In everyday life, we make many decisions about our health. These decisions are made using information from many different sources. This information may be contradictory, uncertain and be very different in regard to its scientific validity. Having access to all this information means that individuals have to judge its quality and make decisions about how to act in different situations in everyday life. In this doctoral dissertation young individuals’ reasoning and justifying concerning trustworthiness and decision-making in issues connected to health are investigated.
DEcision-Making in Health Issues
MATS LUNDSTRÖM

DECISION-MAKING IN HEALTH ISSUES

Teenagers’ use of science and other discourses

Malmö University, 2011
Malmö University, Faculty of Education and Society
Lund University, Faculty of Social Sciences
This publication is also available at:
www.mah.se/muep
”Vem ska jag tro på
Tro på
Tro på när
Tro på när allt är såhär?
Och ingenting vi nånsin med nåt menar
Vem ska jag tro på
Tro på
Tro på när
Tro på när allt är såhär?
Jag hoppas ändå på ett lyckligt slut”

Vem ska jag tro på – Thomas Di Leva

“Love all, trust a few, do wrong to none.” William Shakespeare

“Mistrust makes life difficult. Trust makes it risky.”
Mason Cooley
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ABSTRACT

The purpose of this thesis is to develop knowledge about young individuals’ reasoning and how they justify their standpoints concerning trustworthiness and decision-making in issues connected to health where available information is contradictory or uncertain. This purpose has been addressed in three different steps. In the first step almost 300 students in Swedish upper secondary school answered a web-based questionnaire, which had different types of multiple choice questions about pseudoscience and science. The results demonstrated large differences in acceptance between the different pseudoscientific statements. But there was no pseudoscientific statement where the majority of the students agreed. There was no apparent relationship between the students’ pseudoscientific beliefs and their factual knowledge about the human body. However, the analysis revealed that students who have taken three or more science courses in upper secondary have relatively lower faith to pseudoscientific ideas. The results did not indicate any sex difference with regard to strength of faith in pseudoscientific ideas. In the second step, first year students from the science programme were observed and video-taped during two lessons, while discussing different explanation models in health. They worked in peer-groups with three to five students. The students discussed two different cases which contained a question and then two proposed answers that differed a great deal from each other with respect to scientific level. The results demonstrated that the students used four different types of epistemological resources; relativistic, normative, authoritative and scientific, when supporting their argu-
ments about trustworthiness. No student clearly used resources from pseudoscience. The use of scientific epistemological resources was rare. Instead normative or authoritative resources appeared to be more available or more context appropriate for the students in this study. The study also demonstrated that students were able to use different epistemological resources in different situations, for example when the teacher joined the discussion and put some challenging questions to the group. In the third step, seven teenagers, 17-19 years old, participated in a video diary study and an individual interview. Four girls and three boys documented their decision-making about the new influenza and vaccination against it. The data collection was thus mainly performed outside school, in everyday life surroundings, when the teenagers justified their decision about the vaccination. The different statements and answers were categorised using discourse psychology. The categorised repertoires were of two main types; experienced emphases and important actors. The first category comprised risk, solidarity and knowledge. In the second family and friends, media, school and society were included. The school repertoire was seldom used by the students, indicating that school and science education are not available interpretative repertoires in this context. The results demonstrate the difficulties for the teenagers to use science knowledge, in the format of correct facts or concepts. However, at the same time the results demonstrate presence and reasoning concerning the importance of scientific knowledge. This scientific discourse seems to be important when teenagers reason, make decisions and justifies their decisions in health issues. The results also raise methodological questions concerning how to investigate scientific literacy. Video diaries is suggested as an appropriate data collection tool to investigate scientific literacy in an out-of-school context. With the use of video diaries, the possibilities to investigate everyday life and decision-making go beyond the classroom.

Key words: discourse, epistemological resources, health literacy, identity construction, interpretative repertoire, pseudoscience, science, scientific literacy, trustworthiness, video diary
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INTRODUCTION

During the last decades, one of the aims with science education in large parts of the world has been to educate all students in basic science. The purpose has been to address individual needs in various ways, for instance in decision-making (Driver et al., 1996; OECD, 2003). Scientific knowledge is regarded as important for the citizen when acting in everyday life. In this everyday decision-making, many different sources of information are offered. Family, friends, colleagues, school mates, teachers, experts, fortune-tellers, newspapers, television news broadcasting and Internet (including social media), are some of the possible sources. This smorgasbord of sources offers a wide span of variation in how information is conveyed and what type of information is accessible. The information may be contradictory, uncertain and display large differences regarding scientific level. With access to all these possibilities to obtain information, the individuals have to judge its quality and make decisions how to act in different situations in everyday life. In this decision-making it is not always possible to find a single clear or accurate answer to a question, because of the complexity or uncertainty inherent to the issue. So far, decision-making about contradictory or uncertain information is a subject that has been insufficiently studied in science education research, especially not outside school – in real situations (Christensen, 2009; Kolstø, 2007).

This type of decision-making is believed to be trained and developed at school, for instance in science education. Additionally, it is assumed that school prepares students for citizenship. However, it should not be forgotten that actual decisions are made directly,
while participating in various social activities and contexts outside school (Roth and Lee, 2004). This implies that knowledge and skills, relevant to decision-making, such as scientific knowledge learned at school, must be possible to transfer to other contexts. Only then can such knowledge constitute an available resource in a number of relevant situations outside school, both immediately and in the future. An example of decision-making which is important for the individual's everyday life, are decisions relating to health issues. When decisions on health issues are made, the ontological assumptions which the individual holds are crucial, since they entail different ways of describing the world. Among these different ways of explaining and understanding our physical world, science is frequently used.

1.1 Science as a useful explanation model
Science is well-established socially, and it is often argued that this rich body of conclusions and procedures constitutes the best way of describing and explaining the physical world (McClellan III and Dorn, 1999). An assumption in this thesis is that science in fact offers valuable tools for the individual to understand the world in a relevant way in many situations. By this is meant that it is regarded as a useful means to understand how some aspects of the world function, although science is not seen as the solution to all problems. Empirical data is the basis for scientific explanations. Science offers useful explanations concerning how the physical world functions, even if the objectivity of observations and experiments may be criticised (Chalmers, 1999). In this thesis, the point of departure for the definition of science is that it constitutes “awareness, knowledge, organised knowledge and as activity a systematic and methodical acquiring of knowledge within a certain area” (Swedish National Encyclopedia, 2008). However, science is not only organised knowledge about the physical world; it can also be described as a discourse, with a specific language that differs from everyday talk. Foucault (1997) defines the term discourse as “the group of statements that belong to a single system of formation” and gives as examples clinical discourse or the discourse of natural history (Foucault, 1997, 107). A discourse does not only comprise a spe-
specific language, but involves “instances of communicative action in medium of language” (Johnstone, 2008, 2). Science at school can be seen as a mixture of these two descriptions; it deals with organised knowledge as well as with a specific way of communicating about the world.

In this thesis science is discussed in terms of its properties as an explanation model. Like the school subject, science as an explanation model can be considered to include both the dimension of organised knowledge and the specific way of communicating about the world. Other explanation models will also be discussed, such as for instance “pseudoscience”. Although these different explanation models are not regarded as equal in the frame of the thesis, describing them with same term makes it easier to compare and analyse statements about them.

It has sometimes been assumed (Miller, 1987; Sagan, 1997) that an education in science will work as a “vaccine” against other beliefs that contradict it. With scientific knowledge is supposed to follow a critical standpoint and a capacity to evaluate different types of information. According to this view, it might be supposed that other “non-scientific” explanation models will be neglected if you are successful in science. This supposition is criticised by Ryan et al. (2004) and Shermer (2003) who question the relationships and request more research about the relationships between individuals’ scientific knowledge and his or her capacity to evaluate information using scientific reasoning.

1.1.1 Scientific literacy

In a similar manner, the role of science education has been discussed, and the extent to which it may be successful in creating scientifically literate citizens (Brown et al., 2005; Driver et al., 1996; Roberts, 2007). Laugksch (2000) states that scientific literacy has become a buzzword and a contemporary goal, conveying the rather vague notion of what the general public ought to know about science. According to Laugksch this lack of precision has led to different interpretations and disagreement concerning what scientific literacy should include. Driver at al. (1996) define scientific literacy (SL) as knowledge about science knowledge, or scientific concepts,
scientific processes and situations or contexts. OECD (2003) defines SL as “the capacity to use scientific knowledge, to identify questions, and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity” (OECD, 2003, 133). Both the scientific matter and the processes in which knowledge is used or developed are emphasized in these definitions.

The concept scientific literacy has had a large impact on research and assessments in science education in the western world during the last years (OECD, 2003, 2007; Roberts, 2007). OECD’s PISA-studies have had considerable influence in curriculum development in several countries. The importance of SL is emphasized in the Swedish curriculum for lower secondary school. “Many tasks require each and everyone to have a knowledge of science, especially when it comes to environmental and health issues. Focusing on such issues in teaching creates opportunities for pupils to develop their ability to use scientific knowledge and reasoning as a basis for forming their views. The education thus affects pupils both as individuals and as citizens of society” (The Swedish National Agency for Education, 2000). In a compulsory course (Science studies A) in upper secondary school the ability to understand the difference between facts and values is emphasized (The Swedish National Agency for Education, 2011).

The term literacy indicates the significance of being able to act in different situations. Both researchers, such as Driver et al. (1996), Jenkins (2006), Levinson (2010), Norris and Philips (2003), van Eijck and Roth (2010) and organisations like the OECD (2007) emphasize the necessity of not only being able to use scientific knowledge in the science classroom but also in different situations in daily life. Van Eijck and Roth (2010) describe this use in daily life as scientific literacy, “in the wild”. They stress the importance of developing science education and research about SL in an everyday context, because “in the everyday world, scientific literacy likely does not mean doing well on a test, but it means knowledgeably participating and contributing to worldly affairs where scientific literacy is required” (van Eijck and Roth, 2010, 185).
These two reported interests; the large amount of contradictory and uncertain information with more or less scientific content, and the aim of a scientifically literate citizen are the foundation of this thesis.

1.2 Limitations and justifications of the research field
Much of the uncertain or contradictory information in media and other public sources concerns health and the human body. The senders of media messages appeal to our willingness to protect our life against different risks against our health (Beck, 1992; 1999). Health is also a field where a more specific kind of scientific literacy (health literacy) has been emphasized. Nutbeam (1999) argues for health literacy, where individuals are able to make informed decisions about their health. This includes reading and analysing different types of information about health, like prescriptions and articles in newspapers. But it also means being able to communicate health issues with others. According to Nutbeam, there have not been enough studies that have investigated in what ways individuals are health literate. Similarly, science education research on scientific literacy and uncertain or contradictory information has been insufficient until now (Christensen, 2009; Pettersen, 2007; Roberts, 2007). The choice has therefore been made in the present thesis to focus on issues connected to health and the human body. This area has also been selected in view of the diversity in explanation models underpinning accessible information. Health is additionally emphasized as an important subject in the Swedish biology curriculum (The Swedish National Agency for Education, 2000; 2011). This curriculum stresses the students’ capacity to discuss health questions using relevant biological knowledge as a foundation. Knowledge in biology is in this way regarded as playing a significant role in the individual’s decision-making in health issues.

Two current, public discussions will be examined, so called pseudoscience and the new influenza. These two discussions have framed the work as a whole and have also been objects for the data collection, but in three different studies. There are connections between these two public discussions; both have been the origin of many newspaper headlines, television shows and discussions
around coffee tables during the last years. In the new influenza de-
bate, non-scientific or pseudoscientific messages circulated, for in-
stance about side effects. Both public discussions brought up the
issue of what information can be counted as trustworthy. In this
way the thesis deals with different aspects of explanations or de-
scriptions of the world. Scientific literacy will be examined mainly
from the above mentioned definition from OECD (2003; 2007)
where the use and decision-making perspectives are emphasized
compared to a perspective primarily considering knowledge of sci-
entific concepts.

Throughout the thesis, the term scientific knowledge is used in-
estead of science knowledge. The term emphasizes a broad perspec-
tive, including not only knowledge in science, but also knowledge
about science. This covers understanding about collecting and as-
sessing the quality of data, interpreting data (considering alterna-
tive explanations, integrating empirical data and non-empirical
ideas), using scientific models and appreciating uncertainty in sci-
ence (Ryder, 2001; Sadler, 2009).

1.2.1 The interest in pseudoscience – dealing with
trustworthiness

When I started my first study, a glance at the television programme
revealed a certain interest in broadcasting programmes about phe-
nomena that may be described as paranormal, pseudoscientific and
sometimes belonging to the field of New Age. Preece & Baxter
(2000) describe most New Age ideas as pseudoscience, defined as
“a set of ideas or theories which are claimed to be scientific but
which are contrary to standard tests and which have failed empiri-
cal tests or which cannot in principle be tested” (Preece and Baxter,
2000, 1148). Also newspapers and web sites expose these alterna-
tive explanation models. For instance, health advice in media may
be dressed in explanations that seem scientific even if they are not
correct. Concepts like poison, energy and nutrition are used in a
different manner than in science. The texts thus appear to be scien-
tific but are grounded in explanation models that totally differ
from science. It is today also possible to buy expensive mixtures
without any proved function. In advertisement such products can
be described as natural, and organic. Claims can be made that they have been used for thousands of years, for example in the Far East. Other popular fields are mind-reading and horoscopes. Your health is described as dependent on your zodiac. This way of describing or explaining the world is different from the scientific way of describing and explaining our world. In such cases, the individual needs to reflect about what can be counted as trustworthy. According to Wheeler (2006), belief in pseudoscience may seem harmless, but from a deeper perspective, confidence in this type of information can result in incorrect treatments, passivity or economic exploitation. The necessity to understand the difference between scientific explanations and other explanations has been underlined in science education research (Bell and Lederman, 2003; Donnelly and Akerson, 2007).

Despite widespread exposure to pseudoscience, there are few studies about individuals’ belief in this and other alternative explanation models (Ryan et al., 2004; Shermer, 2003). Earlier Swedish studies about individuals’ ideas about pseudoscience (Morhed, 2000; Sjödin, 1995; 2001) have aimed at describing religious opinions held by individuals, rather than considering pseudoscience from the perspective of science education.

1.2.2 The new influenza and vaccination debate – decision-making outside school

In the 2009-2010 media debate about the new influenza (also called the swine flu), the information from different sources varied a great deal. The information that was offered was sometimes contradictory, both between different sources and within one and the same source. The messages from the newspapers and other media varied from day to day. The reports followed an established genre for how to report on scientific and technological risks (Ratcliffe and Grace, 2003; Ungar, 2008). Shock horror and human drama were common. This diversity in media messages is not surprising but illustrates the complexity of the issue. It was also a field where pseudo- or non-scientific messages were sometimes found. These conditions raise questions about how individuals reason and make decisions about health. There are similarities between the pseudos-
cience and new influenza debate, such as the issue of how to handle contradictory information, but there are also differences. The public discussion about the new influenza was much more explicit than debates about pseudoscience normally are. For instance, the Swedish National Board of Health and Welfare was much more visible in the influenza case compared to advice about how to handle pseudoscience in health generally. In Sweden all citizens were offered free vaccination against the new influenza, something that might have opened up for discussions about the vaccination decision in many different situations during these months.

In earlier research about attitudes towards vaccination, parents’ opinions about vaccinations have been investigated (Duggan and Gott, 2002; Ideland, 2007; Poltorak et al., 2005). In the new influenza debate teenagers’ voices were heard through social media. The vaccination decision could be discussed not only face-to-face but also in chat forums and similar contexts. Different statements could in this way be spread also through Internet. There were possibilities for the teenagers to engage and participate in the discussions. They could both have their own debate and follow or even be a part of the public debate even if the latter was primarily steered by journalists. The capacity to follow and evaluate discussions about science in media is often reported as weak or lacking in the scientific literacy of students (McClune and Jarman, 2010). McClune and Jarman have with the help of different experts in science media reporting identified five categories of competences which contribute to an individual’s capacity to engage critically in science-based news. These are “knowledge of science”, “knowledge of writing and language”, “knowledge about news, newspapers and journalism”, “skills” and “attitudes”.

There is not much reported research in science education about decision-making in everyday life (Kolstø, 2006; van Eijck and Roth, 2010). Previous research has been criticised, because the investigated decision-making differs from real world decisions (Shafir et al., 1993) and decision-making in daily life (Kolstø, 2006). Ratcliffe and Grace (2003) consider deficiencies in research on the interaction between formal education and use of science outside school. Christensen (2009) argues for more research about these
issues, for instance in the field of risk assessment in science education. Christensen states that this research should examine individuals' understanding of science-in-the-making more closely, because science is often presented in school as certain and definitive, while actual science is often much more complex and connected to other areas of knowledge or values. Ratcliffe and Grace (2003) maintain that individuals need to have some understanding of in what ways scientific evidence is generated and used, especially in contemporary science. In the same way, Lederman (2007) and McComas (2004) stress the importance of examining students’ understanding of the fact that science is always exposed to new examination and challenges.

1.2.3 The need for research about trustworthiness and decision-making

To summarise, pseudoscience and the new influenza are both relevant to the field of health. They are also both frequently reported on in media in scientific and less scientific ways. Both debates concern contradictory explanation models or discourses. A lack of research has been found regarding young adults’ opinions about pseudoscience and its relation to science education and also a lack of research about decision-making in everyday life. These are thus aspects of the use of scientific knowledge which demand further research.

1.3 Purpose and research questions

The purpose of this thesis is to develop knowledge about young individuals’ reasoning and how they justify their standpoints concerning trustworthiness and decision-making in issues connected to health where available information is contradictory or uncertain. The purpose is also to investigate if the students use scientific knowledge as an available discourse when they handle contradictory or uncertain information. The research questions are:

- In what ways do students reason, decide and justify their decisions in issues connected to the human body and health?
- How do students use scientific knowledge in issues related to the human body and health?
2 OVERALL DESCRIPTION OF THE THESIS

A PhD-research project running over several years may shift and develop regarding assumptions as well as theoretical perspectives. This has been the case in the present research process. This chapter aims to give an overall description of the development of the process.

The development is described as three “steps”. The step metaphor is chosen to emphasize the ongoing work making changes during the research project. These changes were effectuated to understand more about the research field, to answer the research questions more completely and from different angles. In each step different parts of the overall purpose and research questions are considered. Each step raises new questions, questions that could not be answered in the same way as in the preceding step. With this follows changes in both theoretical perspectives and methodology. In this chapter the three different steps are summarised and discussed from an overarching overall perspective. Each step resulted in a study and each is described in an article except the third step, which resulted in two articles (III & IV). In following chapters (3-5) each step is presented with more precise descriptions, results and justifications. The articles are summarised at the end of each chapter. Article IV, which is a methodological article is summarised in chapter 6. Some methodological considerations are included and discussed in each chapter in order to make the different steps easier to understand, while the main methodological considerations are discussed in chapter 6.
2.1 The three different steps
The three performed steps are here called:

- Pseudoscientific beliefs
- Arguing different explanation models
- Decision-making outside school

All three steps include studies where upper secondary school students are requested to respond to statements or information about health in different ways. The information or statements are contradictory and/or uncertain. In all three steps, it is possible to use scientific knowledge or a scientific discourse as a tool to respond, discuss or justify answers or argumentation. In this way, all steps deal with the overall research questions from section 1.3. The different steps are performed in different ways regarding:

- who the students are
- where they are
- what they talk about
- who they talk to or with
- what they do when talking
- how the data is analysed
Table 1. Summary of the different steps.

