

Doctoral Thesis from the Department of Mathematics
and Science Education 9

Per Anderhag



Taste for Science

How can teaching make a difference for students' interest in science?

Per Anderhag

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Abstract

The objective of the thesis is to describe and analyse aspects of home background and teaching that may be important for students' capability and will to participate in science. The purpose is to make explicit how teaching can support students in developing an interest in science and so counter-balance the restricted opportunities some students may have due to upbringing. In study 1 population data is used to make evident what associations there are between home background variables and the students' choice of applying for the Swedish post-compulsory Natural Science Programme (NSP) in upper secondary school. The findings show that home background is important for Swedish students' choice of the NSP but also that some lower secondary schools can make a difference in that more students than what would be expected choose to apply for the NSP from these schools. Students' interest in science has usually been examined through questionnaires and rarely studied as constituted in classroom action as a result of teaching. In study 2 therefore an action-oriented methodology is developed based on the concept of taste to study what difference a teacher can make for the constitution of interest in the science classroom. The concept of taste is grounded in pragmatism and the works of Pierre Bourdieu and simultaneously acknowledges the affective, normative, and cognitive dimensions of situated science learning, all shown to be important for student's interest in science. In study 3 this methodology is used to examine how a teacher located through study 1 supports his students in developing an interest in science. The results of study 3 suggest how a supportive teaching clarifies the scientific aims of the activity and focuses on assisting students towards these aims. During this process norms and values are explicit and student actions and feelings are negotiated and clarified in relation to what they bring to the accomplishment of the task. The results thus show how a teacher can make the object of science the focus of students' interest and so showing that science, with its aims, norms, and values, can be enjoyed in itself. In study 4, finally, I draw on the findings of studies 1-3 to discuss the possibility of an overlooked field in studying interest in science. I argue that science is transacted in radically different ways at the primary, secondary, and tertiary level but that this may have been overlooked when students' interest have been studied. It is thus possible that primary students, who are said to be interested in science, and secondary students, who seem to lose this interest, in effect have different objects of interest. The findings of

studies 1-4 are used to discuss how teaching may make a difference to a continued student interest in science.

Keywords: interest in science; taste for science; norms; values; aesthetics; secondary school; home background; teaching; learning; equity; pragmatism; Bourdieu

List of Papers

This thesis is comprised of a summary of the following four papers.

- I Anderhag, P., Emanuelsson, P., Wickman, P.-O., & Hamza, K. M. (2013). Students' choice of post-compulsory science: In search of schools that compensate for the socio-economic background of their students. *International Journal of Science Education*, 35(18), 3141–3160.

- II Anderhag, P., Wickman, P.-O., & Hamza, K. M. (in press) Signs of taste for science: A methodology for studying the constitution of interest in the science classroom. *Cultural Studies of Science Education*

- III Anderhag, P., Hamza, K. M. & Wickman, P.-O. (in press). What can a teacher do to support students' interest in science? A study of the constitution of taste in a science classroom. *Research in Science Education*

- IV Anderhag, P., Wickman, P.-O., Jakobson, B., Hamza, K.M. Why do secondary school students lose their interest in science? A possible overlooked explanation. *In review*

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Acknowledgments

Varför har nätterna inga namn? (Palm, 1971)

Någonstans i avhandlingen refererar jag till forskare som refererar till forskare som säger att känslor är naturliga inslag i naturvetenskapliga forskares vardag. Taget ur sitt sammanhang framstår ovanstående som absurt, inte att naturvetare känner saker utan att jag argumenterat empiriskt för att hävda att naturvetare känner saker när de jobbar. Hur skulle det kunna vara något annat sätt? Oavsett vad man arbetar med lär känslor, bra eller dåliga, små eller stora, vara en regel snarare än ett undantag i de flesta människors vardag. Jag kan numera intyga att forska i didaktik – precis som att köra mjölkbil, riva frallor, sälja tapeter eller undervisa i biologi – inte är något undantag. Innan jag tackar de som varit med på denna känslofyllda resa vill jag först tacka de anonyma lärare och elever vars tal och handlingar denna avhandling bygger på. Som lärare får man alltför sällan erkännande för det man gör och i det här fallet, jag studerade klassrum där lärarna påverkar elevernas intresse positivt, känns det därför dubbelt att det är bara jag, mina handledare och de själva som vet vilka de är. Tack för att jag fick ta del av er undervisning!

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Introduction

This thesis examines the influence teaching has on students' interest in science. The theme is far from new, as early as 1899 William James made the following remark: "No topic has received more attention from pedagogical writers than that of interest" (James, 1899/2007, p. 51). Although James addressed education in general, his observation concerning interest was also, and still is, valid for the field of science education. Researchers have regularly recognized the importance of interest and other affective constructs for students' will and opportunity to learn and engage with science (see e.g. Fortus, 2014; Krapp & Prenzel, 2011; Osborne, Simon, & Collins, 2003; Potvin & Hasni, 2014) and for half a century attitudes have been a major research area of the field. Interest in school science is well-examined and we know that teaching is of great importance for students' interest. Yet, surprisingly few studies have actually examined what is happening in classrooms where an interest in science is supported (e.g. Potvin & Hasni, 2014). Consequently, our understanding of how interest in science is constituted through teaching is limited.

Teaching is thus the focus of this thesis and the overarching question addressed is: how can teaching make a difference for students' interest in science? Although the science the students encounter in school greatly influences their interest, experiences related to home background have been shown to be equally important for students will to participate in science (Gorard & See, 2009). Student interest does not only concern their attitudes towards the subject of science and how it is taught, but is also dependent on their capability and will to participate in the normative and value-laden practice of school science. Students' familiarity and identification with the norms and values that are transacted in the science classroom are greatly influenced by home background. As a consequence, some groups of students may be recurrently excluded from science.

In the thesis I approach this tension between teaching and home background in two ways, first by specifically searching for classrooms where it is the teaching in science and not the home background that is the reason for the observed student interest, and secondly by developing and using a methodology that acknowledges the cognitive, normative, and aesthetical dimensions of interest. In study 1, therefore, population data is used to make evident what associations there are between important background variables such as parental educational level and household income and the students'

choice of applying for post-compulsory science. This data is used to locate compulsory schools in Sweden where more students than expected, considering their home background, chose the Natural Science Programme (NSP) in upper secondary school. In schools deviating positively, I assumed, teaching in science may compensate for inequities related to home background. Here teaching in science makes a difference.

As touched on above and as will be discussed in the *Theoretical framework*, students' interest has primarily been approached as correlating to emotions and as being a mental entity associated with some object or situation. Norms and values are regularly recognized to be connected with this construct and it is commonly accepted that interest is of great importance for student learning. Cognition, norms, and values are however often operationalized as separate and only rarely as intertwined when student interest is constituted. Moreover, only rarely is interest approached as situated in a social setting and what we know about student interest is principally based on questionnaires and interviews (Potvin & Hasni, 2014). Study 2 is a response to this; here I develop and present a methodology for studying interest as the constitution of *taste*. The concept of taste is grounded in pragmatism and the works of Pierre Bourdieu and simultaneously recognizes the cognitive, normative, and aesthetical dimensions of participation in the science classroom, all shown to be important for students' opportunity to develop an interest. In study 3 this methodology is used in an explorative way to examine how a teacher located through study 1 supports his students in developing *a taste for science*.

In study 4, I draw on the findings of studies 1–3 to discuss the possibility of an overlooked field in studying interest in science. I present an overview of how interest changes over the primary-secondary transition and argue for a need to study a possible suggestion to explain why students often seem to lose their interest in science in secondary school. I suggest that this may not be the case, namely that students do not lose their interest in science they developed in primary school, but rather that an interest for secondary science is never constituted. Throughout schooling the subject is science, but science is transacted in radically different ways at the primary, secondary, and tertiary level. This concerns subject content but also various social aspects of learning and participating in the science classroom. It is therefore possible that the object of science may differ in such ways that it may not be appropriate to compare the interest constructs, which has usually been done. In study 4 I therefore discuss the need for examining the possibility of whether primary students as opposed to secondary and tertiary students have different objects of interest, so suggesting that there may be important differences regarding what these level-specific interests signify in terms of science.

Finally, this thesis approaches interest as it may reveal itself in young persons' actions, namely how they may consider science as a future career

choice, and how they take part in science class. The scope of the thesis is explicitly didactical¹, that is, its interest is about what a teacher can do to support students' taste for science and its findings are best understood as contributions that could guide teachers and researchers. There are indeed other ways in which interest in science may reveal itself, for example, how young persons' include science as a relevant part of their daily lives. I do not deliver any final judgments regarding how taste for science may be supported and what consequences this may have on young persons' lives, but rather the findings need to be supported with more evidence from other content areas, grade levels, and classroom settings.

¹The term refers to the European educational field of didactics. Didactics is an academic discipline – its historical roots can be found in 17th-century Germany – for teacher education but also for the teacher profession in Europe (Wickman, 2014). Didactics focuses on how teaching decides and organizes content, time, activities, and so on, and what consequences these choices may have for learning. The teacher-content-student relationship is typically addressed through questions of *what* (e.g. content), *how* (e.g. pedagogy or material used), and *why* (e.g. why is the particular content taught and pedagogy used for these students in this situation). In many European countries didactics is therefore recognized as the professional science of teachers (Wickman, 2014).

Previous Research

Why the Interest for Students' Interest?

Due to its importance for participating and learning, students' interest in science is well-studied. It is generally accepted that the constitution of interest is taking place in the complex interplay between on the one hand the *individual* (gender, ethnicity, social class, identity formation, norms and so forth), and on the other hand *the science content* (e.g. cognition and attitudes), *the science classroom context* (e.g. teaching style, teacher personality, norms and values, and so forth) (e.g. Tytler, Osborne, Williams, Tytler, & Cripps Clark, 2008). It is also generally accepted that students' interest towards school science is initially positive but declines rapidly in subsequent school levels (Lindahl, 2003; Potvin & Hasni, 2014; Tytler, et al., 2008). Students have also been shown to distinguish between school science and the science they meet outside school (Osborne & Collins, 2001; Osborne et al., 2003; Tytler et al., 2008). At the same time as they can describe science outside school as interesting, science in school is often reported to be important but tedious, abstract and difficult (Lindahl, 2003; Rennie, Goodrum, & Hackling, 2001; Tytler et al., 2008).

Findings like these, owing to the idea of science as a potent force for societal growth, are often framed as a well-fare issue of great concern (OECD, 2007). Reports have thus argued that many Western countries will experience a future shortage in skilled personnel for the scientific and technically oriented industries (European Commission, 2004; OECD, 2007; The Swedish Technology Delegation, 2010; Tytler et al., 2008). International studies have demonstrated that students' interest and knowledge in science can differ considerably between seemingly culturally comparable countries (Condrón, 2011; Jidesjö & Oscarsson, 2004; OECD, 2010; The Institute for Labour Market Policy Evaluation, 2010; The Swedish National Agency for Education, 2009) which has led researchers and policymakers to investigate why some countries are more successful than others in developing interest for science among students. Also historically, various stakeholders have argued that students with an interest in science are a necessity in order to meet society's requirement of scientifically skilled personnel (De Boer, 1991). Some of the means to generate an interest were also similar to the ones posed today; in the 1920s of USA for example, an interest in science was argued possible to realize by creating a more relevant

and meaningful curriculum in which students' personal experiences were acknowledged (De Boer, 1991).

Students' interest in science can also be framed as an equity-issue of great concern. Cultural background, such as ethnicity, gender and social class has been argued to be of importance for students' attitudes and studies have also shown that background influences the extent to which students continue with post-compulsory science (Gorard & See, 2009; OECD, 2007, 2010; Tytler et al., 2008). It has therefore been argued that specific student groups are not only at risk of becoming excluded from a scientific career but also excluded in terms of perceiving science as something they can partake in and relate to in their daily lives, irrespective of whether they will continue with science or not (Jobér, 2012; Wickman, 2006). This notion, rather than the predicted shortage of scientists, is also the primary backdrop of this thesis.

Methodological Approaches to Interest

Interest in science has usually been approached as an attitudinal construct and therefore primarily studied through student descriptions of their interest (Krapp & Prenzel, 2011; Osborne et al., 2003). Student interest has also been approached as the possible outcome of this inner drive, namely as participation, attainment, and achievement. The relation between these and the interest construct is sometimes ambiguous and studies have demonstrated instances of both positive and negative correlations. It is thus not self-evident that students that attain and do well in science would report that they are interested in the subject. Also the opposite may be the case; students that say they like and are interested in science do not necessarily do well or want to continue with post-compulsory science.

In the review article of Potvin and Hasni (2014), 228 research articles on students' interest, attitudes, and motivation towards science were analysed. The study identified four major categories between the years 2000–2012, namely "Portraits of students' I/M/A [interest, motivation, attitude]" (57%), followed by "Effects of interventions on I/M/A" (33%), "Articles without research results" (6%), and finally "Validation of I/M/A measurement instruments" (4%). Articles in the first category presented findings on perceptions, preferences, and differences between groups and were concerned with psycho-socio-economic variables and particular small-scale object or events. When sub-categorized, the three most common topics addressed were boy/girl differences followed by school-related variables and decline of I/M/A with age and school year. Hence, during this time span the most examined areas were gender differences in regard to I/M/A and the age-associated decline in interest. These topics were regularly investigated through questionnaires.

Of the total of 228 papers, 189 used questionnaires, 16 interviews, 3 class observations, and 8 used other sources. In the articles, a considerable number of tests were borrowed from previous research (107), 74 were exclusively constructed and usually inspired by, or had borrowed questions from other tests. Among these, most were Likert-type and many consisted of multiple choice questions. Rarely were open-ended questions used. The authors conclude that the results presented are similar to what has been reported for earlier periods and that their review, thus, does not present any “outstanding discoveries”. What is known about student interest is thus predominantly based on secondary reports in the form of questionnaires and interviews and the authors also call for alternative approaches (Potvin & Hasni, 2014). Similar claims are also made in earlier reviews (Krapp & Prenzel, 2011; Osborne et al., 2003).

At the same time as interest in science regularly has been approached through questionnaires and interviews, there are a number of studies that have used more situated methods to study aspects important for the formation of an interest in science. These studies, however, have not necessarily positioned themselves as primarily studying interest (and maybe therefore they are only rarely part of the corpus of review articles), but rather they examine, for example, student identity, gender, norms and values of the classroom, student participation, and so on. Sometimes the phenomenon examined is explicitly connected to aspects of students’ *interest* (e.g. Archer, DeWitt, Osborne, Dillon, Willis, & Wong, 2010; Carlone, Haun-Frank, & Webb, 2011) and sometimes it is not (e.g. Jakobson & Wickman, 2008; Jobér, 2012). As will be discussed in the *Theoretical Framework*, the use of the concept of taste to a large extent is a means to approach this complexity, namely by approaching *interest* as originating and developing in social encounters and so being intertwined with content, norms, and values. The aim of the following text is therefore to provide the reader with a broad scope of what is known about students’ interest, both in terms of students’ attitudes to the subject and in terms of students’ participation.

The Decline in Interest in Science

Students’ interest in science has been shown to decline during late primary school and drops sharply at the primary-secondary transition (Pell & Jarvis, 2001; Tytler et al., 2008). According to some studies tertiary educational prospects in science are consolidated as early as at the age of 13 (e.g. Tytler et al., 2008). At the primary level, students’ regularly express positive attitudes towards science, both in regard to content and to the science classroom practice (Agranovich & Assaraf, 2013; Tytler et al., 2008). These attitudes, however, change as the students move through schooling and attitudes become more negative. Although the age-associated decline in

interest is evident in other school subjects as well (Krapp, 2003; The Royal Society, 2008), it has been argued that the decrease may be more significant in science (Hidi, Renninger, & Krapp, 2004; Jenkins & Nelson, 2005; Lyons, 2006a; Osborne & Collins, 2001; Potvin & Hasni, 2014).

According to Logan and Skamp (2008), the lack of relevance of school science for students' lives is an important contributor to why the interest in science declines. Gender, teaching quality, and classroom experiences are also argued to be strong contributors to this trend (Logan & Skamp, 2008). Similar reasons to why students' interest declines have been summarized by Murphy and Beggs (2003), namely the nature of the scientific content of the curriculum, the ineffectiveness of the science teaching, the difficulty of school science, and home background. This is supported by the longitudinal study of Carlone, Scott and Lowder (2014), who demonstrated how three students identity work in terms of becoming scientific, was facilitated or hindered by the classroom culture's notion of science vis-a-vis race, social class, and gender. Speering and Rennie (1996), who in their study followed students across the primary to secondary school transition, also identified the impersonal nature of teacher-student relationship, the move from activity-based science to transmissive approaches, and an impersonal curriculum as important for the change in students' attitudes. Similar themes were reported in Lyon's meta-analysis (2006a) on Lindahl's (2003), Osborne and Collins' (2001) and his own study (Lyons, 2006b), namely, that students perceived science teaching as transmissive, the decontextualized content do not engage interest or commitment, and the school science is unnecessarily difficult. Major reviews such as Osborne et al.'s (2003), Tytler et al. (2008), The Royal Society (2008) and the more recent of Krapp and Prenzel (2011) support this as well. Based on this, the suggestions given to why students' attitudes towards science are negative at the secondary level can be summarized as follows:

- Difficult and/or impersonal curriculum
- Transmissive and/or impersonal and/or excluding teaching
- Lack of relevance of school science to students' lives
- Home background-student identity (influences from parents and peers, gender, social class, ethnicity) which is intertwined with the other suggestions

Home Background and Teaching

Experiences of previous schooling and home are, as suggested above, important for how science will be perceived. In the following section I will present research regarding these aspects of interest, namely how student interest is influenced by home background and teaching. Since norms and

values have been shown to be important for students' interest in science, I will initially give an outline regarding the transaction of content, norms, and values in the science classroom.

