persistent tendency of not wanting to change the teaching methods or content could be seen as a kind of gratitude to the order of things and reproduction of this order instead of critical reflections, a strategy seen amongst those teacher students emanating from a family background without inherited educational capital i.e. parents without university experience (also found by Hultqvist 2006).

As an orthodox defender of traditional views and thus as a guardian of status quo, it seems that this habitus is in line with natural science doxa but in opposition to the national education policy and the syllabus in secondary school (Lpf 94), where four overall perspectives are stressed: the environmental, the historical, the international, and the ethical perspectives. According to the syllabus, these perspectives should be involved in all education (all subjects) and should represent the core in education for sustainable development (Swedish National Agency for Education 2010). But as a manager of the traditional, the teacher has a traditional

approach to the subject, characterized by the classical ideal of natural science (Frängsmyr 1984), which searches for the truth and for explanations thereof (Babour 2000).

In their answers from the questionnaire, we observed everyday activities linked to "working culture" in choices of newspaper (not a liberal or conservative, more of a socialistic one), vacations and leisure activities and ways of designing and decorating their homes. For example frequent visits to discotheques/clubs and watching soap operas on TV, but rare or no visits to theatre, opera or museums and never reading poetry (supported by Karlsson 2005). The amounts and kind of social capital includes for example friends with professions like teachers or workers. We interpreted a distancing from highbrow culture, such as poetry, classical music, visiting art museums and "study circles", and not so often working at the computer but also repudiations of handicraft and musicianship. The cultural activities are interpreted as neither seeking entrance to the cultural performance activities such as playing instruments, art, and poetry or to more societal/political issues and activities. However, the teachers seem to read the cultural pages in the newspaper, which indicates a kind of curiosity related to more highbrow culture. This habitus has similarities with a petit-bourgeois habitus, described by Donald Broady (1991), which is characterized by dislike of both negligence and recklessness as well as excesses and extravagance about food, home furnishing, clothing, personal finance, education and so on, but they praise school-related values and place their children in programs that reward hard work and adjustment to school. Petit-bourgeois habitus is also characterized by a tense and anxious relationship to cultural activities.

The habitus possesses educational capital in terms of degrees as teachers of mathematics and physics and work experience as a physics teacher for 3 – 10 years, but does not include a special position within the school. We can also observe non-recognition for their own ideas by their school board or outside the school (for example being consulted as a lecturer in developing the school in accordance with the prevailing environmental politics and school-related values). The managing traditional habitus is characterized by an absence of new ideas about one's own teaching practices and resoluteness to stand firm in these convictions.

The teaching practices entail teaching almost nothing about the more value-related content (for example related to sustainable energy or sustainable development). The students are not involved in determining the course content; neither do they work in collaborative teamwork with course content that is adapted to events in society and media. The teaching strategies do not imply thematic work or give students opportunities to discuss and evaluate societal issues. Concerning the inspiration for the work, we found that reading literature papers etc. about physics and physics teaching were not prioritized and using Internet to find material or theories about science education was not a frequent option. In sum, it is obscure what influences the physics teaching strategies. We interpret however an interest in physical science, since there are statements of a wish to improve and pursue further training in physics. This habitus contributes to a firm reproduction of the subject content teaching, including fact emphasizing methods and definitions of physical concepts, primarily using formulas for solving physical problems and tasks. Such teaching could be seen as based on the conviction that it is unproblematic to learn physics because the ideas of physics are unproblematic. Thus in this view there are observable unambiguous truths that can be accurately represented in the mathematical formulas. The traditional manager habitus uses the concepts, definitions and formulas as a starting point in the teaching, but this method is not successful in contributing to the students' understanding of the *meaning* of concepts (Mulhall and Gunstone (2008).

The Challenger for Technology

This habitus seems to work as an "agent for change" of the physics subject, characterized by being optimistic about technology and having great self-confidence from a well-known field – natural science, thus emphasizing the usefulness of physics to technological development. In

other words, the habitus features a “Futurist” with willingness and courage to develop the physics subject for use in technology, using both economic and utility arguments. The economic argument is underpinned by the habitus’ origin from the upper middle class, meaning high praise for economic welfare. Accordingly teachers with this habitus would appear as rather confident with a materialistic and sporty approach and seem to have little interest in cultural activities.