<table>
<thead>
<tr>
<th>Step</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>293 upper secondary students from all study programmes</td>
<td>27 Science programme students in upper secondary</td>
<td>7 teenagers (from upper secondary)</td>
</tr>
<tr>
<td>Where</td>
<td>Classroom</td>
<td>Classroom</td>
<td>Outside school</td>
</tr>
<tr>
<td>Subject</td>
<td>Pseudoscientific beliefs</td>
<td>Pseudoscientific versus scientific explanations</td>
<td>Uncertain, vaccination decision</td>
</tr>
<tr>
<td>Talking to</td>
<td>Nobody</td>
<td>Peer-students, teacher</td>
<td>Camera</td>
</tr>
<tr>
<td>Type of talk</td>
<td>Responding</td>
<td>Discussing</td>
<td>Narrating/Justifying</td>
</tr>
<tr>
<td>Analysis</td>
<td>Statistical, descriptive and ANOVA</td>
<td>Epistemological resources</td>
<td>Discourse psychology</td>
</tr>
</tbody>
</table>

2.1.1 Step 1 – pseudoscientific beliefs

In the first step almost 300 students from a majority of the study programmes in Swedish upper secondary school were asked to answer a web-based questionnaire (Appendix 1). Almost all of the students had studied the compulsory course in science, Science studies A. After that course, the students had studied science to widely varying extents. The majority sat in front of a computer in a classroom during their response. A few of the students responded from a computer at home. All students answered individually, even if the classmates sat next to them. They filled in the questionnaire which had different types of multiple choice questions about pseudoscience and science. The analyses of the results were made statistically. The answers were inserted to SPSS for Windows. Mean and standards deviations were calculated. Two different indexes; Human Biology Knowledge Index (HBKI) and Pseudo-Scientific Belief Index (PSBI) were created. After that, a one-way ANOVA-test was used to check for correlations or lack of correlations between dif-
different variables. Also a cluster analysis was made to reveal relationships between how the students responded and their sex, study programme and the two indexes that had been created.

The analyses gave an overall image of upper secondary students’ decisions about pseudoscientific statements on an individual level. However, the web-based questionnaire gave no explanation to how individuals reason about or justify these decisions. The analyses had investigated correlations and lack of correlations to scientific knowledge. Nevertheless, the explicit use of scientific knowledge in decision-making could not be investigated. Therefore, a second study was planned and conducted in order to answer those parts of the overall research questions that not had been answered in the first step.

2.1.2 Step 2 – arguing different explanation models
In the second step, the explicit talk about use of scientific knowledge was the focus of interest. Therefore, first year students from the science programme were observed and video-taped during two lessons. This group was chosen because students from the science programme can be expected to use scientific knowledge in their reasoning, at least to some degree. They were video-taped in their science classroom while discussing different explanation models in health. They worked in peer-groups with three to five students. The students discussed two different cases which contained a question and then two proposed answers that differed a great deal from each other with respect to scientific level. One of the offered answers can be considered as scientific, and the other as pseudoscientific. The material was analysed with a framework from Hofer (2004a) and Lemke (1990). The key analytical concept was Hofer’s personal epistemological resources.

The analyses made it possible to answer the research questions about how students reason and justify decisions when the information is uncertain or contradictory. To certain extent, also the second research question, concerning how students use scientific knowledge in issues related to the human body and health had been answered. However, the first two steps had investigated the research questions only in a school context. To answer the research
questions in a more complete way, it was necessary to investigate
students’ reasoning, decision-making, justifying and use of scientific knowledge also in an out-of-school context.

2.1.3 Step 3 – decision-making outside school
In the last step, the research differs from the first two steps, especially regarding context and subject. Seven teenagers, 17-19 years old, participated in a video diary study and an individual interview. The students were enrolled on five different programmes in upper secondary. In this manner, diversity in education that might provide interesting variety in reasoning about scientific knowledge was emphasized in the selection of informants. Four girls and three boys documented their decision-making about the new influenza and vaccination against it. The data collection was thus mainly performed outside school, in everyday life surroundings, when the teenagers justified their decision about the vaccination. They videotaped their diary themselves. It was mainly a monologue with the camera. The material can therefore also be regarded as talk or narration directed to the researcher. In the interviews with the teenagers a couple of weeks after the video diary making, the video clips were discussed. Also questions concerning school, science education and their daily life were broached. The material was analysed with a discourse analysis approach, using Potter and Wetherell’s (1987) discourse psychology, where interpretative repertoires is the main analytical concept.

The third step was a methodological development in investigating decision-making and scientific literacy in everyday life. Video diaries have not been common in science education research and with it follows that this way of collecting and analysing data needed to be described and discussed in this last step.

2.2 Comparisons between theoretical perspectives underpinning the different steps
The different steps are analysed with different theoretical frameworks. In the first step, students’ beliefs about the world were regarded as rather stable and thereby possible to map. Cobern (1989; 2000) describes an individual’s perspectives about how the world
functions as an individual worldview; an epistemological macrostructure, which also belongs to the field of ontology (Hansson, 2007). This individual worldview is influenced both by formal and informal learning situations. The individual worldview consists of many different parts, where one part is grounded by our understanding of science. It is, according to Cobern, not impossible, but difficult to change an individual worldview, for example by science education.

However, in a survey study of the kind performed in the first study it is not possible to investigate the students’ underlying argumentation or use of different discourses. To do this, the informants must produce talk/text. Such texts can be analysed in different ways compared to the statistical analysis in a survey. Reasoning and justifications can be analysed more qualitatively. The observation study in the second step was analysed with a framework taken mainly from Hofer (2004a). Hofer argues that the differences between individuals in how they interpret information can be explained in terms of a personal epistemology. This personal epistemology is a way of seeing knowledge as something that will affect your standpoints, for example in what ways you choose information. How stable a personal epistemology is may, according to Hofer, be an object for discussions, even if personal epistemology often is regarded as context dependent.

Hofer’s framework was adequate for analysing the short statements in the peer-group discussions. The third study, with video diaries and interviews, contained another type of data than the short statements within a limited question which prevailed in study 2. Instead the data consisted of rich descriptions about the informants’ everyday life. The teenagers constructed an identity when talking about their decision about the vaccination. It was also obvious that the students used different discourses from society to legitimate their decisions. For that reason a constructionist perspective was applied in the third step where the data was analysed with discourse psychology (Potter and Wetherell, 1987). This made it possible to analyse how the teenagers describe themselves, something not possible with Hofer’s framework but important in step 3. A constructionist perspective (Potter, 1996)
emphasizes that the world is not categorised in a certain way that everybody is forced to accept. Instead descriptions of the world are human practices and the world as we know it is constituted as people talk it, write it or argue it (Johnstone, 2008; Potter, 1996). Language, combined with actions and interactions builds and re-builds our world (Gee, 1999). Different individuals make their own constructions. Hacking (1999) emphasizes that social constructions are ideas about different phenomena. The phenomenon itself is not the construction, the construction is how individuals interpret and interact with the phenomenon or parts of the phenomenon. How we regard and construct the world will thereby change, both for an individual and over time. With time means both the individual’s view of a phenomenon over time, and that the physical world changes over time, it doesn’t look the same today as in the 19th century. A deeper justification to the shift in framework in step 3 is described in chapter 6.
3 THE FIRST STEP
– PSEUDOSCIENTIFIC BELIEFS

Studies about young individuals’ beliefs in different pseudoscientific phenomena are rare, and more studies in a Swedish context with connections to science education are needed. One reason why this has been neglected in science education and research, may be the totally different explanation models which are used in pseudoscience and related fields. These explanations are far from scientific explanations. One such different/alternative explanation model is New Age. There is no uniform definition of the concept New Age (Hammer, 1997). Instead Hammer describes New Age as a mixture of beliefs and convictions of religious character but where certain kinds of supernatural explanations exist. Closely associated to pseudoscience are paranormal phenomena. Paranormal phenomena are defined by Hammer as phenomena that until now neither can be confirmed, nor rejected by scientific methods (Hammer, 1997). One such example is ghosts, while there is no reason for science to accept the existence of ghosts, there is today no possibility to prove their non-existence. The field of pseudoscientific or non-scientific claims is not new, it has been described for many years, but the on-going wider coverage in media is interesting.

In this first step, young people’s attitudes towards these alternative explanations are discussed in relation to scientific explanations, which has not been so common in science education research. This, despite the fact that there seems to be a great interest among students in secondary school for such subjects (Jidesjö et al., 2009).
3.1 Earlier studies about pseudoscientific beliefs

A few Swedish studies about beliefs in pseudoscience have been conducted. Sjödin (1995) investigated upper secondary students' paranormal beliefs and Morhed (2000) investigated beliefs in different pseudoscientific and paranormal phenomena. Morhed asked 1963 adults in Sweden (with a respondent rate of 65 per cent) about their attitudes to pseudoscience and paranormal phenomena. Both studies were conducted mainly with the aim of investigating connections to religious beliefs. Sjödin found that more than one third of the students agreed or partly agreed with statements that there are people who are able to contact spirits, tell the future, or read other people's thoughts. About one fifth of the participants stated that they believed in astrology, reincarnation, and that some people have the ability to move objects by telekinesis. Morhed's study demonstrates a similar image of what people believe in. In a question about health, one third of the respondents agreed with the statement “People can get healthy through healing, crystal therapy, zone therapy or other methods that have not been approved by the established health care” (Morhed, 2000, 77). Morhed found that only seven per cent of the informants were positive to the majority of the 12 statements about pseudoscience and paranormal phenomena, indicating large differences in agreement between the different statements. Younger (16-29 years) individuals were more open/ believed more in the statements than older respondents. Individuals with a high level of education were more negative to the statements with one exception. They were more positive to alternative medicine compared to individuals with a lower education level.

In studies about pseudoscientific beliefs, sex differences are often investigated. Results present a contradictory image even if females often are described as having more trust to pseudoscience compared to males, as in for example in Morhed’s (2000) study. Also in a study by Preece and Baxter (2000), females, to a higher extent than males, revealed that they give credence to pseudoscientific and paranormal ideas, such as crystal healing, astrology and ghosts. There is, however, one exception; males tended to more readily accept that aliens from outer space have visited earth. Similarly, Sjödin's analysis (1995) revealed sex differences among upper sec-
ondary students, for example, females expressed a greater confidence in general occult phenomena, astrology and reincarnation. As in the study by Preece and Baxter (2000), males, to a greater extent than females, seemed to believe in the existence of UFOs. In a Norwegian study, female health science students demonstrated more positive attitudes to alternative medical treatments than male students (Pettersen, 2007).

However, other studies imply that there are no general sex differences concerning to what extent males and females express acceptance of or faith in paranormal phenomena. For example, Johnson and Pigliucci (2004) compared adult males’ and females’ pseudoscientific ideas and found no apparent gender differences. Their study also contains content-related issues in which males and females had diverging levels of conviction. Males communicated a pronounced acceptance of the existence of the Loch Ness monster, while females more readily believed that animals can sense ghosts. Regarding giving credence to magnetic healing, telepathy and voodoo, Johnson and Pigliucci found no clear differences. The authors argue that the content matter is decisive when discussing sex differences and correlations in belief in paranormal phenomena. In the same way, Wiseman & Watt (2004) conclude that males and females seem to be superstitious to different degrees, depending on what paranormal area they are asked about. These claims are supported by Shermer (2003), who argues there is no sex difference in the power of belief, only in what phenomena subjects choose to believe in. (For further discussion about what can be counted as pseudoscientific in health issues see for example Pettersen, 2007 and Singh and Ernst, 2008).

The reported results about pseudoscientific beliefs are not the same as mistrust in scientific knowledge. Even if science sometimes is questioned, two major studies (EC, 2005; NSF, 2006) conclude that the majority of Europeans and Americans express explicitly that research in science is crucial for a society’s welfare and development. According to these studies, people of all ages, are of the opinion that science and technology can both make our lives easier and solve problems. Furthermore, they believe that science and
technology—particularly within the spheres of medicine, energy and ICT—will have a positive effect on our lives in the future.

3.2 Study 1: Opinions on pseudoscientific ideas
As there was little research about individuals’ opinions about pseudoscience and how these beliefs are correlated to different aspects of science education, it was important to map the field in Sweden. This was achieved by a study conducted from a science education perspective, where relevant correlations could be analysed. The study was conducted mainly to answer the question about decision-making and to a lesser degree use of scientific knowledge from the overall research questions. The study is reported in article I; Students’ ideas regarding science and pseudoscience in relation to the human body and health (Lundström and Jakobsson, 2009) and is published in the Nordic Studies in Science Education (NorDiNa) 2009. In the next section a short summary of the study is made.

3.2.1 Students’ ideas regarding science and pseudoscience in relation to the human body and health.
The aim with the study was to explore what pseudoscientific, paranormal and superstitious ideas students in upper secondary school actually hold and how their ideas are related to their scientific knowledge concerning the human body and health. The study also sought to investigate if there were any sex or educational differences related to the issues. The research questions were:

- What pseudoscientific ideas concerning the human body and health do students hold and how do they relate these ideas to scientific explanations?
- In what ways is students’ knowledge about the human body and health related to their pseudoscientific beliefs?
- Are there significant gender differences related to these questions?
- Is it possible to identify differences concerning students’ ideas, depending on what educational programme the students study on?
Almost 300 students in upper secondary school responded to the web-based questionnaire (Appendix 1). The respondent rate was 83.7%. The respondents were not randomly chosen but sampled with the objective of reflecting the general student population in upper secondary school in Sweden. In the questionnaire, the respondents were asked to consider different statements about the body, some of them pseudoscientific, but also to answer knowledge questions about the human body and health. The knowledge questions were of multiple-choice type.

The results demonstrated large differences in acceptance between the different pseudoscientific statements. But there was no statement where the majority of the students agreed with the statement. About one third of the students agreed to statements about the possibility for some people to read other people’s thoughts, and that phases of the moon can affect a person’s health. These results were essentially similar to earlier Swedish studies (Morhed, 2000; Sjödin, 1995). There was no apparent relationship between the students’ pseudoscientific beliefs and their factual knowledge about the human body. The results did not indicate any sex difference with regard to strength of faith in pseudoscientific ideas. This result is contrary to the results from Morhed (2000) and Sjödin (1995). The analysis revealed that students who have taken three or more science courses in upper secondary have relatively lower faith to pseudoscientific ideas even if it was not possible to find any simple explanation to why such apparent differences exist. It cannot definitely be explained by the studied courses; another possible explanation is therefore that students who are sceptical to other explanations choose to study more science courses. The results indicated that it is possible to be a rather successful student in the science classroom and at the same time maintain a high confidence in pseudoscientific explanations. This result thereby disproves the hypothesis that knowledge in science leads to an “enlightenment” and a capacity to be critical against non-scientific ideas, an argument proposed by Miller (1987), Sagan (1997), and Wallace (2000).
4 THE SECOND STEP
– ARGUING DIFFERENT EXPLANATION MODELS

In the first study, some important statistics and correlations or absence of correlations in the field were discovered. The complex relations between factual knowledge in science, study programme, studied science courses, sex and agreement with pseudoscientific statements were analysed quantitatively. The students in the first study responded to the questionnaire individually, in a classroom, in front of a computer. However, in a study in which students answer a web questionnaire individually it is not possible to analyse how they reason or make decisions when facing pseudoscientific statements. The survey questionnaire invited to short answers and thereby measured factual knowledge rather than reasoning skills. To get insight to students’ reasoning and justifications as stated in the overall research questions I decided to investigate students’ reasoning and justifications to their decision-making in study 2. Therefore I chose to investigate what happens if the students have to argue in support of their decision-making and justifications. What happens if they must confront other individuals and together discuss trustworthiness, to make a decision about health?

The lack of general differences between males’ and females’ pseudoscientific beliefs in study 1, led to the decision not to focus gender in study 2. Much information in the media is short, dense and often presented as human drama, controversies or shock horror to capture people’s interest and differs from scientific informa-
tion presented in text books (Ratcliffe and Grace, 2003). This makes media information appropriate to use or be inspired by, in order to examine reasoning and decision-making.

4.1 Trustworthiness and decision-making
The need and relevance of different aspects of decision-making in science teaching has been argued for a long time by several researchers (e.g. Kolstø, 2007; Millar and Osborne, 1998; Zeidler et al., 2004). In this thesis trustworthiness and decision-making are investigated when the students have to deal with different types of information and reach a decision based on contradictory or uncertain information.

There is rich diversity in studies about decision-making, but studies are often related to argumentation and reasoning skills justified by the close relations between the concepts (Driver et al., 2000; Kolstø, 2007). Erduran et al. (2004) contend that argumentation is a vital skill in the field of scientific literacy including decision-making in science education contexts. To convince other individuals about what is trustworthy or what decision you should make, argumentation skills play a central role. Driver et al. (2000) put forward two important reasons for science education where argumentation is in focus. Firstly, the public must be able to make their voice heard in discussions and different types of decision-making. Secondly, the public needs a more authentic description of what is involved in scientific inquiry. For that reason, understanding arguments used in science is essential. Arguing is considered as a human practice that is situated in specific social settings (Driver et al., 2000). For those reasons, Driver et al. (2000) and McClune and Jarman (2010) call attention to the importance of investigating students’ reasoning about media information.

A few studies have been conducted, where trustworthiness and decision-making are related to reliability, for example uncertain and contradictory information (Christensen, 2009; Kolsto, 2007). Kolsto et al. (2006) investigated science education students’ capacity to assess the reliability of scientific claims in scientific articles. The 89 university students worked in groups of two or three. They were asked to assess the reliability of scientific claims in articles of
their own choice. The students focused on empirical and theoretical adequacy, completeness of presented information, social aspects, and manipulative strategies. The students in this way demonstrated certain skills in reasoning. However, Kolstø et al. contend that examination of texts with a science dimension must be emphasized in all science education and research.

In another study about trustworthiness, Kolstø (2001) found that 16-year-old students find it difficult to know what information to trust and what sources to believe in when they examined statements about trustworthiness concerning the risks with power transmission lines. Kolstø used a news brief about power transmission lines and their role in causing leukaemia as the basis for an interview study about students’ way of judging information relating to a socio-scientific issue. Four different “resolution strategies” were identified, which were used by the students for this task. The different categories were used when trying to find the reasons for their decisions. The four categorised ‘resolution strategies’ were ‘acceptance of knowledge claims’, ‘acceptance of authority’, ‘evaluation of statements’ and ‘evaluation of authorities’. This implies, according to Kolstø, that the students managed to make decisions regarding the trustworthiness of knowledge claims, information and arguments. Some students used more than one strategy. Sources of knowledge were more evaluated than the content. This evaluation of sources is of interest when contradictory or uncertain information is in focus.

4.2 Theoretical considerations in study 2
A theoretical framework by Hofer (2004a; b) was used as an analytical tool. This framework combined with Lemke’s (1990) thematic patterns could be used to explain differences between how the students reasoned individually in study 1, compared to when they reasoned in a peer group in study 2. This framework has connections to a socio-cultural perspective. In a socio-cultural perspective, learning and other human capacities are considered to be situated in social practices (Säljö, 2000; Wertsch, 1991). Learning must be seen as something that changes all the time, individuals will judge situations differently on different occasions. Säljö con-
siders learning as situated, dependent on the content, and as a matter of how humans are able to deal with cultural artifacts in situated practices. The peer-group discussions in study 2 had a specific content (pseudoscience versus science) and the classroom is a specific practice.

This framework was chosen because it made it possible to analyse students’ statements about how the world is constituted and how they regard knowledge, which is of importance for reasoning about pseudoscientific statements. The framework from Hofer (2004a; b) about epistemological resources regards acting as the use of these epistemological resources. In this view, all individuals develop a personal epistemology during life which constitutes how and in what ways they evaluate information and draw conclusions about phenomena in the world. Additionally, personal epistemology is referred to as the theories and thoughts about knowledge and knowing that the individual develops during encounters in the social and cultural world. This implies that individuals develop different epistemological resources due to what they encounter and experience, and that these resources can be utilised in different contexts or discourses (Hammer and Elby, 2003; Hofer, 2004a; Louca et al., 2004). This framework fits well with a socio-cultural perspective as the use of epistemological resources is described as variable, situated, and depending on the context and less stable than in a cognitive view (Hammer and Elby, 2003; Hofer, 2004a; b, and Louca et al., 2004). The resources are available for the learner and the context will decide which resources are brought to the fore. Any given situation will differ from others; the context will affect what resources are used in that particular situation. Together with Lemke’s (1990) thematic patterns a framework for study 2 was decided. Lemke describes thematic patterns as a pattern of connections between the meanings of words. For a thicker description of Hofer’s framework, see Hofer (2004a), or Lundström (2010).
4.3 Study 2: Discussions about different explanation models

The study was conducted with the purpose of answering the overall research questions about students’ reasoning, decision-making and justifications of these decisions. The purpose was also to investigate students’ use of scientific knowledge in a peer-group discussion. The study is presented in article II: Scientific trustworthy: the considerations and perceptions of students. The article is written together with Anders Jakobsson (Lundström & Jakobsson, accepted with revisions). In the next section a short summary is made.