Learning science – facts, norms, and values

To participate and learn science is not only a question of transforming a scientific content but also, as demonstrated by Lemke (1990), to learn how this practice classifies, evaluates, and distinguishes actions, artefacts, and utterances. According to Lemke (1990), learning science means “learning to communicate in the language of science and act as a member of the community of people who do so” (Lemke, 1990, p.1). Becoming a member of this community is of course easier for students that are accustomed with and can relate to the rules permeating this specific way of acting and talking. As implied above, such competence is not about familiarity with words and concepts, but rather ways of communicating what in the science practice that is valued as good/bad, important/unimportant, interesting/uninteresting, included/excluded, and so on. With its historical roots in a rational-positivistic and male European middle-class context, these communication patterns also, implicitly or explicitly, project and reproduce norms regarding what science is and for whom (Lemke, 1990). Consequently, some students have great difficulty to relate to the norms and values that are projected in the science classroom and can also describe themselves as excluded (Aikenhead, 1996; Costa, 1995; Jobér, 2012; Lemke, 1990; Schreiner, 2006). Studies have also shown that students often refer to school science in negative terms, such as science being impersonal, male biased, primarily for the smart kids, and with little meaning for them as individuals (e.g. Lyons, 2006a; Osborne, et al., 2003; Tytler, et al., 2008). There is thus reason to believe that values and norms of the science classroom indeed are important for student participation and interest.

Even if students report an interest in science (as typically observed through student questionnaires or interviews) it does not necessarily mean that they also perceive science as being of any relevance to their lives. Rather, the opposite may sometimes be the case (Breakwell & Beardsell, 1992; Carlone et al., 2011; Wickman, 2006). It has been shown that at the same time as students may do well in science and even report that they like the subject, they may describe themselves as excluded from science as a practice (Archer et al., 2010; Carlone et al., 2011; Lindahl, 2003). The extent to which students may develop an interest in science is thus not only a question whether they come to enjoy science as a content, but also about whether the students perceive science as something that they can relate to and want to participate in. Authors have therefore argued that it may be misguided to solely equate student engagement in science with achievement

or whether the students report it to be fun or interesting. Also their feelings regarding themselves as participants in the normative practice of science should be acknowledged (Archer et al., 2010; Carlone et al., 2011; Wickman, 2006).

Norms and values of the classroom have, however, often been overlooked when students' engagement and interest in science have been studied (Carlone et al., 2011; Potvin & Hasni, 2014). Even if we only have a limited understanding of how such aspects are transacted when students become or not become interested in science, there is evidence that norms and values are significant parts of scientific meaning making. For example, aesthetic judgments² are used by small children doing science in primary school (Jakobson & Wickman, 2008), teachers and students in secondary school (Säljö & Bergqvist, 1997; Yung & Tao, 2004), as well by teachers and students in university biology, chemistry (Wickman, 2006), and physics courses (Berge & Danielsson, 2012; Hasse, 2002). Findings like these suggest that norms and values, being evident through the judgments the participants are making, may be important for participating and so also developing an interest in science. Indeed, situated classroom studies have also shown that aesthetics are important for learning science in general. In their studies on students and teachers at the university and primary levels, Wickman (2006) and Jakobson (2008) have demonstrated that normative and aesthetic judgments are central for what route learning takes in the science classroom. Aesthetic judgments, positive or negative, have been shown to have an important function in orienting the participants in relation to purposes of the science activity. Positive judgments are typically used by students and teachers to distinguish conducive and preferred actions (e.g. "That is a *wonderful* experiment", "My larvae is the *cutest*"). Aesthetics are also used by students and teachers for summing up processes that come to closure (e.g. "*Nice* work"), thus describing a continuous rhythm of anticipation and consummation (Wickman, 2006). In this way the participants construe meanings regarding what is the case in terms of

² According to Wickman (2006, 2012), who refer back to Immanuel Kant's *Critiques*, the inner feelings of a person and his/her opinion on the qualities of an object, are evident as aesthetic or value judgments (e.g. I feel fine, that's a fine wine). Aesthetics is about feelings, emotions, and values and consequently aesthetic judgments are about pleasure and displeasure or the beautiful and ugly. Normative judgments, which concern what is preferred or agreeable in terms of right and wrong, good and bad, can also be in the form of aesthetic judgments, e.g., "That's a beautiful question!" but not necessarily, e.g. "This is not the way it should be done". Historically norms and values have been defined, operationalized and studied as clearly separated from the third classical component of human knowledge, namely: facts. Contrary to norms and values, facts are usually defined as something that can be proven, either by empirical tests or by logic reasoning. Typically facts are what are referred to when cognitive aspects of learning are studied and discussed. As opposed to norms and aesthetics, facts are also typically looked upon as the hearth and soul of the scientific enterprise. In the thesis I use facts-cognition and values-aesthetics synonymously.

scientific facts, but also how actions, artefacts, and utterances are aesthetically valued in relation to purposes of the science activity. Doing science is thus not solely a question of transforming a cognitive content, but as Wickman (2006) and Jakobson (2008) have shown, also an aesthetic experience of feelings and emotions. Consequently, content, norms, and aesthetics are simultaneously transacted when students learn science (Wickman, 2006).

Aesthetic experience is thus closely connected to learning normatively and cognitively in science class. Having this function, aesthetics is of great importance for learning what is right and wrong and what should be included and excluded in regard to the phenomenon and artefacts encountered (Jakobson, 2008; Wickman, 2006). The extent to which students can acknowledge and distinguish these aspects of doing science is important for their opportunity to successfully participate in the science practice (Jakobson & Wickman, 2008; Wickman, 2006). These norms may concern, for example, what is the preferred way to present data, which equipment that is most accurate and so should be chosen for making measurements, what characterizes a good experiment, and so on. If students fail to recognize these norms and so how to pursue with activities, they are at risk of also failing in learning cognitively in relation to the subject being taught (Jakobson, 2008). It is therefore likely that the development of a science interest both requires an understanding of the science content, as well as a capability to cope with scientific norms. In this way students may have the opportunity to learn how to successfully bring processes in science class towards purposes and to closure, that is; they may learn to participate by talking and acting science (Lemke, 1990; Wickman, 2006).

Home background and interest

In Sweden and in other Western countries, teachers, students, parents, and other important stakeholders often refer to science education as an elitist practice (Bertilsson, 2007; Carlone, 2003; DeWitt, Archer, & Osborne, 2013; Jobér, 2012). Science is reported to be important and difficult and therefore primarily appreciated by individuals having certain personal dispositions, such as intelligence and scientific mindedness (Archer et al., 2010; Bertilsson, 2007; DeWitt et al., 2013; Shanahan & Nieswandt, 2010). Indeed, in Sweden the NSP has been labelled as *The Royal Road* of post-compulsory education especially suited for certain student identities (Bertilsson, 2007; Broady, Bertilsson, Börjesson, & Lidegran, 2010). Initiatives have been taken to counter-balance this image of the NSP as an elite programme. In 2009, for example the Swedish government launched *The Broad Line* campaign deliberately drawing on identity issues to recruit more students to science (Andrée & Hansson, 2013). Interestingly, the campaign was shown to emphasise utility and attainment values rather than

enjoyment in the field of science (Andrée & Hansson, 2013). Somewhat similar issues are raised in the study of Carlone (2004). She studied the meanings made by upper middle class girls that participated in a reformed physics curriculum in which the stereotypical view on physics as fact oriented and impersonal were challenged by emphasising students as producers, rather than receivers, of scientific knowledge. The study showed that instead of connecting to science in any meaningful way, the students were concerned with maintaining a student identity that would be rewarded by a culture of achievement (e.g. grades). So rather than facilitating the students in developing a science identity and so possibly becoming a “science person”, the curriculum were for these students primarily a way to get good grades and credentials on a transcript (Carlone, 2004).

Since norms and values are essential parts in identity formation and consequently are important aspects of whether students can identify themselves with the science practice (Aikenhead, 1996; Brickhouse, Lowery, & Schultz, 2000; Costa, 1995; Schreiner, 2006), it is possible that some of the alienation and disinterest students describe towards science are linked to students’ difficulties in understanding, and therefore also identifying themselves with the norms and values that the science classroom rewards and reproduces. The home of the students is of great importance in regard to this; here parents share knowledge and dispositions assisting their children’s acquaintances with the norms and values associated with science education (Adamuti-Trache & Andres, 2008; Bertilsson, 2007; Broady et al., 2010; Jobér, 2012; Lemke, 1990; Lyons, 2006b). Studies have also shown that participation and attainment in science is associated with socioeconomic background³ (Gorard & See, 2009; Statistics Sweden, 2003; Svensson, 2002; The Swedish National Agency for Education, 2007). The effect of socioeconomic background is seen in other subjects as well, although possibly it is more persistent over time in science (The Royal Society, 2008). Examinations on the PISA 2006 data have nuanced this picture since only a weak relationship was found between home background and student answers concerning science career preferences (Kjaernsli & Lie, 2011).

It has been suggested that it is the educational level of the parents that is the key factor responsible for this relationship (Gorard & See, 2009; The Royal Society, 2008; Turmo, 2004) indicating that it is cultural capital, rather than economy that is important for student interest. This seems to suggest that students coming from homes with high cultural capital will find it easier to relate to what is valued in the science classroom and will also to a

³ Studies have operationalized socioeconomic background/status differently but usually variables capturing some aspect of education, income, and occupation are used. It is, regardless variables, commonly used as a measure to describe the social position the individual, family, or the group have in relation to others.

greater extent be recognized as included by teachers and peers (Broady et al., 2010; Jobér, 2012).

Besides parental educational level, other background variables such as immigrant background and gender are important for the transmission and reception of norms, values and expectations concerning science. There are, however, only negligible differences in application frequency to the post-compulsory NSP in Sweden between male and female students (The Swedish National Agency for Education, 2013). The same trend is found between students with immigrant background and students with non-immigrant background (The Swedish National Agency for Education, 2004; 2013). Large scale studies have shown that interest in science differs between countries and there is a notable difference between developed and developing countries, whereas young people from the latter have been shown to express more positive attitudes towards science (Boe, Henriksen, Lyons, & Schreiner, 2011). Studies have also shown that the interest differs between boys and girls, whereas interest usually correlates negatively with being a girl (Tytler, et al., 2008). These differences are primarily evident at subject level and in regard to specific areas within the subjects of chemistry, biology and physics (Potvin & Hasni, 2014). However, science is well-known to be white male gendered and, consequently, the expectations that are put on students, by others and by themselves, are likely to be affected by this (Calabrese Barton & Tan, 2010; Carlone, 2004). For example, in the studies of Brickhouse et al. (2000) and Carlone et al. (2014) it was shown how the teacher failed to recognize the potential which the female African-American students had for science due to these students unconformity to the stereotypical “good girl” identity. Moreover, in their longitudinal study on the experiences of women of colour being in the science pipeline, Carlone and Johnson (2007) showed that the recognition of others – of them being members in this predominantly white male culture – was a key factor for these women’s science identities. Gender and ethnicity differences towards post-compulsory science courses and careers have also been reported (e.g. Brotman & Moore, 2008; Lewis, Menzies, Nájera, & Page, 2009; Riegle-Crumb, Moore, & Ramos-Wada, 2011; Sadler, Sonnert, Hazari, & Tai, 2012), suggesting that gender and immigrant background indeed are important for students opportunity to participate in science.

Immigrant background, gender, and parental educational level are highly problematic to treat as homogenous variables and it would be erroneous to assume that each in isolation can explain an individual’s interest in science. Even if studies have reported differences in regard to, for example national background and interest, it is difficult to say anything about what this may mean in general terms, as social groups always must be understood relative to other groups in society. In the case of achievement in science, for example, variables such as parental educational level and/or parents being part of the workforce, rather than ethnicity, to a large extent explain

observed student differences (Kao & Thompson, 2003; The Swedish National Agency for Education, 2004).

Finally, norms and values are, as discussed above, clearly intertwined with upbringing and identity and therefore the classroom norms are likely to be more easily accessible to some students than to others. This concerns the individual student's ability to act conduively in the classroom (as argued by Jakobson (2008) and Wickman (2006)), but also – which is more problematic and so possibly also the reason why it has been more readily recognized by the research field – the risk of that the science practice excludes students due to their unconformity to implicit and explicit norms of what science is and for whom. So, students that often or always are having difficulties relating to why actions, phenomena, and artefacts are valued the way they are (e.g. why some questions are beautiful while others are not), or feel alienated to the practice as a whole (e.g. science is for the elite), are likely to experience feelings of marginalisation (Säljö & Bergqvist, 1997; Wickman, 2006). Also students that, for whatever reasons, recurrently are having negative aesthetic experiences in the science classroom (boring, disgusting, provoking, hostile, grouse, and so on) are also likely to turn away from science.

Teaching and interest

When students who are interested in science are asked about the origin of their interest, they often refer to a passionate teacher who supported and encouraged them in school (Tytler et al, 2008). In general, teachers who are successful in making science interesting seem to be specifically skilled in engaging students in the activities of the classroom. As mentioned above this may be associated with their personality as a teacher, but it is also associated with how they actively support their students to participate in the practice. Since it has been demonstrated that participation in the science classroom is not only about learning a content but also learning specific ways of talking and acting (Lemke, 1990; Wickman, 2006), successful teaching is likely to provide settings where this may come about. Considering what has been discussed in previous sections, practices where an interest is supported are also likely to acknowledge the students as individuals, irrespective of their backgrounds. That is, the norms and values of such classrooms are likely to include, rather than exclude, students.

Waldrip and Fisher (2003) and Waldrip, Fisher and Dorman (2009) have demonstrated that exemplary teachers are successful in creating an including environment in which students' will to participate and learn is stimulated. These teachers also try to engage their students in the learning process. Somewhat similar results have been reported by Osborne and Collins (2001); Yung and Tao (2004); Tytler, Waldrip and Griffiths (2004); Maltese and Tai (2008); Yung, Zhu, Wong, Cheng and Lo (2013) and Xu, Coats and

Davidson (2012) who also reported that effective teachers stress the need to utilise links with students' lives, interest and community. Similar issues have been raised by Fitzgerald, Dawson and Hackling (2013), who also stressed the importance of contextual dimensions when studying teaching in the science classroom. In the study of Carlone, Haun-Frank and Webb (2011) it was shown how two similar exemplary practices differed in regard to what and how norms were projected and made continuous in the classroom. These differences were shown to be of great importance for whether the students saw science as something that they could identify themselves with. There is thus evidence that in order for the students to be interested and learn science, the students do not only need to be supported in regard to the science content, but also in regard to how to relate to and articulate themselves as participants in the science practice. As shown by Wickman (2006), this can be a question of learning how norms and aesthetics align to the scientific object and how the student as a participant can learn to distinguish this.

Considering what has been discussed above, namely that teaching is of importance for students' interest, there is surprisingly little work done to identify how teaching may stimulate interest and engagement in science (Krapp & Prenzel, 2011; Osborne et al., 2003; The Royal Society, 2008). Moreover, at the same time as it is generally accepted that norms and values are important for the development of an interest in science, such aspects of learning science have often been overlooked when student attitudes and attainment have been examined (Carlone et al., 2011; Wickman, 2006). Since the majority of studies have approached interest through questionnaires, our understanding of how student interest is developed as part of a social practice is limited. Accordingly, we know little about how content, norms, and values are transacted in the classroom as a result of teaching and what consequences these may have on student learning and interest in science. This suggests a need not only to examine interest as constituted in classroom action, but also to examine what role norms and values of the science classroom may have on this constitution.

Aim and Research Questions

The objective of this thesis is to analyse and describe how teaching may influence students' capability and will to participate in science. The purpose of these analyses is to produce close descriptions of how teaching can support students in developing an interest in science and so increase our understanding of how teaching in science may compensate for inequalities related to student background. The thesis is guided by the following overarching question:

- How may teaching make a difference to students' interest in science?

In what follows I will present a short rationale for how the four studies together with their specific research questions approach this overarching question.

The aim of study 1 was to find compulsory schools in Sweden where teaching recurrently supports students' interest in science. In order to find such practices, I chose to approach students' interest as their choice of applying to the post-compulsory NSP in upper secondary school. Even if this does not necessarily mean that these students are interested in science in an emotional sense (i.e. love science), at least students choosing post-compulsory science do not consider themselves as excluded from the social practice of science. The choice of programme in upper secondary school is formally important and may have consequences for the student's future educational career. The choice of studying the transition between lower and upper secondary school was further motivated by the decline in interest at this point. Moreover, since home background has a strong impact on students' interest, it was necessary to find schools where it is the teaching in science rather than home background that explains students' interest. Consequently, in paper I the following research questions were addressed:

- 1) Is it possible to find lower secondary schools where the school compensates for the socioeconomic background of its students?
- 2) What association is there between socioeconomic variables and application frequencies to the Swedish NSP?
- 3) To what degree do schools deviate from the predicted NSP application frequencies when we control for the socioeconomic background of their students?

Students' interest in science has predominantly been investigated through questionnaires and interviews. Students have thus responded to questions regarding their attitudes towards science, future career choices or what characterize teaching and teachers that support their interest in science. Our knowledge of how teachers can support their students' interest in science is thus limited. In study 2, therefore, I developed a methodology to study the constitution of interest in classroom action. It has been demonstrated that participation in the science classroom and also students' attitudes towards science do not solely concern the subject content, but also the norms and values that are reproduced and rewarded in the classroom. In order to be able to acknowledge these dimensions of learning science, namely norms and aesthetics, the methodology was grounded in pragmatism research and the works of Pierre Bourdieu. Hence, in study 2 classroom data from a school where more students than expected chose post-compulsory science was used

to operationalize the action-oriented concept of taste. In the paper (paper II) I demonstrate how taste can simultaneously recognize cognitive, normative, and aesthetic aspects of participating and learning in the science classroom. Although not explicitly stated, I addressed the following question in paper II:

- 4) How can students' interest be studied as constituted in classroom action?

In study 3, the methodology developed in study 2 was used to examine how a teacher located through study 1 supported his students in developing an interest in science. Study 3 thus examined the following research question:

- 5) How may a teacher support students in developing a taste for science?

In paper IV I do not present any new empirical data but rather draw on the arguments and findings presented in papers I-III to suggest a largely overlooked possibility that may be examined in future studies, namely:

- Do primary students as opposed to secondary and tertiary students have different objects of interest, so suggesting that there may be important differences regarding what these level specific interests signify in terms of science?