The usefulness of physics is emphasized along with a core value conviction that physics is the subject that most of all subjects is the base for technological development and enables success in industry and business. From the standpoints we can conclude a will to encourage students to continue to study in the energy technology area, and they have their students discuss and evaluate energy issues in contemporary society. It seems that *challenge* is a keyword in terms of the challenge of the physics subject towards a better understanding of technology and the fact that physics serves as useful knowledge in doing this. This “utilitarian” view is closely related to an alternative view on the physics subject that became prominent in the 17th century and led to a conflict between the ancient classical science knowledge/educational ideals (physics from classical antiquity – astronomy, mechanics, optics) and the newer science ideal formed by usefulness (alternative physics areas were develop later – for example thermodynamics, electricity, aerodynamics). The universities were responsible for the classical physics, and institutions outside the universities, such as the Royal Swedish Academy of Sciences represented the new natural science (Frängsmyr 1984). Later on when politicians started to show an interest in science research, they put a premium on usefulness and the academies of science were used for research rather than the universities (Frängsmyr 1984). Thus, for this reason, one can find both a highly valued classical physics and a more capitalistically valued physics research in engineering.

The composition of cultural capital shows work experience as teachers in physics and mathematics for 2 - 5 years and frequent previous jobs in the technology sector. Practical knowledge seems to be a core value, meaning that these teachers will both understand and use technology – a value related to a knowledge view found in engineering, expressed in the context of technology (Ingelström 2009). Here we identified a teaching practice grounded in technological optimism along with the intention that physics will be applied in “system thinking,” an approach that means that the technology will be seen in relation to human values, the society and nature (Hallström 2009).

The standpoints characterizing this habitus reveal that there is a strong conviction in arguments for teaching that understanding the laws of physics is important for developing sustainable solutions of the future. But it tends not to be enough; the standpoints also show advocating science teaching with collaboration on the solutions between engineers, physicists, economists and sociologists, an opinion formed in science education by, for example, the World Conference on Physics and Sustainable Development (2005). Furthermore, positions indicated that the students should continue with physics and technology in higher education. We found democratic and utilitarian arguments but also economic arguments for studying physics, also emphasized by Svein Sjøberg (2005).

As mentioned above, the habitus shows self-evidence in relation to technology issues and highly valuing schools with technology and science profiles, emphasizing the usefulness of physics knowledge for technological development. There were statements indicating ambitions to spread the view about the technology as a problem solver – thus, interpreted as having a desire to change physics teaching. The habitus assembles statements that expressed a positive attitude towards independent schools, to private industry and the importance of technology development for economic growth. University education in physics and technology seem to have been obvious paths and have been accomplished with recognition and motivation. Technology is recognized as a problem solver and the ideals of progress

contained in the natural sciences related to the economic growth are important symbolic values, both in teaching and in lifestyles. A characteristic in the habitus is economic prosperity, which seemed important, and we observe that the lifestyles stress an upper middle class affinity, indicators of which have been suggested by Bourdieu (1984) and Erik Bihagen (2000) in a Swedish context.

Economic, social and cultural capital were composed by having more than one car and travel to work by car and liking to arrange dinners with good food for friends and acquaintances, spending the holidays in a cottage or on a self-owned sailboat, visiting friends in other countries or going on holiday abroad, to “theme journeys” and weekend holidays, also found by Tally Katz-Gerro 2002 and as indicators for upper middle class and Lena Karlsson (2005) in a Swedish context. Other cultural indicators are present, such as reading liberal newspapers and trendy homes, and the favorite dress code tends to be creased trousers. As mentioned above, the lifestyle stresses an upper middle class affinity, and we interpret a view characterized by materialism and commercialism and a tendency to lack of interest in cultural values, exemplified by habits of mostly watching news and science programs on TV, which provide an indication of a limited sphere of cultural life. They also watch sports on TV, which would however indicate a lower class activity according to Bihagen (2000). But their own sports activities could explain the interest in watching sports on TV. Being active in sports could also strengthen the upper class affinity as investments in their body fitness and "looks," as Karlsson (2005) suggests. Cultural activities do not include playing an instrument, and this standpoint could maybe even view culture as a non-issue. The focus is instead on sports: jogging and playing golf. Their social commitment extends to the sporting activity, related to their children's participation in team sports.

The self-evidence of and beliefs in technology could be seen as originating in the social family background. For example, having a father who was employed in engineering or in the science field and a mother with education in engineering or science, both working in the private sector and not as teachers, shape "inheritors of technology" that use physics as a tool. This can be seen a heretical heterodox action according to the doxa in the natural science field.