4.3.1 Scientific trustworthy: the considerations and perceptions of students

The aim was to explore what kind of epistemological resources upper secondary students use when they discuss issues related to the human body and health. The students were supposed to evaluate scientific trustworthy in texts and articles related to scientific as well as to non-scientific suggested explanations. The pseudoscientific statements in study 2 were either inspired by or collected directly from media. The topic for the study was argumentation and decision-making about different explanation models concerning the human body and health.

The research question was:

- In what ways may students’ considerations and perceptions of scientific trustworthy be expressed through their use of different epistemological resources?

27 students in their first year of the science programme in upper secondary school were chosen to participate in the study. The students worked in peer groups with two assignments (Appendix 2) that were constructed by the author in order to present two completely different explanation models to the same problem. The first case consisted of a person’s description of her allergy and two alternative explanations about the causes and cure of allergy. The second case discussed if planets and stars may have an influence on
our health or if genes and life style are decisive. Students’ discussions were videotaped and then transcribed.

The results demonstrated that the students used four different types of epistemological resources: relativistic, normative, authoritative and scientific, when supporting their arguments about trustworthiness. No student clearly used resources from pseudoscience. The use of scientific epistemological resources was rare. Instead normative or authoritative resources appeared to be more available or more context appropriate for the students in this study. The study also demonstrated that students were able to use different epistemological resources in different situations, for example when the teacher joined the discussion and put some challenging questions to the group. A statement from a student could some minutes later be re-formulated or rejected by the same student. This result supports theories where knowledge and decision-making are regarded as situated and dependent on the situation or context, rather than constituting stable structures in the mind as the world view framework would suggest.
5 THE THIRD STEP – DECISION-MAKING OUTSIDE SCHOOL

In two studies the research questions have been examined mainly from a school context perspective. In the literature review about studies in scientific literacy (SL), the low number of studies in an out-of-school context is demonstrated (Roberts, 2007). Roberts’ review shows that a large majority of studies have been conducted in a school context even when analysing argumentation or decision-making in everyday life. At the same time, research about the use of scientific knowledge has been called for by several researchers (Driver et al., 1996; Kolstø, 2006; Laugksch, 2000; Roberts, 2007). With a theoretical perspective where the use of knowledge is regarded as dependent on the context, the methodological aspect of the settings chosen in studies about SL needs to be discussed. If knowledge and its use are regarded as situated, dependent on the context, then studies about the use of scientific knowledge in decision-making in everyday life have to be conducted in everyday life settings. The need thus appeared to complement earlier studies about decision-making in everyday life. This third step aimed to contribute to our understanding of how individuals reason, justify and make decisions outside school.
5.1 Scientific literacy in an out-of-school context

Studies about scientific literacy indicate the difficulties students have using relevant scientific knowledge in different situations (Driver et al., 1996; Roberts, 2007). These studies have mostly been conducted in a school context and Roberts (2007) discusses different aspects of what is measured in the name of SL in such studies. Martin (1994) and Driver et al. (1996) stress that the aim with science education is not only to handle science, but also to be scientific, to think and act in a scientific way in daily life. Levinson (2010) focuses the democratic aspects of the concept, “science education towards scientific literacy should provide the means for informed citizens to participate in democratic decision-making on contemporary technoscientific issues” (Levinson, 2010, 76). Scientific literacy has an important role in informed decision-making about future issues like environmental and health problems (Norris and Philips, 2003; Ratcliffe and Grace, 2003). In this thesis the democratic and decision-making arguments for SL in everyday life, are the most important aspects of the concept. This includes critical consumption of scientific research (Osborne and Dillon, 2008).

There is debate about overestimating the significance of scientific literacy. Ryder (2001) questions if the reported deficiencies in scientific literacy are alarming. In his review of case-studies about using science outside school he found that when individuals need to communicate with experts they usually learn the science content required. Also Wynne (1996) discusses the use of science knowledge. Wynne demonstrates how common sense reasoning and observations are more important than science knowledge, either based on their own background in science or from expertise, when citizens try to make sense of situations caused by or related to science.

Despite these objections put forward by Ryder (2001) and Wynne (1996) a majority of research argues for the importance of SL (Driver et al., 1996; Laugksch, 2000; Roberts, 2007) and SL is described as decisive. Nevertheless, the debate about scientific literacy opens up for further research about individuals’ decision-making and how science may be used in situations outside school.
5.2 The outbreak of the swine flu as a case for a study

One such situation where science may be a tool to explain and handle a situation is how an individual understands and chooses cure for a disease. A disease has a scientific explanation that is more or less available or plausible for the individual. The outbreak of the new influenza in Mexico and USA during the first months of 2009 was dramatic, but interesting from many perspectives. It was clearly a health issue and scientific knowledge was involved beside other types of knowledge. When the Swedish National Board of Health and Welfare took the decision June 2009 to distribute and offer free vaccination to all citizens, a clear trustworthiness and decision-making situation has been formed. The swine flu epidemic was thus an interesting and important issue for research to investigate how individuals interpret scientific information and make decisions about their health. The new influenza and its associated vaccination gave birth not only to well-articulated reports and articles but also a great deal of speculation and rumour. The available information about the influenza and vaccination was contradictory. On the one hand the influenza was reported as a disease that could cause death, while on the other hand it was reported that the vaccination against it in some cases could lead to unpleasant side effects.

Messages in the media appear to be important to teenagers. When students report what sources they use to get knowledge about health from, many students refer to television, often commercials, newspapers and posters (Turner et al., 1999). Research about health information reports the difficulties for citizens to handle, but mainly to obtain relevant information about health. For example, personal experience is often the only relevant information for many patients to understand their disease (Sander and Krüger, 2008). Also Hämeen-Anttila et al. (2006) demonstrate how students’ medical opinions are grounded mainly in their own experiences. They found that 13-14-year-old students often have superficial knowledge in the area, a negative attitude towards medicines and prefer to avoid pharmaceutical preparations if possible. At the same time Ratcliffe and Grace (2003) remark that many textbooks explain the biology content connected to infectious dis-
eases and vaccinations. However the textbooks seldom debate the wider personal and social impact of the disease or vaccination. These studies indicate that school and science education do not always contribute to or form a part of individuals’ reasoning about health issues, for instance risk, even if more studies must be conducted about how health information is interpreted.

5.3 Risk assessment in daily life
Deciding how to handle diseases and vaccinations involves managing risk. Risk is something that the individual needs to deal with and decide about in his or her daily life. The different risks may be of different magnitudes or relevance (Ratcliffe and Grace, 2003). Beck (1992; 1999) discusses contemporary society from a risk perspective. Beck considers that civilization today has to face a lot of different types of risks. He defines risk as a “systematic way of dealing with hazards and insecurities induced and introduced by modernization itself” (Beck, 1992, 21). He considers the judgment of risks as difficult, but necessary for the individual. In the judgment, both for the individual and for society, different types of experts play a central role. But it is not only a matter of science knowledge. Rationality, fact and interest are involved in the process of risk determination. Also Giddens (1991) states that risk assessment is of great importance for the citizen but emphasizes the difficulties, because there are always unintended and unforeseen outcomes. Giddens talks about fateful moments “when individuals are called on to take decisions that are particularly consequential for their ambitions, or more generally for their future life” (Giddens, 1991, 112). These fateful moments are not daily activities in day-to-day life but instead moments where the decision is experienced as crucial for the individual, as for example the risks of a possible deadly disease like the new influenza. The new influenza vaccination may be regarded, and was described in media, as one such fateful moment since the outcome of the decision could be to avoid a serious disease or get ill from side effects. Beck (1992) means that there is a strong variation in how individuals judge and think about side effects. Scientists only trust scientific proofs while
an individual sees it in another way, maybe when a child is sick shortly after a new occurrence in the neighborhood.

5.3.1 Studies about risk assessment
Kolstø (2006) argues that making a risk assessment frequently is about how to judge a disputed scientific claim. Kolstø states that there is almost always some science related to the question even if this is not always obvious. Christensen (2009) argues that the role of risk understanding and risk judgment has not been sufficiently addressed in different studies of socio-scientific issues. There are some studies that have investigated socio-scientific issues and risks. Kolstø (2006) looked at students’ decision-making arguments about a local power transmission line and if this should be buried in the ground because the possible risk of increasing childhood leukemia if the line is in the air. After group discussions and interviews he categorised the students’ reasoning patterns in five categories. The first category consisted of students who thought the risk was too small to motivate the high costs from underground lines. Kolstø calls this category the relative risk. In the second category, the precautionary argument; students emphasized “safety first” even if the risk is small. There were also students in the study who could not come to a decision about how to do. In the fourth category students stated that risks are natural parts of our life and not anything to make a big fuss about. In the last category Kolstø put the students who really weigh the pros and cons before they made their judgment. To a certain extent these pros and cons may be grounded in the individual’s view of science.

Christensen (2007) investigated young adults (aged 18-26 years) risk assessment about mobile phones, looking at the question if these pose significant health risks. The stimuli for discussions were recent television news reports about conflicting scientific research findings about health risks with mobile phones. Christensen found that the young people interpreted the uncertainty of the scientific knowledge mainly in social terms and had difficulties interpreting data as elements of scientific reasoning.
5.4 Justifying study 3
The possibility to follow participants in their daily life by taking field notes or with a video camera appeared problematic to handle both from a practical and ethical view. One possibility was interviews but if the time delay between the decision-making and the data collection should be minimized, interviews were not appropriate as the main method. Just using interviews also did not meet the requirement of an everyday life context, close to the participants.

The problem was solved by putting the teenagers themselves in charge of the data collection. Inspired by descriptions in television of young peoples’ expressed thoughts about everyday life, the solution for how to collect data close to the participants became video diaries. In this manner, it was possible to perform a study about decision-making in the context it concerned, in everyday life, and at the same time meet the earlier reported calls for studies about use of scientific knowledge and trustworthiness. As explained in articles III and IV, video diaries have mainly been used in other research fields than education, but the method has been reported as successful in describing and analysing everyday life (e.g. Holliday, 2000; 2004). Most young individuals today have no problems with handling a video camera. With a video camera they are able to document different situations where decision-making about the new influenza and vaccination would be one of the themes. In this way an everyday context was the place for the data collection. Before the summary of article III, the theoretical framework in step 3 is described and justified.

5.5 Discourse psychology
Discourse is a certain way to talk about and understand the world (or a part of the world) (Johnstone, 2008; Potter and Wetherell, 1987; Winther Jørgensen and Phillips, 2000). Gee (1999) emphasizes that there exist no clear boundaries between different discourses. Potter and Wetherell include all forms of spoken interaction in discourse, formal and informal, and written texts of all kinds. Thereby discourse analysis belongs to the field of social constructionism, which is a language based approach. This should not be confused with the constructivist theories in education, building
on Piaget’s theories. A discourse analytic approach instead emphasizes that the way we understand the world is historically and culturally dependent and thereby contingent (Potter and Wetherell 1987). In line with ethnomethodology discourse analysis focuses on how people use their language to do things. “People are using their language to construct versions of the social world. This construction implies active selection where some resources are included and some omitted” (Potter and Wetherell, 1987, 33-34). Descriptions and accounts construct the world or versions of the world and these descriptions and accounts are themselves constructed (Johnstone, 2008; Potter, 1996).

One of the theories in the field of discourse analysis is discourse psychology. The theory is mainly developed and described by Potter and Wetherell (1987) and Wetherell and Potter (1992). Discourse psychology is based on the social constructivist assumption that the I is not an isolated autonomous agent, but instead a social entity, which arises, transforms and is an object for negotiations in social practices (Potter and Wetherell, 1987; Wetherell and Potter, 1992; Winter Jørgensen and Phillips, 2000). With this view, discourse psychology rejects the idea that individuals have a solid identity. When you talk you also construct an identity which is not always the same (Gee, 1999; 2001; Potter and Wetherell, 1987). Different discursive resources are used in different social relations. However, one does not assume a new identity every time one talks, strata of earlier discursive practices are important in expressed identity (Wetherell and Potter, 1992; Winther Jørgensen and Phillips, 2000). Identity in this sense “refers to the outcome of processes by which people index their similarity and differences from others” (Johnstone, 2008, 151). The identity will be the “performance”. Johnstone describes this identity construction as sometimes self-conscious and strategic, while at other times sometimes a matter of habit. Potter (1996) contends that identity normally is not consciously constructed. The understanding of identity building connected to learning science is emphasized by for instance Brickhouse (2001), Lave and Wenger (1991) and Wenger (2008). It takes its departure in a social theory on learning (Lave & Wenger, 1991). The primary focus of this theory is that you learn
when you participate in social practices and communities and when you are able to construct an identity in relation to these. Learning and identity building are in other words interdependent on each other; “meaning is constructed in relation to the community, specific practice and the identity” (Wenger 2008, 5).

Discourse psychology focuses on individual’s concrete daily practice, to a higher degree than for example Fairclough’s critical discourse analysis focus, even if discourse psychology also is interested in how this daily practice builds on or transforms structures in society (Winther Jørgensen and Phillips, 2000). Gee (1999) describes different levels of discourses in terms of Discourses with a “big D” and discourses with “little d”. The little d-discourses are described by Gee as language-in-use and thereby the definition is close to the individual’s daily practice, which discourse psychologists are interested of. In the big D, Gee includes “language plus other stuff” (Gee, 1999, 17). As examples of this Gee mentions being a factory worker, being a Sikh woman etc. With the discourse follows what is possible to say as a factory worker or a Sikh woman. Discourse is about talking, acting and valuing in a certain way in a certain context (Gee, 1999; 2001).

In discourse psychology the interest is how discourse is used as a flexible resource in social action. Often, the concept interpretative repertoire is used instead of discourse to emphasize the discursive resources’ flexibility in social action (Potter and Wetherell, 1987; Winther Jørgensen and Phillips, 2000). Talking in terms of interpretative repertoires is according to Potter and Wetherell (1987), an alternative compared to describing attitudes, beliefs and attributes as mental constructions which are stable and hard to change (Potter and Wetherell, 1987). “Interpretative repertoires are recurrently used systems of terms used for characterizing and evaluating actions, events and other phenomena” (Potter and Wetherell, 1987, 149). The interpretative repertoire will be organised around specific metaphors and figures of speech and has no clearly defined fixed borders. A repertoire is not connected to a certain social group and an individual may use different interpretative repertoires in different situations or contexts.
5.6 Study 3: The new influenza

The study was conducted with the purpose of answering the overall research questions about students’ reasoning, decision-making and justifications of these decisions. The purpose was also to investigate students’ use of scientific knowledge. These were the same purposes as in study 2. However, this time the study was conducted outside school. It was also made with a topic that was more uncertain from the perspective of scientific knowledge compared to studies 1 and 2. The reasoning, decision-making and justification were regarded from a discourse and identity construction perspective. The use of this framework is in further detail discussed in section 6.3. The study resulted in two articles. Article III: To vaccinate or not to vaccinate: how teenagers justified their decision is presented in the next section. Article IV: Using video diaries in studies about scientific literacy is a methodological article and is summarised in section 6.4. Both articles are written together with Margareta Ekborg and Malin Ideland.

5.6.1 Teenagers’ justifications to their decision-making concerning the new influenza vaccination

The purpose of the study was to develop knowledge about connections between how students in upper secondary school talk about themselves and the decision they made about the new influenza and the vaccination against it. The purpose was also to investigate if the students use school and science education as an available repertoire within a discourse on the new influenza.

The research questions were:

- How are the decisions about the vaccination justified among upper secondary students?
- How can this decision-making be understood in relation to the students’ discursive constructions of themselves in a specific social context?

Seven teenagers, four girls and three boys, aged 17-19 participated in the study after responding to a missive. (Appendix 3). The teenagers documented their decision about the new flu and vaccina-
tion in a video diary. The informants were requested to document situations where their decisions about the vaccination against the new flu were discussed. (Appendix 4). All teenagers made their diaries during the weeks the vaccination programme was going on. The students were also interviewed 1-4 weeks after recording their diary (Appendix 5).

The different statements and answers were categorised using discourse psychology. The categorised repertoires were of two main types; 1/experienced emphases and 2/important actors. The first category comprised risk, solidarity and knowledge. In the second family and friends, media, school and society were included. The school repertoire was seldom used by the students, indicating that school and science education are not available interpretative repertoires in this context. They may not be equally preferred, or are not perceived as equally appropriate. Instead the repertoires of risk, solidarity, family and friends and the media repertoire were available, even if for example the risk repertoire was used in different ways by different students.

The teenagers in the study discussed risks almost only from the perspective of the vaccination, not the influenza. This result indicates a need for deeper risk assessment discussions in their education. The importance of a family and friends repertoire indicates the possibility to start close to the student’s daily life when working with socio-scientific issues. These results indicate the need for using media reports in dealing with scientific literacy.
The methodological considerations were to some extent discussed in chapters 2-5. However, questions about the feasibility of investigating individuals' reasoning and decision-making about trustworthiness and use of scientific knowledge, demands some more reflection. This chapter discusses methodological considerations of the research project, for instance validity and reliability in the different steps. The aim is to discuss what the use of different methods has contributed within the research project. The different parts of the research are therefore also discussed, even if the focus is on the various types of analysis. These methodological discussions lead to discussions about the theoretical frameworks. The lack of earlier studies and thereby articles connected to the third step, investigating scientific literacy in an everyday context, resulted in a methodological article. In this chapter, article IV – *Using video diaries in studies about scientific literacy* is summarised. At the end of the chapter ethical considerations are accounted for.

The overall research questions were specified in sub questions in the different steps. These different sub questions and attendant methods in the different steps resulted in different types of answers. The aim is to compare different results and draw overall conclusions, contributing to a deeper understanding of the answers to the research questions, even if it should be remembered that the informants were not the same all through the research project. Despite these considerations, it is of interest to reason about methodological consequences in the different steps.
6.1 What different methods can investigate

The two research questions have been investigated with different methods. Study 1 used a web-based questionnaire, while study 2 employed case descriptions where peer-group discussions were observed, and study 3 analysed video diaries and interviews. In this way, study 1 was quantitative while studies 2 and 3 were qualitative. Based on a framework that emphasizes the importance of context, differences in results between the different studies was not surprising.

6.1.1 Study 1- the survey, a quantitative study

A survey study is appropriate when the aim is to map and make conclusions about many individuals’ attitudes (Patton, 2002). The lack of earlier relevant studies motivated a quantitative study. Several types of analyses were performed with the aim of finding possible correlations between pseudoscientific beliefs and different variables. In this analysis an ANOVA-test was used. The data material was also analysed with cluster analysis. A cluster analysis seeks to sort different objects into groups depending on the degree of association between two objects. This cluster analysis resulted in six different clusters, where it was possible to see what was common for the students belonging to the same cluster. The study gave answers concerning upper secondary students’ confidence in pseudoscience on an individual level, in a school context, in front of a computer. It is not necessary to always regard questionnaires as measuring stable opinions. It can also be regarded as a measure of opinions at that moment. Irrespectively, it was strength to demonstrate how students in upper secondary responded in issues concerning health where information is contradictory. It had consequences for the ongoing project; the to certain extent agreement in certain statements, demonstrated a need for further research in the field.

6.1.2 Study 1 – reliability and validity

Results in quantitative studies are often reviewed in terms of their reliability. Reliability is the extent to which scores are free from errors (McMillan, 2004). The most widely used estimate of reliability
in quantitative studies is internal consistency. It indicates the degree of homogeneity among the items in an instrument (McMillan, 2004). In study 1 Cronbach’s Alpha was used to measure this. The items in PSBI (Pseudo-Scientific Belief Index) had a value of 0.76 and the items in HBKI (Human Biology Knowledge Index) 0.66. According to Ntoumanis (2001) values between 0.60-0.70 indicate relatively strong internal consistency while values between 0.70-0.90 indicate that items are strongly related to each other. The two constructed indexes can therefore be seen as consistent. These values also demonstrate that the students’ have taken the survey seriously and have not just tacked randomly.