If this possibility is valid it may be ill-advised to routinely compare the interest reported at different levels. Neither may it be appropriate to assume that students lose their primary school interest in science, but rather that an interest in secondary school science is never constituted. Paper IV is not separately presented but is merged into the *Discussion* of the thesis. In paper IV and in the *Discussion*, then, I address a group of questions that may be rewarding to study and these revolve around the following two overarching questions:

- 6) What signifies the interest in science constituted at different educational levels?
- 7) How can the interest in science at one school level be made continuous with the adjacent levels?

Theoretical Framework

Here I will present and discuss the theoretical framework of the thesis. Initially an overview of different attitudinal concepts related to interest is presented. This presentation is justified by the fact that research often refers to different theoretical constructs when students' attitudes and engagement with science are studied. As will become evident, the attitudinal constructs are intertwined and sometimes they have been used synonymously. After this outline the concept of interest is presented, first according to how previous research usually has referred to and used it, and then as operationalized in this thesis. Finally, interest will be discussed as taste and how development of taste can be understood as change of habits.

Interest, Attitudes, Motivation, and Engagement

The focus of this thesis is how an interest in science is constituted in situated classroom action. Although interest is well-examined, there is no consensus in the field regarding what is actually referred to when interest is studied (Bybee & McCrae, 2011; Osborne et al., 2003). In the literature different attitudinal constructs may be used interchangeably and several authors have indeed called for clarity when attitudinal dimensions of learning are examined (Krapp & Prenzel, 2011; Osborne et al., 2003; Ramsden, 1998). As discussed in *Previous Research*, student attitudes and interest can also be approached, explicitly or implicitly, as participation and attainment and studied as the observed consequence of an interest. However, attainment and achievement in science do not automatically suggest that the students are interested in the subject. There may be a variety of reasons for why a student chooses to attend post-compulsory science, for example a particular science programme may be a necessity in order to get access to future educational choices with little relevance to science.

However, usually when research examines interest, especially in interventional studies or studies seeking to measure larger groups of students' interest, it is usually the attitudinal construct one refers to. Therefore, I will give a brief outline of how *attitudes*, *motivation*, and *engagement* commonly are defined and how they relate to *interest*. There are several other attitudinal constructs that the literature may refer to when students' attitudes are studied, for example *self-determination*, *curiosity*, or

self-efficacy, but I chose to focus on the ones mentioned above since these are more clearly related to the interest construct used in this thesis.

Attitudes may be defined as “a predisposition to respond positively or negatively to things, people, places, events or ideas” (Simpson, Koballa, Oliver, & Crawley, 1995, p. 212) and attitudes to science are thus regularly observed as a person’s positive or negative response to science (Simpson et al., 1995). Although the concept may seem simple and straight-forward, attitudes towards science may concern a variety of different aspects of school science, for example the students’ enjoyment of the subject, their *motivation* towards science, or their feelings regarding failure, difficulties, achievement, and so on (Simon & Osborne, 2000). Moreover, attitudes can also be described as specific dispositions well-suited for science and as such often distinguished by science persons (i.e. scientific attitudes). In these cases the attitudes signify certain personal traits such as being logic, open-minded, curios, and so on (Gardner, 1975; Simpson et al., 1995). It is not self-evident that a student likes science just because he or she expresses scientific attitudes and, so, may be suited for a scientific career (Lindahl, 2003).

Motivation is usually defined as an overarching entity that causes, directs and maintains the behaviour of the individual (Koballa & Glynn, 2007). According to Simpson et al. (1995) motivation is clearly goal-oriented and as such of great importance for learning. Other internal entities, such as interest and self-efficacy, are suggested to influence the person’s motivation to participate and attain in subjects. In relation to learning, motivation can be further differentiated as extrinsic and intrinsic. The former is suggested to be more important for any genuine education as persons with intrinsic motivation finds enjoyment in their own learning (Koballa & Glynn, 2007; Logan, 2007). In their review Koballa and Glynn (2007) refer to Csikszentmihalyi’s (2000) work on flow and state that “Students who are intrinsically motivated to perform a task often experience *flow*, a feeling of enjoyment that occurs when they have developed a sense of mastery and are concentrating intensely on the task at hand” (Koballa & Glynn, 2007, p. 89). A person who is extrinsically motivated, on the other hand, is suggested to be more interested in completing a task, or a course and this type of motivation does therefore not primarily concern the content or the activity of the learning (Koballa & Glynn, 2007; Logan, 2007).

Student engagement with science is usually suggested to be a result of attitudes, motivation, and interest. These constructs are in turn affected by other sub-constructs as for example self-efficacy and curiosity (Logan, 2007) which in turn may be affected by still other factors such as identity, social context, and understanding (Logan, 2007; Pugh, 2004). In the study of Pugh (2004) it is suggested that engagement can be subcategorized into two forms of student engagement in the classroom, one which concerns content and one which concerns peripheral things. In the former the student can be said to be

interested and deeper understanding may be realized. The latter is more focused on things not obviously related to the science classroom content, for example the interaction with friends or having a good time.

The concept of interest will be discussed more thoroughly below, but as evident from this outline, interest affects and also intersects in important ways with attitudes, motivation, and engagement. Logan (2007, p. 30) has summarized the relation between the constructs as follows: "In a classroom environment in order for students to develop a sustained interest in science and develop positive attitude to the subject, he or she needs to display motivation towards science; such students will be engaged in both the activities and the content".

Interest as Entity

As with the other constructs, there is no consistent definition of student interest. Important aspects of the construct are shared, however, and researchers usually agree that the level of a student's interest has a powerful impact on learning. Also teachers, parents, and students often refer to interest when they consider conditions for teaching and learning. Students' success or lack of success in developing an understanding of subject content is also often referred to interest. According to Hidi et al. (2004), three features of the interest construct distinguish it from other motivational variables. First, interest is content or object specific, namely a person being interested is interested in something specific. Second, the conceptualization of interest exists in a particular relation between a person and content, not in the person and not in the object of interest (Hidi et al., 2004). Interest is thus the outcome of an interaction between the individual and a particular content and Hidi et al. (2004, p.95) describe this as "that the individual, as a potential source of action, and the environment as the object of action, constitute a bipolar unit". Third, interest has both cognitive and affective components. Hidi and Renninger (2006), whose interest construct is grounded in a psychological-neurobiological framework, argue that the affective component of interest "describes positive emotions accompanying engagement, whereas the cognitive component refers to perceptual and representational activities related to engagement" (p.112).

Interest is often distinguished as either situational or individual/personal and whereas the former is short-termed and caused by temporary interest-arousing events, the latter is stable and also more important to learning. The situational interest is easiest to affect through teaching but has only a small effect on a more enduring interest. Typically this interest must be sustained by external support (Hidi & Renninger, 2006). The individual interest, which is suggested to be more difficult to affect through teaching, is specific, stable, develops over time, and is associated with personal significance,

positive emotions, high value, and increased knowledge (Koballa & Glynn, 2007; Wade, 2001). In order for the interest to have any genuine effect on learning the initial short-termed interest needs to transform towards an individual interest. It has been argued that this may be realized if subsequent activities (in relation to what aroused interest) are perceived as meaningful or/and allow for personal involvement. If given proper support an individual interest may develop and the person will successively value and seek opportunities to re-engage in tasks related to the emerging interest (Hidi & Renninger, 2006).

As described above, it has been argued that it is not always clear what kind of interest that studies actually examine (Bybee & McCrae, 2011). This may concern, for example, whether the enjoyment or engagement of the respondents signify a temporary interest or are signs of a more enduring individual interest. Other examples may be whether the respondents and the researchers are referring to the same kind of interest, such as extrinsically or intrinsically oriented interest constructs or a subject or area interest in science. Although this dilemma often is referred to how interest has been conceptualized, the problem may possibly be related to how different studies usually examine interest. As mentioned above, certain important aspects of the construct are usually acknowledged, such as for example that interest concern content and that interest is an outcome of the individual and this content, but the methods to make evident student's interest differ. Research has regularly approached interest as a mental entity and typically this entity has been extracted through secondary reports such as interviews and questionnaires (see reviews by Krapp & Prenzel, 2011; Osborne et al., 2003; Potvin & Hasni, 2014). Consequently, the observer needs to make assumptions regarding what observed actions and words may mean in relation to the internal entity studied. The ambiguity of how a particular action or statement should be interpreted may be approached by using more precise questions which seek to separate different kinds of interest from each other (Bybee & McCrae, 2011) or by cross checking different data, such as verbal and written accounts (Ramsden, 1998). However, the underlying dilemma remains, namely to what extent observed actions correlates with the mental entity we want to make conclusions about (Östman & Öhman, 2010; Stenlund, 2000; Wickman, 2006). Below I will argue for an alternative way to operationalize interest in which this problematic step of translation may be avoided.

Interest as Participation

Since the aim of this thesis is to examine how interest comes into being in the classroom, student interest needs to be examined more directly through bit-by-bit processes in situated classroom action. Consequently interest is

here approached as social and procedural, and rather than being a mental state explaining action, or vice versa, interest is in this thesis operationalized as constituted in action. This approach to interest does not in any significant way differ from what has been discussed above. The action-oriented dimension of interest is regularly recognized by the research field. Koballa and Glynn (2007, p. 88) for example, state that a student who is interested in a science topic “has a readiness to pursue it” (see also Gardner, 1975; Hidi et al., 2004; Osborne et al., 2003). The contextual nature of interest is also readily recognized; interest is the situated outcome of the interaction between the individual and the object in a particular environment (Hidi et al., 2004).

Drawing on pragmatist research on learning and engagement in science (cf. Jakobson, 2008; Jakobson & Wickman, 2008; Wickman, 2006) and John Dewey’s writings on interest (cf. 1913/2012, 1929/1996); student interest is understood as a directional process oriented towards near or distant goals in which actions and artefacts are valued and enjoyed based on what they bring to the fulfilment of this process. This definition, which originates from Dewey (1913/2012, p.43), focuses on the situated process in which the individual brings some course-of-action to its accomplishment. Since actions and artefacts are distinguished and valued in relation to what they mean in facilitating the process forward, interest is clearly normative. These norms do not only concern what is interesting and what is not, but also what actions that should be included and excluded in order to proceed. Content, norms, and values are thus jointly transacted when interest in science is constituted. At the same time as this process is goal-oriented, its directional nature reflects the rhythm of anticipation and consummation rather than illustrating a predetermined movement to some fixed and final goal. Being interested is thus not primarily the question of coming to closure, but rather the totality of the process which is summed up when reaching consummation. For example a person experiencing interest when reading a book, playing a PS3-game, or riding a horse is usually interested throughout the process and not only when the book, game, or ride comes to an end. Outside school this process is often unproblematic; an interested person is regularly competent in distinguishing and judging actions carrying the process forward. In the example above, the person riding will choose some particular route that suits the temper of his horse, the weather conditions or whatever is of importance to his expectations of the riding experience. In school, however, aims and goals, and sometimes also the means to reach them, are usually not for the students to decide. Consequently, students rarely have full control over this directional rhythm of anticipation and consummation.

The interest construct defined above may seem somewhat detached and bland. Nothing in it explicitly suggests “personal significance, positive emotions, high value, and increased knowledge”, descriptions which are usually used when students’ interest is described. However, if one

scrutinizes what we typically ground our descriptions of interest on, when saying, for example, that a friend is interested in horses, it is usually observed actions we refer to. The friend spends much time in the stable; he knows much about horses and can distinguish what is of relevance or not when some aspects of riding are discussed. We could ask him about his feelings, what it is with horses that he enjoys, why this is so, and so on, but it is not necessary for us to do that in order to observe whether he is interested or not. In the light of student interest in science, and what teachers can do to support it, this is also what really matters. Namely, that the student has a capability and will to pursue in the science classroom. There is grandeur in this view of interest and a reason to why the attitudinal constructs previously presented also may be used in this thesis. As stated, in regard to the aim of this thesis it is not critical if an observed action may be a sign of motivation rather than interest or vice versa (as defined above), or what some word or utterance represents in terms of the internal feelings of the students, but rather what consequences these actions have in the situated activity.

Normative and aesthetic judgments – distinguishing what is right and wrong, good and bad, nice and ugly, and so on – are of great importance to what route learning takes in the classroom. The extent to which students can acknowledge and distinguish these norms is thus important for their opportunity to successfully participate in the science practice (Jakobson & Wickman, 2008; Wickman, 2006). Participating and maybe also developing an interest in science is therefore not only a question of understanding and enjoying the content of science, but also the norms and aesthetics of the practice (Jakobson, 2008; Jakobson & Wickman, 2008; Wickman, 2006). To make aesthetic and normative judgement is usually described in terms of *taste* and to participate and develop an interest in science therefore becomes a question of learning the distinctions of the practice that are conducive to its goals and aims (Jakobson, 2008; Wickman, 2006).

Pierre Bourdieu (1979, 1984, 1996) has convincingly demonstrated how taste is developed through upbringing and education and that taste is of great importance when it comes to people's opportunity and will to pursue in social practices. Interest operationalized as taste does not only acknowledge students' attitudes towards science, but also the extent to which they can participate and act meaningfully in the science classroom. In the following section I will discuss this, namely how interest and participation can be described as taste.

Participation as Taste

Here I will discuss the concept of habitus and taste in relation to the pragmatist framework and it is therefore necessary to initially make a caveat. In this thesis taste plays a key role, not habitus. The concept of habitus is

primarily presented in order to clarify the social origin of taste and what relation this concept has to the pragmatist notion of habits. *Habitus* becomes active in relation to a field and consequently it is not applicable in this thesis to make any statements regarding, for example, the relevance of a certain student *habitus*. I simply do not examine students' *habitus* or a field in which it is situated. In other words, notwithstanding that this thesis examines distinctions of taste – which is the manifestation of embodied dispositions – trajectories of a particular student *habitus* is not the focus of this study.

Habitus and habits

In a pragmatic framework meaning of words, utterances, and actions are not ready-made once and for all, but instead they get their meaning through their use and consequences in situated activities (Wickman & Östman, 2002; Wickman, 2004). Wickman and Östman (2002), who draws on the later Ludwig Wittgenstein and the works of John Dewey, describe the process in which people construe meaning as a continuous rhythm between anticipation and consummation. This rhythm is halted when people encounter situations where they cannot take action. By using the terminology of the Practical Epistemological Analysis (Wickman & Östman, 2002), the person can be said to have encountered a *gap*. A gap can be anything that hinders the process in which the person is engaged, for example encountering a new word (“Can you give me the *beaker*?”), an ambiguous outcome of an experiment (“Why did it turn red?”), or a practical obstacle (“The car will not start!”). In order to proceed, the gap needs to be filled with *relations* to what already *stands fast*. What stands fast is what is immediately intelligible and which the individual does not question (e.g. “Do you mean this *glass*, is it a beaker?”). Framed in this way, the answer to why people act the way they do is consequently not to be found in some underlying structures but rather meaning making is understood and examined as situated in specific activities with certain implicit or explicit purposes (e.g. measuring the volume of a liquid, doing an experiment, using the car).

The Bourdieuan framework may seem to conflict with this situated approach since the *habitus*, of which taste is an essential part, usually is defined as embodied disposition structuring action, thus connoting something static and deterministic. However, when recognizing the empirical project in which the concept of *habitus* once was developed and how this concept is used by Bourdieu, similarities with the pragmatic stance become apparent (see e.g. Aboulafia, 1999; Shusterman, 1999).

Recurrent in the works of Dewey and Bourdieu is the questioning of dichotomies rooted in the notion of an internal subjective mind and an external objective reality. To both authors this worldview, to Bourdieu manifested as a scholastic reason and to Dewey as the spectator theory of knowledge, has its origin in the historical and social conditions in which

some groups of people had the privilege to position themselves in a purely theoretical and so detached position towards human existence. In principle this position, which both authors argue is evident in different forms of the contemporary philosophical traditions, has resulted in a general detachment from human conduct and the doings of people are primarily understood as the workings of isolated minds in an objective reality (Bourdieu, 1998, 2000; Dewey, 1958). The tendency of universalizing particular cases and forgetting the social conditions which made it possible is, according to Bourdieu, the source of fallacies with serious consequences for the way the social and historical world is grasped and described. The first fallacy involves the collapsing of practical reason into theoretical reason and so overlooking the embedded and embodied logic of practice. Bourdieu refers to John Austin (1964) who exemplifies the scholastic view as “the particular use of language where, instead of grasping and mobilizing the meaning of a word that is immediately compatible with the situation, we mobilize and examine all the possible meanings of that word, outside of any reference to the situation” (as quoted in Bourdieu, 1990, p. 380). Utterances and actions in every-day activities tend therefore to become mystified and through the work of the observer a “social chimera” is created, “a monster with a waiter’s body and a philosopher’s head” (Bourdieu, 2000, p.155). The second form of fallacy is expressed as ethical universalism, which tends to suppress the social and economic conditions of access and therefore exclude those who are deprived of the means to realizing it. This may be exemplified by how questions of opinion polls are constructed in which the producer:

“has the leisure to detach himself from the self-evidences of ordinary existence in order to ask himself some extra-ordinary questions or to ask some ordinary questions in an extra-ordinary way, the sociologist asks the respondents to be their own sociologists, by asking them directly the question he is asking himself about them (... ‘Do you think social class exists?’ or ‘In your view, how many social classes are there?’)” (Bourdieu, 2000, p.59)

A third form of fallacy concerns the universalization of aesthetic judgments which fails to see that such judgments are rooted in a historical and social context (Bourdieu, 2000).