Friends are engineers, with degrees in social sciences, workers or teachers. The current partner seems often to be a minor civil servant, often in science and technology, but not a teacher. Their children are pursuing natural science programs in upper secondary school; thereby they will be prepared for further studies in engineering. From the statements, conclusions can be made that the teachers were high achievers in physics and wanted to learn about and work within the subject. The path of teaching as a profession seemed not fully been mapped out, but the choice was between being an engineer, a physicist or a teacher. For further training in the subject and in physics teaching, reading professional literature and journals is common. Teaching practices are mainly based on books about physics and technology.

The role as a “challenger” of the traditionally defined Physics subject means having an interest in students’ learning more about sustainable energy and a desire to teach about sustainable development related to physics. In order to achieve success in their own position it could be in terms of developing the subject in accordance with the policy documents about environmental sustainability. It could mean fulfilling the definition of its ethos as a “subject representative,” but maybe also due to the personal conviction regarding the benefits to society of achieving environmentally friendly technological development. In the statements connected with this habitus we also observe an inclination to choose teaching practice based on the students’ experiences, a thematically approach and an urge for students to develop into citizens with a thorough understanding for energy issues. Having achieved a position as

"subject representative" at the school and having received some support from the school direction implies that the holder has great skills and high competence in the subject.

The habitus' related statements show that there is an evident desire to change the school physics field and to do so with comprehensive physics knowledge. The acquired position and a dedicated interest and expertise in classroom experiments, technical equipment and contemporary technology are facilitators. We find indications that the teacher is presumed to have a great knowledge of and skills in physics applications and can thus bring physics into context and develop teaching in line with current research in science and technology.

The Challenger for Citizenship

This habitus tends to work as a democratic and intellectual "challenger" of the physics subject, characterized by engagement in society and political issues and self-confidence from both natural science and the educational policy field, emphasizing the concerns of physics for sustainable development. This is an "activist" or a "rebel" habitus with an urge and courage to develop the physics subject to be more related to environmental, political, ethic aspects, with an ambition to teach all students physics for their future citizenship. The engagement in society and environmental issues are likewise apparent in the habitus, which is molded by an origin from the upper middle class, highly valuing cultural activities but appears as rather confident and satisfied with a modest approach.

From the statements in the questionnaire we observe that sustainable development and contemporary political issues in society are influencing the physics teaching, combined with ambitions to organize students work thematically, in group work with projects and allowing students discuss and develop their own projects. We also found that the teaching practices were designed in line with the students' experiences and discussions. There is also an indication for dialogical teaching, which means that even if the teacher has a specific message, a discussion in the classroom opens up for new, unique, questions (as described by Alexander 2004). Furthermore, the strategies are characterized primarily by teaching more of evaluating content, than the other habituses' choice of methods. Interdisciplinary teaching is highly valued and social sciences tend to have high status in their own schools. Physics seems to be an important subject for the teacher, but difficult to change because of its tradition, and an evident standpoint is that physics knowledge is needed for general education. Physics is considered not only as a subject for the elite students or for students that will continue to study technology at the university – it is recognized as important that all students have the opportunity to learn physics. According to the standpoints, the physics subject is related to many of our environmental problems. Therefore, in relation to the traditional and orthodox view of school physics, this is a heterodox standpoint that everyone should have the opportunity to learn physics in order to act as responsible and enlightened citizens in society.

Regarding the our reconstruction of the habitus and its formative dispositions, it seems that the solid interest in teaching per se that we mentioned above might grow out of experiences from growing up with a father who was a teacher, with experience from teaching at university level, and a mother who either worked in the health sector or as a teacher. In other words, in this habitus it is a composition of both inherited and acquired educational capital. If both parents work in the public sector, it could be imagined that through their occupations they procured the importance of being engaged and involved in civic, political and societal issues. This societal engagement seems to be important and can be seen in participation in student union work during university studies and present involvement in different community associations. The engagement in and involved in civic, political and societal issues could also be sustained through living with a spouse that works in the health care profession or as a teacher, and is also active in community-related issues. The statements also point out that teachers seem to have motivated their children to study natural science or social science,

pathways which ensure a smooth entrance to university studies in Sweden (Broady and Börjesson 2007). The response patterns among items measuring the teachers' legacy of educational and cultural capital to the next generation indicate that the first child tends to study natural science programs, but the second child tends to study social science programs. There is also a breadth in their children's leisure activities, such as singing in a choir, dancing, engaged in athletics, scouts, recreation, technology or swimming.