Quantitative studies are also often evaluated from their validity. Validity is traditionally defined as to which degree an instrument measures what is said to be measured (McMillan, 2004). McMillan discusses a shift in definition of validity that has taken place during the last years. A more contemporary definition is, according to McMillan, “the extent to which inferences are appropriate and meaningful. In other words, validity is a judgment of the appropriateness of a measure for the specific inferences or decisions that result from scores generated by the measure” (McMillan, 2004, 136). The indexes in step 1 can therefore be discussed with respect to their validity also in the latter sense. The construction of a Likert scale in the measuring of pseudoscientific beliefs resulted in an inference that it is not possible to establish if an individual holds general pseudoscientific beliefs or not, it is a matter of what type of pseudoscience that is presented. This can be inferred from the large diversity in agreement between the different statements. At the same time, the indexes PSBI and HBKI were constructed and correlations between them were investigated. These two approaches may be regarded as conflicting. If there are large differences between agreements concerning different pseudoscientific beliefs, why construct an index such as PSBI? This can be explained through the main research questions. Since the aim was to examine individuals’ decision-making about the body and health and how scientific knowledge is used, the indexes appeared to present an opportunity where the two research questions crossed each other. It was then possible to analyse correlations between scientific knowledge and
decision-making. Another possibility to validate results and interpretations is to compare with other studies. The comparisons with earlier studies (Morhed, 2000; Sjödin, 1995) were one way of reviewing the results. The results in study 1 resembled the results in Morhed’s and Sjödin’s studies. If large discrepancies had been observed, it would have been important to explain those differences.

However, there are limitations to the type of quantitative study conducted in step 1. According to Patton (2002), it is not possible to get a multifaceted understanding of individuals’ thoughts and experiences through this methodology. Such understanding demands other settings than a survey.

6.1.3 Studies 2 and 3 – qualitative studies
To meet this methodological objection from Patton (2002), group observation was used in the second study about students’ reasoning and decision-making in two cases with conflicting information. It was then possible to analyse students’ argumentation and decision-making when they have to justify their decisions, something they were not invited to do in study 1. In the second study, a framework was used that is dependent on what encounters and experiences the individual has had, and where the epistemological resources the person actually uses are seen as strongly related to the specific context or situation (Hammer and Elby, 2003; Hofer, 2004a). Those epistemological resources were not regarded as stable entities, instead as more flexible. In this way, different situations during the students’ discussion could be analysed with the aim of finding such flexibility in students’ reasoning.

Qualitative studies often result in an abundance of data. “The challenge of qualitative analysis lies in making sense of massive amounts of data” (Patton, 2002, 432). It is necessary to reduce the volume of data in an appropriate way to communicate the essence of what data reveals. This challenge was to some extent avoided in studies 2 and 3 because all data could be transcribed and analysed. Kvale (1997) emphasizes the importance of reliability and validity also in transcription. This was considered through listening to the tapes and watching the videos again, even after transcription to check the transcription. The transcriptions were not analysed until
they had been checked in this manner. However, in the process of reducing the data, for instance in writing the articles and choosing appropriate excerpts, there was a risk of being blind to data that did not readily agree with the main conclusions. After coding the material with respect to different epistemological resources (study 2) and interpretative repertoires (study 3) it was possible to once again reanalyse, and establish how much of the data did not fit into these epistemological resources respectively interpretative repertoires. In both studies almost all material could be coded into epistemological resources respectively interpretative repertoires even if the two studies differed with respect to data collection, interpretation and analysis.

In qualitative studies reliability and validity are impossible to reason about in the same way as in quantitative studies. There are no scores to measure errors with, and no straightforward tests for reliability and validity (McMillan, 2004; Patton, 2002). Instead the quality of the research must be discussed in different ways. Kvale (1997) emphasizes that the description of the cases must be rich, dense and solid to be valid. The topics were limited to pseudoscience respectively the new influenza to meet these demands. McMillan (2004) defines reliability in qualitative studies as “the extent to which what has been recorded as data is what actually occurred in the setting that was studied” (McMillan, 2004, 278). With this definition, also supported by Kvale (1997), the possibility to document the data collection in an appropriate way is important for the reliability. Both study 2 and 3 were recorded; study 2 and the first part of study 3 were video-taped and the second part of study 3 (interviews) were recorded with a tape recorder. The interviews during study 3 were in this way a type of test of the reliability because during the interviews some parts of the teenagers’ video diaries were viewed and discussed. This documentation of all discussions and monologues strengthens the reliability of the two studies. This was possible since both study 2 and study 3 were limited in time, especially study 2 which was recorded during two lessons, with a video camera following each group. In study 2 the aim was to document “normal” discussion during lessons. The usual teacher moved between the groups and made comments or asked
questions in order to facilitate the discussions, which aimed to create an authentic everyday classroom situation (Goldman-Segall, 1998). However, the presence of a camera affected the students and thereby also the data collection. Imitations and jokes were common in the beginning but decreased later in the discussion or when the teacher joined the group. There were also students for which the video camera in the group observation seemed to function as a monitor. These students acted seriously and challenged each other with questions.

The data collection with video cameras functioned completely different in step 3. In that step the teenagers were aware of the video cameras from the beginning. They had even applied to join the research project and were therefore conscious of the implications. In step 2 the teacher had made the decision that the class should participate and even if it was voluntary for the students to join, they may have experienced a pressure from the teacher to take part even if they felt uncomfortable about being filmed. Another difference was that I had contact with all students in the video diary study before the data collection began. This was not the case with all students in study 2, and may have affected the engagement in the tasks.

Validity in qualitative studies implies proper use of the information that is gathered through measurement (McMillan, 2004). Kvale (1997) and McMillan (2004) emphasise that review of the validity must include also the consumers of the research. In other words, through relevant and careful descriptions of the research, it is possible for others to be a part of this validity process. This is the case in this research project. The results and conclusions have been presented at different occasions such as seminars, and at national and international conferences, with posters, papers and presentations. These occasions have been opportunities to communicate different aspects of the research and thereby improve it.

6.2 Validity in discourse psychology
One validity framework in discourse psychology is presented by Potter and Wetherell (1987) which was used as theoretical framework in study 3. They present four main analytic techniques which
can be used to validate research within the discourse psychology framework; coherence, participants’ orientation, new problems and fruitfulness (Potter and Wetherell, 1987, 169.)

Potter and Wetherell emphasize that “a set of analytical claims should give coherence to a body of discourse. Analysis should let us see how the discourse fits together and how discursive structure produces effects and functions” (Potter and Wetherell, 1987, 170). They also stress that explanations should cover both broad patterns and micro-sequences and that exceptions from the patterns are of importance. In study 3, both in video diaries and interviews, different available repertoires were categorised. The teenagers’ uses of several of these repertoires, or refraining to use them, are analysed in article III. Their use of interpretative repertoires is utilised in the analysis of three students’ statements from an individual perspective. The analysis focuses on how the decision was made, and how different interpretative repertoires functioned as justifications. The analyses demonstrated how different interpretative repertoires were emphasized and sometimes combined to justify decisions. One girl (Sandra) use of a scientific repertoire functioned as a justification to get vaccinated. In the same way, another girl in the study, Amanda’s use of a risk repertoire available in media and among her friends, functioned as justification not get vaccinated. In this way the study meets the demands from Potter and Wetherell (1987) to see how the discourse fits together and how discursive structures produce effects and functions, for example in constructing an identity.

As a second point, Potter and Wetherell mention participants’ orientation. They emphasize the importance of what the participants see as consistent and different. Potter and Wetherell assume that interviews or observations can bring forward data where this field can be analysed. In study 3, participants’ orientation could be recorded during the interviews that followed a couple of weeks after the video diary was completed. In these interviews, the participants’ decision about vaccination was discussed, while viewing a short sequence of their video diary. In the interviews the teenagers discussed their decision and reflected on about it. None of the participating teenagers said that they regretted their decision about the
vaccination. This must not be considered as a certain proof of the stability of their opinions, since it can also be seen as a way of presenting themselves for me as a researcher as rational, consistent individuals. The time between the different types of data collection is important when what participants see as consistent is discussed. An interview some months later when side effects had been even more discussed in media could have resulted in other statements from the students. Especially because science is often regarded as consistent (Lederman, 2007; McComas, 2004). The new influenza case was an example of how scientific knowledge is negotiated and changed, something that several of the students commented in terms of uncertainty and risk.

Potter and Wetherell (1987) discuss in their third point the emergence of new problems and their solutions. They emphasize that any single theory or framework does not provide the solution to all problems or questions and that this must be obvious in the validation. One such problem was discovered in the analysis. There were difficulties in using discourse psychology to analyse how macro-level subjects, for instance the government’s decision has influences on a micro-level. This is important to analyse because it can help understand how campaigns and media are interpreted by the individual. An example of this from study 3 is a boy named Jakob’s reasoning about his vaccination decision. Jakob reasons about the government’s decision to offer free vaccination, but he does not express anything about how this influenced his decision concerning the vaccination. He expresses doubt about the necessity, but despite that understands the decision from the governments. The fact that Jakob reasons about governments both in his video diary and in the interviews indicates an influence, although it is not explicitly expressed as a foundation for the decision. In other words, how is the small d affected by the large D (Gee, 1999)? This problem also stresses the importance of analysing the video diary data before the interviews and so that the interviews can be used as opportunities to search for questions which arise, such as connections between small d’s and big D’s.

The last of the four points, fruitfulness, refers to the scope of an analytical scheme to make sense of new kinds of discourse and to
generate novel explanations. I regard the way of analysing discourse in an out of school context as very fruitful. It has given new knowledge about how teenagers express themselves in everyday life. Through investigating the issues outside school, repertoires usually not focused in science education could be noticed. For instance, solidarity repertoire was used by several of the teenagers to justify their choice, a repertoire that not always is noticed in science education. It has also generated thoughts regarding if the use of a scientific repertoire must be more clearly considered as use of two repertoires, the individual’s own scientific knowledge and scientific discourse offered in the society.

6.3 From epistemological resources to discourse psychology

As discussed above, this section will provide a more detailed account of the theoretical framework of the present thesis came to shift from Hofer’s (2004a) epistemological resources to Potter and Wetherell’s (1987) discourse psychology and interpretative repertoires.

There are similarities in these two frameworks, for instance the situation is by both regarded as important for the outcome. Different contexts entail different results. In both theories talking about knowledge is regarded as a set of resources, used differently depending of the situation. Knowledge is seen as situated. The environment and other persons are considered to play important parts in what resources are used. But the frameworks also have specific traits that distinguish them. Discourse analysis focuses on “activities of justification, rationalization, categorization, attribution, making sense, naming, blaming and identifying” (Wetherell and Potter 1992, 2) and thereby marked out as a social field owned by the individual. Discourse psychology investigates how Discourses (Gee, 1999) are expressed in individuals’ activities of justification. This framework was useful when the research interest was placed on how individuals justify their decisions, describing themselves. Analysing how individuals describe themselves in relation to different situations and actions was appropriate in relation to the data material. These descriptions could not have been analysed within
Hofer’s framework. The data material was largely about making sense of reasoning and decisions about the new influenza. The teenagers thus became more visible through this approach than in study 2. The visual images with gestures and facial expressions were another type of data than the material which had been collected through observation study in study 2, even if these gestures have not been explicitly analysed in their own right here. The teenagers in study 3 tried to tell a story, not only about their decision concerning the vaccination but also about who they were or who they want to be seen as. Such “stories” was not so obvious from all students in study 2, because the number of students and the peer group format. These stories are not regarded as well considered intentions or activities that the teenager has consciously reflected over, but the analysis nevertheless provides a possibility to express how they construct themselves in this particular context. It is likely that many of the characteristics of the data are closely linked to the format of a video diary. With the diary genre will follow a certain way of expressing and representing yourself. It is possible to analyse how the teenagers construct an identity in relation to social practices (Lave and Wenger, 1991). Buckingham (2009) argues that a video diary gives the informants a possibility to create representations of their own experiences and “creates positions from which it is possible for participants to speak” (Buckingham, 2009, 648). Also Pink (2001; 2007) emphasizes visual representations as constructions and thereby suitable for discourse analysis.

6.4 Article IV: Using video diaries in studies about scientific literacy

As mentioned earlier the possibility to analyse decision-making in everyday life was a crucial consideration in the third study. Video diaries were chosen because they provide an opportunity to catch everyday experiences close to the participants both in time and space. The use of video diaries as a data collection tool has not been widespread in science education research even if a few studies exist (Cottrn et al., 2010; Noyes, 2004). These two studies were both conducted in a school context. Some earlier research in science education has considered science in daily life (Roth and
Lee, 2004), but handing over the camera to the informant leads to very diverging data. The absence of studies and articles where video diaries are used for investigating scientific literacy has been one of the reasons for writing an article of this kind.

Studies where informants document their life can be found in other disciplines, such as medicine and sociology. The video camera has for instance been used in video diary studies about media (Voithofer, 2005), health (Buchwald et al., 2009), consumer research (Brown, 2010), and sexuality (Holliday, 2000; 2004). The experiences from study 3 demonstrate that video diaries constitute a useful tool in research about use of scientific knowledge in decision-making in everyday life. But the use of this tool requires reflection in the light of theoretical perspectives. The fourth and last article; Using video diaries in studies about scientific literacy discusses methodological, including theoretical aspects, of using video diaries to investigate science education, and more particularly scientific literacy outside school. The article takes its starting point in van Eijck and Roth’s (2010) requests for studies about scientific literacy “in the wild”. In other words; to investigate scientific literacy in everyday life, in an out-of-school context. It can be discussed to which extent any type of observation study can be considered as “in the wild”. However, an out-of-school context is regarded as closer to “in the wild” than a classroom. Although the presence of a video camera will necessarily affect the informant’s behaviour (Pink, 2001), a video diary study is regarded as appropriate to investigate everyday life. However, it should be remembered that video diaries do not automatically produce explicit use of scientific concepts.

Holliday (2000; 2004), Quadri and Bullen (2007) and Noyes (2004) argue that video diaries provide a fuller description of life with more honest information than other forms of evaluation. According to these authors, the video diary enables the informant to make links to other aspects of his or her broader daily experiences. They contend that data collected through video diaries would not have been accessible through a survey or an interview. Nevertheless, Buchwald et al. (2009), Cotton et al., (2010), Holliday (2004), Pink (2001) as well as Quadri and Bullen (2007) all argue for
combining video diaries with other methods. This is also the experience from study 3. The follow-up interviews that were made 1-4 weeks after the video diaries complemented the data from the video diaries in significant ways. With a theoretical framework that emphasizes the context, the combination of methods is even more important than with use of a framework that views attitudes as stable and long lasting. In the study about the new influenza some important data came up during the interview that had not been mentioned in the diaries, for instance the discussion in school about the disease.

The editing possibility in a video diary is frequently discussed among video diary researchers (Buchwald et al., 2009; Brown, 2010; Holliday, 2004). It allows the video diary maker to take control over the data collection. In this way the informant has the possibility to choose what he or she wants to show and also to prepare some of the diary clips. Holliday (2004) maintains that “video diaries afford participants the potential for a greater degree of reflection than other methods, through the processes of watching, recording and editing their diaries before submission” (Holliday, 2004, 1603). This reflection is not always possible in an interview or discussion, but can be an element in important decision-making in everyday life. Everybody will at times change plans, see problems from another view, regret a previous standpoint, and so on. The editing possibilities therefore help the video diary come closer to decision-making that may be a long process. In this way the editing possibility is important.

The theoretical aspects of video diaries discussed in article IV build on Pink’s (2001; 2007) perspective of visual representations as constructions of the world. This perspective opens up for a framework where the social world is seen as constructed and dependent on the context, as in discourse analysis. The data could be analysed from many perspectives, not only discourse psychology, for instance also Gee’s (1999) discourses and Discourses which are closely related to Potter and Wetherell’s (1987) framework. In the article we also consider the ethical aspects of video diary studies.
6.5 Ethical considerations

The ethical aspects are important in all kind of research. If careful ethical considerations are not made, the public will lose confidence in research (Shamoo & Resnik, 2009). This research project has followed Swedish law on ethical considerations applying research that involves humans (CODEX, 2010). This law describes how the informant will be informed. The basic rule is that research is only allowed if the informant has explicitly consented to the research that includes him or her. The informants in this project have been informed about:

- The overarching plan of the research project
- The purpose of the research
- The methods that will be used
- The consequences and the risks the research could result in
- Which research department was involved
- That participation was voluntary
- That they had the possibility to interrupt their participation at any time

This information meets the demands of the Swedish Research Council with respect to information, consent, confidentiality and use in the research process. These four demands must be fulfilled to protect the informants in a research project.

6.5.1 Ethical considerations in the different studies

In the first study the informants were anonymous. The format of responding to a web-based questionnaire in front of a computer does not involve any deeper ethical considerations. If a question was regarded as strange or offensive the informant had the possibility not to answer that question or even skip the entire survey. The students logged in to the web questionnaire with an arbitrary code. They knew that nobody had the possibility to combine their answers with their identity. This is why study 1 was regarded as relatively unproblematic with respect to ethical considerations.
In the second study, in accordance with the demands of the Swedish Research Council, participants received information both in a letter to the teacher and communicated to the students at the beginning of the videotaped lessons. The students were informed about their possibility to participate or refrain from participation in the project. Four students opted to discuss the same cases as the other students but without being videotaped. The students in the study have chosen a nickname themselves, and cannot be identified by the reader. Only transcripts from the observation study have been used when data has been discussed in seminars and similar occasions. This way, the students’ identity remains confidential.

The third study was more complicated with respect to ethical demands. The teenagers who had responded to the first call for documenting their decision-making in a video diary (Appendix 3) were sent more detailed instructions (Appendix 4). If the teenager was still interested in participating, a meeting was held. On this occasion, the conditions for the project were discussed more in detail and the teenagers were informed about the demands from the Swedish Research Council. I suspected that the video diaries mostly would be made in the teenager’s home. For that reason a parent’s permission was obtained if the teenager was not 18 years old. The video format of the diaries makes the demand for confidentiality difficult to meet. Transcriptions of the monologue in the diaries have been used in many cases where the data was discussed with third parties. The permission to show some short clips from their video diaries for research purposes was requested from all teenagers.

One of the video diaries contained material which differed substantially from the others. Much of the material in this diary did not have to do with school or science. Instead the girl talked about her life, friends and family. Some of the information could be considered emotionally sensitive, where she talked about problems in her life. After consulting legal experts and supervisors I decided to talk with the girl about these problems. At the end of the interview I asked her about this part of the video diary and if she needed some help to manage it. Since she explained that it was not a problem and that she was not in need of any help, I decided not to act.
Compared to other observation methods, the video diary format has the advantage that the diary maker collects the data independently. He or she can choose situations to record, and even edit or delete if they are not satisfied with the material after recording. In this manner, the video diary format remains ethically appropriate, even if it is close to the participant’s personal life.
7 DISCUSSION AND IMPLICATIONS

This chapter will discuss the results in relation to the research questions. Implications of the results for both research and education will be considered. The research questions were:

- In what ways do students reason, decide and justify their decisions in issues connected to the human body and health?
- How do students use scientific knowledge in issues related to the human body and health?

The first section will discuss trustworthiness. The ways in which individuals reason, decide and justify their decisions will here be summarised and discussed in terms of what an individual counts as trustworthy in different situations. Considered from this angle, reasoning, decision and justification of the decision are all related to aspects of trustworthiness. In other words, individuals have to reason, decide and justify why they regard something, for example a statement or an article, as trustworthy or not. With respect to trustworthiness, the context will be decisive for the availability of an interpretative repertoire or discourse. Who you are talking to and in what situation the talk takes place will affect the availability. What an individual talks about as “correct” or true is a matter of who he or she wants to be regarded as; in other words a construction of him- or herself (Johnstone, 2008; Gee, 1999; Potter and Wetherell, 1987; Wetherell and Potter, 1992). It follows that not using a particular discourse/repertoire is not the same as it does not exist. There are a variety of reasons why it might not be used,
for instance regarded as totally wrong, unacceptable or not discovered by the individual.

The second section will more specifically focus to which extent scientific knowledge is used in different situations. This will above all be discussed with regard to an out-of-school context. The section deals with the problem how to educate for scientific literacy in the everyday life of individuals, so that scientific knowledge may become a part of the reasoning and decision-making process beside or together with other knowledge or values.

Scientific literacy is connected to both themes mentioned above, not only use of scientific knowledge. Trustworthiness and related concepts, such as risk assessment and decision-making can also be discussed in terms of scientific literacy because they deal with scientific processes and situations or context, a part of the definition of scientific literacy (Driver et al., 1996; OECD, 2003). The scientifically literate individual will thus be a person for whom science is an available discourse. Of course, other discourses than science will sometimes be available and useful when trustworthiness is discussed.