Bourdieu thus argues that there is a tendency to operationalize mind and practice as separated, a notion which also Dewey overtly question and which Bourdieu attempts to overcome by using the concept of habitus (its historical roots can be dated back to Aristoteles, see e.g. Nash, 1999; Reay, 2004). To Bourdieu objective structures in the society affect the actions of the individual, for example a nation’s educational system is a structure where curricula, grading and examination systems are likely to favour some particular type of learning, knowledge, values, and so on (Bourdieu, 1979; Bourdieu & Passeron, 1990). However, these structures alone cannot explain

the actions of the individual, for example by referring to gender, ethnicity, or social class when students report their attitudes towards science. That is, a background variable such as working class does not determinate a certain course-of-action. At the same time, since there are statistically significant differences in how different groups act, actions of the individual can neither solely be understood as the rational choice of a subjective mind. For example, the reported gender differences towards post-compulsory science courses and careers (e.g. Brotman & Moore, 2008; Riegler-Crumb et al., 2011; Sadler et al., 2012) indicate that there are important structuring principles excluding women from science. In the Bourdieuan framework, therefore, human action is understood as the habitual doings of the subject in relation to the objective structures, and these structuring structures have in turn been internalized through the lived life. Habitus is thus a set of dispositions resulting from the embodiment of the objective structures the individual has encountered through upbringing and education. These dispositions are open and constantly subjected to experiences and as such constantly affected, they are therefore durable but not eternal (Bourdieu & Wacquant, 1992).

The concept of habitus thus has important similarities with Dewey's habits. According to Dewey, a habit is a special accessibility to different groups of situations and not the mechanical repetitive of some specific actions. Habits are developed and transformed by the social encounters people experience (Dewey, 1922/2002). Habits are thus acquired through previous experiences and Dewey stress that the concept should not be understood as something latent but rather as being dynamic, active and anticipatory. Bourdieu also acknowledges this affinity with Dewey. As with the concept of habits, habitus should be "understood as an active and creative relation to the world, [which] rejects all the conceptual dualisms upon which nearly all post-Cartesian philosophies are based: subject and object, internal and external, material and spiritual, individual and social, and so on" (Bourdieu & Wacquant, 1992, p.122). Both concepts thus clearly recognize the social and habitual nature of meaning making.

Developing a taste

Taste, which reflects the habitus and so is a result of upbringing and education, has consequences for the individual's potential to participate in different activities. According to Bourdieu (1984), taste is fundamental to how the individual understands and distinguishes the world. The distinctions people make project this understanding. Consequently, through our taste we distinguish the world according to the preferences we carry, and when doing that we also distinguish ourselves towards others. Bourdieu (1979, 1984, 1996) has demonstrated how people of different social groupings share taste preferences in terms of what is good and what is bad, right or wrong, and

nice and ugly. Being socially situated, distinctions of taste on phenomena such as politics, interior design, education, and so on make evident to what extent the distinguisher belongs in a particular setting or not. Irrespective of the taste embodied, individuals' regularly acknowledge that there are distinguished and vulgar tastes. The norms of the distinguished taste are usually perceived as legitimate and better and are also the taste that is reproduced in – and usually also rewarded by – the educational system. In his studies on the selective structures of education, Bourdieu (e.g. 1996) has demonstrated how students become recurrently judged on how well they conform to the taste of the school, rather than how they achieve in the classroom and on tests. Successful students who fail in distinguishing the preferred taste are described by their teachers as possessing a shallow knowledge acquired through diligence and rote learning. Students that have the taste that the educational system rewards, on the other hand, are looked upon as brilliant and gifted and therefore well-suited for academia.

Consequently, educational choices and success in the path chosen is thus greatly associated with the taste of the individual and the norms and aesthetics of the sanctioned taste of the educational practice (e.g. Bourdieu, 1979, 1984, 1996). Also in the context of science education students may be judged in relation to unspoken norms, that is; some students may be described by their teachers as naturally talented for science whereas others are not (see e.g. Brickhouse et al., 2000; Carlone, 2003; Carlone et al., 2014; Jobér, 2012). There is thus reason to believe that other things than enjoyment for science or content knowledge may be valued and rewarded in the science classroom (Carlone, 2004).

Distinctions of taste are not necessarily actions made intentionally. They are neither arbitrary actions, rather they are habits or a lack of habits as recognized by others (Bourdieu, 1998; Dewey, 1922/2002). Dewey describes taste as a quality that is continuously transformed through experiences (Dewey, 1929/1996, p.209) and thus something that can be developed through education. According to Dewey (1997), all genuine education comes about through experience. The experiences need to have certain kinds of qualities in order to be educative. One aspect concerns the agreeable side to the experience and another deals with its possibility to influence further experiences. Thus, an educative experience needs to be continuous. This means that what the student experiences now, needs to be connected to what has been and it also needs to have a direction forward. The directional side of the experience can be equated with purposes, not necessarily being about specific things like completing an assignment but rather as a force that arouses curiosity and strengthens initiative (Wickman, 2006).

Neither Dewey nor Bourdieu empirically studied the constitution of taste, but both authors clearly acknowledged its situated nature. Moreover, although Dewey's theories regarding taste are not grounded in data and much of Bourdieu's empirical work is from the French society of the 1960–

80s, preferences of taste are of relevance in contemporary science education. For example, as described in *Previous Research*, interest in science not only refers to attitudes to the conceptual content, but also attitudes to scientific norms as they are projected through its practice (e.g. Taconis & Kessels, 2009; Wickman, 2006). Moreover, aesthetics has been shown to have a bridging function for cognitive and normative learning in the science classroom and so being vital for student meaning making and consequently also participation in science (Wickman, 2006, 2012).

Finally, the scientists themselves have been shown to describe norms, values, and feelings as vital in the social practice of science⁴. Indeed, some scientists have also explicitly acknowledged *taste for science* as a disposition evident among scientists. In his book “The art of scientific investigation” published in 1957, the animal pathologist William Beveridge uses in a chapter *taste* to describe important aspects of doing science⁵. The similarities with how Bourdieu and Dewey have discussed taste and interest are striking and a rather long quotation from Beveridge (1957/2005, p.79) can be used to summarize much of what have been discussed above:

⁴ This regards science as a practice where scientists have experienced feelings of happiness, despair, excitement, and so on (see for example the autobiographies of Charles Darwin (2002) and Mary Leakey (1984) or contemporary palaeontologist Neil Shubin’s (2008) book on Tiktaalik, the tetrapod fish that he co-discovered in 2004) but also as a practice where aesthetic and normative judgements are, just as in everyday life, important for what route some course-of-action may take. Hence, in the context of doing science as a scientist, aesthetic experiences have been important for the emergence of thoughts, concepts, models, and theories. See Wickman (2006) for examples and a thorough discussion regarding this.

⁵ Beveridge notes that other scientists have made the same observation and refers to the mathematician Jaques Hadamard (1945), who also acknowledged taste as an important characteristic of scientists (Hadamard in turn, refers to a book of Ernest Renan (1891) who uses the concept in relation to the cultivation of a personality (p.150) and in which he suggests that there is a scientific taste just as there is, for example, a literary taste). Hadamard’s description of a scientific taste is more or less identical with Beveridge’s in that it recognizes aesthetic dimensions concerning feelings of anticipation and consummation when the individual is pursuing some course of action (Hadamard, 1945, p.127). Although capturing essentially the same disposition, other scientists have, according to Beveridge, called it “intuition”, “instinct”, or “feeling” (1957/2005, p.79). De Boer (2014) provides another interesting example from the 1893 of United States. In a report on secondary school science from the National Association of Education, it is stated that direct observations in zoology and botany was to help students “form the *habit* of investigating carefully and of making clear, truthful statements, and to develop in them a *taste* of original investigation” (as quoted in DeBoer, 2014, p.561, my italics). In these examples taste for science is thus looked upon as habits that are continuously developing through social encounters and therefore, which the last example explicitly shows, possible to influence through education. This is interesting in relation to what has been discussed above, namely that the school tends to reward a certain taste without supporting those that does not have it by not teaching it. That is, the taste the students bring into the classroom is often treated (according to the studies of Bourdieu), by teachers and other stakeholders, as more or less congenital and therefore not possible to affect through education.

Taste can perhaps best be described as a sense of beauty or aesthetic sensibility, and it may be reliable or not, depending on the individual. Anyone who has it simply feels in his mind that a particular line of work is of interest for its own sake and worth following, perhaps without knowing why. How reliable one's feelings are can be determined only by the results. The concept of scientific taste may be explained in another way by saying that the person who possesses the flair for choosing profitable lines of investigation is able to see further whither the work is leading than are other people, because he has the habit of using his imagination to look far ahead instead of restricting his thinking to established knowledge and the immediate problem. [...] Our taste derives from the summation of all that we have learnt from others, experienced and thought.

So, a taste for science does not mean merely that the person reports that she or he is interested in science, but entails that she or he can engage in and take part in scientific communications by making certain linguistic and actional distinctions. These normative and aesthetic judgments concern what is the case and are thus continuous with cognitive learning and so dealing with facts and phenomena encountered in the practice (Jakobson, 2008; Wickman, 2006). Judgements of taste are made in relation to purposes, that is, in regard to what are going on in the situation, and although they may not be oriented toward a fixed and final outcome, they distinguish expectancy and closure. Hence, in this view to gain a taste for science means developing habits of distinguishing and valuing actions and utterances which are conducive to purposes and so belong in the science classroom.

Methods

This thesis is based on large-scale statistical data and bit-by-bit processes extracted from classroom interactions. The findings thus originate from both quantitative and qualitative methods. Since the four papers draw on separate sources of data and also differ in their empirical, theoretical, and methodological scope, a more thorough presentation of how the data was collected and processed will be given in connection to the presentation of each paper. Here I will just give a brief overview of the methods used and how they contribute to the project as a whole. After this overview aspects of validity, reliability, and generalizability will be discussed. This is also done briefly since such aspects of the research project are better addressed in relation to how I have operationalized theoretical constructs and interpreted the findings. Consequently these issues are addressed throughout the thesis and especially in the *Theoretical Framework* and *Discussion*. In the last section of this chapter I discuss the ethical issues the studies had to consider.

An Overview of the Methods

Study 1 is a quantitative study using statistical data, study 2 is a methodological study supported by classroom data, study 3 is an explorative study using empirical data from classroom observations, and finally, study 4 is a review study.

The aim of study 1 was to make evident what associations there are between the students choice of applying to the NSP and important background variables and to examine to what extent schools may counter balance these relationships. The data, coming from Statistics Sweden, covered the whole population of ninth grade students. The independent variables that were used were: gender, immigrant or non-immigrant background, the educational level of the parents, house hold income before tax, grades in mathematics and science, and final grades. Before the associations were calculated the data were treated and coded, for example students with missing variables such as parental educational level or income before tax were removed from the data set. Also schools that had less than 20 students in the ninth grade were removed. Ultimately, the data consisted of 106 483 students attending 1 342 compulsory schools. With the Stata software a logistic regression model was built and this model was used to

calculate the associations. The outcome of the regression analysis was then used to calculate the average application frequency for every compulsory school in the data set. This predicted outcome was compared with observed application frequency. In this way it was possible to locate schools that deviated positively from what was predicted.

The aim of study 2 was to develop a methodology for studying the constitution of interest in classroom action. Classroom data from a compulsory school located in a suburb of Stockholm was used to support and validate the theoretical construct of the methodology. The classroom of this study was chosen because students from this school were shown to recurrently choose the NSP to a greater extent than what would be expected considering the home background of the student population. I filmed and audio recorded the students (grade 7, ages 13–14) and their teacher during a practical on physics. The audio recordings were transcribed verbatim and analysed with Practical Epistemology Analysis (PEA). The PEA together with theoretical construct of taste, as used by pragmatist research and Pierre Bourdieu, was used to locate instances in classroom action where the participants made distinctions of taste.

In study 3 the same method as mentioned above was used, that is, video and audio recordings from classroom observations were collected and transcribed. In study 3, however, I used the taste analysis developed in paper 2 to analyse how the teacher supported his students in developing an interest in science. The school, which had three science teachers at the lower secondary level, was located through study 1. In order to locate the teachers that were likely to be responsible for the high application frequency, I talked to the principal about my findings and interviewed 8 students from each class. The teacher ultimately chosen was also the one the principal initially had referred me to when I approached the school.

Methodological Considerations

The odds ratios of the regression analysis of study 1 describe the association between a number of independent variables and the dichotomous dependent variable of choosing or not choosing the NSP. Considering that one of the purposes of study 1 was to make evident the effect of home background for the choice of the NSP, the method seemed to be fairly good in providing precisely that. The odds ratio of a given variable shows the likelihood of choosing the NSP independent of the other variables, thus giving information about the strength each variable has on the choice. However, it is important to stress that these variables do not reveal any causalities and consequently should not be interpreted as such. For example, the findings cannot be used to predict the future choice of a particular student profile, nor can they be used to explain why some students recurrently chose, or not

chose, the NSP. It is just not applicable to make any assumptions regarding the behaviour of the individual based on group data (Valsiner, 1986). Moreover, the findings reflect the student population of 2009 and one cannot assume that the same associations would be found in another sample year. Although it is probable that similar associations would be present, the study needs to be repeated with a new set of data in order to establish whether this is the case. This, however, was not a great issue for this thesis since the main purpose of the study was to make evident whether compulsory schools in Sweden could counter balance the effect of home background and if this should be the case, then qualitative studies could be conducted at one of the deviating schools.

An obvious question is to what extent I actually succeeded in locating variables that were important for the choice of the NSP? Even if the choice of variables was motivated by what previous research has shown to be of importance for students' interest, there is a possibility that there are other variables that may be vital for the choice of the NSP. For example *significant persons*, which have been suggested to have an impact on students choice of science (Sjaastad, 2011), were not accessible through the data sets of Statistics Sweden. There is likely to be other variables that may be important but, as already mentioned, study 1 was primarily a tool to locate schools where I could find examples of teaching in science that supported students' interest. A reasonable question arises in relation to this, namely whether I can be certain that it is the teaching in science that is responsible for the high application frequencies and not some other overlooked variable of the school context. This is a fair question and the answer is that I cannot be certain. However, the purpose of the study was not to establish, once and for all, how teaching affects student interest, but rather to examine what can be found in a science classroom at a school where more students than what would be expected chose post-compulsory science. More studies using the same approach are thus needed before any general conclusions can be made.

Finally, students' choice of applying to the post-compulsory science programme was used as an indicator of their interest in science. Although it is reasonable to question the validity of such assumption, attainment in science is an established approach to student interest and, as argued in the *Theoretical Framework*, choosing the NSP *at least* suggests that the students do not perceive themselves as excluded from science. Moreover, when framed as taste, participation in post-compulsory science is indeed a valid approach to students' interest in science, this argument is motivated and developed throughout the *Introduction* and the *Theoretical Framework*.

Studies 2 and 3 are qualitative and consequently the methodological considerations should primarily address transparency rather than reliability of measurement or whether they can be replicated or not. This is motivated by the fact that qualitative studies, as opposed to more quantitatively

oriented studies, rarely formulate research aims that assume a social reality that can be described in terms of fixation or finality (LeCompte & Goetz, 1982). In what follows I will discuss studies 2 and 3 in relation to this, namely possible shortcomings in regard to how the methods align to the purposes of the studies. I will also address degrees of transparency and generalizability but as mentioned above, these aspects will also be handled in the *Discussion*. A qualitative study needs to be reliable, that is, the results, but also the process in which these were constructed, should be consistent and transparent (Cohen, Manion & Morrison, 2007). The findings of studies 2 and 3, which in paper II is the methodology of taste and in paper III the outcome of the taste analysis, have been discussed at research seminars and smaller group sessions and, so, have been internally corroborated. Ultimately, however, the reader needs to judge whether the interpretations I have made are justified. Consequently, in order to appreciate the findings the reader is referred to the papers where I provide descriptions of the study setting, classroom context, the data, and the analysis resulting in the findings presented.

Another aspect that should be addressed is the extent to which the findings can be generalized and so transferred to other settings. This is of course an empirical question which also is central for this thesis, namely that the methodology developed needs to be applied to other classroom settings and school levels before any final judgments can be made regarding its usefulness. The same goes for study 3 which does not provide a final description of how teaching makes students interested in science, but rather serves as an example of how a teacher may support the students towards an increased interest. Again, the findings of this study need to be compared with findings from other studies using this or similar approaches.

Ethical Considerations

In the project description submitted to Statistics Sweden we (I and my two supervisors) presented the background to the project (home background, teaching, and the decline in students' interest in science), the over-arching aim (to examine what may be important for students' interest in science), the variables that we were interested in, and who would be the owners of the project. In the description we explained that we were interested in examining processes within schools and that our expectations was that the findings could be used to develop teaching in science. Consequently, besides examining the impact of home background on students' interest in science, Statistics Sweden was informed that the data was going to be used to locate schools where we could conduct qualitative studies. In order to receive the statistical data, I and the other participants of the research project (my two supervisors and two statisticians) had to sign a confidentiality agreement

with Statistics Sweden. By doing so we guaranteed that the data would not be used to determine the identity of any of the individuals in the material. Moreover, by signing the agreement we also assured that we were the only ones that would use the material and findings based on the data would not be presented so the identity of an individual or a school could be disclosed. Since the study was interested in variations at the school level, rather than variations at the individual level, this was not an issue and the data was handled in accordance with the agreement. Consequently the requirement of information, confidentiality and restricted use was met (see Gustafsson, Hermerén, & Petersson, 2006).

Studies 2–3 are based on classroom data from two lower secondary schools located in two different suburbs of Stockholm. Initially I met the teachers and informed them in person about the project. In short, I told them that the purpose of my project was to increase our understanding of how teaching in science may support students' interest in science and that the findings may be used in science teacher education. By doing so they were informed that I was interested in the classroom practice that they create together with their students and that the findings may be used to develop science teaching. They were told that they, the students, and the school would be kept anonymous and that they were free to interrupt their participation whenever they wanted. Before the data was collected I visited the classes and gave the students the same information that I had given to their teachers, namely that they would be kept anonymous and they could interrupt their participation at any time. I also informed them that the researchers participating in the project (I and my two supervisors) were the only ones who would have access to the data but in accordance to conventions of the research field, it needed to be stored in case another researcher would want to verify the findings. Finally I told them that the findings would be published in an international journal and a doctoral thesis. During these occasions the students were given opportunity to ask questions about me and the research project. The students were given forms to take home in order to get their parents written permission to participate in the study. The form described the purpose of the study and contained the information that I had given verbally to the teachers and the students. In the form I encouraged the parents to make contact, by email or telephone, if they had any questions regarding the project.