We interpret the teachers' statements as a judgment that physics should be linked to real life, which is supported by certain physics education research and contemporary political steering documents. Roberts (2007) proposes a connection to real life so that the students will be able to use their knowledge of science, including physics, in contexts outside of school. In this habitus a standpoint is then to change physics education from being presented as "ready-made science", which means applying teaching practices that answer questions that no student has asked, to another practice that allow students to discuss controversial issues including both natural science and even more sociological aspects. We conclude from the habitus' dispositions and positions that teachers often work in schools with a natural science profile and they establish close connections to nature as an opportunity to increase students' interest in physics and also for enhancing their future civil engagement – a standpoint that Sjøberg (2005) expresses: "...the safeguarding of nature and the environment is part of participation in a democracy and a good knowledge of science makes it possible for students to obtain such a commitment "(ibid p 178).

In the statements from the questionnaire we interpret diverse interests in both science and social science, which is notable even in the lifestyle indicators, where the interests of a more cultural and creative side of the teacher emerge. The home, for example, is described as being timeless and characterized by harmony and seems to be well thought-out and carefully designed furniture, not necessarily functional but easy to tidy. It is designed by miscellaneous "deliberately selected" furniture and things with specific purposes; the furniture was preferably purchased in antique shops, at a flea market or in second hand shops, but not in specific furniture stores. The social life seems to imply elements of enjoying inviting friends and appreciating homemade and fine food. The spare time is often spent with relatives and friends, who work as teachers, or are academically educated in the social sciences or engineering. Different kinds of cultural activities that the community offers are used: cinema, museums, classical concerts and jazz concerts, which are considered upper class cultural activities (Bourdieu 1984). Reading poetry and playing instruments are amusement activities, as well as handcrafts (Bihagen 2000). Going in for sports is not a significant interest, nor is watching sports on TV, a stance in line with those mentioned earlier (Katz-Gerro 2002). However, the statements point to an ambition to keep up with news and media and having insight into different channels. If they watch TV it tends to be nature programs and science programs, but also entertainment and music programs, but definitely not reality shows, feature films/action, series, comedy, sports or local programs. These standpoints also show affinities with the upper class choice of TV (Karlsson 2005).

Being a "challenger" means expressing a symbolic standpoint that the teaching should be implemented in such a way that all students feel "at home" in physics, which we interpret as a solid interest in the teaching role and an interest in various subjects besides physics. It seems as if the teachers really wanted to follow a teacher profession, due to for example a deep fascination with their own physics teachers and a willingness to read professional literature to acquire further training in physics and for developing their skills in physics teaching. Regarding the composition of dispositions, it seems that a prolonged experience as a physics teacher of more than 20 years is present and also experience of teaching other subjects in upper secondary school, university level but also lower secondary level. The typical

educational background in this habitus consists of a degree in mathematics and physics, but is often combined with one more natural science subject.

The dispositions also include a high level of recognition from the local school management, and consulting tasks externally would contribute an understanding of the ease in acting in different arenas and with differentiated content orientation. Having achieved a position as program coordinator at their own school and in that role received great amount of support from the school management and sometimes also having been consulted as a lecturer outside their own school are examples of recognition. This habitus originates from upper middle class life conditions and has a willingness to appear unassuming, bohemian and environmentally conscious. At the same time the habitus features an intellectual and conservative person with compassion for the wider community. A casual attitude to education is evident, thus it means a feeling of ease towards the education system and openness for studies at university in science and other areas.

Other lifestyle indicators that were present in the dispositions were the residential conditions where the teachers tended to live in an house or apartment they own in a city with more than 100 000 inhabitants or in a small town, but not in Stockholm or Gothenburg. They do not necessarily own a car and travel to work could be by other alternative means, and if there was a car in the family it was a small one. The expressions of a bohemian approach were for example the use of ergonomic shoes, clothes should be classic and of good quality, not fashionable, but comfortable, stylish and environmentally friendly. Holidays are mostly spent in Sweden, but not in a boat or on the "sunny beach." The statements revealed that teachers usually read a conservative newspaper, and mostly the editorial and foreign sections.

The role of a program coordinator in the school requires a multidisciplinary, holistic approach and an understanding of current policy documents, also curiosity about new findings from educational research and from the nature science field. The stance that the students have to get insights that make them critically thinking democratic citizens is a requirement for all education, and this is also what we conclude as a highly valued belief, also emphasized in the present curriculum (Lpf 94) and specifically concerning education for sustainable development. The position requires interest and respect for other disciplines as well as involvement in the development of teaching.