7.1 Trustworthy – in what context?
All three conducted studies have focused trustworthiness, but in different ways. In the first the relation between pseudoscientific statements, scientific knowledge, study programme, studied science courses and sex were studied. Possible correlations were analysed on an individual level. In the second study, issues of trustworthiness were investigated in the sense of comparing the students’ recourse to scientific explanations versus pseudoscientific explanations. The fact that in this context other individuals’ statements and reactions were added made the analysis somewhat more complex. In the third study, the school context was largely abandoned, while an out-of-school context dominated, but the study still concerned different explanation models in health and what or who to trust.
The availability in different contexts

The results from the first study did not differ noticeably from earlier studies about individuals’ pseudoscientific beliefs (Johnson and Pigliucci, 2004; Morhed, 2000; Preece and Baxter, 2000; Sjödin, 1995; 2001) besides the often reported sex differences which were not observed in study 1. Different pseudoscientific statements were regarded as trustworthy to different degrees. Earlier research in the field has mainly regarded pseudoscientific beliefs from an individual and cognitive point of view (Johnson and Pigliucci, 2004; Preece and Baxter, 2000). In this thesis a more context-dependent perspective has developed over the various steps. Comparison between results from the first and second study indicates the impact of the situation for decision-making. Both study 1 and study 2 were performed in a school context, but the first study was individual and anonymous, in front of a computer, while the second was conducted in peer groups. In these two studies, two different Discourses with big D (Gee, 1999) were discussed; scientific and pseudoscientific. They represent two completely different explanation models which is why they are regarded as Discourses with capital D’s. While in the first statistical study, a number of individuals agreed with the different pseudoscientific statements, also among successful students, none of the students in the second observation study clearly stood up for pseudoscientific explanations. In other words, in the first study the two different Discourses were sometimes used in parallel by certain students. Corresponding ways of reasoning could not be discovered in the second study.

It must be remembered that the two studies were not undertaken with the same students and this should be kept in mind when results are compared. However, the results cannot entirely be explained by the fact that the students in the second study were studying on the science programme in upper secondary, and therefore may have had good knowledge in human biology. In the first study, some students with good factual knowledge in human biology still had a high PSBI. The conclusion is that the pseudoscientific discourse was not available in the same way in the two different contexts. This difference in available discourse may be a case of what is possible to say. In front of the computer, for some students
it seemed possible to agree with some of the pseudoscientific statements, while in a peer group discussion in the classroom it did not appear equally possible to use the pseudoscientific Discourse for justifications. Instead some of the statements in the second study indicate that a scientific Discourse is established and available for students in the class. Using this scientific Discourse can be seen above all expressing an acceptance of belonging to the scientific culture, even when a student does not master the “correct” scientific terms. The use of a scientific Discourse may therefore be regarded from two perspectives. Firstly, as expressing the student’s own scientific knowledge, using the scientifically correct explanations and concepts, secondly, as expressing trust in scientific explanations and the scientific culture. In this second case it is more about acceptance of scientific claims and considering scientific explanation models as useful for society.

7.1.2 Implications for research and education on trustworthiness

The results from study 1 and 2 open up for discussion and research concerning how individuals make decisions when information is contradictory. Will they decide on their own, together with others or will they combine various approaches? Christensen (2009), Kolstø (2001; 2006) and Kolstø et al. (2006) have, as reported, conducted a number of studies in the field, using uncertain information as starting point for interviews and peer groups discussions. The present research project has contributed with further knowledge relating to these issues. Nevertheless, more science education research is needed about how individuals reason, decide and justify their decisions in different contexts to gain a better understanding of trustworthiness as basis in their decision-making. The way different contexts influence students’ perceptions of trustworthiness is in this respect a highly interesting research question.

I also believe that the different explanation models used in this project need to be discussed in science education and not neglected. The research project has not investigated to which extent explanations that differ from scientific ideas are discussed in the science classroom today. However, Jidesjö et al’s (2009) report on stu-
ents’ interest in questions where science cannot provide a definitive answer provides a possible entrance for discussions about pseudoscience in science education. Such discussions would address demands from several researchers (Driver et al., 1996; Levinson, 2010; Martin, 1994; Norris and Phillips, 2003; Norris et al., 2003) for a science education that contributes to decision-making on scientific grounds, and where the individuals are able to validate different types of information in an appropriate way.

7.1.3 The importance of others in decision-making

Within the field of decision-making the influence of authorities is an interesting aspect. As demonstrated in earlier research, (Kolstø, 2001; Kolstø et al., 2006) authorities are important in the individual’s decision-making. Results from the present research project also indicate the impact of others in decision-making processes. The use of authoritative epistemological resources was frequent in study 2. The students often referred to authorities when they discussed the allergy case. These authorities frequently had some kind of connection to scientific discourse as the pharmacy shop or researchers. Such claims were sometimes questioned but generally accepted as good arguments by the other students in the peer group. In study 3 the concept of authority was replaced by an actor concept in the analysis to demonstrate that we trust, or at least refer to, also actors who not can be categorised as “real” authorities, in the sense of occupying a recognized social position of experts. The use of scientific discourse in terms of trust in scientific explanations and culture are richly represented in the actor or authority concepts in study 2 but also in study 3. Different actors and authorities act as agents for the scientific discourse, and can help the individual reach a decision. Sometimes other actors than those with strong connections to a scientific discourse are most important. Amanda mentioned her classmates’ concerns about side effects of the vaccinations, and their opinions seemed to have had an influence on Amanda’s decision. In the class, they had talked a great deal about the risks in getting vaccinated. When Amanda talked about herself and her decision, the classmates were thus important. Her classmates used a repertoire which was much more available
for Amanda compared to the scientific messages reported in media. Another girl, named Sandra, instead constructed herself as a girl who belonged to the scientific culture, by consistently using a scientific repertoire, irrespective what actor was discussed.

7.1.4 Implications for research and education on the importance of others in decision-making
The role played by others in individuals’ decision-making is a question that requires further investigation, for instance with respect to the relation between authorities who are recognized as experts and other actors. It is important for individuals involved in education to know more about this relation. Such research, and studies by Kolstø (2001) and Kolstø et al. (2006), analysing actors can complement earlier knowledge about the importance of authorities in relevant ways. This is especially important in science education research where authority is generally regarded as embedded in scientific enterprises (Zeidler et al., 2004). Such studies have to consider the context, since different claims on authorities may be discussed in different ways depending on the situation.

The importance of other actors, not only established authorities, may be noticed in science education. The students can with help from the teacher practice judging different actors in different situations. Starting with issues close to the students’ life, there are numerous opportunities for discussions about trustworthiness and decision-making in daily life where scientific knowledge is presented and discussed together with other types of knowledge, as well as values and emotions. It is also a matter of making different individuals’ opinions visible, and discussing these in a respectful way since identity construction appears to play a crucial role in reasoning about actors/authorities.

7.1.5 Risk assessment and decision-making
The type of risk assessment and decision-making individuals were forced to undertake when deciding whether or not to have the vaccination are according to Christensen (2009) and Levinson (2010) not so commonly discussed, but nevertheless important in science education. The results in study 3 describe the same picture as
Christensen and Levinson. According to the teenagers in the study, the new influenza has not been discussed in science lessons. Instead the issue of vaccination had been discussed on other occasions, mostly in a random fashion, outside formal lessons. The results support findings from Turner et al. (1999) and Sander and Krüger (2008) concerning the paucity of health information at school and where personal experience often is the main basis for decision-making in health issues. The teenagers had sometimes discussed the new influenza and vaccination with others, while science education had not contributed in any higher degree. However, one risk message had been communicated by the schools; the hygienic message, wash your hands. Other risk assessments during lessons, for instance the risk of getting infected, were not reported by the teenagers. Both Christensen’s results and the results in the third study of the present research project demonstrate difficulties in understanding science research processes. Also the study in step 2, shed light on the difficulties the students experienced in understanding scientific processes. When the teacher in the group observation asked for proof of a drug’s effect, the students had difficulties describing the scientific testing processes required before new medicine is approved. The students talked in terms of peoples’ actions and guinea pigs when the teacher asked for proofs and the test process. The students appeared unable to reason about proofs and test processes in a more sophisticated manner. This may because science sometimes is presented in the classroom as definite knowledge that is established without problems or conflicts (Christensen, 2009; Ratcliffe and Grace, 2003).

7.1.6 Implications for education about risk assessment and decision-making

Hopefully, risk assessment is an issue which will be more discussed in science education in the future. This discussion needs to be broached not only from an individual risk perspective, but should also focus risks in society that individuals will be affected by, thereby addressing the calls from Beck (1992; 1999) about educating in a risk society. Such science education could also deal with science-in-the-making (Christensen, 2009) or contemporary science
Individuals’ assessment of risks associated with the vaccine against the new influenza is an example of views of science-in-the-making, like Christensen’s study about individuals’ opinions about risks with using mobile phones. Discussing science-in-the-making may thus include some type of risk assessment. I agree with Christensen (2009) and Sadler (2009) who call for science education where science is presented and discussed as a field still in progress. I also agree with Ratcliffe and Grace (2003) and McClune and Jarman (2010) who believe that students need to understand the reasons why experts sometimes disagree and learn more about how this is portrayed in media. Such knowledge is especially important to support decision-making if the available knowledge in the subject is uncertain and has not been sufficiently researched, as in the case of the new influenza.

7.2 The use of scientific knowledge
The results from the first study show that students could be sceptical towards explanation models that did not correspond to scientific explanations, even when they were not able to provide accurate answers with respect to factual science knowledge. In other words, it was not necessary to have good knowledge concerning human biology to reject pseudoscientific statements. This result supports the critique from Ryan et al. (2004) and Shermer (2003) who question the supposed correlation between scientific knowledge and a critical standpoint towards explanations which differ from scientific views. Also in the third study the use of scientific knowledge was investigated from an individual perspective. However, this time it was investigated mainly in everyday life, outside school. Six of the seven teenagers did not express any use of knowledge with obvious connections to school science curricula in their video diaries. In the interviews, some references to school were made, but science lessons or science knowledge was clearly mentioned only by Sandra, a girl on the science programme, who expressed strong statements in defence of scientific knowledge. Clear references to the student’s own scientific knowledge were also very rare in studies 2 and 3. This implies that it is very difficult for students to express and use scientific knowledge as a resource. The re-
sults support earlier studies of difficulties in using biological concepts in practical decision-making (Grace and Ratcliffe, 2002; Ratcliffe and Grace, 2003). However, it must also be considered to what degree a video diary would provoke the diary maker’s use of scientific concepts. Even if the informants were requested to talk about how science affects their life, the video diary format seems to establish an everyday context and thereby a preference for everyday talk.

At the same time the references to actors sometimes indicated that although these teenagers did not use their own scientific knowledge, they did not necessarily neglect it. Instead they appeared to see scientific knowledge as important in decision-making in health issues. This is not totally in line with Wynne (1996) who demonstrated how common sense reasoning was more important than science knowledge when citizens tried to make sense of situations caused by or related to science. Even if the informants in studies 2 and 3 reasoned in a common sense way, they also saw scientific knowledge as important in decision-making. Common sense seems to be enough for many of the teenagers when the information is far from scientific, and they can use normative resources. However, when the information is more complex, or deeper justifications are requested, the students/teenagers express scientific knowledge as important in society. For instance, the students in study 2 talked several times about the scientific processes in testing medicine, when they were requested to justify their decisions about why they chose the scientific alternative for a question about allergy. In this way the use of a scientific discourse appears to be available although the students did not make use of their own scientific knowledge in decision-making. With this reasoning follows that scientific literacy can be reasoned about in terms of using a scientific discourse (Sadler, 2009).

7.2.1 Scientific literacy as using a discourse
If we instead regard scientific knowledge in terms of scientific literacy and the use of a scientific Discourse, scientific literacy is a matter of being able to use scientific knowledge in relevant ways in completely different contexts. Gee (1999) describes how the life-
blood of many institutions is repetition of activities, routines, language in use and so on. If school science is regarded as one such institution with a certain Discourse the students will construct their knowledge as school science knowledge. Consequently, in their daily life, in new situations, they have to deconstruct and construct their scientific knowledge to fit in to new contexts. It is not possible to simply transfer school science knowledge to these other contexts. The situation outside school is often much more complex than the school science presented in textbooks or by the teachers (Aikenhead, 2006). Many different discourses are represented at the same time. It is a matter of dealing with different discourses in decision-making. In addition, if school and science education have not brought in the issue it is hard for the teenagers to use science as a repertoire, because earlier discursive practices are important for the outcome (Potter and Wetherell, 1987). If scientific reasoning is neglected and not practiced at school, it might be easier to borrow or use a repertoire from media or parents. In study 3 Sandra’s reasoning and expressions about trustworthiness and explanation models were totally different to Amanda’s. While a scientific discourse was available for Sandra, Amanda instead used classmates or media reports as her foundation for the vaccination decision. Another student, Cornelia, who also studied the science programme, still did not use a scientific discourse. The scientific discourse was not available for Cornelia, neither in her diary, nor in the interview, when she decided about the vaccination. This demonstrates the complexity in using a scientific discourse when making decisions. However, the data does not allow us to conclude whether other available interpretative repertoires, such as the friends and family repertoire could have included discussions about scientific reasoning. The results above can also be seen as the construction of an identity (Gee, 1999; 2001; Sadler, 2009). Sandra constructs an identity by using the scientific discourse. She participates in social practices, for instance in her science class, and construct an identity in accordance with these practices (Brickhouse, 2001; Lave and Wenger, 1991; Wenger, 2008). Sandra’s identity construction can be compared to Cornelia’s. Despite the fact that they are enrolled in the same science programme at the same
school, Cornelia constructs her identity in a totally different way compared to Sandra.

The results, both in study 2 and study 3, indicate difficulties in using science knowledge as an available repertoire for most of the students, both within and outside of school. However, a clear use of pseudoscientific resources was not observed. Additionally, all participants in study 3, except one, followed the urgent request from the scientists on the Swedish National Board of Health and Welfare. This indicates that the scientific message was well-established among the investigated individuals. At the same time the overarching message about getting vaccinated was comprised of political, economical and solidarity messages, besides the scientific dimension. These results with respect to accepting the scientific message resembles Ryder’s (2001) discussions concerning functional scientific literacy. However, functional scientific literacy is very dependent on authorities and thereby vulnerable in certain situations, such as when relevant authorities are lacking, or have dubious intentions (Shamoo and Resnick, 2009). These risks should not be overemphasized, but still kept in mind when the need for scientific literacy is discussed and when considering what the concept should include.

The teenagers in study 3 did not clearly demonstrate that they control the scientific knowledge which was appropriate for reaching a decision about the vaccination. The results support Jenkins (2006) who observes that although the need for science knowledge as a part of an active citizenship has been discussed for many years, the aims still not been attained. The scientific knowledge underpinning the choices was not explicitly investigated as such, and should not be overemphasized. Nevertheless, results from study 3 do not support Ryder’s (2001) contention that appropriate science can be learnt in situations that demand it. The issue of vaccination was an example where scientific knowledge could have been used to reach a decision, but at least to participants, Amanda and another girl named Helena, did not demonstrate any knowledge connected to the issue, neither in the video diaries, nor in the subsequent interview. Jenkins (2006) emphasizes that if science education is to play a role as part of an active citizenship, a wider know-
Knowledge base is required, than school disciplines, such as biology, chemistry and physics traditionally provide, a conclusion which is also supported by the results in this thesis. Common sense reasoning will not be enough, because common sense is not the same thing for all individuals.

In the investigated field, human body and health, the decisions we make in everyday life, alone or together with others can be of decisive importance for our life and well-being. Nutbeam (1999) argues for health literacy for all citizens, so that individuals can make informed decisions about their health. Health literacy is in this thesis not investigated in terms of questions about medical concepts. Instead, it is to large extent seen as a matter of dealing with the trustworthiness of different sources/availability of different repertoires, which can be used for risk assessment and ultimately decision-making about for instance how to get healthy, choice of treatment or sometimes rejecting offers about better health. All three studies indicated that the informants in the studies, according this view of health literacy, appear to be more literate than illiterate even if they do not explicitly use science content knowledge in their decision-making. This is shown by the fact that the majority in the first study reject pseudoscientific statements. In the second study scientific epistemological resources were sometimes used, while pseudoscientific epistemological resources were not. Finally, in the third study a scientific discourse was questioned but appeared more available than a pseudoscientific repertoire for several of the students. This result raise questions concerning what the use or understanding of a scientific discourse should include.

Something that not should be forgotten in this conclusion is that the alternatives which the students were presented with in the first two studies were rather extreme and differentiated very much. However, in real life some individuals do choose alternatives which differ substantially from established science, so the question still required investigation.

7.2.2 Handling media reports

One example of the difficulties with handling scientific knowledge in everyday life is how to deal with media reports, an issue which
has been earlier reported by Korpan et al. (1997), León, (2008) and McClune and Jarman (2010). These difficulties were obvious in the present research project. The students in both study 2 and 3 refer to media in their reasoning. In study 2 some discussions took place about horoscopes, while in study 3 questions concerning the new influenza were considered. In both instances references to media could be found. These media reports can be of very different kinds and scientific knowledge cannot always be distinguished from other types of knowledge or values. In study 2 the media reports were mainly connected to horoscopes, since this was part of one of the cases. The fact that the horoscopes are published in newspapers that normally claims to publish the truth was not commented on by the students. Instead the horoscopes were either rejected or reasoned about using relativistic resources such as “nobody knows for sure”. The media reports about the new influenza followed Ungar’s (2008) schedule concerning health alarms. With this followed both a mixture of different types of information and changes in perspective during the period the study took place. The students in study 3 managed to handle these reports in very different ways. Amanda used the information without any critical comments while other students, such as Sandra, Anders and Jakob were critical to much of this information. Despite the attitudes they expressed, the teenagers who had appeared to be critical chose to vaccinate, while the girl who had appeared to be the least critical with respect to the media reports chose to not get vaccinated.

It might also be discussed how social media can be included in the skills forming a capacity to engage critically in science-based news, reported by McClune and Jarman (2010). Their five categories were not used to analyse the data in this project. Nevertheless, the large amount of references to media raises questions about how individuals can handle the increasing complexity in media reports which social media contribute to.

7.2.3 Implications for education and research about the use of scientific knowledge

How can science education prepare for health literacy where the use of scientific knowledge helps the individual in the decision-
making? The teenagers in the third study, except one girl, did not refer to science education as their main source in decision-making. Instead they mention discussions with parents and media reports as sources they consider trusting. Such repertoires seemed more available for several students which is not surprising if no science lessons brought up the theme of the new influenza, as the students explained in the interviews. A contributing factor may have been that upper secondary school in Sweden is designed in courses, and some of the students had no science courses during the months the new influenza was focused in media. An additional danger with the course system in upper secondary school is as Ratcliffe and Grace (2003) stress, that the compartmentalisation of the secondary curriculum prevents scientific and societal perspectives from being considered together. In other words, in order to develop the competences needed by the scientifically literate citizen, has to deal with two problems – both what content or skills are appropriate and how to organise studies in a way that does not neglect important real subjects at the time when they happen.

7.3 Concluding reflections
To summarise, the research project has shed light on some of the difficulties students have in using their own scientific knowledge to make decisions about the human body and health. At the same time the project has demonstrated that scientific knowledge is trusted and sometimes referred to when decisions are made. We can thus conclude that a scientific discourse is regarded as trustworthy in many situations even if the students’ own scientific knowledge not is clearly expressed. This project has also shown the importance of investigating different resources/repertoires and how these are related to identity construction in teenagers’ decision-making.

It may be difficult to identify scientific knowledge as it is used by an individual out there, in the wild. This might be explained, not only because scientific knowledge is seldom used, but also since it is sometimes hard to distinguish from other types of knowledge. Reasoning about how a disease infects, connected to a message promoting hygiene, may be regarded as use of a scientific discourse
but also as common sense reasoning. The science content was not easy accessible in the media reports about the new influenza. It is also possible that scientific knowledge is used but not explicitly used as an argument in the video diary, and therefore also not found in the analysis. This project has in its third step attempted to come closer to individuals’ everyday life when investigating the use of scientific knowledge connected to decision-making. Further research needs to come even closer to authentic situations, to contribute to our understanding of decision-making. Two tracks within this field could be followed. One is to closer investigate the correlation between scientific knowledge and decision-making, by testing participants’ knowledge in science more explicitly than in this project. The other track is to reason more from a discourse perspective and regard scientific knowledge as using a certain discourse to support daily life. This does not mean that the second rejects the use of scientific concepts. Naturally, the use of a discourse is easier if the concepts used in that discourse are familiar. In this second track the video diary could contribute to the development of knowledge in the field.