In summary, the participants were informed about the purpose of the studies (the information requirement, see Gustafsson et al., 2006) and that they were going to be anonymous (The confidentiality requirement, see Gustafsson et al., 2006), that the teachers and the students, who had their parents' permission to participate, could terminate their partaking at any time (The requirement of consent, see Gustafsson et al., 2006), and that access to the recordings were restricted to me and my supervisors and that the findings

would be published as research articles and a doctoral thesis (The requirement of restricted use, see Gustafsson et al., 2006).

Summary of the Papers I-III

Paper I: Students' Choice of Post-compulsory Science: In Search of Schools that Compensate for the Socio-Economic Background of their Students

Paper I examines the extent to which compulsory schools in Sweden may counter-balance the restricted science career opportunities afforded to some students because of their socioeconomic background. In this paper therefore the following research questions are answered (a) what is the association between socioeconomic variables and the application frequencies to the Swedish Natural Science Programme (NSP) in upper secondary school?, and (b) Are there compulsory schools in Sweden that deviate from what the model predicts? Besides investigating the strength of the association between the background of the students and their educational career choice, this study also served as the primary tool for finding a school in which study 3 (paper III) could be conducted.

Methods

The associations between background variables and the students' choice of the Natural Science programme in upper secondary school were examined by a logistic regression analysis. The logistic regression analysis makes it possible to describe and test relationships between a categorical outcome variable (as choosing or not choosing the NSP) and categorical or continuous predictor variables (Agresti, 2002). It is thus possible to examine dichotomous outcomes and also to handle non-linearity and data that is not normally distributed. This is done by applying a logit transformation to the dependent variable so a linear function that is neither positively nor negatively limited is attributed to the relationship. The logit is the natural logarithm of the ratio of the probability of a student choosing the NSP to the probability of a student not choosing the NSP. The logit is thus the natural logarithm of the *odds* that a student with his/her specific background variables will choose the NSP. In order to be able to make evident the effect of a certain value of a background variable (e.g. the effect of a *high* income level on student choice), every odds is relative to one arbitrarily chosen value in each variable, for example the odds of tertiary education level of the

parents is relative to the odds of the secondary education level. The resulting odds are thus a ratio which shows what the odds are for a student with parents with tertiary education to choose the NSP. In order to avoid any confounder effects, all the other variables were controlled for when a specific variable was calculated. This means that when values were calculated, this was for a given combination of the dependent variables (i.e. every effect is isolated). The analysis was carried out with the Logistic regression procedure in Stata version 12.0 (StataCorp, 1985-2011, <http://www.stata.com>). Two statisticians from the university's department of mathematics assisted in carrying out the analysis.

The data was collected from three different data sets from Statistic Sweden (SCB) and covered the 2009 population of ninth graders, ultimately consisting of 106 483 observations of students (age 15–16) distributed on 1342 schools. The regression model accounted for background variables that previous research had identified as important for student interest. In the model the following independent variables were therefore used: *gender*, *immigrant background* (born in Sweden with Swedish background or immigrant background, born or not born in Sweden), *parental educational level* (compulsory school and upper secondary school [since no critical differences were observed between compulsory and upper secondary school these were grouped as one] or tertiary education). The effects of *grades in science and mathematics* (Not Graded, Passed, Passed with distinction, and Passed with special distinction) were observed to show a linear relationship to the choice of NSP and were thus modelled as such. *Final grade* was coded into three classes: low (10–155 credit points), middle (160–235), and high (240–320). *Household income before tax* was also coded into three classes: low (lower quartile), middle, and high (upper quartile). We chose to leave out students that had a strongly adjusted curriculum, students attending a school with a non-standard grading system (e.g. Waldorf schools), and schools with less than 20 students applying for upper secondary school (since these could display a great deviation from predicted by pure randomness). *Application for the NSP* was used as the dependent variable.

The variables of grades, which are a measure of achievement, may be considered problematic since the school indeed is likely to affect these. However, I chose to treat achievement as a form of educational capital which means that grades are to be understood as an asset which is transformed from the other capitals the students possess. For example, having high grades in mathematics can be a result of an educated home, quality of the instruction and/or the attitudes and cognitive skills of the individual. Moreover, dispositions important for how a person value what is to be considered a good investment, such as high grades in mathematics and science, is likely to originate from the home (Adamuti-Trache & Andres, 2008; Broady et al., 2010; Lyons, 2006a), but also possibly from the school (Basl, 2011; Kjaernsli & Lie, 2011). In summary, since achievement is a variable

impossible to separate from both the socioeconomic background and the school, this was considered the most conservative procedure.

The data was thus used to determine the association between a set of independent variables and the choice of NSP and so investigate to what extent lower secondary schools tended to deviate from predicted results. Due to interactions between gender and immigrant and non-immigrant background we used separated models consisting of four gender and immigrant/non-immigrant background specific models. These four models were fitted to the data to test the relationship regarding application for the NSP and the independent variables. The odds ratios from this analysis were used to calculate the number of students that the model predicted will choose the NSP in each school; the predicted number was then compared to observed counts. In deviating schools home background cannot account for the high or low application frequency observed. In these schools, therefore, other variables such as for example the teaching in science may have an important influence on students' choice.

Results

The findings showed that cultural capital (defined in paper I as parental educational level) was clearly associated with choosing post-compulsory science in Sweden. Also educational capital (defined as grades in mathematics and science) was strongly associated with the choice of post-compulsory science. The study also revealed differences between the four student groups (non-immigrant background boys (1) and girls (2), immigrant background boys (3) and girls (4)). The findings showed that boys, irrespective of national background, will invest high grades in science in a science education career. Girls, irrespective of national background, will invest high grades in mathematics in a science education career. Moreover, for boys cultural capital was more important for their choice of the NSP, suggesting that girls in greater extent make educational career choices that break with low cultural capital. Finally, an interesting finding was the ambiguous association between economic capital and choice of the NSP. The lowest probability of choosing NSP was in the middle-income group, suggesting that children from low-income homes perceive science as a suitable career choice. Of 1 342 compulsory schools in Sweden, 158 were shown to deviate significantly from predicted. Of these 158 schools 85 deviated positively and 73 deviated negatively. Consequently in 85 schools of the total of 1 342, students chose to apply for post-compulsory science in a significantly greater extent than expected considering their socioeconomic background.

Conclusions

The findings corroborate the strength of the association between the backgrounds of the students and their choice of post-compulsory science. In Sweden, students' interest in science, understood as their choice of applying to post-compulsory science, is thus influenced by home background. At the same time the findings also imply that lower secondary schools can make a difference to students' interest in science. As argued there may be a variety of variables in a school that may be an important influence on students' choice of the NSP, it is however to be expected that teaching in science should play at least some role in this. Consequently, the next step was to examine what characterizes the teaching in science in a school where more students than expected choose post-compulsory science. Before that, however, I needed a method for studying how interest is constituted in classroom action. The aim of Study 2 was to develop such a method.

Paper II: Signs of Taste for Science: A Methodology for Studying the Constitution of Interest in the Science Classroom

The findings of paper I showed that home background is important for students' interest. The study also showed that schools can make a difference and thus compensate for home background. In paper II a methodology is developed for studying how this difference may come about, thus being a step towards studying the influence of school as situated in the science classroom. The question I address is: how can interest in science be studied as constituted in classroom action? As argued in the *Introduction* the rationale for studying interest as taste is motivated by the need of more action oriented approaches acknowledging the situated aspects of cognition, norms, and aesthetics in learning and participation in science. Paper II, therefore, is a methodological-theoretical paper rather than an empirical paper. However, the theoretical constructs needed to be grounded in empirical data and I therefore applied the framework on student conversations recorded from a public K-9 school.

Methods

Since the aim of the paper was to develop a method for studying interest in classroom action, I searched for a classroom practice in which I could expect to observe positive instances of a taste for science being constituted. A classroom where students' recurrently turn away from science would not be of any use for my aim. Since students' interest in science has been shown to

decline to be the lowest at the lower-secondary level, I wanted to do my study in a lower secondary setting. The lower secondary classroom ultimately chosen was located through statistics on application frequencies to the NSP. Over a two year period 25% of the students in this school applied for the natural science program, as compared to the national mean of 15% for the same period. Unlike the school that was chosen for study 3, the educational choices of these students were not statistically controlled for socioeconomic background. However, based on where the school was situated and the principal's and the teachers' description of the sociocultural backgrounds of the students that recurrently attended their school, the school was not in any way unusual in terms of the background of the student population. Moreover, municipality statistics showed that during the sample period 29% of the students had immigrant background which was higher than the national mean during the same period of 18%. During the same period, 50% of the students at the school had parents with tertiary education. This was slightly less compared to the national mean of 51%.

I contacted the principal of the school about my findings who directed me to the three science teachers working at the lower-secondary level. I arranged a meeting with the teachers (one male and two females) in order to inform them about my project and to discuss the possibility of making observations in their classrooms. Besides providing them with information about myself and the project, I said that I would like to hear more about the school, the students and their teaching. At this first meeting I met two of the teachers who expressed their appreciation to participate in the study. One of the teachers could not attend (later I met and talked with her as well) so instead her colleagues redirected her thoughts from their joint discussion to me. The three teachers were well-aware of that students' interest in science usually declines with age and were therefore happily surprised to hear that so many of their students recurrently chose post-compulsory science. When we talked about what they thought characterized their teaching in science that, hypothetically, could explain the high application rate, the following suggestions were discussed: they taught their favourite science subject (they had divided up the subjects between each other so they taught either biology, chemistry, or physics), they enjoyed teaching in general, and they enjoyed working together and often attended each other's lessons in an informal and unplanned way. They recurrently returned to their enjoyment for their work and the company of the colleagues and that this perhaps was something that the students perceived. After the initial meeting I met and talked with the teachers at several occasions and in total I visited and recorded six lessons. Before I started the data collection I presented myself and the project to the students (in total three classes, one at level 7, 8, and 9, respectively). I told the students that I was interested in what was happening in science classrooms in order to better understand how teaching in science may be

improved. During these instances the students were encouraged to ask questions about me and the project.

Accordingly, a class (grade 7, ages 13–14), with the home background composition as described above and with an even mix of boys and girls, was filmed and audio recorded during one physics lesson. The lesson was chosen because students had ample opportunities to interact in speech and with materials. The aim of the lesson was to introduce, and for the students to use, formulas and methods to measure the volume of different objects. The classroom climate was friendly and the students seemed to enjoy the activity. One camera followed the teacher as she visited and interacted with the different lab groups. The recordings were transcribed verbatim and analysed for situations where students actively made distinctions of taste (see below). The data presented in paper II thus come from one lesson but I observed and collected data from two lessons with this teacher. This data, but also the data gathered from the other lessons with the other teachers, helped me to validate the observations I made regarding taste. The findings of paper II are thus representative for how distinctions of taste were observable in these classroom interactions.

To support the analysis of taste I used Practical Epistemology Analysis (PEA) (Kelly, McDonald, & Wickman, 2012; Wickman, 2004; Wickman & Östman, 2002). PEA is based on four operational concepts: stand fast, encounter, relations and gaps. In an activity, what stands fast is what is immediately intelligible; that which the interlocutors do not need to ask each other about in order to proceed. As the activity continues gaps are noticed due to encounters with utterances, actions and artefacts and the activity proceeds as gaps are continuously filled with relations to what already stands fast. For the context of taste my interest was specifically gaps relating to distinctions and judgments of taste. Gaps noticed by the students, by themselves or because the teacher had made them pay attention to them, were assumed to be important parts of learning to make distinctions of how to proceed in the science classroom and so developing a taste for science. Also the relations construed to fill the gaps were considered to be important to examine with regard to taste.

Results

The motives for approaching interest as taste have already been discussed in the *Theoretical background* so here I will just provide a brief comment on the relation between taste and interest. Both concepts revolve around cognition, norms, and values. Taste has been empirically demonstrated to be associated with home background and being socially situated, taste is of great importance for people's will and opportunity to participate in social practices. By making distinctions of taste we not only distinguish ourselves in relation to content, norm, and values, we also make evident to others

whether we are included or not. To develop a taste for science, therefore, is a question of learning to make conducive distinctions of inclusion and exclusion that will be acknowledged in science practices. As examined in paper I, choosing a post-compulsory science programme is influenced by upbringing which suggests that some students may already be familiar with the taste that is distinguished in school. The findings also suggest that school can compensate, implying that taste for (or interest in) science can be developed in school. How this happens is, however, another empirical question and paper II is a step towards making such an empirical study. Of great analytical importance, therefore, is the fact that taste is overtly distinguished and therefore possible to study in classroom action.

The aim of the first step of the taste analysis is to clarify the aims and purposes of the activity, namely what are students supposed to do and talk about? The so called proximate purposes (Johansson & Wickman, 2011) are evident as the science related tasks the students are set to do by the teacher.

In the second step it is examined whether students' distinctions of taste are oriented towards these purposes. Distinctions of taste are analysed as the choices of action evident through (a) language usage, namely how the participants include and exclude certain ways of representing content or actions, (b) procedures, how ways-of-acting are included and excluded in the practice, and finally, (c) ways-of-being, how the participants include and exclude persons and manners in the science classroom. This part of the analysis makes evident how norms are distinguished in relation to content and purposes of the classroom.

The third step of the analysis was developed in order to make evident to what extent the students enjoy making conducive distinctions of taste and so enjoy participating in the science classroom. In this step it is thus examined how the distinctions made are valued through aesthetic judgments and humour.

Finally, the last steps of the analysis are motivated by the fact that enjoying making distinctions is not enough to develop a more enduring taste of science. The current taste of the classroom, which usually originates from the teacher, must be examined with regard to how it allows for personal contributions of the student as well as its continuity with a more current taste of science and so acknowledging other stakeholders (e.g. curriculum) and science practices (e.g. subsequent science educational levels, science outside school). Here, therefore, it is examined how students' more personal taste is acknowledged and made continuous with the current taste and finally, the taste constituted is analysed in relation to science proper.

Conclusions

In paper II I develop and present a methodology to study how taste is distinguished and developed in the classroom. Taste, which is observable

through overt action, acknowledges cognitive, normative, and aesthetic aspects of participating and learning in the science classroom, all shown to be important for students' interest. Developing an interest in science is thus understood in this thesis as the development of a taste. In order to make evident how teachers may support their students and so make a difference for their opportunity to develop an interest, the methodology was used to examine a classroom practice located through study 1.

Paper III: What can a Teacher do to Support Students' Interest in Science? A Study of the Constitution of taste in a Science Classroom

In paper III the methodology of paper II is used to examine how a teacher from one of the schools identified in paper I supported his students' interest in science. This is thus an explorative study seeking to approach the question raised in papers I and II, namely how teaching can counter-balance home background by supporting students in developing an interest in science. The specific question that is examined in this paper is: How may a teacher support students in developing a taste for science? In this paper, therefore, I examine how a teacher assisted his students to participate by making, and enjoying, distinctions in terms of language usage, procedures, and being; namely, how students were supported in developing a taste for science. The classroom was chosen because this school was shown to recurrently deviate positively in respect to the extent to which the students choose post-compulsory science.

Methods

Before I decided which of the schools located through study 1 I would do my study in, I checked if (a) a comparatively high proportion of the students in the school recurrently applied for the NSP in upper secondary school (study 1 was based on student population data of the year of 2009), and (b) the present science teachers of the school worked during the statistical sample period. Consequently the procedure of study 2 was also used here, although in study 3 the home background variables were also statistically controlled for. The school ultimately chosen met the criteria stated above. Over a four year period 22% of the students of this school applied for the NSP, as compared to the national mean of 15% for the same period. The school is a regular public school located in a suburb of a large city and the data was collected during the second semester of the ninth and final grade.

In order to get in contact with the science teachers, I contacted and informed the principal of the school about my findings. The principal

directed me to one of three science teachers whom he considered to be an outstanding teacher. When I had talked with the teachers, who approved to the study, and interviewed 8 randomly chosen students (4 boys and 4 girls) from their classes, I decided to make my study in the classroom of the teacher initially recommended by the principal. The experienced male science teacher, who was happily surprised to hear about my findings, had worked at the school for almost 20 years. We arranged a meeting in which I could present the project and in which we could discuss his and his students' participation. In total I met and talked with the teacher at six different occasions. Although the aim was not to locate, study, and describe a particular teacher profile (i.e. his academic background, teacher training, pedagogical ideas, and so forth) but rather to analyse and describe situated science teaching that may be important for how students' interest is supported, we nonetheless touched on such issues when we talked. Besides the necessary teacher education, this teacher had university credits in engineering and had continuously, over the years, attended in service training. As with the teachers of study 2, also this teacher enjoyed teaching and believed that this may be important for how the students perceived the science subjects. He was serious about his job and believed, in general, that teaching may make a difference to students' lives. Other than that, he did not give any details to what in his teaching that may possibly influence his students' interest in science. Nevertheless he was confident in his role as a teacher and he struck me as a devoted and skilled science teacher. It was understandable why the principal initially had directed me to him.

During the observations the students (grade 9, ages 15–16, with an even mix of boys and girls from different backgrounds) worked in pairs building simple electrical circuits by connecting wires, bulbs, and switches to a battery. Two lessons were observed and 24 students were recorded. I audio recorded and filmed the students with digital equipment as they were working in pairs. One camera followed the teacher as he visited and interacted with the different lab groups. The classroom climate was friendly and relaxed and the students seemed focused on the assignment, which they enjoyed working with. I did not interact with the teacher or the students during the lessons but if a student talked to me (e.g. if I was going to film other classes), which happened occasionally, I of course responded. The recordings were transcribed verbatim and analysed for situations where the teachers and the students actively made, discussed, and negotiated distinctions. The video data served as analytical cues clarifying non-verbal interactions such as actions, gestures, and expressions. This data assisted me in the interpretation of aesthetic utterances; occasionally it was for example necessary to review the filmed material to determine whether an utterance was a joke or an ironic remark. The video material was also used to interpret students' emotional responses and feelings when making aesthetic judgments.

The transcribed data was analysed according to the taste analysis developed in paper II. Focus here, however, was how this teacher supported the students in distinguishing taste.