Teachers' strategies in relation the social space of school physics

The starting point of this study was to problematize physics teachers` *use* or the *non-use* of the valuating content in physics teaching and its' relation to environmental contexts. Based on a questionnaire, which had been used in a previous study (Engström and Gustafsson 2010), we continued to analyze why physics teachers in upper secondary school choose to teach as they do. We reconstructed the polarization of ideal physics teaching practices through information about their positions as physics teachers in secondary school, their dispositions (capital) and their standpoints on content and methods in teaching, which are related to symbolic values in larger social fields. In order to do this, we have used a Bourdieuan framework that helped us to reconstruct teachers' habitus in relation to a specific social universe – *the social space of school physics*, existing at the intersection of natural science, the educational policy field and the reproductive field, with a core function of reproducing the social order and a core of knowledge that has been negotiated in symbolic struggles (Bourdieu and Passeron 2008). The social space of school physics is nevertheless influenced by other larger social fields mentioned above, where specific kinds of capital are vigorous and certain standpoints are recognized to different degrees. The poles of values offer an opportunity for the teachers to seek legitimacy in their choices of teaching practices, but also offer other important values in their choice of lifestyles.

As mentioned earlier, we basically recognize the collective physics teacher habituses as somewhat homogeneous, primarily because they share a common position in the defined social space, as physics teachers in upper secondary school, which are assigned a middle-class position. In terms of cultural highbrow consumption in the habituses' lifestyle conditions, there are general similarities in class related patterns like visiting museums, theaters, libraries etc. (for example in Bihagen 2000 but also in Karlsson 2005 in a Swedish context and Katz-Gerro 2002 in a comparative perspective). But we also found differences in the kind and amount of economic capital, inherited educational capital and some features of cultural capital such as interest in societal engagement and in discussing political issues, sports as leisure activities etc. However, they have profound differences in the habituses' views of physics teaching, which evince a clear tension between an urge to change or to preserve traditions, i.e. reproducing the order of things.

In the study we have studied the relationship between teaching strategies and the poles in school physics at the intersection between three larger social fields that offers bases of cultural legitimacy or recognition in doing the right thing. In addition, we analyzed homologies of strategies and their legitimacy bases related to the teachers' social and cultural dispositions, which resulted in the reconstruction of three habituses; *The Manager of the Traditional, The Challenger of Technology and The Challenger for Citizenship*.

Methodological and theoretical considerations

Taking into account some of the present criticism against the somewhat ambiguous features of a multilayered concept as 'habitus' itself (e.g. Sayer 2004) is challenging, both methodologically and theoretically. Margaret Archer's (2003) criticism of the concept of habitus claims that the concept is underdeveloped in relation to everyday reflexivity and calls for a third analytic level i.e. *inner conversations*. Anthony King (2000) discusses habitus in relation to Bourdieu's theory of practice and concludes that the concept of habitus is a key vehicle to a return to objectivism, while Bourdieu's work on practical theory is more nuanced and sensitive to intersubjective practice. Roy Nash (2002) concludes in his article on the use of habitus as an analytic tool, that "if the full value of Bourdieu's method is to be achieved, it will be through the close investigation of the structure of definite *habitus*, as states of mind or effective dispositions," like his own analysis reported in the article (ibid, p.46). Examples of studies concerning this dimension are Simon Charlesworth (2000) on the phenomenology of the working class and Lesley Pugsley (2004) on social stratification within higher education, that is, works that both have anthropological/ethnographical approaches. It would be of importance to continue the study of teaching practices and teacher habitus further. Methodologically, it could involve life-history methods and ethnographic field work, which could give a more in-depth understanding of the practice in action and also study how the teachers justify their choices in their own words.

In other critical discussions, such as when Bourdieu refers to "open concepts designed to guide empirical work" (Bourdieu 1990, p. 107), Reay discusses the indeterminacy of the concept, which fits well with the "complex messiness of the real world" but there is also a risk of habitus becoming "whatever data reveals" (2004, p. 438). For Diane Reay it is important to work *with* the concept instead of using it as an explanation of data. Her criticism is mainly directed towards studies that use habitus mechanically and that do not consider the mix of embodiment and the instinctive with reflective and pre-reflective activities. Our study can be criticized for applying the concept without considering these aspects of reflexivity in relation to habitus. However our aim is not to provide a comprehensive, universal and final understanding of teaching practices among physics teachers in upper secondary schools in Sweden, but rather to offer a basic understanding of present collective habitus and possible objective relations which an individual habitus would operate within. As we mentioned in the

beginning, this study is as a first step to understand physics teachers' practices from a sociological point of view. A second step would be to explore collections of individual habitus, using anthropological/ethnographical approaches in order to capture the dynamics, variation and ambiguousness within a collective habitus, for example physics teachers' habituses. In order to fully comprehend the social space of school physics, individual habitus and practices, other more qualitative and in-depth approaches are indeed necessary.

The inclination to change or to maintain the status quo?