This thesis has not focused teacher education. The question has not been neglected because it is unimportant or does not relate to the issues treated here. On the contrary, the questions raised in the thesis also need to be raised in teacher education.

7.4 Epilogue
There are many opportunities to discuss trustworthiness, decision-making and risk assessment. Writing these words, in August 2011, once again the debate on the swine flu is in focus. This time the debate concerning side effects, as narcolepsy, and if not only the vaccine causes this side effect, but also if the disease itself may be a cause to narcolepsy. Such events must occupy a central position on the agenda at school even if immunology had not been planned for the curriculum these weeks. In this way, science education might contribute to young people’s scientific literacy, among all other literacies. Be aware, there will in the future be many opportunities for relevant discussions in the science classroom concerning issues which affect your life!
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APPENDICES
Web-based questionnaire

1 Sex
No answer  Male  Female

2 What programme are you studying on?
No answer  Theoretical  Practical-technical  Practical service  Other

3 Which course or courses have you studied?
Science A  Science B  Biology A  Biology B  Physics A  Physics B  Chemistry A  Chemistry B

In part A you are requested to answer questions about your attitude towards science/science studies and scientists. In the questions no distinction is made between science and science studies. In all questions in part A you have to choose between the alternatives:

I totally agree
I agree to a large extent
Uncertain
I only partly agree
I disagree

4 I think science is fun and interesting.

5 I think science is important.

6 I think science is difficult.

7 Science and technology are important for society.

8 Scientists always follow a scientific method which always directs them to the right answer.

9 Scientists are neutral and objective.

10 Theories in science are developed and improved all the time.

11 We should always trust what scientists say.

12 Science and technology can solve almost every problem.

13 Research in gene technology is dangerous and should be totally forbidden.

14 Stem cell research can teach us a lot and should be supported.

In part B you are requested to choose one alternative. Choose according to your personal opinion. You have to choose between the alternatives:

No answer
I am sure the statement is correct
I am rather sure that the statement is correct
I am uncertain if the statement is correct
I am rather sure that the statement is incorrect/false
I am totally sure that the statement is incorrect/false

15 Pain associated with rheumatic ache decreases if you wear a bracelet with magnets.

16 Every organ in the body can be affected by massaging certain points on the foot.

17 Some drugs can relieve pain.

18 The soul still exists after the body has died.

19 People who get murdered will arise again as a ghost.

20 Inflammations can be cured by placing noble crystals on the skin close to the sick area.

21 Some individuals can transfer thoughts by telepathy.

22 The DNA has no influence on which diseases a person might be affected by during her life time.

23 The phases of the moon affect an individual's condition.

24 It is possible to decide the sex of a foetus by swinging a ring in a string above the stomach of the pregnant mother.

25 You can relieve pain through acupuncture.

26 If you are a vegetarian and do not eat meat, you risk getting too much protein, and thereby reduce the proteins in your diet.

27 Substances that are healthy for the body in small amounts can be toxic in large amounts.

28 No human can read others' thoughts.

29 Some individuals can levitate by using mental forces.

30 You can detect every disease an individual has by examining her iris.

31 Some individuals can move things with mental forces.

32 Anti-depressive drugs, happy pills, make you feel less depressed.

33 No individual can heal by laying their hands on the sick.

34 There is a greater risk of falling ill on a Friday 13th.

35 An individual's zodiac does not have any impact on which disease the person gets.

36 Sugar can be transformed into fat in the body.

In **part C** more than one alternative can be marked if you consider several alternatives correct.

37 Which is/are the most important function of the red blood cells?
- To resist diseases in the body
- To transport oxygen to all parts of the body
- To remove carbon dioxide from all parts of the body
- To produce substances that coagulate the blood

38 At school you learn that blood circulates in the body. How would a drop of blood that passes the big toe circulate?

- Heart, to big toe, back to heart. Then the same once again.
- Heart, to big toe, a lung, back to heart. Then the same once again.
- Heart, to a lung, back to heart, to big toe, back to heart. Then the same again.
- Heart, first to a lung, to big toe, back to heart. Then the same once again.

39 What does the heart do?

- Clean blood
- Produce blood
- Pump blood
- Support the blood with oxygen

40 The food you eat gives you energy. Where in the body is the energy released?

- Stomach
- Intestines
- Blood
- Cells

41 What happens in the body when you run and the heart beats faster?

- You burn more water
- You get more oxygen to your heart
- The cells get more glucose
- You get more blood to your organs

42 Which nutrient/nutrients do we need regularly?

- Fat
- Carbohydrates
- Aroma
- Hydrogenfluorinecarbons

43 It is important for our health that we eat leaf vegetables. This is because those vegetables contain much of one or several of following nutrients. Which?

- Protein
- Carbohydrates
- Minerals
- Fat

44 What is a cell called that can develop to different types of cells?
45 A culture of bacteria that consisted of 1000 bacteria was treated with antibiotics (penicillin). After a couple of days, 40 bacteria were still alive. These 40 bacteria bred until they were 1000 again. Then they were treated with the same antibiotics again. How many bacteria may be expected to live after a couple of days this time?

- 0
- 1-39
- 40
- More than 40

46 Who a father is to a child can sometimes be determined by a paternity test, when the possible fathers leave a blood sample. A child wants to know who her father is. The child has blood type 0 and the mother blood type B. Who of the following can be the father?

- Man with blood type A
- Man with blood type AB
- Man that has not been tested for blood type
- Man with blood type AC

47 Instead of burning oil or coal, some people have begun to burn the crop barley in their furnace. Below (47-49) are three reactions that describe what happens when you have barley in a furnace. Does this happen also in our body when we eat barley? (in bread).

Oxygen is used?

- Yes
- No

48 Carbon dioxide is produced?

- Yes
- No

49 Energy is produced?

- Yes
- No

50 Where is urine produced?

- In the liver
- In the kidneys
- In the intestines
- In the sex organs
51 Which of the following should not be a part of food?
- Genes
- Protein
- Carbohydrates
- Chlorine (not the element, the cleaning agent)

52 How are our thoughts transmitted between the different nerve cells in the brain?
- With chemical substances
- With electrical impulses
- With sound waves
- Nobody knows for sure
What causes allergies?

Today, many different explanation models can be found for the causes and treatment of various illnesses. Below you will see a question which was asked on an internet website, and which received two quite different answers. Discuss in your group what you think about the different suggestions. Share your experience and knowledge in the area. Argue for your opinions.

Question

After having been examined several times, it appears that I have allergic reactions to something that I eat or am exposed to every day. I am using an elimination diet to find which substance it might be, but have not yet succeeded, since I am still getting worse. I would need someone to help me find out what I am reacting to.

Answer 1

From a purely emotional point of view, irritation or anger towards someone close affects the probability of getting allergies. If the person who has an allergy deals with the conflict or conflicts that exist in the family, circle of friends or workplace, the allergy will also get better. All physical illnesses also comprise a psychological aspect which needs to be considered to reach complete healing. This is why it is possible to help most people, even when they have physical illnesses, by using healing and deep therapy. One form of healing is pendulum healing, which is an efficient method for finding imbalances and energy blocks, both in the physical body and in our aura layers. By using a pendulum to heal, you remove bad energy and restore clean and light energy. We are daily exposed to various kinds of influences that we can not always defend ourselves against. Everything that doesn’t belong in our aura I call “bengles”, it could be anything from slander to deceased loved ones who we are not able to let go of. When we remove bengles by using a pendulum (clear our aura), and then build a protective layer of love and light, we feel much better.

Answer 2

Hypersensitivity (type 1-allergy) means that you react differently to naturally occurring proteins than other people do. The body’s immune system suddenly forms antibodies targeted against specific substances that other people tolerate. If you are allergic and are exposed to one of the proteins
which are called allergens, the body’s immune system is activated: white blood cells (B-lymphocytes) form IgE-antibodies (a kind of “antidote or immune substance”) against the allergen. The antibodies attach themselves to the outside of the allergy cell’s wall (membrane). This makes the body better at fighting the allergen next time you are exposed to it, since the allergen can be detected quicker. This process is called sensibilisation.

Histamines are a type of substance which play a central role, among other things for allergic reactions. They irritate the body, and produce swelling and itching, among other symptoms. Antihistamines block the effects of histamines, and can be administrated in many ways: for instance as tablets, inhaled (for problems in the respiratory tract), as eye drops (for runny eyes). These are appropriate to take, for instance during the pollen season. They can also be combined with cortisone, if the effect should prove insufficient.

Case B

Do the moon, stars and planets affect our health?

Many people witness that the moon, stars, and planets affect us in various ways. They believe that the time we are born, the phases of the moon and the movement of planets affect our lives in different ways. It does not just have to be our general traits of character, or events, but also illnesses and health are partly influenced and controlled by these phenomena.

Others feel that this is not true at all. Instead, they believe that our lives and our illnesses are partly affected by our genetic predisposition, partly by various infectious agents, our life-style, for instance what we eat and drink, as well as other factors that are not related to astrology.

Discuss these two sets of beliefs with your group. What is your opinion? Present arguments, use your knowledge and personal experience.
Will you join an exciting research project and make a photo or video diary?

Did you choose to vaccinate yourself?

What is decisive for which decisions you make in your daily life about what you eat, your health, exercise etc?

In your life you are constantly making decisions about what you eat, if you have the energy to exercise, if you should believe in the horoscope in the newspaper, and so on. The most topical theme right now is if you got vaccinated or not against the swine flu. But what determines what decisions you make, what do you regard as trustworthy? Have the topics you worked with in school any consequences for your decisions?

My name is Mats Lundström and I work at Malmö University. In my research project, I am investigating how young people make their decisions in questions relating to health. The purpose is to investigate how young people regard what is trustworthy and if education at school has any importance for decision-making. In a longer perspective, the purpose is of course to influence how subjects are taught at school, so that they feel even more relevant to you as a student.

For that reason I am looking for some students in upper secondary school to participate in the project. You should be prepared to film or take photos from your daily life, in different situations, when you are considering what is trustworthy or making decisions. It will be about everyday situations, such as what you eat, what you do if you get sick, commercials, etc. You can make these photo diaries on your own or in pairs. After that, we will discuss the video footage/photos together. The video footage and the photos are material for research and none of this material will be shown to anybody else without your permission.

Everybody is welcome to announce their interest, irrespective of you have an interest in food and exercise or not. If it sounds interesting, send me an e-mail and then we can decide a meeting, when I will come to the school and provide more information about the project.

Mats Lundström, PhD-student, Malmö University

Mats.lundstrom@mah.se  0708-779 667

Supervisor: Associate Professor Margareta Ekborg, margareta.ekborg@mah.se

Mats Lundström, PhD-student, Malmö University

Mats.lundstrom@mah.se  0708-779 667

Supervisor: Associate Professor Margareta Ekborg, margareta.ekborg@mah.se
Video/photo diary

Using your video camera/camera, please document different daily situations which are connected to the human body and health. It can be at the dinner table, in the shop, at the gym, or any other place. The situations which are most interesting to document are when you make different choices, or are thinking about if something is trustworthy. Some examples of this may be:

- Which food do you eat and why do you eat it?
- Why do you exercise, or why not?
- What do you do if you get sick?
- Do you check the horoscope in the newspaper, and if so, why?
- What do you think about commercials in television that are connected to the human body and health? For instance, commercials for different products that claim to improve your health?

One topic that I want you to document in some way is your decision about getting vaccinated against the new influenza. What spoke in favour of vaccination? What weighed against it? What was decisive for your decision? You can record these questions with the video camera or just document them.

There are of course many other situations that you can document or comment. It is important that you add an oral comment, in connection with your photos and video footage, about why you have included the situation and what you think about it. To what degree you choose to record or take pictures is up to you. Afterwards I will watch the video footage and read your notes. My purpose is to see what had an impact on the decision you made. After that we will meet and talk about the video.

Mats Lundström, Malmö University

Mats.lundstrom@mah.se 0708-779 667
Appendix 5

Interview guide with questions on the video diary

How did you think when you made the video recording? What did you film? What did you not film?

What did your friends say?

Tell me about some situations.

What knowledge is appropriate when you make decisions about what you filmed?

What do you think about science?

What affects your decisions in different questions?

What is most important when you make decisions?

What do you think about how you can benefit from the science you have studied at school?

Is there anything you missed in the science lessons?

(What programme, and in what year are you studying?

Why did you choose that programme?

What are you planning to do after upper secondary?

What do you do on your spare time?
PAPERS I–IV
Students’ Ideas Regarding Science and Pseudo-science in Relation to the Human Body and Health

Abstract
This study investigates the pseudo-scientific and superstitious ideas Swedish upper-secondary students articulate and if there is a relationship between their ideas and their knowledge of the human body and health. The study is based on a questionnaire among 300 students in which the students were asked to consider statements related to different treatments that may influence the human body and health, and questions about physiology, health and nutrition. The analysis reveals that a relatively large group of students give credence to statements such as that some people can transfer thoughts or that the phases of the moon can affect a person’s health. The analysis also shows that there is no apparent relationship between the students’ pseudo-scientific beliefs and their scientific knowledge about the human body. Furthermore, although the results do not indicate a gender difference with regards to the power of faith in pseudo-scientific ideas, they do indicate that male and females consider these questions differently. The results imply a need for discussion and critical investigation in school science concerning the relationship between science and pseudo-scientific ideas in order to enhance critical thinking and development of the understanding of the nature of science.

Introduction
Studies within the field of science education and in other areas, such as psychology or religion, demonstrate a rather complex image of people’s understanding of the relationship between science, pseudo-science and New Age ideas. The National Science Foundation (NSF, 2006) and the European Commission (EC, 2005) recently revealed that about fifty percent of Americans and Europeans concur with the statement that society depends too much on science and not enough on faith. Other studies (e.g. CBS, 2002; Preece & Baxter, 2000; Sjödin, 1995) describe an image in which large groups of individuals in contemporary Western society believe in pseudo-science, superstition and paranormal phenomena such as crystal therapy, lucky numbers and telepathy. In a CBS news poll (2002), 57% of the respondents make manifest their belief in extra sensory...
perception (ESP), and in the Eurobarometer (EC, 2005) nearly four of ten participants state that they consider some numbers to affect their luck. In addition, studies about students’ ideas concerning these questions reveal a similar picture. Sjödin (1995) investigated upper-secondary students’ paranormal beliefs and found that more than one third of the students’ agree or partly agree with statements that there exist people who are able to contact spirits, tell the future, or read other people’s thoughts. About one fifth of the participants communicated that they believe in astrology, reincarnation, and that some people have the ability to move objects through telekinesis. According to the Eurobarometer (EC, 2005), many Europeans find it problematic to determine what science is and to conclude if a subject is scientific or not. For example, more than one third of the participants of the Eurobarometer study categorise homeopathy as science.

On the other hand, some studies (EC, 2005; NSF, 2006) conclude that the majority of Americans and Europeans express explicitly that research in science is crucial for a society’s welfare and development. According to these studies, people are of the opinion that science and technology can both make our lives easier and solve problems. Furthermore, they believe that science and technology - particularly within the spheres of medicine, energy and ICT - will have a positive effect on our lives in the future. The study results also indicate that citizens in the USA and in Europe, to a high degree, want society to economically support research, even if the outcomes cannot not be immediately utilised. Roughly fifty percent of Europeans convey that in the future the scientific community will be able to give us an entire image of nature and the universe. Furthermore, almost 90% of Europeans assume that research will produce a cure for AIDS and cancer, and also contribute to a healthier life. According to the EC (2005) and the NSF (2006), individuals communicate a confidence in science, as well as a positive attitude towards science, technology and, in particular, medical and environmental issues.

In short, two different images of how people tend to experience science, pseudo-science and New Age ideas have materialised. On the one hand, studies indicate that relatively large groups of individuals in modern society believe in pseudo-science, superstition and paranormal phenomena. On the other hand, the majority of Americans and Europeans communicate that they are fairly confident that research in science can make our lives healthier and that it can contribute to finding cures for serious diseases. This gives rise to the following questions: Is it possible that individuals may hold these two different views simultaneously and, if so, how is it possible to express both of these conflicting ideas? Unfortunately, there is, in general, a lack of studies regarding the relationship between an individual’s ideas about science and pseudo-science, and, in particular, research that investigates how these conflicting ideas may be cohabitants within the worldviews of an individual. Instead, most research in this area has focused on the impact of education in science on students’ pseudo-scientific and non-scientific ideas.

Consequently, this study intends to investigate what pseudo-scientific ideas people actually hold and how their ideas are related to their scientific knowledge. In essence, this study seeks to explore upper-secondary students’ ideas about science and pseudo-science related to their knowledge about the human body and health. In addition, it seeks to investigate existing gender and educational differences in relation to these issues.

**Scientific knowledge in relation to New Age and pseudo-scientific beliefs**

There exists no uniform definition of the concept New Age, but in everyday language it is commonly described as a movement with supernatural explanation models containing, on the whole, religious features. Hammer (1997) defines the phenomenon as a mixture of beliefs and confessions about the world. According to him, it is distinguished from traditional religion because there no central authority or complete system of ideas, myths and rituals exists. Preece and Baxter (2000) describe most New Age ideas as pseudo-science, and they define the phenomenon as a set of ideas
or theories that are claimed to be scientific but are at variance with science. This means that the phenomena have failed empirical tests or are impossible to investigate by using scientific methods. Preece and Baxter also point out that well-organised groups, often with commercial interests, and the popular media propagate a number of expanding pseudo-scientific enterprises, such as astrology and homeopathy.

With regards the relationship between scientific knowledge and pseudo-scientific ideas, Sagan (1995) argues that an education in science may function as “enlightenment,” and he describes science as a “candle in the dark.” It is evident, according to Sagan, that when students use and understand scientific methods, they thereby develop a form of critical thinking that leads to a marginalization of their pseudo-scientific beliefs. Wallace (2000) expresses similar thoughts and argues that only education and investment in educational programmes, such as project 2061, can contribute to the development of an individual’s critical views about these issues. However, research in this area reveals that there is a more complex relationship between people’s education in science and their beliefs in pseudo-science. For example, Goode (2002) found a distinctly negative correlation between the level of students’ education and their belief in astrology. At the same time, he refers to several public opinion polls which describe an inconsistent relationship between education and classic forms of belief in the paranormal. Shermer (2003) refers to three different studies that have investigated the same relationship; however, the factors measured were different in the three studies (critical thinking skills and educational performance). Shermer concludes that it is hard to find a consensus among researchers concerning a distinctly marked correlation between scientific knowledge and scepticism of pseudo-scientific ideas.

In a definitive study, McLeish (1984) investigated students’ superstitions and related the results to the subjects the students were studying. The analysis revealed that students studying science, mathematics, language and literature showed a lower degree of superstition than those students studying social science and practical subjects, such as catering or typing. On the other hand, Walker, Hoekstra & Vogl (2002) did not find any relationship between the level of student’s scientific knowledge and their scepticism regarding paranormal beliefs. These results were also confirmed by Ryan et al. (2004), who found that science majors had a larger base of knowledge in science compared to other majors. However, this did not influence their acceptance of non-scientific concepts such as extra-sensory perception (ESP), alien abductions and the misfortune associated with broken mirrors.

**Gender differences and pseudo-scientific ideas**

The discussion, so far, indicates a divergence concerning in what ways the level of education is related to students’ ideas about pseudo-scientific ideas. Research results and conclusions also differ regarding how pseudo-scientific beliefs are related to gender. In a study by Preece and Baxter (2000), female subjects, to a higher extent than their male counterparts, reveal they give credence to pseudo-scientific and paranormal concepts, such as crystal healing, astrology and ghosts. There is, however, one exception; males tend to more readily accept that aliens from outer space have visited earth. Preece and Baxter’s results are, to some degree, a confirmation of an earlier study by McLeish (1984), in which he describes significant gender differences with respect to superstitious ideas. Similarly, Sjödin’s analysis (1995) reveals gender differences among students, for example, females express a greater confidence in general occult phenomena, astrology and reincarnation. As in the study of Preece and Baxter (2000), males, to a greater extent than females, seem to believe in the existence of UFOs. Petersen (2007) demonstrates that female health science students are more positive to alternative medical treatments than male students. Preece and Baxter (2000) discuss possible explanations for the existence of these gender differences and argue that they could derive from the influence of magazines aimed at females. As a general explanation, the researchers refer to a combination of social and cultural factors.
However, other studies imply that there are no general gender differences concerning the extent to
which males and females express acceptance of or faith in paranormal phenomena. For example,
Johnson and Pigliucci (2004) compared males’ and females’ pseudo-scientific ideas and found no
apparent gender differences. However, this study also contains content-related issues in which
males and females had diverging levels of conviction. Males communicate a pronounced accep-
tance of the existence of the Loch Ness monster, while females more readily believe that animals
can sense ghosts. With regards to giving credence to magnetic healing, telepathy and voodoo, the
researchers found no differences to speak of. The authors argue that the content matter is decisive
when discussing gender differences and paranormal phenomena. By the same token, Wiseman
and Watt (2004) conclude that males and females seem to be superstitions to different degrees,
depending on what paranormal area they are asked about. These claims are supported by Shermer
(2003), who argues there is no gender difference in the power of belief, only in what phenomena
subjects choose to believe in.