Results

Salient findings in regard to students' interest and participation were that purposes, norms, and values were in the open and explicitly referred to by the teacher in this classroom. The teacher was thus very careful in clarifying purposes of the activity. Initially this was done by explaining how the task at hand was continuous with previous lessons and lessons to come. During the assignment the teacher regularly followed-up on whether students could take action towards the purposes of the activity. He then stayed with students until he saw that they could act according to the distinctions made. When students were stuck, the teacher valued together with the students expected consequences of distinctions and so clarified why a particular action were preferred in respect to purposes of the practice. The students were thus supported in learning to anticipate how actions could contribute to fulfilment of task. Throughout the activity, failure to act towards purposes (for example a student might have difficulties to distinguish the proper action to reach a purpose, e.g. make one bulb go out when pressing the switch) was never a question of shortcomings of the students, but such occasions were instead referred to the complexity of task or faulty equipment. When tasks were accomplished, the teacher habitually made the students pay attention to their feelings. By doing so, the students were encouraged to emotionally understand how it felt when task accomplishment results in consummation and at the same time see its object. In summary, the teacher was shown to support the students in developing a taste for science by:

- a) Routinely following up that purposes of the activity were understood by the students
- b) Encouraging student reasoning towards purposes rather than asking for correct answers
- c) Staying with students until they could take conducive action.
- d) Making students' personal distinctions of taste continuous with purposes of the activity and so allowing them to contribute to the scientific taste constituted
- e) Paying attention to students feelings and that they were positively related to scientific objects and purposes
- f) Checking that students were satisfied when tasks were accomplished and so ensuing that steps a) to e) were conducive to an aesthetic experience of consummation

Conclusions

Paper III thus gives examples of how teaching may positively influence students' interest in science. Again, there are no causalities examined here and the extent to which the teaching is responsible for students' interest I cannot know for certain. Moreover, this is an explorative study based on two classroom observations so clearly additional studies are needed from other settings, grade levels, and so on. However, the high proportion of students from this school that recurrently attend post-compulsory science, and the fact that the students clearly enjoyed being part of the activity observed, suggest that the particular teaching presented indeed can make a difference.

The findings of paper III seem to exemplify a teaching that makes science in itself a concern that could be enjoyed by all students, irrespective of their background. This observation raised an issue that has been central in papers II–III and which becomes the chief interest of paper IV, namely that a decontextualized and too one-sided focus on *interest* may have overlooked *science* when students' interest has been studied. In paper IV, which is merged with the discussion and thus not presented separately, I suggest the possibility that the science transacted at the primary, secondary, and tertiary levels may differ in such ways that it may not be applicable to compare the interest constructs reported at different educational levels. In the paper, I put forward the possibility that students do not lose their interest in science developed in primary school, but rather that an interest for secondary science is never constituted.

Discussion

The findings in this thesis support the notion that home background is important for students' interest in science. Although there are differences in how the background variables of the four student groups analysed were associated with their choice of the NSP, parental educational level and educational capital are both strong predictors for students' participation in post-compulsory science. At the same time, however, school can counteract this relationship and so make a difference to students' will to pursue in science. The detailed analysis of the deviating science practice of study 3 showed that this support may be about how aims, norms, and values are made continuous in the science classroom. The purpose of the analyses were to (a) produce close descriptions of how teaching can support students in developing an interest in science and (b) increase our understanding of how teaching in science may compensate for inequalities related to student background. In the first subsection I discuss the relationship between home background and student participation, thus approaching aspects of (b) above. The outcome of this is used as a backdrop to subsection 2, where I discuss (a) above, namely how teaching may support students in developing habits that are conducive in science practices. In this section I include the central arguments of paper IV and so expand the discussion to also acknowledge a science interest that is continuous between educational levels. Together these parts address the overarching question of the thesis; namely how may teaching make a difference to students' interest in science?

Taste for Science and Home Background

An educated home is important for students' capability and will to pursue in science. This is not surprising since the same association is also found in other programmes preparing for tertiary education (Lidegran, 2009). The school reproduces an academically oriented middle-class taste that rewards students who acknowledge and can distinguish certain norms and values (Bourdieu, 1996; Carlone, 2004). In Sweden, the NSP is regarded as an elite programme and also international studies have demonstrated that teachers, parents, and students regularly look upon participation and attainment in science as something exceptional and therefore specifically suited for a certain student profile (e.g. Broady et al., 2010). Values reproduced in

school and society regarding who science is for thus favour students with a background where such values are shared (Adamuti-Trache & Andres, 2008; Lemke, 1990; Jobér, 2012). Indeed, the associations found in paper I seem to suggest that this may be the case also in Sweden. Cultural capital, evident through parental educational level, is especially important for students' choice of NSP. In all student groups, irrespective of any other background variable, higher parental educational level amounted to greater likelihood of choosing the NSP. Since a similar trend was not evident in regard to economic capital, affluence in terms of money is not important for students' choice of the NSP, suggesting that the NSP is indeed recognized as an educational investment in which a certain academic habitus is given apt opportunities to develop.

At the same time as there were common trends in the material, for example did parental educational level and grades affect the choice positively, the findings also revealed differences between the four student groups. These differences may suggest that background variables have different meanings for student interest. For example, parental educational level was more important for boys' choice of the NSP. Again, this variable was also strongly associated to girls' choice of the NSP but not to the same degree which may suggest that girls more readily make educational choices that transgress cultural capital. Moreover, although being variables that are difficult to refer to either the individual, the home or the school, educational capital in the form of grades in science and math also had different associations to the choice of NSP for boys and girls. To a greater extent higher grades in math, as compared to science, increased the likelihood of choosing the NSP for girls. The opposite was evident for boys, namely to a greater extent as compared to math, higher grades in science increased the likelihood of choosing the NSP. Especially the association between mathematics and the NSP is interesting, since it seems to imply that confidence in math may be important for girls' choice of post-compulsory science. Girls' interest in science may thus be supported by initiatives focusing on teaching in mathematics, rather than teaching in science. Such an approach would be, however, misguided and also missing the argument driven in this thesis. Firstly the findings presented are not causal relations between variables and choice; secondly, as argued by for example Valsiner (1986) and Krapp (2003), it is not justifiable to draw conclusions from population data about "general laws" that can be used to describe processes at the individual level (Krapp, 2003, author's quotation, p.65). The process in which students come to understand and develop an interest in science is highly situated and the importance of the findings of paper I can instead be summarized as follows: (a) they make evident that home background is important for students' interest in science, and (b) they show that school can compensate for home background in regard to this.

In the next section taste for science and teaching is discussed. At the same time as these results agree with previous findings on what characterizes practices where an interest in science may develop, for example as being an inclusive and enjoyable environment where student learning and empowerment are stimulated (e.g. Fitzgerald et al., 2013; Xu et al., 2012), it hopefully becomes evident that the action-oriented approach of taste can offer additional perspectives on how interest is constituted in classroom practices. I will start by discussing in general terms how teaching may support the development of a taste for science and so facilitating students to become, by using the words of Lemke (1990), possible *members of the science community*. After this I will present the most important findings under three headings, namely how teaching can: (1) orient student action towards scientific aims, (2) make the norms of the classroom a shared concern, and (3) establish continuity between aims, norms, and aesthetics.

Taste for Science and Teaching

Acquiring taste for science means developing habits of making conducive distinctions that lead to fulfilment and are valued in the classroom. As discussed above, for some students this taste may already be functional when they enter school. They can, for whatever reason, relate to the distinctions made and can also make the distinctions the school science practice values. They can successfully participate in the science classroom by more independently learning to distinguish and value the norms of the practice. Most students, however, need more influences from school in order to develop a taste for science that is recognized by others and so is continuous with other fields of science.

Previous research and also the findings of paper I seem to suggest that a scientific taste to a large extent can be equated with a general academic taste and so favouring students that are familiar with academic reasoning, norms, and values. However, as shown in papers II-III, distinctions of taste are socially situated and as such intimately intertwined with what is going on in the practice in which it is constituted. As demonstrated in the classroom study of Hamza and Wickman's (2009), teachers and students encounter a diversity of planned and unplanned events in the science classroom that may be significant for what meanings that are construed. The learning path can thus be a highly contingent process as the students may need to redirect their interest on other things than the conceptual content to be learnt, such as how to handle the equipment or make decisions on what is sufficient accuracy of measurements (Hamza and Wickman, 2009). Consequently, in the science classroom the participants need to relate to things that may not have been consciously planned for (Hamza & Wickman, 2009). As shown in paper III, during a practical on electrics, for example, the teacher and the students may

jointly construe meanings regarding what science is for, that a wire can be a nasty thing, and whether it is okay for a teacher to encourage an extensive use of paper.

The development of a taste for science thus entails something that is unique to science and indeed unique to the practice where it is developing. For example, in the classrooms studied the teachers were shown to shift between a scientific and a more colloquial language and especially the teacher of paper III often used humour when he assisted his students towards aims. In these practices the teachers were thus breaking the communicative rules of science (Lemke, 1990) and even if they habitually made the students pay attention to preferred words, actions, and ways-to-be, they also, as long as the scientific aims were in focus, sanctioned students' play with scientific norms. This allowed students to try and explore scientific norms and values, such as what distinctions can, or should be, questioned and negotiated? Am I a brain? What is okay to joke about? What is funny in this practice? Although this needs to be examined more thoroughly, it is probable that experiences like these are important for students' opportunity to develop an aesthetic sensibility for the communicative rules of the practice and so, by using the words of Bourdieu (1984), gain *a feel for the game*.

Finally, at the same time as a classroom taste is unique, there need to be elements in it that makes it current and so continuous with other practices of science. The lower secondary science classrooms examined in this thesis, especially the one presented in paper III, but also the one used to develop the methodology and presented in paper II, thus represent instances where the development of such a taste seem to be supported by teaching. The role of the teacher in respect to the active guidance of the students toward engagement and participation, as discussed by for example Tobin and Fraser (1990) and Waldrup, et al. (2009), may, at least partly, be about how the students are supported in understanding what they are supposed to do and why (Wickman & Ligozat, 2011). The findings showed that the teachers recurrently clarified for the students why certain actions were preferred in relation to the scientific aims of the tasks. In both practices the students also had ample opportunities to contribute to the distinctions made. The norms of the science classroom were thus explicit and also open for negotiation. Accordingly the students were supported in distinguishing the preferred ways to act, talk, and be in the science classroom.

Orienting the process of interest towards scientific aims

As described in the *Theoretical Framework*, being interested is a directional process oriented towards near or distant goals in which actions and artefacts are valued and enjoyed based on what they bring to the fulfilment of this process. Outside of school, this process is often unproblematic. A person being interested, for example when reading about the favourite soccer team

or playing *Minecraft* or golf, keenly pursues ways that will lead processes to consummation, for example by practicing alternative actions, talking to friends, or surfing the Internet for inspiration or tips. Successively this interest may develop into habits where actions are anticipated and distinguished in relation to what they convey to aims and goals, in a near or distant future (e.g. on this particular hole a nine iron would be the preferred choice). That is, the interest develops into and may be observed as purposeful habits. In paper IV it is suggested that primary students' interest for science can be likened with this type of personal interest. As opposed to older students, younger students' interest in science may thus to a greater extent be freed from external aims (paper IV).

Students at the secondary level are usually aware of that there are specific scientific aims towards which the activities in the science classrooms are oriented (paper IV). It is not enough, so to say, to be interested; the students need to direct their interest toward the aims that the activity is oriented at. The total absorption smaller children can display when they become caught in an activity, whether playing a game at home or observing plants at school, often develops into a self-governed process which often is not oriented towards extrinsic goals. The process of interest is rewarding in itself. At subsequent educational levels this type of engagement is not likely to be enough; but rather it has to be oriented towards specific shared aims in order to be acknowledged and rewarded. However, even if students know that the activity entails certain aims, it does not mean that they know what these are (Anderhag, Danielsson Thorell, Andersson, Holst & Nordling, 2014; Högström, Ottander, & Benckert, 2010; Säljö & Bergqvist, 1997). Practices in which this often is the case, namely that the students seldom or never understand what they are supposed to do and why, are likely to exclude students from successfully participating in the science activities (Säljö & Bergqvist, 1997). In such practices, consequently, students have few opportunities to develop an interest in science.

A teacher can thus support students by clarifying how distinctions of taste relate to the aims of the activity. The teacher in paper III did this by carefully monitoring whether assisted students could act according to distinctions made. During these instances the distinctions were regularly aesthetically judged by the teacher and in line with the findings of Wickman (2006) and Jakobson and Wickman (2008), positive and negative aesthetic judgments anticipated preferred or non-preferred actions. This study contributes in that it shows what it may look like when a teacher makes the students pay attention to these aspects of doing science, that is; how the norms of the classroom are conducive to aims. On occasions when students were assisted, the teacher typically did not leave the students until he saw that they could pursue according to distinctions and so toward aims. The importance of this type of guidance towards aims can be illustrated by a contrasting example coming from the study of Säljö and Bergqvist (1997) on students working on

a physics lab on optics and light. In the study it was demonstrated how the initially positive attitudes of the students rapidly declined as the activity proceeded. At the same time as the students distinguished the equipment as exciting, they were acutely aware of that there was a more scientific oriented aim with the activity. However, as the activity continued they could not distinguish this aim and they became overtly frustrated. The students described the activity as boring and they told the teacher that they did not know what it was for. These students were thus well-aware that it was not enough for them to freely engage and have fun with the equipment but rather to do something pertinent to a scientific aim. As they could not distinguish this aim or any means to act purposefully they finally raised the possibility that it was they who were stupid. According to these students, failing in seeing the relevant things was thus a question of ways-to-be in the classroom and not a feature of the activity as such.

Making norms of the classroom a shared concern

The norms of the science classroom decide what and who is included and excluded in science practices (Lemke, 1990) and for that reason norms are of great importance for students' will and capability to pursue in science activities (Wickman, 2006). Consequently they are also of great importance for whether the student will perceive science as something that is meaningful for them personally. In this thesis, the joint transaction of content and norms has been examined through how the participants excluded and included ways of talking, acting and being. The findings showed that the two teachers in papers II and III were very careful in having the students pay attention to how actions and utterances can be valued in relation to their alignment with scientific aims. During these instances distinctions of taste and attached aesthetic judgments were overtly negotiated and so became central components in the interest process of these students. Norms were thus recurrently explicit and also open for discussion in these classrooms.

In paper IV examples are used to illustrate how taste for science may be constituted at the primary, secondary, and tertiary level and so suggest the possibility that students in primary practices to a lesser extent are guided by norms current and shared in the classroom. Enjoyment for science may thus be freed from scientific norms and aims, which are of central importance in subsequent practices. As discussed above, in the lower secondary practices of studies 2 and 3 norms were significant aspects of doing science that the teachers made students aware of. At the same time the teachers allowed for the more personal taste of the individual student to contribute. In this way the taste of the students were made continuous with the current classroom taste. At the university setting norms are likely to be embodied and to a larger extent so transacted more habitually. At this level students rarely question that there are preferred ways of doing science and that the activity

revolves around specific scientific aims (Wickman, 2006, paper IV). They have a more developed taste for science in terms of engaging purposefully with aims. This implies that along the science pipeline participation in science may transform from a normative-pluralistic to a more normative-homogenous practice. Consequently, at some point the students are expected to make specific distinctions of taste and it is fair to assume that some students will perceive this strictness as something unfamiliar and maybe negative. The often negative descriptions of upper secondary science as strict and impersonal indeed seem to suggest this. For the students to be able to fully participate, therefore, the pluralistic mundane taste for science needs to be made continuous with the more directed taste of the secondary science classroom.

As discussed earlier, different stakeholders may have diverse sentiments regarding what science is for and for whom, and consequently science education is not only a question of rationality, but also what people value. It is therefore necessary to stress that the classrooms I examined was chosen because here all students, irrespective of gender, social class, or ethnicity, seemed to be supported by teaching in developing an interest in science. Even if I could not identify any instances where the teachers made distinctions that excluded students' ways of talking and being or that some students contributions was not acknowledged, it is possible that a more long-term study had revealed other things. Indeed, as shown in the study of Carlone et al. (2011), science practices that are enjoyed by the students and also support their learning, can, which may only become evident when studied over a longer period of time, reproduce meanings that exclude certain students. Even if this need to be examined, it is possible that such meanings are reproduced in the schools shown to deviate negatively in study 1. Moreover, the ways students are socially positioning themselves relative to their peers (see e.g. Hasse, 2002) and how this may change through space and time is likely to be a significant influence on students' opportunity to participate in the science classroom. It is therefore possible that an alternative approach would have exposed structures that may be important for how individual students perceive themselves as a student of science.

Finally and of great importance, at the same time as teaching in science in general may be successful in changing students' taste for science in ways which are compatible with science education or with society, marginalized fields in relation to ethnicity, social class, gender, or sexuality may still be excluded in ways which may be questioned or criticized.

Establishing continuity between scientific aims, norms, and aesthetics

Studies on the role of affect and emotions for student learning in science are relatively underrepresented in science education research journals (Reiss, 2005; Fortus, 2014). One likely reason for this is the strong position reason and cognition traditionally has had in science and science education (e.g. Fortus, 2014). At the same time as this may be the case, it is generally accepted that affect and emotions are significant features in the practice of science. Not only have various authors questioned the popular description of science as rational and emotionally detached (see e.g. Reiss, 2005; Wickman, 2006) but also the cognition-emotion dichotomy and the general impact this divide have had for science education research have been questioned (see e.g. Reiss, 2005). Wickman (2006) has, for example, empirically demonstrated how cognition, norms, and values are jointly transacted when students are doing science and so showing that aesthetics and emotions are crucial for the meanings construed in the classroom. Studies have thus argued (e.g. Alsop & Watts, 2003; Reiss, 2005; Fortus, 2014) and also demonstrated (e.g. Carlone, 2004; Jakobson, 2008; Wickman, 2006) that affect and emotions are central for students' opportunity to participate and learn science.

The findings of this thesis contribute to earlier research in that it sheds some light on the role teaching may have for how teaching can support students in making aims, norms, and values continuous in classroom action. The teaching examined can be said to assist the students in learning the socially situated distinctions – the norms of action – that are conducive to aims and so possibly resulting in experiences of cognitive and emotional consummation (Wickman, 2012). As will be discussed below, such support may be important for students' capability to pursue in science activities and so developing a taste for science.