In the social space of school physics, we noticed a strong polarization between the traditional managing habitus and the two challenger habituses, a tension between inclinations to "preservation or status quo" and "change". In terms of Bourdieu's metaphor "a game of cards" (Bourdieu 1989), the habituses enjoy different recognitions depending on these polarizations. Teachers with intentions to change content and methods in their teaching due to actual political documents about sustainable development, for example, and with the desire to reach more of the students or with the intention of giving students the opportunity to become interested in higher education in energy the field of technology may be seen as aces in the card game depending on the what legitimacy the pole is accorded and its dominant doxa. *The Manager of the Traditional* habitus, which is representative of "the status quo," and is consolidating and reproducing high symbolic values in the natural scientific field, can be seen as losers in the same card game, given the reference of the above perspective. But they may instead be aces, from the natural science field point of view, while the challenger habituses could be seen as agents for increased shallowness in the physics subject. Thus, we can conclude that the teachers' point of views and teaching practices are judged from different angles and thereby recognized differently. The teachers themselves estimate their own value, by choosing a suitable economy of symbolic goods for measuring and evaluating their practices. For those who seek recognition in relation to natural science doxa, it is evident that they do not really care about the game within school physics, which is presently heavily governed by current political values embodied in the national curricula in Sweden.

Teachers determined to choose subject content in physics including more values and society-related issues, that is, teachers corresponding to *The Challenger for Citizenship* habitus, are clearly characterized by engagement in society, being self-confident in the education system and showing interest in both natural science and cultural fields. That kind of habitus admits openness to political issues and to pursuing an interest in developing a physics subject for all students, practices a kind of *physics for citizenship*. On the other hand, the other challenger habitus *The Challenger for Technology* practices are a kind of *physics for technology*, which is clearly characterized by technology optimism, being self-confident in the educational system and a high valuation of the importance of technological development for economic and humanitarian welfare in society. But the most predominant habitus *The Manager of the Traditional* is the more traditional one and is characterized by a reverence for the field of natural science and a sense of anxiety towards culture fields and resistance to social engagement. This habitus is characterized by closeness to natural science and unwillingness to contest and change. Hence, the teaching will include traditional methods for understanding concepts and for succeeding with calculations using physics formulas. This kind of anxiety in the face of change is probably based on a low level of self-confidence in the educational system, due to parents with no academic experience from higher education, which has its genesis in no or low amounts of inherited educational capital.

Consequences for teaching practices in Physics Education

The teaching practices carried through by the habitus *The Manager of the Traditional* may lead to consequences for students, such as a non-use of physics knowledge in contexts if the

teacher has no intention of changing their teaching in the direction of critical questioning and a reflective approach. Due to the dominance of this habitus in the social space of school physics, the traditional practices may be reproduced, because this is the predominant group and the natural science ideals are deeply rooted in the physics subject and its devoted teachers. Even in the larger social space of science education, where the space of school subject physics adjoin, there is a strong focus on developing teaching practices essentially for conceptual change, not necessarily in the more traditional way but in a more dialogic way (for example found in Driver et al. 1994 and in Alexander 2006). The teaching for conceptual change is based on students' own constructions and explanations of physical concepts. The role of the teacher is then to influence the student to think in a scientific way, a process called conceptual change or conceptual addition (Fensham et al. 1994). From a conceptual change point of view, facts, definitions and formulas will be seen as the endpoint of significant intellectual efforts, as in all times when physicists have tried to understand physical phenomena (Mulhall and Gunstone 2007). Scientific knowledge is symbolic and is socially constructed. Understanding a concept means more than just reading in a textbook or making unreflected observations. Physical concepts are constructions placed on the phenomena as explanations and interpretations. These constructions are deeply implemented in scientific thinking, and the understanding of them is highly valued in physics teaching when the teaching is characterized by high symbolic values related to natural science (Driver et al. 1994).

A crucial difference between the dominant habitus *The Manager of the Traditional* and the two challenger habituses *The Challenger of Technology and The Challenger for Citizenship* is the goal of teaching. Is teaching supposed to end up with an understanding of concepts or is it permitted to use concepts in another context? Or, the other way around, to start with a specific context and let students themselves notice a need of a conceptual understanding? Taking physics to another context requires courage to challenge the strong influences of sacred values in natural science and seeking legitimacy from other fields. The concern of conceptual understanding and calculative competence are indeed found in the traditional habitus as well as in the two challenger habituses, but the latter also offer their students something more, albeit in different ways. However, the traditional habitus, would undoubtedly argue that they also are offering their students more (though more of the same).