Pseudo-scientific beliefs related to knowledge about the human body
Research about students’ understanding of the human body and its function has often focused on
their understanding of specific concepts or different internal organ systems. But very few studies
investigate students’ understanding of the relationship between scientific explanations, alternative
explanation models and different pseudo-scientific health claims. As mentioned before, studies
about these issues are often related to students’ general proficiencies, such as their level of edu-
cation, but they are not specified to a certain area of knowledge, although some studies explore
attitudes towards alternative medical treatment methods in health care. Pettersen (2007) studied
health science students’ and health science teachers’ ideas about complementary alternative medi-
cal treatments (CAM) and found that none of the treatments which the respondents considered in
the study have been empirically explained. The study reveals that the majority of the students have
a positive attitude towards 8 of 15 CAM-treatments. For example, more than 70% of the subjects
expressed positive attitudes about zone acupuncture and therapeutic touch, but they were less
positive to iris- or hair diagnostic, crystal therapy and aura photos.

The study
So far, we have described and discussed different studies with the objective to investigate what
pseudo-scientific, paranormal and superstitious ideas people, in general, and students hold. Some
of these studies also investigated the relationship between students’ scientific knowledge and their
pseudo-scientific beliefs, or the relationship between gender and superstition. The image that
emerges on the basis of these studies seems to be rather complex, incomplete and, in some cases,
even contradictory. For example, there are different understandings concerning to what extent
people’s pseudo-scientific ideas are related to their knowledge about science. Some scholars (e.g.
Sagan, 1995; Wallace, 2000) claim that enhanced knowledge in science could be an antidote
towards paranormal beliefs. Others (e.g. Goode, 2002; Shermer, 2003) do not seem to find any
relationship between scientific knowledge and paranormal beliefs at all. Even when it comes to
the relationship between gender and pseudo-scientific ideas, the image seems to be sprawling or
diffused. Some studies (e.g. Preece and Baxter, 2000; Sjödin, 1995) imply an existing gender dif-
ference, while others (e.g. Shermer, 2003) claim that such a relationship does not exist.
Hence, the aim of this study is to explore what pseudo-scientific, paranormal and superstitious
ideas students in upper-secondary school actually hold and how their ideas are related to their
scientific knowledge concerning the human body and health. The study also seeks to investigate
if there are any gender or educational differences related to these issues. The research questions
in this study are:
Students’ Ideas Regarding Science and Pseudo-science

- What pseudo-scientific ideas concerning the human body and health do students hold and how do they relate these ideas to scientific explanations?
- In what ways is students’ knowledge about the human body and health related to their pseudo-scientific beliefs?
- Are there significant gender differences related to these questions?
- Is it possible to identify differences concerning students’ ideas, depending on what educational programme the students study?

Methodological Considerations

In order to get a general view of the research questions, as well as a means of attending to the rather complex, incomplete and sometimes contradictory image that emerges from empirical studies in this area, a questionnaire was chosen for the study. This is the first part of a larger project that aims to explore student’s epistemological understandings of the relationship between scientific- and non-scientific explanations. As a first data collection, a questionnaire gives an opportunity of mapping a relatively large group of respondents and, above all, it serves to create a stable starting point for further investigations. Further, it makes statistical analysis of the data possible.

In this way, the survey functions as one part of a method triangulation in which ethnographical methods such as participating observations and interviews will be included in future phases within the larger study.

The web-based questionnaire referred to in this article was responded by 293 upper-secondary student participants, 175 males and 118 females, aged between 17-19 (mean value 18.4). The total respondent rate was 83.7%. The respondents were not randomly sampled but chosen with the objective of reflecting the general population in Swedish upper-secondary school with reference to educational programme and size of residential area. However, this objective has only partly been fulfilled as random factors have skewed the proportion between boys and girls. This circumstance has to be included in the analysis and the interpretation of the results.

In Sweden there are 17 national educational programmes in upper-secondary school. These programmes consist of primary subjects, character subjects, eligible subjects and project work. All of the national programmes contain the same eight primary subjects (e.g. Swedish, mathematics, history and general science), which means that these subjects are part of all educational programmes. The character subjects are specific, depending on which programme students choose, which means that they can be preparatory for higher studies or a future profession. In this study, the 17 educational programmes were categorised into four main groups depending on the alignment of the education: a theoretical programme (e.g. science, civic programmes), a practical-technical programme (e.g. car engineers or carpenters programmes), and a practical-service programme (e.g. hairdressers or childcare programmes). The fourth group is comprised of those students who do not participate in a national programme but instead choose an individual programme. However, all students have to attend a compulsory science course comprising of 50 hours. On a national basis, about one fifth of the students choose to study the science programme, which offers more extensive courses in biology, chemistry and physics.

In the first part (A) of the questionnaire, the respondents were asked to consider ten different statements concerning pseudo-scientific ideas about the human body, health and different treatments such as that the phases of the moon can affect a person’s health or that some people can move objects through telekinesis. The statements in this part were inspired by questions used in earlier studies by Preece and Baxter (2000), Walker et al. (2002), and Johnson and Pigliucci (2004). The students responded to the statements on a four-grade Likert scale, from totally agree (4) to totally disagree (1). This means that a high value for a statement expresses a high student belief in the statement. Part B of the questionnaire consisted of 13 knowledge questions about physiology, health and nutrition. For example, 1) Where in the body is urine produced? 2) In which way...
are our thoughts transmitted in the brain? In this part of the questionnaire, the contents, to some extent, were influenced by the TIMSS (2003) and the PISA (2003) studies.

The questions in part B offered multiple-choice options, and sometimes more than one answer was correct in order to decrease the possibility for the respondents to randomly give the right answer. But it is important to remember that the respondents only were asked to consider a limited number of questions about the human body and no complex reasoning was requested. According to Patton (2002), it is actually not possible to get a multifaceted understanding of students’ lives, their thoughts and experiences, and what these beliefs mean to them when using quantitative methods and statistical analysis of a questionnaire. In a future phase of the project, other methods such as participating observation and focus groups interviews will be used in order to deepen the understanding of these phenomena.

**Analysis**

Since the research questions are related to a possible correlation between students’ knowledge about the human body and health, and their pseudo-scientific ideas, two different indexes were constructed: Pseudo-Scientific Belief Index (PSBI) and Human Biology Knowledge Index (HBKI). To be able to measure whether the different statements and questions were related to each other, a reliability analysis of homogeneity was carried out. The advantage of carrying out the analysis was the possibility to create a common index that could describe the students’ opinion or understanding about the statements, or the questions. The reliability analysis examines the homogeneity or cohesion of the items that comprise each scale. Items with a high internal consistency were then used to construct the two indexes. Values (Cronbach’s alpha) between .70 and .90 indicate that the items are strongly related to each other, and values between .60 and .70 indicate that the items are relatively-to-strongly related to each other (Ntoumanis, 2001). The analysis displayed that the Pseudo-Scientific Belief Index (PSBI) had a reliability value of .76 and the Human Biology Knowledge Index (HBKI) had a value of .66.

However, the PSBI consists of the nine items with high internal consistency and was constructed by adding the value of the nine different items (see Table 2). The exception was the statement *Astrology has no impact on what diseases a person gets.* As it is likely that the negation in this statement may have caused some confusion or misunderstanding, it was therefore excluded in the analysis. A low PSBI-value indicates a low confidence in the statements. Hence, the minimum PSBI-value was 9 and the maximum 36. The Human Biology Knowledge Index (HBKI) was constructed in a similar manner. Since all items had a high internal consistence, the HBKI also consists of all 13 items related to scientific knowledge and can take a value of 0-36. The indexes

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**Table 1. Numbers of students in each programme**

<table>
<thead>
<tr>
<th>Programme</th>
<th>Boys</th>
<th>Girls</th>
<th>Unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical</td>
<td>56</td>
<td>33</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>Practical (service)</td>
<td>39</td>
<td>67</td>
<td>2</td>
<td>108</td>
</tr>
<tr>
<td>Practical (technical)</td>
<td>43</td>
<td>4</td>
<td>1</td>
<td>48</td>
</tr>
<tr>
<td>Individual/Special</td>
<td>33</td>
<td>10</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>Unknown</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>175</td>
<td>114</td>
<td>4</td>
<td>293</td>
</tr>
</tbody>
</table>
can also be correlated to the background variables, and in that way they contribute to the resolution of the research questions in this study.

In order to compare the two indexes with variables such as gender or educational programme, a one-way ANOVA-test was used. The correlations between the two indexes were calculated through using the correlation coefficient Pearson’s r. This analysis aimed to measure the strength of the relationship between the two variables. In other words, it aimed at explaining whether there exists a relationship between students’ knowledge about the human body and health and their tendencies to either accept or reject pseudo-scientific statements. The coefficient (Pearson’s r) will be 1 if there is a perfect co-variation between the indexes and -1 if the co-variation is the reverse (Djurfiedt, Larsson & Stjärnhagen, 2003). Another method to conduct a deeper analysis of the results is to use a cluster analysis. A cluster analysis is an exploratory data analysis tool which seeks to sort different objects into groups depending on the degree of association between two objects (Statsoft, 2006). In a nutshell, all students’ answers are placed in a coordinate system in which the x-axis is the HBKI-value and the y-axis is the PSBI-value. Upon completion, some clusters become visible, which means that some groups of respondents are deemed to answer in a similar way (see Figure 1).

Results
The main intention of this study has been to explore what pseudo-scientific ideas students actually hold regarding the human body and health, and how they relate these ideas to scientific explanations. One way of gaining knowledge about these phenomena has been to investigate students’ views about the human body and health, and how they relate these issues to scientific explanations or pseudo-scientific ideas. The results from this part of the questionnaire are presented in Table 2. The table reveals a ranking of how students experience the credibility of the statements. The items are ranked from the item that students believe to be the most plausible to the item that they believe to be the least plausible. The statement with the superior highest mean value is acupuncture can relieve pain (3.20), which, consequently, signifies that the students express a rather strong belief in the statement. An explanation for this assertion is that acupuncture is currently an approved pain-relief treatment in the Swedish healthcare system (Socialstyrelsen, 2006). Other statements that obtain relatively high scores are some people can transfer thoughts (2.32), and the phases of the moon can affect a person’s health (2.27). These results are confirmed in Sjödin’s (1995) and Preece & Baxter’s (2000) studies, in which students distinctly express that they believe that some people can transfer thoughts. The lowest credibility is obtained from statements such as inflamations can be cured by placing noble crystals on the skin (1.80), and it is possible to decide the sex of a foetus by swinging a pendulum above the pregnant woman’s body (1.60).

As mentioned before, Cronbach’s alpha coefficient is .76 for these nine items. A low PSBI-value indicates a low confidence in the statements and a low pseudo-scientific belief. The mean PSBI-value for all students was 19.15 (SD 4.58).

In Table 3 the PSBI-value is compared to factors such as gender and students’ different educational alignment in upper-secondary school. The PSBI-values in Table 3 point to only small gender differences and the analysis reveals no general significant difference between boys and girls. Only one statement out of nine shows a significant difference between the sexes; girls seem to have higher confidence in acupuncture than boys (p = .047), which Johnson and Pigliucci (2004) confirm in their study (a study which failed to find any general gender differences). Statements concerning magnetic bracelets or telepathy did not show any differences at all, however, the authors found a gender gap in declarations about the Loch Ness Monster and whether animals can sense ghosts. As mentioned earlier, previous studies about gender and belief in pseudo-science and superstition are divergent. On the one hand, Preece and Baxter (2000), as well as Wiseman and...
Watt (2004), claim that females are more inclined than males to acknowledge different pseudo-scientific statements. On the other hand, Shermer’s (2003) and Johnson and Pigliucci’s (2004) studies do not describe any general gender differences at all. One possible explanation for these alleged gender differences is that some differences are actually present, depending on the explored pseudo-scientific content. Nevertheless, this does not necessarily entail that females generally are more superstitious than males.

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Table 2. Statements, mean score. (n= 293) A high mean value expresses a high student belief in the statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acupuncture can relieve pain</td>
<td>3.20</td>
<td>0.86</td>
</tr>
<tr>
<td>Some people can transfer thoughts (telepathy)</td>
<td>2.32</td>
<td>0.98</td>
</tr>
<tr>
<td>Phases of the moon can affect a person’s health</td>
<td>2.27</td>
<td>0.95</td>
</tr>
<tr>
<td>Rheumatic pain decreases if carrying a magnetic bracelet</td>
<td>2.16</td>
<td>0.74</td>
</tr>
<tr>
<td>Many diseases can be discovered through iris diagnostic</td>
<td>2.14</td>
<td>0.80</td>
</tr>
<tr>
<td>Some people can move objects with their mind</td>
<td>1.85</td>
<td>0.92</td>
</tr>
<tr>
<td>Some people can heal when putting their hands on the sick</td>
<td>1.84</td>
<td>0.97</td>
</tr>
<tr>
<td>Inflammations can be cured by placing noble crystals on the skin</td>
<td>1.80</td>
<td>0.79</td>
</tr>
<tr>
<td>It is possible to decide the sex of a foetus by swinging a pendulum above the pregnant woman’s body</td>
<td>1.60</td>
<td>0.81</td>
</tr>
<tr>
<td>[Astrology has no impact on what diseases a person gets]</td>
<td>2.67</td>
<td>1.23</td>
</tr>
</tbody>
</table>

Table 3. Mean Pseudo-Scientific Beliefs Index (PSBI) value related to gender and educational program. (Some students have not answered all questions about pseudo-scientific statements.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>18.88</td>
<td>4.58</td>
<td>128</td>
</tr>
<tr>
<td>Girls</td>
<td>19.43</td>
<td>4.23</td>
<td>74</td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Theoretical</td>
<td>17.91</td>
<td>3.31</td>
<td>67</td>
</tr>
<tr>
<td>Practical (service)</td>
<td>20.12</td>
<td>4.83</td>
<td>66</td>
</tr>
<tr>
<td>Practical (technical)</td>
<td>19.33</td>
<td>5.50</td>
<td>36</td>
</tr>
<tr>
<td>Individual/Special</td>
<td>19.21</td>
<td>4.92</td>
<td>34</td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>19.15</td>
<td>4.58</td>
<td>206</td>
</tr>
</tbody>
</table>

Watt (2004), claim that females are more inclined than males to acknowledge different pseudo-scientific statements. On the other hand, Shermer’s (2003) and Johnson and Pigliucci’s (2004) studies do not describe any general gender differences at all. One possible explanation for these alleged gender differences is that some differences are actually present, depending on the explored pseudo-scientific content. Nevertheless, this does not necessarily entail that females generally are more superstitious than males.

Table 2. Statements, mean score. (n= 293) A high mean value expresses a high student belief in the statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acupuncture can relieve pain</td>
<td>3.20</td>
<td>0.86</td>
</tr>
<tr>
<td>Some people can transfer thoughts (telepathy)</td>
<td>2.32</td>
<td>0.98</td>
</tr>
<tr>
<td>Phases of the moon can affect a person’s health</td>
<td>2.27</td>
<td>0.95</td>
</tr>
<tr>
<td>Rheumatic pain decreases if carrying a magnetic bracelet</td>
<td>2.16</td>
<td>0.74</td>
</tr>
<tr>
<td>Many diseases can be discovered through iris diagnostic</td>
<td>2.14</td>
<td>0.80</td>
</tr>
<tr>
<td>Some people can move objects with their mind</td>
<td>1.85</td>
<td>0.92</td>
</tr>
<tr>
<td>Some people can heal when putting their hands on the sick</td>
<td>1.84</td>
<td>0.97</td>
</tr>
<tr>
<td>Inflammations can be cured by placing noble crystals on the skin</td>
<td>1.80</td>
<td>0.79</td>
</tr>
<tr>
<td>It is possible to decide the sex of a foetus by swinging a pendulum above the pregnant woman’s body</td>
<td>1.60</td>
<td>0.81</td>
</tr>
<tr>
<td>[Astrology has no impact on what diseases a person gets]</td>
<td>2.67</td>
<td>1.23</td>
</tr>
</tbody>
</table>
Table 3 also displays an explicit difference in PSBI-value depending on what educational programme the students take. Students in theoretical programmes have a lower mean PSBI-value compared to students in other programmes. Further, the analysis reveals a correlation between educational alignment and PSBI-value ($p = .04$). In short, students who attend theoretical programmes in upper-secondary school, in comparison to students of other programmes, tend to disregard pseudo-scientific statements. It is also apparent that the results of the respondents studying practical programmes show a larger statistical spread and a higher standard deviation compared to the results of students from theoretical programmes.

One important question thus far is if these differences can be explained by the fact that students in theoretical programmes actually have a more extensive or a deeper knowledge about the human body and health than the other students, or are there other phenomena that can explain the results? In order to answer this question, a Human Biology Knowledge Index (HBKI) was constructed in the same way as the PSBI. As mentioned previously, all 13 items have a relatively high internal consistence (Cronbach’s alpha is .66) and were therefore included in the HBKI. The maximum value of the HBKI is 36, and the mean value for all students is 13.53 (SD 6.55).

The HBKI-value, which can be seen in Table 4, was correlated to the factors of gender and the students’ different educational alignments in upper-secondary school. The results indicate that girls have a slightly higher mean HBKI-value than boys, but the difference is small and not significant ($p = .26$). It is also clear that theoretical programmes in secondary schools seem to succeed in supporting students’ knowledge development about the human biology and health better than other programmes. The analysis reveals a correlation with high significance between educational programmes and the HBKI ($p = .005$). In this study, this indicates that students in theoretical programmes have significantly better knowledge about the human body and health than students in other programmes.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>12.99</td>
<td>6.44</td>
<td>175</td>
</tr>
<tr>
<td>Girls</td>
<td>14.35</td>
<td>6.71</td>
<td>114</td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Theoretical programme</td>
<td>17.62</td>
<td>6.80</td>
<td>90</td>
</tr>
<tr>
<td>Practical pr (service)</td>
<td>12.32</td>
<td>5.42</td>
<td>108</td>
</tr>
<tr>
<td>Practical pr (technical)</td>
<td>11.83</td>
<td>6.41</td>
<td>48</td>
</tr>
<tr>
<td>Individual/Special pr</td>
<td>10.35</td>
<td>4.56</td>
<td>43</td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>13.53</td>
<td>6.55</td>
<td>293</td>
</tr>
</tbody>
</table>

Table 4. Mean Human Biology Knowledge Index (HBKI) value related to gender and educational program

Students’ Ideas Regarding Science and Pseudo-science
The successive emerging image of students’ pseudo-scientific ideas about the human body and health has, so far, indicates small gender differences. At the same time, the analysis reveals significant differences depending on the particular educational programme the students attend. Students in theoretical programmes seem to exhibit less credence in pseudo-scientific statements and more knowledge about the human body and health than other students. The question is if this means that the better scientific knowledge students have, the lower confidence they have in pseudo-scientific statements. In other words, are these two phenomena related to each other, and, if so, are they related by cause? In order to answer particular questions, it was necessary to conduct an additional analysis. It was then of current interest to relate the PSBI and HBKI to the number of science courses the students had taken in upper-secondary school. The results of this analysis are presented in Table 5 and reveal that the more science courses the students have studied, the higher mean HBKI-value the students hold. This result is unsurprising, as one can assume that students who have taken more courses in science have superior or more developed knowledge of the subject.

Table 5. Mean HBKI and PSBI score related to number of studied science courses in upper secondary school.