Studies have shown that aesthetics is involved when students and teachers are doing science (e.g. Berge & Danielsson, 2012; Hasse, 2002; Jakobson & Wickman, 2008; Wickman, 2006). Also the participants in this study valued their doings aesthetically, for example when reaching fulfilment or distinguishing preferred ways of doing things. The findings from the lower secondary classrooms examined in this thesis are thus consistent with previous findings, suggesting that aesthetics is likely to be an important part of science learning throughout schooling. As mentioned above, the study has also shown how teaching can make aesthetics and norms continuous when students learn science and so supporting students to pursue towards aims of the classroom. Besides encouraging the students to verbalize their experiences when reaching fulfillment, aesthetic judgments were used by the teacher in paper III to distinguish what feelings the students could anticipate when choosing some particular course of action. These was not used in a

generic way but was closely tied to the scientific aims of the activity. The teacher thus not only supported the students to make conducive distinctions of taste, but he also encouraged them to discover how it feels when distinctions of taste lead them to consummation. In this way the students learned how it feels to understand science, both as content and as a normative practice, which is likely to create anticipation of future encounters with science.

Enjoyment and satisfaction are key aspects of developing a taste for science. It has been demonstrated that even if students may achieve well in science and so being identified as a “science person” by peers and other stakeholders, they can find the subject boring and with little personal meaning (Lindahl, 2003). However, any enjoyment is not likely to be sufficient. For example, at the same time as experiments usually are enjoyed by students there is little evidence that practical work per se leads to a more lasting interest in science (Abrahams, 2009; Lindahl, 2003; Toplis, 2012; Wellington, 2005). The studies of Carlone (2004) and Carlone et al. (2011), also show that one cannot assume that a more student-centred curriculum, offering an alternative to science as fact-oriented, transmissive and socially detached, will engage students. Moreover, it is not necessarily self-evident that activities that students’ genuinely enjoy and are interested in, as for example comics, dogs, computer games, or whatever, can be used to engage students in science. They surely could, but in general it is misguided to assume that science can be made interesting by inserting *fun things* into the practice (Jakobson, 2008). Rather actions, activities, and artefacts (such as dogs, laboratory work, or computer games) may become important for a genuine interest in science when they support students in pursuing towards aims and so possibly reach fulfilment in the science classroom.

The findings of paper III seem to demonstrate this, namely how elements of science were enjoyed and also helped the students pursue in a typical science activity. The task of making electrical circuits was not adjusted for students’ already existing everyday interests, but on the contrary it was a typical electrical practical in which certain things should be accomplished according to scientific norms. The activity was enjoyed and was shown to include all students by acknowledging and making personal contributions continuous with the task at hand and so also continuous with science proper. The teacher was shown to support this process by routinely following-up accomplishment with tasks by asking students about their feelings. By doing so he checked if the students were satisfied and so ensured that the process in which purposeful actions were distinguished and judged was conducive to an aesthetic experience of consummation. Accomplishment with scientific task was thus not only about cognition, that is; to gain an understanding of the facts (which is a well-reported student description of the science classroom, see e.g. Lyons, 2006; Osborne et al., 2003), but of equal importance was also how it felt to reach ends-in-views. In the classroom

studied the students were thus supported in learning how it feels to understand science. Doing science – with its norms and values – was expected to be, and also seemed to be, appreciated in itself.

Conclusions and Suggestions for Teaching

Here I will use the conclusions of papers III-IV to provide some suggestions that a teacher may consider in order to support student interest in science. First, however, I will give a brief summary of what has been discussed above and so make a final return to the overarching question of the thesis, that is, how teaching may make a difference to students' interest in science.

The thesis has drawn attention to the intimate connection between cognition, norms, and aesthetics and the impact these may have for students will and capability to pursue in science activities. More important, the study has also given examples and discussed what teaching can do to make these dimensions continuous. These findings should be understood in relation to the problematic issue of that teachers and also the students themselves may misjudge students' potential and/or interest in science (or worse, even exclude them from science) because of the way they act, talk, and are in the science classroom. For a student to be acknowledged as a person included in the school science practice it is sometimes not enough to achieve or behave well, the student also need to achieve and behave in a way that is recognized by the classroom culture (see e.g. Carlone, 2014; Säljö & Bergqvist, 1997). This is indeed problematic as the sanctioned taste, as shown by Bourdieu (1979), is rarely taught or made explicit. On the contrary, norms and aesthetics of the classroom usually remain hidden from those who are not familiar with them and indeed are the ones that would benefit the most from support (Bourdieu, 1979, 1984; Bourdieu & Passeron, 1990). Studies seem to suggest that this is sometimes the case in the science education context; both in terms of how teachers, students, and other stakeholders look upon participating in science (e.g. Bertilsson, 2007; Broady et al. 2010) as well as how students are judged according to unspoken norms of the science classroom practice (see e.g. Carlone et al., 2011; Hasse, 2002; Jobér, 2012; Wickman, 2006). The practices examined in this thesis clearly contrasts with the image of a sorting and excluding science teaching. The teaching observed did not judge students' contributions by how they talked, acted or were as individuals, but rather student action was judged in relation to the consequences it had for reaching the scientific aims of the practice.

As has been argued, the findings are not statements of how students' interest should be supported, but rather examples from practices where more students than expected chose to apply for post-compulsory science. That said, however, the practices studied seem to suggest that teaching can make a difference to students' interest in science by explicitly orienting the process

of interest towards scientific aims, making norms of the classroom a shared concern, and by making norms and values continuous with the content to learn. In paper III the outcome of the analysis of the teacher-student interactions were formulated as step-by-step suggestions on how this may come about. Although these steps indeed may describe a successful practice, they need to be empirically tested, by a teacher or a researcher, and instead of being a recipe to follow they should serve as a heuristic for thoughtful action.

The thesis has only indirectly touched on how continuity may be established between school levels and has no empirical evidence to put forward. Nevertheless the high application frequency to the NSP can, indirectly, serve as an indicator of continuity between lower and upper secondary school science interests, that is, the science the students have encountered has at least not excluded them from post-compulsory science. Again, the characteristics of the practice studied may thus not only be important for how the students enjoy the particular activities I observed and analysed, but may possibly also be important for a more continued interest.

I can only speculate here, but aspects of the teaching analysed may give some ideas of what may be important for how secondary science may be made continuous with the experiences the students have of their primary school science. The teachers of the practices studied acknowledged students contributions and so made them continuous with the task at hand, regardless of whether the contributions reflected a more mundane taste. Their teaching allowed for every student to participate. This was not supported uncritically or in an unreflective way, but rather the actions of the students were carefully connected to what was going on in the classroom and student contributions were made continuous with the scientific aims of the tasks. It is possible that this may be important for how students perceive the science they encounter, namely, that the taste they bring into the classroom situation is recognized and clarified in relation to norms and values of the science practice. Findings from previous research that have shown that connections to students lives and communities may be important for whether a student develops an interest (Xu et al., 2012), seem to support this.

Obviously these questions need to be examined empirically and in the next section I discuss possible areas, such as the ones raised above, that would be rewarding to study more closely.

Further Research

Since our knowledge of students' interest is primarily based on questionnaires and interviews, studies approaching interest as situated should have the potential to contribute with important findings. Such examinations may make evident whether there are important differences in how an interest

in science is constituted at different levels and with different teachers and students but also in different science activities. For example, students recurrently report that they enjoy experiments, but our understanding of how these can be used to support an interest in science that is continuous with other science practices, is little examined. Studies explicitly examining how science is transacted in practical activities should have the potential to increase our knowledge about why certain school level science practices are described as having an effect on the students' interest for science. Also the area that has been the focus here, namely teaching, should be important to study more systematically. For example, how are students supported in distinguishing and enjoying a taste for science that is positively related to scientific objects and purposes? How do personal distinctions of taste transform to become socially shared judgments oriented towards the fulfilment of the science activity? In such a process objects and procedures are distinguished in terms of their meaning for completion and eventually consummatory feelings of satisfaction are intimately connected to the object of science. A promising study would therefore be to examine how teachers orient their students toward the aims of the science activities possibly resulting in an aesthetic experience of consummation.

The thesis has examined bit-by-bit processes of how teaching may support the constitution of student interest and only indirectly touched on how this may result in an enduring student interest. Since the taste analysis alone does not give any insights in possible trajectories of the individual student, longitudinal approaches are needed. Such studies could shed light on how the micro moments described here may transform into changed habits of the students. An interesting set-up would therefore be to follow students through the primary-secondary transition and so examine how students' habits possibly change through space and time. In the pragmatism framework used here, this would amount to developing habits of making conducive distinctions of taste that is valued by the students and recognized by others. Such changes may be observed as alterations in student trajectories (e.g. change in the choice of post-compulsory programme) or through secondary reports (e.g. change in how the students describe their attitudes). It would also be possible to observe changes in students' habits as they unfolds in long term classroom action. For example, the teacher in paper II recurrently made the students pay attention to the importance of giving names that are scientifically viable to the objects they were measuring. This was something that the students acknowledged and explicitly talked about and in some instances also questioned. It would thus be interesting to follow such specific judgments and see how and when distinctions of taste become habitually transacted. In the case of preferred names for scientific objects, this would mean that naming as such is no longer an issue that the students have to overcome in order to pursue in the science activity, they just act.

Moreover, the reproduction of inequities cannot be observed through isolated classroom action and complementary approaches are needed if we want to examine structures that are simultaneously operating and reproduced at the macro level (e.g. who belongs in science, socio-political issues, curriculum, etc.) and at the meso and micro levels (who belongs in the science classroom, what taste is acknowledged and rewarded, etc.). In a more macro oriented Bourdeuian framework, such aspects are usually approached as a struggle for power between different habitus in a specific social field. This struggle could be studied both in terms of how different student habitus position themselves in the field, but also in terms of how the social field of the classroom relate to larger fields. At the micro level in which my studies have been conducted, such a struggle would be possible to make evident with the taste analysis, for example in how the participants include and exclude certain ways of talking, acting, and being and so positioning themselves in relation to the taste that is sanctioned and rewarded in the classroom practice. It is possible that some distinctions of taste are more clearly connected to structures also operating outside the classroom and an example of this may be what type of person that the science classroom practice distinguishes as included in science. As discussed, science is known to be biased towards white, middle class males and various stakeholders also look upon science education as an elitist practice. A more amalgamated approach may give insight into how such structures are constituted and reproduced in classroom action.

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Svensk sammanfattning

Smak för naturvetenskap: Hur kan undervisning göra skillnad för elevers intresse i naturvetenskap?

Den här avhandlingen handlar om hur undervisning kan hjälpa elever att utveckla ett intresse för naturvetenskap. Elevers intresse för naturvetenskap är inte ett nytt forskningsområde utan tvärtom något som det naturvetenskapsdidaktiska forskningsfältet har studerat intensivt sedan 1960-talet. Det är därmed väl belagt och allmänt vedertaget att intresse är betydelsefullt för elevers vilja och möjlighet att lära sig och engagera sig i naturvetenskap. Även om elevers intresse för naturvetenskap är väl undersökt och också visar att undervisning kan ha en betydande effekt, har förvånansvärt få studier studerat vad som händer i klassrum där intresse för naturvetenskap utvecklas. Vår kunskap om vad lärare gör i klassrum där elever blir intresserade av naturvetenskap är således begränsad.

Tidigare forskning har visat att elevers intresse inte enbart är beroende av de erfarenheter de får i skolan, utan i hög utsträckning också av hem och uppväxt. På låg- och mellanstadiet uttrycker eleverna sig oftast positivt om ämnen och företeelser som rör naturvetenskap men detta förändras successivt och i högstadiet blir elevernas attityder mer negativa. Naturvetenskap kan då beskrivas av eleverna som en opersonlig, faktafokuserad och elitistisk verksamhet. De har svårt att relatera till ämnet på ett personligt plan och beskriver också naturvetenskap som exkluderande. Då tidigare forskning har visat att elevernas socioekonomiska bakgrund, och då speciellt föräldrarnas utbildningsnivå, påverkar intresset och således är av betydelse för de elever som ändå fortsätter med naturvetenskap på gymnasiet, finns det anledning att tro att vissa elevgrupper systematiskt utestängs från naturvetenskap. Syftet med avhandlingen är därmed att undersöka hur undervisning i naturvetenskap kan kompensera för detta, nämligen: hur kan undervisning stödja elevers möjligheter att delta meningsfullt i naturvetenskapliga sammanhang?

I avhandlingen närmar jag mig spänningsfältet mellan skola och hem på två sätt, dels genom att specifikt undersöka klassrum där det är undervisningen i naturvetenskap och inte elevernas bakgrund som är orsaken till elevernas ovanligt höga intresse, och dels genom att utveckla och använda en metod som gör det möjligt att i klassrummet studera de kognitiva, normativa och estetiska dimensionerna av intresse. Alla tre har

visat sig vara viktiga för hur intresse uppkommer men har sällan studerats tillsammans i ett sammanhang. Avhandlingen har en tämligen logisk uppbyggnad och nedan kommer jag att beskriva syftet med de olika studierna (de fyra studierna, studie 1–4, är presenterade i fyra artiklar, artikel I–IV), deras resultat och hur de relaterar till varandra och projektet som helhet. Mycket kortfattat gjorde jag följande: i studie 1 använde jag populationsdata från Statiska centralbyrån för att hitta grundskolor där fler elever än förväntat, med avseende på deras socioekonomiska bakgrund, väljer det naturvetenskapliga programmet på gymnasiet. I studie två utvecklar jag en metod för att studera hur intresse konstitueras i handling. Med hjälp av klassrumsdata operationaliserar jag begreppet *smak* som jag använder som ett mer handlingsorienterat alternativ till att studera intresse. Smakbegreppet kommer från Pierre Bourdieu och pragmatisk forskning. I studie 3 använder jag denna metod för att studera vad en lärare gör för att hjälpa eleverna att utveckla smak/intresse för naturvetenskap. Denna lärare lokaliserades med hjälp av studie 1. I studie 4, slutligen, sammanfattar jag viktiga poänger från de tidigare studierna och för fram ett förslag på ett förbiset område som kanske borde studeras närmare, nämligen möjligheten att när intresse har studerats har man inte studerat vilken typ av naturvetenskap eleverna säger sig vara intresserad av. Det är tveksamt om man kan påstå att elever förlorar sitt låg- och mellanstadieintresse för naturvetenskap, snarare kanske det handlar om att ett intresse för högstadiets naturvetenskap aldrig utvecklas. Nedan presenteras varje studie under fyra rubriker som, mer eller mindre, beskriver vad respektive studie handlar om.

Avhandlingen närmar sig alltså intresse för naturvetenskap som något som är synligt i elevers handlingar, i studie 1 genom att se i vilken utsträckning elever anser naturvetenskap vara ett lämpligt utbildningsval, och i studie 2–4 genom att titta på hur de deltar i skolans naturvetenskapliga undervisning. Det är en avhandling i didaktik, vilket betyder att dess intresse är vad en lärare kan göra för att stödja eleverna i sin undervisning. De resultat den presenterar förstås bäst som bidrag som kan vägleda lärare, men även forskare, i att göra mer genomtänkta val. Jag levererar således inga slutgiltiga rekommendationer för hur undervisningen bör se ut för att elever ska bli intresserade, utan resultaten måste grundas i ytterligare data från andra ämnesområden, skolnivåer och klassrumskontexter. Helt säkert finns det andra sätt som unga människors intresse för naturvetenskap kan visa sig på, till exempel hur de inkluderar naturvetenskap som en relevant del i sina liv. Fler studier av hur smak konstitueras och utvecklas behövs således.

Studie 1: Hitta skolor som gör skillnad

I studie 1 undersöker jag huruvida det finns grundskolor i Sverige där fler elever än förväntat väljer naturvetenskapligt (NV) program på gymnasiet. Som beskrivits ovan har man visat att det inte enbart är undervisningen som

har betydelse för elevers intresse (som alltså i denna studie förstås som deras gymnasieval, mer om detta nedan) utan även deras socioekonomiska bakgrund. I Sverige, men även internationellt, anses naturvetenskaplig utbildning vara en form av elitutbildning och NV-programmet har också beskrivits som skolans *Kungsväg*. Detta betyder givetvis inte att de som väljer NV måste vara intresserade av naturvetenskap ur ett emotionellt perspektiv ("Jag älskar fysik!") utan elever kan välja NV-programmet av en mängd olika anledningar, till exempel att NV-programmet håller "dörrarna öppna" eller att man tycker att NV-programmet ger den bästa förberedelsen för universitetsstudier (oavsett vad man ska studera). I studien argumenterar jag för att ovanstående är fallet men motiverar ändå tillvägagångssättet dels genom att det är ett vedertaget sätt att närma sig elevintresse och dels genom att man kan utgå ifrån att de elever som väljer NV *åtminstone* inte anser sig vara exkluderade från NV. Utifrån det perspektiv som sedan utvecklas och används i de följande studierna, det vill säga smak för naturvetenskap, är valet av gymnasieprogram dock inte problematiskt. Att ha smak eller att vara intresserad handlar inte enbart om att gilla ämnet, utan det handlar även om att vara inkluderad i praktiken. Det vill säga att för sig själv och gentemot andra urskilja sig själv som inkluderad i verksamheten.