Implications for teacher education

Not every student in the Physics A course in secondary school in Sweden will complete higher education in the physics or energy domain, but all of them will meet notions and relations in the course that they are expected to understand and use to describe the world. Secondary school physics should incorporate physics teaching for citizenship and at the same time foster competence for those who want to seek higher education in physics. An important implication is that physics teacher education should give future teachers an opportunity to reflect on their views of the subject of physics and their view of science, as well as their view of how physics should be taught and why they think that way. Giving aspiring teachers a chance to reflect upon their dispositions can be a way to provide individuals with a foundation for an understanding of the way they act together with their inherent values.

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Biographical information

Susanne Engström has a PhD in science and technology education, and is a senior lecturer at Mälardalen University. Her research focuses on school subjects seen as social practices and teachers' different views on for example the subject of physics and the subject of technology.

Carina Carlhed has a PhD in Education, and is an associate professor in Sociology of Education and currently holds a four-year post doc position at Uppsala University. Her research focuses on students' study patterns, transfer and dropouts in higher education and mobilization and professionalization processes, classification struggles and academization in Medicine and Education and in their boundary areas.

Appendix

Table 1. Examples of differences in statements between the three habituses 1= The manager of the traditional, 2 = The challenger for technology and 3 = The challenger of citizenship

Respond to a question, statement, etc.	**n =**	**Habitus 1 (%)**	**Habitus 2 (%)**	**Habitus 3 (%)**
I have a special function in my workplace.	151	45.1	60.0	65.0
I often get a hearing for my ideas with school management (with the principal).	151	39.1	34.4	71.4
I became a physics teacher because I was fascinated by physical phenomena.	190	54.5	62.7	74.1
I wanted to become a math teacher and needed another subject.	190	23.9	18.7	7.4
I was good at physics.	190	22.7	28.0	18.5
I wanted to become a teacher and mostly liked physics.	190	14.8	22.7	33.3
I studied physics at university and finally chose to become a teacher.	190	21.6	14.7	11.1
I wanted to become a physics teacher and work in such a way that all children and young people are given the opportunity to "find" physics.	190	9.1	20.0	29.6
I have been hired for lecture assignments or similar outside my school. Often or sometimes.	170	20.8	19.4	66.6
I never read about physics education in journals that I pay for myself.	153	71.8	55.6	21.1
I never read about physics education in research reports.	154	78.6	60.9	25.0
I never use the internet at work to keep me updated on physics education.	156	31.0	16.7	5.3
I never use the internet in my spare time to keep me updated on physics education.	156	43.8	20.0	10.0
It is not true that physics is a subject that should be studied primarily by those who will be involved and contribute to the technological development of society.	146	46.4	48.2	90.5
It is absolutely true that physics is a subject that must be connected to real life.	155	32.9	41.7	57.1
I have received a scholarship during my studies.	155	36.5	34.4	60.0
My father worked as a: Worker. lower civil servant	190	37.5	30.7	18.5
My father worked within technology.	190	6.8	10.7	7.4
My father worked as a farmer.	190	10.2	6.7	7.4
As a teacher or as a university teacher.	190	11.3	8.0	29.6
My mother worked as: worker. lower civil servant. clerk.	190	33.0	25.3	11.1
My mother worked in nursing or teaching.	190	22.7	26.7	48.1
My father's highest education is a graduate degree.	149	5.6	3.5	20.0
My mother has a university degree.	148	32.0	41.1	55.0
I am active in an association with involvement in social issues.	190	3.4	8.0	22.2
I read Svenska Dagbladet (conservative newspaper) at least once a week	190	12.5	9.3	25.9
I read the Dagens Nyheter (a liberal newspaper) at least once a week.	190	27.3	34.7	25.9
I read Aftonbladet (a socialist newspaper) at least once a week	190	20.5	14.7	14.8
I read the editorial in the newspaper.	190	31.8	37.3	55.6
I read the foreign pages.	190	44.3	46.7	59.3
I read the sports pages.	190	42.0	41.3	25.9
I watch SVT1 daily. (public service television)	147	40.0	50.9	25.0
I watch SVT2 daily. (public service)	146	41.4	45.6	21.1
I watch TV4 daily. (commercial television)	146	29.0	26.3	15.0
I watch reality shows on TV every month. .	128	27.1	19.2	5.9
I watch sports on a daily basis.	130	31.7	32.7	16.7
I never look at sports.	138	25.0	19.2	44.4
I go to art galleries a few times a year - about once a month.	143	27.9	37.5	63.2
I go to a concert of classical music a couple times a year - about once a month.	139	17.9	33.4	50.0
I never participate in study circles.	139	74.6	54.7	52.6
I have relatives over for a visit a few times a week - a month.	140	45.5	56.4	73.7
I have visits from friends and acquaintances a few times a week - a	139	64.7	71.1	89.5