Jag var alltså intresserad av att hitta en skola där undervisningen och inte hemmet kunde förklara varför så många elever väljer NV-programmet. Utifrån tidigare forskning valdes ett antal bakgrundvariabler som skulle vara med i den data jag planerade att beställa från Statistiska centralbyrån. Dessa var: föräldrars utbildningsnivå, hushållets sammanlagda inkomst före skatt, utländsk bakgrund, kön, betyg i naturvetenskap och matematik och meritvärde. Den beroende variabeln var val till NV-programmet med två möjliga utfall, eleven valde eller valde inte NV-programmet. De olika variablerna är mått på kulturellt, ekonomiskt, och utbildningskapital. Utbildningskapitalet, det vill säga betyg i naturvetenskap, matematik och meritvärde, kan anses vara problematiskt då skola och undervisning i allra högsta grad påverkar dessa. Eftersom jag ville se vilken betydelse hemmet har för valet, men utelämnade faktorer som kan härledas till skolan, var dessa alltså problematiska. I studien argumenterar jag dock för att betyg är svåra att härleda till enbart hemmet eller skolan utan att det är en kombination av eleven själv, eventuellt stöd från hemmet och skolans undervisning. Efter att materialet, som bestod av 2009 års niondeklassare, hade bearbetats och kodats bestod datamaterialet av 106 483 elever fördelade på 1 342 skolor. Med hjälp av en logistisk regressionsanalys skattades oddskvoter mellan den beroende variabeln och de oberoende variablerna. De oddskvoter som analysen resulterade i visar vilken association, svag–stark, det är mellan varje steg i variabeln och valet till NV-programmet. I princip kan man beskriva det som hur mycket sannolikheten för att en elev ska välja NV förändras med varje steg i den oberoende variabeln, till exempel ökade sannolikheten att välja NV ju högre betyg eleven hade i matematik och

naturvetenskap. Analysen visade att framförallt föräldrars utbildningsnivå påverkar valet till NV-programmet. Ekonomiskt kapital visade inte på någon tydlig trend, ju högre betyg i matematik och naturvetenskap desto större sannolikheten att välja NV-programmet. Dock var det skillnader mellan grupperna med avseende på de associationer som fanns mellan betyg och val.

Resultatet av regressionsanalysen användes för att beräkna medelsannolikheten för varje skola (baserad på elevpopulationen på skolan, med sina specifika skattningar) att elever skulle välja NV-programmet. Resultatet av detta jämfördes med det faktiska utfallet, det vill säga hur stor andel av eleverna som hade valt NV-programmet. Av totalt 1342 skolor var det 158 som avvek signifikant från vad modellen förutsade, det vill säga på dessa skolor valde fler eller färre elever NV-programmet än vad som var förväntat med tanke på deras bakgrund. Av dessa 158 skolor var det 85 som avvek positivt och 73 som avvek negativt. I 85 skolor valde alltså fler elever än vad man kan förvänta sig NV-programmet på gymnasiet. I korthet visade studie 1 att elevers bakgrund är betydelsefull för deras intresse i naturvetenskap (förstått som val av NV-programmet) då endast 158 skolor avvek från vad modellen förutsade. Studien visar emellertid också att skolor kan göra skillnad.

Studie 2: Smak för naturvetenskap, en metod för att studera intresse i handling

I studie 2 utvecklar jag en metod för att studera hur intresse för naturvetenskap utvecklas i klassrumssituationer. Vanligtvis har man förstått och även studerat intresse för naturvetenskap som en personlig egenskap med stor betydelse för hur elever uppfattar och lär sig saker i klassrummet. Elevens intresse för ämnet kan i sin tur påverkas positivt eller negativt av undervisning. Intresse för naturvetenskap handlar emellertid inte enbart om attityder till ett ämnesinnehåll, utan även om hur eleven uppfattar de värden och normer som verksamheten uttrycker; är detta någonting jag kan identifiera mig med och vill vara del i? Intresse har därmed också en normativ dimension som handlar om huruvida eleven kan och vill delta i praktiken, dels i den aktuella klassrumssituationen men också i framtida naturvetenskapliga sammanhang. Även om ovanstående är välkänt vet vi förvånansvärt lite om sammanhangets betydelse för hur intresse för naturvetenskap skapas och utvecklas. Metoden som presenteras i artikeln är ett svar på ovanstående. Jag visar här hur *smak* kan användas för att studera hur intresse konstitueras genom tal och handlingar i sociala interaktioner. Att ha smak för någonting, till exempel klassisk musik eller speedway, innebär inte enbart att man på en direkt fråga svarar att man tycker om eller är

intresserad av speedway, man kan även delta i sammanhang där kunskap om speedway uttrycks och värderas.

Att få smak för skolans naturvetenskap handlar därmed om att utveckla vanor för att uttrycka och värdera distinktioner för hur man talar, handlar och är i naturvetenskapsklassrummet. Då smak uttrycks genom hur vi i sociala interaktioner urskiljer vad som är rätt och fel, fint och fult och så vidare, är smaken därför också möjlig att observera i handling. Metoden, som baseras på teori från Pierre Bourdieu och den pragmatism som utvecklats i Stockholm och Uppsala skolan, användes för att analysera hur smak urskiljs i ett högstadielklassrum.

De teoretiska begreppen grundas i klassrumsdata från en grundskola som ligger i närheten av en stor stad. Då syftet med studien var att utveckla en metod för att studera hur intresse konstitueras i klassrummet behövde jag hitta ett klassrum där man kunde observera elevers intresse för naturvetenskap. Vidare var det nödvändigt att hitta en skola där det var undervisningen i naturvetenskap, snarare än elevernas hemförhållanden, som kunde vara orsaken till detta intresse. Jag använde mig av statistik från Skolverket och Utbildningsförvaltningen i den stad där studien bedrevs för att hitta en skola där (a) en högre andel av eleverna än riksgenomsnittet återkommande väljer det naturvetenskapliga programmet på gymnasiet, (b) det var samma lärare i naturvetenskap som arbetade på skolan under ovanstående period och (c) skolans elevpopulation är heterogen med avseende på social och nationell bakgrund. Den skola som slutligen valdes uppfyllde ovanstående kriterier. Video- och ljuddata samlades in från totalt sex lektioner. Den lektion som slutligen valdes för studien transkriberades och analyserades. Under denna lektion arbetade eleverna i grupper om tre (varje grupp spelades in via video och ljud) med att mäta och beräkna volymen på ett antal olikformade objekt.

Med hjälp av det empiriska materialet visar jag i studie 2 hur smak konstitueras i deltagarnas möten med fenomen, artefakter och andra deltagare i klassrummet och detta är möjligt att se genom deras: (1) språkanvändning, det vill säga hur elever och lärare väljer att tala genom hur de inkluderar och exkluderar ord och begrepp, (2) tillvägagångssätt, hur de väljer att agera genom de handlingar de inkluderar och exkluderar, och (3) sätt att vara, vilken typ av personer de anser tillhöra klassrummet genom vem de inkluderar och exkluderar. I studien beskriver jag också hur metoden kan användas för att synliggöra hur kognitiva, normativa och estetiska urskiljningar samverkar när smak konstitueras i klassrummet. Jag visar även hur detta har betydelse för utvecklingen av intresse.

Studie 3: Vad kan en lärare göra för att stödja sina elevers smak för naturvetenskap?

I studie 3 använder jag metoden som utvecklades i studie 2 för att studera hur en lärare som jag lokaliserat genom studie 1 hjälper sina elever att utveckla ett intresse för naturvetenskap. Som beskrivits ovan har tidigare forskning visat att läraren har stor betydelse för elevers intresse för naturvetenskap men att man sällan har studerat hur duktiga lärare stödjer detta intresse genom sin undervisning. Syftet med studie 3 var således att undersöka detta. Till skillnad från studie 2 är den skola som användes i denna studie statistiskt kontrollerad för elevernas bakgrundsvariabler men i övrigt användes samma urvalskriterier. Jag kontakade skolans rektor och berättade om mitt resultat och att jag skulle vilja komma i kontakt med de naturvetenskapslärare som undervisade på högstadiet. Rektorn hänvisade mig till en lärare som han ansåg vara mycket kompetent. Jag träffade denna lärare och de två övriga som arbetade på högstadiet. Efter att ha intervjuat 8 elever ur respektive lärares klass valde jag att göra min studie med den lärare som rektorn initialt hade rekommenderat. Den manliga läraren hade undervisat på skolan i nästan 20 år och var, precis som rektorn, glatt överraskad över att få höra om att fler elever än förväntat väljer NV-programmet på gymnasiet. Den kommunala skolan ligger i en förort till en stor stad.

Två fysiklektioner spelades in (video och ljudupptagningar av varje elevgrupp) och under dessa arbetade eleverna (årskurs 9) med att koppla ihop glödlampor och strömbrytare med ett batteri. Målet med lektionen var att introducera området ellära genom att inledningsvis repetera saker de gjort i årskurs sju. Läraren berättade för eleverna att under de följande lektionerna kommer de att prata om och arbeta med mer och mer avancerade saker inom ellära. Eleverna (totalt 24 elever med en jämn fördelning mellan pojkar och flickor) arbetade två och två med att koppla ihop glödlampor, sladdar, strömbrytare och ett batteri. Uppgifterna var formulerade som att de skulle koppla ihop ett antal komponenter för att få någonting specifikt att hända (t.ex. ”Använd ett batteri, en strömbrytare och två glödlampor, koppla så att en glödlampa slocknar när du trycker på strömbrytaren”). Innan de gjorde ovanstående skulle de först rita ett kopplingschema som de trodde skulle kunna resultera i detta utfall. Det inspelade ljudmaterialet transkriberades ordagrant (samtliga elevgrupper spelades in) och analyserades sedan med den metod som utvecklats i studie 2. Fokus här var dock vad läraren gjorde för att hjälpa eleverna att uppmärksamma och urskilja den specifika klassrumssmaken.

Resultatet visade att denne lärare var mycket noggrann med att klargöra syftet med det eleverna förväntades göra. Dels i relation till uppgiften men också i relation till vad de hade gjort tidigare och vad de skulle göra senare. I korthet gjorde läraren detta genom att urskilja hur olika handlingsalternativ, urskiljda av eleverna eller av honom själv, kunde hjälpa dem mot de mål aktiviteten hade. Under sådana tillfällen tilläts elevernas mer personliga smak ta plats och elevernas förslag avfärdades aldrig som opassande eller

felaktiga, utan istället införlivades de i den mer naturvetenskapliga klassrumssmaken. Även klassrummets normer, vilka blev synliga genom deltagarnas smakurskiljningar, var således explicita och öppna för diskussion och förhandling. Vidare var läraren noga med att kontrollera att eleverna verkligen kunde ta sig vidare efter han gett dem stöd. Vanligtvis lämnade han inte en elevgrupp innan han såg att de urskiljningar de hade gjort resulterade i handling. Dessa urskiljningar utgjorde aldrig färdiga svar utan de var istället klargöranden i relation till målet för aktiviteten. Genomgående använde läraren estetiska värdeomdömen i relation till dessa smakdistinktioner. Ett intressant resultat var lärarens vana att kontinuerligt fråga eleverna om hur det kändes när de hade lyckats lösa ett problem eller klarat av en uppgift. På detta sätt lärde sig eleverna hur det känns att förstå naturvetenskap och i enlighet med vad som beskrivits ovan handlade den här förståelsen inte bara om att transformera ett naturvetenskapligt stoff utan även om att urskilja sätt att handla meningsfullt i naturvetenskapsklassrummet. Helt klart var lärande i naturvetenskap inte enbart en fråga om att förstå ett stoff, utan även om att lära sig verksamhetens normer och estetik.

Studie 4: Är intresse för naturvetenskap samma sak på olika skolnivåer?

Vår kunskap om elevers intresse i naturvetenskap bygger framförallt på enkäter och intervjuer. Genom dessa vet vi att elever på låg- och mellanstadiet är intresserade av naturvetenskap, men att detta förändras när de kommer upp i högstadiet. Även om detta är väl belagt och allmänt accepterat har få studier undersökt *hur* naturvetenskap blir intressant. Följaktligen är vår kunskap begränsad gällande vad det är för slags naturvetenskap som eleverna säger sig vara intresserade av. Detta är bakgrunden till studie 4 som diskuterar en möjlig förklaring till varför eleverna tycks förlora sitt intresse för naturvetenskap i högstadiet. Jag föreslår att det kanske inte förhåller sig på detta sätt, det vill säga eleverna tappar inte det intresse för naturvetenskap som de utvecklat i lågstadiet, utan snarare utvecklas inte ett intresse för *högstadiets* naturvetenskap. Denna möjlighet har betydelse för hur man kan förstå elevers intresse för naturvetenskap och därför borde den vara intressant att studera närmare

Studie 4 tar således vidare den diskussion som jag fört i de tre föregående studierna genom att lyfta en förbisedd aspekt som kan behöva undersökas, nämligen hur intresse i naturvetenskap konstitueras i olika årskurser. I likhet med studierna 2–3 förstås intresse som en process i vilken objektet för personens intresse blir vad det är i en situerad och framåtsyftande rörelse. Att vara intresserad handlar således om att vara upptagen i en process där artefakter, utsagor, fenomen, etc. blir meningsfulla utifrån vad de gör för att

föra processen framåt. För att förstå vad det är med ett experiment som gör det intressant måste vi studera vad experimentet är i denna process. Vilka förväntningar har den intresserade på aktiviteten och vad syftar dessa förväntningar mot, naturvetenskapliga mål eller mer vardagliga? Till exempel kan ljudet och röken från en explosion göra ett experiment i kemi intressant för en elev, medan för en annan är det den kemiska förklaringen till varför explosionen skedde som är intressant. Även om båda eleverna skulle säga att experimentet är intressant är de förväntningar de har på experimentet och vad som skulle utmärka att dessa uppfylls, inte desamma. I det senare fallet kan man tala om ett tydligt naturvetenskapligt intresseobjekt, i det andra inte.

Även om ämnet är naturvetenskap under hela skolgången (dvs. olika områden inom fysik, kemi och biologi) är det stora skillnader i hur naturvetenskap behandlas på de olika nivåerna. Detta gäller ämnesinnehåll men också olika sociala aspekter på elevers deltagande och lärande i klassrummet. Det är därför möjligt att objektet för elevernas intresse kan skilja sig på sådana sätt att det inte är lämpligt att jämföra elevers beskrivningar av sitt eventuella intresse. Detta görs dock vanligtvis och i studien diskuterar jag därför möjliga konsekvenser av a priori-antaganden om vad intresseobjektet *är* när elevers intresse för naturvetenskap studeras.

I studien använder jag exemplet *laborationer* för att synliggöra ovanstående. Ett flertal studier har visat att yngre barn uppskattar praktiskt arbete för att det gör naturvetenskap kul och intressant. Detta intresseobjekt, det vill säga laborationer, jämförs sedan med äldre elevers intresse och laborationer blir därmed ett medel för att påverka äldre elevers vikande intresse. Poängen är att vi egentligen inte vet mycket mer om laborationer än att eleverna säger att de gillar dem. Vi vet således inte vad laborationer innebär för den naturvetenskap som konstitueras i klassrummet. Genom exempel från tidigare studier visar jag att intresset och objektet för detta intresse kan skilja sig på betydande sätt i ett lågstadie-, högstadie-och universitetssammanhang. På universitetsnivå är studenternas intresse tydligt riktat mot aktivitetens mål. Intresseobjektet är således tydligt sammankopplat med specifika naturvetenskapliga mål och dessa mål delas också av studenterna och läraren. Att vara intresserad är därmed en process där utsagor, fenomen, observationer och så vidare värderas och urskiljs i relation till dessa mål. Dessa studenter kan sägas ha en utvecklad smak för naturvetenskap. Även på lågstadienivå var elevers intresse tydligt sammankopplat med normer och värden. Dessa normer var dock inte, till skillnad mot vad som var fallet på universitetsnivån, specifika för en naturvetenskaplig praktik och följaktligen var elevernas handlingar endast i undantagsfall riktade mot naturvetenskapliga mål. Att delta i naturvetenskap handlade på lågstadiet i liten utsträckning om att urskilja sätt att tala, handla och vara för att nå specifika naturvetenskapliga mål, utan snarare kännetecknades intresset av att fritt engagera sig med det naturvetenskapliga

objektet. På lågstadiet kan eleverna därför sägas uttrycka en mer vardaglig smak med liten koppling till en mer formaliserad naturvetenskap.

Detta skiljer sig således mot vad jag har observerat i studie 2 och 3 där normer och värden var intimt förenade med den naturvetenskapliga praktiken. I de två skolor där jag gjorde mina observationer (som alltså valdes för att eleverna var intresserade av naturvetenskap) var eleverna ytterst medvetna om att det fanns ett naturvetenskapligt mål med uppgiften och deras intresse var tydligt riktat mot detta. Utsagor och handlingar urskiljdes i relation till dessa mål och den klassrumsnorm som uttrycktes var därmed explicit och möjlig att ifrågasätta. Till skillnad från universitetspraktiken var lärarna noga med att uppmärksamma eleverna på dessa normer. Dessa elever kan sägas vara på väg att utveckla en smak för naturvetenskap.

Ovanstående betyder inte att det finns bättre och sämre sätt att vara intresserad på. Poängen är att det intresse yngre elever erfar kan vara frikopplat från mål, normer och värden som är centrala delar i de efterföljande årskursernas naturvetenskap. En rolig och meningsfull aktivitet är helt enkelt inte samma sak överallt och det vore därför felaktigt att utgå från att experiment, eller något annat naturvetenskapligt objekt, kan påverka intresset på något universellt sätt. Den absoluta upptagenhet som små barn kan uppvisa när de sugs in i en aktivitet, oavsett om det handlar om en lek hemma på gården eller att studera insekter i skolan, tenderar att utvecklas till en självgående process som sällan är beroende av syften eller externa mål. Att vara *i* intresset är tillräckligt i sig. I högre årskurser räcker den här typen av engagemang oftast inte, utan intresset måste vara riktat mot specifika mål för att erkännas och belönas. Äldre elever är oftast medvetna om att aktiviteter i skolan har ett syfte och att det finns bättre och sämre sätt att handla i relation till dessa syften. Att vara intresserad är inte tillräckligt utan eleven måste vara intresserad på ett sätt som är meningsfullt för de mål aktiviteten strävar mot.

Slutligen, studien lyfter att antal frågor som vore intressanta att studera vidare. Till exempel hur blir mer personliga smakomdömen, som till exempel att en humla är fin, delar av en praktiskspecifik smak där humlan är fin utifrån förväntningar kopplade till naturvetenskapliga mål? Hur kan undervisning skapa kontinuitet mellan olika årskurser? Hur kan den smak för naturvetenskap som små elever utvecklar i de lägre årskurserna göras kontinuerlig med den smak som de förväntas omfatta i senare årskurser?

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