month.				
I read novels a few times a week.	142	38.6	38.9	57.9
I never read poetry.	139	82.4	66.0	55.6
I read nonfiction a few times a week.	143	30.4	43.6	63.2
I play a musical instrument a few times a week - once or twice a month.	139	35.3	33.9	61.1
I never engage in crafts / hobbies.	138	82.4	79.2	52.6
I go for long walks several times each week.	139	38.2	42.3	63.2
I live in a rented apartment.	190	30.7	18.7	14.8
I live in house that I own.	190	33.0	44.0	37.0
I go on holidays in my own boat.	134	16.5	42.0	23.6
I never go on holiday in the sun.	137	47.8	47.2	64.7
I never go on theme trips with a guide.	134	85.1	68.0	82.4
I never go on theme trips (food. culture. wine. etc.)	132	83.3	69.4	76.5
I wear comfortable shoes at work.	190	25.0	28.0	40.7
I like science programs on TV.	190	64.8	64.0	59.3
My household has a combined annual income of more than SEK 600 000.	138	28.4	45.3	33.3
I would describe my furniture (alternatives): timeless design.	190	12.5	20	37
I would describe my furniture as “deliberately selected” with a specific purpose	190	18	12	33
Most of all I want my home to be (alternatives): Easy to clean	190	33	29	22
Practical and functional	190	36	31	26
When I invite guests to dinner. I prefer to serve: Traditional home cooking	190	14.8	5.3	3.7
Delicious and luxurious food	190	13.6	22.7	29.6
Heaps of good food.	190	4.5	13.3	11.1
Original and exotic food.	190	4.5	13.3	11.1
My household has more than one car.	190	19.3	29.3	14.3

Table 2. Relative frequencies in the sample and in the population. regarding sex. age. work experience. position. school control. and residential locality of the teachers.

Variable		**Sample n=268 (%)**		**Population n=1434 (%)**
Sex	No response	23.5		-
	Women	17.5	Women	35
	Men	59.0	Men	65
Age	No response	23.9		-
	< 30 years	7.1	< 30 years	10.0
	30-40 years	20.5	30-40 years	37.4
	41-50 years	15.7	41-50 years	33.7
	51-60 years	16.8	51-60 years	16.0
	> 60 years	16.0	> 60 years	2.9
Work experience as physics teacher	No response	14.1		-
	< 3 years	11.9	< 3 years	24.4
	3-10 years	25.7	3-10 years	35.7
	11-20 years	16.0	11-20 years	22.2
	> 20 years	32.3	> 20 years	18.1
Position*	No response	13.8		-
	Upper secondary teacher	76.9	Upper secondary teacher	97.5
	Lecturer in Physics	10.4	Compulsory/ lower secondary teacher	1.6
	Compulsory /lower secondary teacher	10.8	University teacher	0.2
	Physics at university. no teacher qualifications	7.2		
	Other occupation (i.e. engineer)	14.6		
School control	No response	22.0	-	-
	Community	61.2	Municipality	71.7
	County	1.5	County	1.5
	Private	15.3	Private	15.1

Residential locality	No response	23.5	-	-
	Stockholm incl. suburbs	9.3	Stockholm	14.7
	Gothenburg incl. suburbs	8.2	Gothenburg	11.4
	Malmö incl. suburbs	1.1	Malmö	7.7
	Smaller cities and countryside	57.7	Smaller cities and countryside	61.5

*multiple response item. proportions do not add up to 100%

Table 3. “Physics A: Goals to aim for

The school in its teaching of physics should aim to ensure that pupils:

- develop their knowledge of the central concepts of physics. quantities and basic models.
- develop their ability to speak and write. as well as reflect over the phenomena of physics. its models and concepts.
- develop their ability to quantitatively and qualitatively describe.
- analyze and interpret the phenomena and processes of physics in everyday reality. nature. society and vocational life.
- develop their ability to propose. plan and carry out experiments to investigate different phenomena. as well as describe and interpret what is happening when using the concepts and models of physics.
- develop their ability with the help of modern technical aids to compile and analyze data. as well as simulate the phenomena and processes of physics.
- acquire knowledge of the development of the history of ideas concerning physics. and how this has influenced humankind’s worldview and the development of society.
- develop the ability to analyze and evaluate the role of physics in society” (SKOLFS 2000:49. the English translation)