<table>
<thead>
<tr>
<th>Nr of science courses</th>
<th>Mean HBKI</th>
<th>SD</th>
<th>Mean PSBI</th>
<th>SD</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>11.39</td>
<td>5.28</td>
<td>16.36</td>
<td>4.68</td>
<td>179</td>
</tr>
<tr>
<td>2</td>
<td>13.03</td>
<td>5.51</td>
<td>15.76</td>
<td>3.65</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
<td>15.69</td>
<td>5.79</td>
<td>14.10</td>
<td>2.88</td>
<td>17</td>
</tr>
<tr>
<td>4-7</td>
<td>17.27</td>
<td>7.65</td>
<td>15.13</td>
<td>3.91</td>
<td>64</td>
</tr>
</tbody>
</table>

But Table 5 also reveals that the relationship between the number of science courses and the mean PSBI seems to be more complex. The group of students that has attended at least four science courses does not have the lowest mean PSBI; rather, the group that has taken three science courses holds the lowest PSBI value. However, this group of students is relatively small (n=17) and therefore further analysis was necessary. Instead, a comparison between a group of students that have taken only one science course (the compulsory course) and those who have attended at least two courses was conducted. This analysis revealed no significant difference (p = .17) between the groups, and it is not possible to discover any general differences between those students that have taken one science course and those who have taken two or more courses. A similar image appears if a bivariate analysis of the relation between the PSBI and HBKI is undertaken. This analysis endeavours to measure the strength of the relationship between the two variables. In other words, it attempts to explain if there is a relationship between students’ knowledge about the human body and health and their tendency to either accept or reject pseudo-scientific statements. The analysis clarifies that there is no existing correlation between PSBI and HBKI and that the Pearson’s r was – .09. A value close to zero reveals a lack of a relationship between the variables (Field, 2005).

But the image of how students relate to pseudo-scientific statements seems to be even more complex. A comparison between those students who have attended at least three science courses and those who have taken only one or two reveals significant differences (p = .02). The analysis indicates clearly that students who have taken three or more science courses have a lower mean...
Students' Ideas Regarding Science and Pseudo-science

PSBI-value than the other students. However, it is not possible within this study to find any simple explanation as to why such apparent differences exist. A conceivable explanation or hypothesis could be that students that have attended three or more courses take part exclusively in the science programme in upper-secondary school. This could mean that they, to a greater extent than others, are socialized into a scientific worldview and therefore tend to discount the pseudo-scientific statements. However, another possible explanation is that students that are quite sceptical of pseudo-scientific statements choose studying science in upper-secondary school. The relationship between students’ knowledge in science and their ideas about pseudo-science is still not fully explained and more research is needed. One possible method of conducting a deeper analysis of the results is to use a cluster analysis. This method revealed a distinct divergence between the clusters when using a six-group cluster. The results of this analysis are presented in Figure 1.

As seen in Figure 1, clusters A and B consist of students who show the highest PSBI-value and thus tend to discount the pseudo-scientific statements more than other students. The difference between these two clusters is that the students in cluster A are just beyond the mean HBKI-value whereas the students in cluster B have a very low HBKI-value. This also indicates that students in cluster B have less knowledge about the human body and health than students in other clusters. When investigating the respondents in cluster A and B, it became obvious that they to a high extent, attend the practical alignments and that students from the theoretical alignments are under represented in these clusters. Cluster A mainly consists of male and female students from the practical service alignment, which traditionally attracts females; cluster B is comprised of students from the practical technical alignment. However, there are no obvious gender differences between clusters A and B. Cluster C consists of students who attend both the practical and theoretical alignments, and it is close to the mean value of both indexes. In Table 6 the cluster centres are related to the mean PSBI- and HBKI-values.

Figure 1. Cluster analysis by case

NordNIA 5(1), 2009
Table 6. Cluster centres related to PSBI and HBKI.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>37</td>
<td>20</td>
<td>30</td>
<td>24</td>
<td>46</td>
<td>47</td>
</tr>
<tr>
<td>PSBI mean</td>
<td>24.51</td>
<td>23.50</td>
<td>18.52</td>
<td>18.10</td>
<td>17.13</td>
<td>13.87</td>
</tr>
<tr>
<td>HBKI mean</td>
<td>14.59</td>
<td>4.96</td>
<td>12.39</td>
<td>27.20</td>
<td>18.17</td>
<td>8.30</td>
</tr>
</tbody>
</table>

The students in cluster D have the highest HBKI-value, which means that they scored the highest result on the knowledge test. At the same time, the PSBI-value of these students is close to the mean value. In this cluster female students attending the theoretical alignments and students who have taken three or more science courses are over-represented. This group consists of 60% girls, despite the fact that the whole sample in the study only consists of 36.3% girls, which means that girls are clearly over-represented in this cluster. It is possible to claim that the students in this cluster embody the lack of relationship between students’ knowledge about the human body and health and their tendency to accept or reject pseudo-scientific statements. This also seems to be valid for students in cluster E, in which the students have a score close to the mean PSBI-value and a high HBKI-value. Compared to the students in cluster D, they have a slightly lower PSBI-value and a significantly lower HBKI-value. Cluster E consists of female and male students from the theoretical alignments, and they have attended a varying number of science courses. The last cluster consists of students who in total have the lowest PSBI-value. This means that students in cluster F, to a greater extent than others, tend to disagree with the pseudo-scientific statements. At the same time, the students in this cluster obtain a low HBKI-value. An investigation of the students in this cluster reveals that it consists of male and female students from different educational alignments. However, students who have taken only one science course are over-represented.

As a whole, the cluster analysis has made some patterns explicit concerning students’ ideas about pseudo-scientific statements. At the same time, the analysis raises a number of questions. For example, why is the relationship between students’ knowledge about the human body and health and the tendency to disagree with pseudo-scientific statements indistinct and divergent in different clusters? Are there any differences in how students in the different clusters relate pseudo-scientific statements to scientific explanations, and, if so, are they possible to explain?

**Discussion**

The results demonstrate a rather complex image of how upper-secondary students in Sweden relate to pseudo-scientific statements concerning the human body and health. The first analysis revealed that students express a higher confidence in statements about acupuncture, telepathy and that the phases of the moon can affect a person’s health in comparison to statements concerning pendulums and crystal nobles. This result is, to some extent, confirmed by Sjödin (1995), who shows a general tendency among people to believe that some individuals are able to contact...
spirits, tell the future and read other people's thoughts. With regards to gender, it is not possible to find any significant differences in the power of belief between the sexes, which is also confirmed in studies of Johnson and Pigliucci (2004) and Shermer (2003). But according to Wiseman and Watt (2004), there seems to be some gender differences related to what type of phenomena males and females choose to believe in. In this study only one statement revealed a significant gender difference: girls communicated a higher confidence in the statement "acupuncture can relieve pain."

When it comes to the relationship between students’ knowledge about the human body and health and their tendency to either agree or disagree with pseudo-scientific statements, it is not possible to find any clear and unambiguous correlation. However, students that attend theoretical alignments tend to express lower confidence in the pseudo-scientific statements than students in the practical alignment. Furthermore, they scored higher on the human body and health knowledge test than students in practical alignments. These results are significant in this study. However, does this mean that the more scientific knowledge students have, the lower the confidence in the pseudo-scientific statements they express? In other words, are these factors related to each other by cause? The analysis, which compared the students’ knowledge about the human body and health and their opinions concerning the pseudo-scientific statements, showed no such correlation. This means that it is not possible from the results in this study to claim that the greater the knowledge about the human body and health students express, the less they believe in pseudo-scientific statements or non-scientific explanations. This is also true when it comes to the correlation between the numbers of science courses the students have attended and their opinions about pseudo-scientific statements. Only when those students who have attended three or more science courses were compared to those who did not was there a significant correlation.

Miller’s (1987) and Sagan’s (1995) claim that science education may function as a protection or a cure against superstition and pseudo-scientific beliefs appears to be simplified. The results, instead, support the contention made by Shermer (2003), who points to the lack of correlation between students’ science knowledge and scepticism about pseudo-science. But an important question related to these results is how it is possible to be a rather successful student in the science classroom and at the same time express a high confidence in pseudo-scientific and non-science explanations. Is there not an incompatible contradiction in these two different epistemological explanations of the world? Or is it possible to hold parallel conceptions and explanation models in different contexts or discourses, such as schools and different youth sub-cultures? It is, of course, not possible to answer these questions in this study; nevertheless, the analysis has made these questions explicit.

One attempt to address this type of reasoning has been to conduct a cluster analysis. The results from this analysis indicate, for example, that it is possible for students (cluster D) to score very high on the knowledge test and simultaneously express a rather high confidence in pseudo-scientific explanations. In this cluster, girls in the theoretical alignments who have attended three or more science courses are over represented. But it is also possible for students to express a critical or even a negative view about pseudo-scientific statements and at the same time score low or very low on the knowledge test. In this cluster (F), students who have attended only the compulsory science course are over represented. Another interesting cluster is cluster A, which contains students that express the highest confidence in pseudo-scientific statements, but at the same time score above the mean value on the knowledge test. The existence of this cluster is confirmed by the assertion of Ryan et al. (2004) and Walker, Hoekstra, & Vogl (2002) and again raises the question if science education today actually succeeds in developing a critical and scientific understanding. To be able to answer this question and the questions about the existence of students’ parallel conceptions, further research in the field is needed.
The results in this study indicate that it is possible to be a rather successful student in the science classroom and at the same time maintain a high confidence in pseudo-scientific and non-science explanations. Therefore, a possible implication of the results is to recommend that science educators discuss pseudo-scientific issues in relation to science with their students henceforth. This study, in addition to Shermer’s (2003), points to the lack of correlation between students’ science knowledge and scepticism towards pseudo-science and non-science statements. This implies that if students were to examine pseudo-scientific explanation models, as opposed to ignoring them, such an approach would likely provide possibilities to enhance their critical thinking and would create opportunities to explore and develop an understanding of the nature of science.

REFERENCES
Students’ Ideas Regarding Science and Pseudo-science

Scientific trustworthiness: the considerations and perceptions of students
Mats Lundström & Anders Jakobsson, Malmö University

Abstract
This article reports from an empirical study where Swedish students in upper secondary school discuss different explanation models about phenomena related to the human body and health. The aim has been to analyse and assess the students’ understanding of the concept of trustworthiness and reliability in relation to scientific as well as non-scientific explanations. In order to come close to these issues we have analysed the students’ personal epistemology through interpreting their use of different epistemological resources in argumentative situations. The analysis suggest that students utilise four different kinds of resources; relativistic, normative, authoritative and scientific epistemological resources when underpinning arguments about trustworthiness. However, the result indicates that most of the students use different kinds of epistemological resources on different occasions and in relation to different content. Further, we argue that the framework of these epistemological resources may contribute in shedding light over the phenomenon that students may use different explanation models in school contexts and in everyday contexts.

Introduction
The concept of nature of science (NOS) has been in focus in a large number of research studies in recent decades and the significance of both students’ and the broader public’s understanding of this area has been highlighted by several scholars in the field. For example, Lederman (1992, 2007) asserts that students’ perceptions of NOS, above all relate back to their understanding of the epistemology of science; science as a way of knowing, or the values and beliefs that are inherent to scientific knowledge and its development. According to him, the concept is also related to issues of ontology; i.e. how individuals understand which concepts and categories they need to use in order to give coherent and consistent descriptions or explanations of the world. Sadler, Chambers & Zeidler (2004) argue that students’ understanding of the concept may become explicit when they are involved in discussions about issues related to scientific trustworthiness and reliability in contemporary science. In
their study, upper secondary students in the US were requested to evaluate the scientific trustworthiness of popular scientific articles. The study revealed that the students had a strong tendency to overestimate the trustworthiness of articles that supported their own original idea. 

Kolstø (2001) found that students in Norway expressed strong hesitation in evaluating what kind of sources to trust when they examined statements related to the risks of power transmission lines.

One way of understanding why issues related to NOS and scientific trustworthiness seems to cause such problems for students may be to use Cobern’s (2000) framework. He asserts that an individuals’ different interpretation of the world and world view may be explained by the epistemological macrostructure, which constitutes the fundamental organisation of mind and influences how we view, act and argue in and about the world. However, Hammer and Elby (2003) and Hofer (2004a) take another philosophical perspective when arguing that an individual’s understanding of scientific trustworthiness is related to their personal epistemology and to what kind of epistemological resources the individual is able to use. According to them, personal epistemology is dependent on what encounters and experiences the individual has had, and the kind of epistemological resources the person actually uses is strongly related to the specific context or situation. From this perspective the different epistemological resources used by an individual are not seen as stable, mental entities but rather different argumentative resources whose use is dependent on the situation or context. Thereby, this perspective differs from studies that connect epistemological beliefs with cognitive structures (i.e. Wu and Tsai, 2011).

In this study we intend to use framework of Hofer (2004a) and Hofer and Pintrich (1997) in order to explore Swedish upper secondary students’ considerations and perceptions of scientific trustworthiness through analysing what epistemological resources they use when discussing issues related to the human body and health. The student assignment is to evaluate
the scientific trustworthiness in texts and articles that are related to scientific, as well as non-scientific explanations.

The ability of students to evaluate scientific information

Erduran, Simon, & Osborne (2004) argue that one way to develop students’ understanding of issues related to the nature of science is to focus on the students’ use of arguments when they are involved in discussions about science. The authors suggest, for example, a focus on educational situations where students are requested to work with so-called socio-scientific issues. These tasks tend to be less well-structured, more value-laden and open-ended than standard learning tasks that are framed within accepted disciplinary discourses. In these situations, learning science seems not only to be related to learning scientific concepts, problem solving skills and process learning, but also to students’ appropriation of the practice of argumentation in scientific communities. Bricker and Bell (2008) also focus on science learning in situations where explanations and models of scientific phenomena are jointly constructed through social discourse in which the explanations and models are questioned, evaluated and revised. Several studies indicate that this way of organizing science lessons creates opportunities of developing the students’ understanding of scientific trustworthiness and reliability. For example, Ratcliffe and Grace (2003) show in a study that students improved their understanding of these issues and their reasoning skills related to NOS issues when working with socio-scientific issues, especially if the teacher facilitated the discussions with well-structured questions about the content. Other researchers (e.g. Erduran et al. 2004) assert that this way of organizing science education develops the students’ abilities when it comes to seeing and exploring new perspectives. In their study, the students increased their ability to use counter-argument and rebuttals to higher degree than other students.
However, a lot of other studies indicate that the development of students’ understanding of issues related to scientific trustworthiness and reliability may be problematic. For example, in a study by Sadler et al. (2004), upper secondary students were requested to evaluate the scientific value of popular scientific articles. The results revealed that approximately 40% of the students had a tendency to overestimate the scientific value of articles that supported their own original idea. Kolstø et al. (2006) investigated the ability of 89 science student teachers to assess the trustworthiness and reliability of different scientific claims in popular science articles during group work. The students’ answers and statements were analysed and categorized from 13 different criteria, such as the students’ abilities when it comes to evaluating the empirical and theoretical adequacy, the completeness of information and the social aspects in the articles. The result indicates that the students above all focused on the consistency or validity of the argumentation in the articles, and that they emphasised the importance that the conclusions in the articles did not go beyond the referred evidence. When it comes to the social aspects, the students questioned the possible influence of the underlying institutional interest and the competence of the authors or experts. According to the conclusion of the study, the quality of the students’ critical examination clearly indicates that these issues need to be emphasized in science teacher education in the future. Korpan, Bisanz, Bisanz, & Henderson (1997) also point to the fact that science students in general usually request more information about how the empirical part of the research process is conducted when they assess the value of short news items with scientific content. Additionally, the students often ask for descriptions of how the researchers were able to draw conclusions from their research. Very few of the students raised questions about closely related research or if other research studies have come to the same conclusion.

In another study Kolstø (2001) found that 16-year-old students in Norway expressed hesitation when it came to evaluating what kind of information to trust and what sources to
believe when they examined statements related to the risks of power transmission lines. In the study Kolstø used as a basis for interviews a news item about power transmission lines and their significance in relation to leukaemia. The analysis identified four different resolution strategies that were used to different extents by the students when they assessed the information in the article. The resolution strategies were *acceptance of knowledge claims, acceptance of authority, evaluation of statements and evaluation of authorities*. Most of the students only used one of the strategies but some of them could use more than one in order to come to a conclusion. However, according to the author, the students to some extent were able to draw conclusions regarding the trustworthiness of the knowledge claims, the reliability of the information and arguments used in the articles.

**The students’ world view and personal scientific epistemology of students**

Cobern (2000) argues that the ability to understand issues about the nature of science and to assess and evaluate scientific trustworthiness and reliability in contemporary science is, above all, related to the individual’s world view. According to him, the individual’s world view is mainly established in early years and is difficult but not impossible to change during a person’s life. Formal schooling may build up cognitive frameworks that can influence the world view and the epistemological macrostructure. Hofer & Pintrich (1997) and Hofer (2004a) take a different philosophical perspective when describing the individual’s beliefs and knowledge about the world in terms of *personal epistemologies*. They argue that all individuals successively and constantly develop their personal epistemology during life and that this also constitutes how and in what ways individuals evaluate information and draw conclusions about phenomena in the world. Additionally, they refer to personal epistemology as the theories and thoughts about knowledge and knowing that the individual develops during encounters in the social and cultural world. This implies that individuals develop different *epistemological resources* (Hammer and Elby, 2003; Hofer, 2004a; Louca, Elby,
Hammer, & Kagey, 2004) due to what they encounter and experience, and that these resources may be utilized in different contexts or discourses. According to Hammer and Elby (2003) and Hofer (2004a) the idea the individual seems to use of different epistemological resources on different occasions may explain the phenomenon that people are able to express different world views or understandings, depending on what situations or contexts they are involved in. From this perspective, the different epistemological resources used by an individual are not seen as stable, mental entities but rather as different argumentative resources whose use is dependent on the situation.

In relation to research on the world view of individuals, Hofer (2004a) argues that carefully conducted explorations of the personal epistemology, used in action may create a framework for describing and analyzing an individual’s personal theory of knowledge and a tool to analyse which authorities the students believe and why. Additionally, Hammer and Elby (2003) and Hofer (2004a) refer to resources as context-dependent and situated, which imply different kinds of analyses than used in studies where knowledge is viewed as stable and constant in all contexts. However, Hofer (2004b) calls for more observational studies about individuals’ personal epistemology in everyday and educational settings; studies that focus on the individuals’ view of the nature of science and students understanding of issues related to reliability, trustworthiness and justification of knowing.

One study that partly explores these perspectives is Hansson’s (2007) study about upper secondary students’ understanding of the Big Bang theory. According to the author, the results indicate that the students’ world view makes it possible for them to present and understand scientific explanations without making them their own in other contexts. The students were able to describe thoroughly and use explanations about the theory during physics lessons despite the fact that their own ideas or beliefs actually were quite different. The study also reveals that most of the students were not familiar with some of the
fundamental presuppositions or ideas that relate to a scientific world view about the universe, despite the fact that they have chosen to study the natural science programme in upper secondary school. In this way, the study clearly indicates that the personal epistemology used by students is related to the situation in which individuals evaluate and assess new information and when they form their ideas about what can be counted as scientifically trustworthy. Sinatra, Southerland, McConaughy, & Demastes (2003) also investigated students’ understanding of the reliability and trustworthiness when related to issues of different scientific content. They found that students to a relatively high extent seem to accept the scientific explanation of human evolution but expressed hesitation or even scepticism in relation to evolution in other species. In conclusion, the authors elaborate on possible explanations in a discussion about the relation between the students’ ability to display scientific knowledge on the one hand and their willingness to accept the same knowledge as their own on the other. In another study, Lundström and Jakobsson (2009) found no obvious correlation between students’ knowledge about the human body and health and their tendency to agree or disagree with non-scientific explanations and statements. The results indicate that the students’ level of knowledge of and about the function of the human body did not automatically seem be related to their dissociation with non-scientific or even pseudo-scientific statements about the human body and health. Shermer (2003) comes to a similar conclusion and argues that our beliefs or ideas about the world are often not immediately related to empirical evidence and logical reasoning. Instead it seems that social and cultural influences such as family and peer pressure, experiences and life impressions have a strong impact when we make choices of what we believe in.

All these studies clearly demonstrate the complexity of the relationship between the individuals’ displayed knowledge and their acceptance of that knowledge as a part of their own world view. However, we argue that the difficulties of interpreting and fully
understanding these issues should not prevent the research community from taking further steps in order to increase its understanding of them. A number of scholars such as Sadler et al. (2004) and Hofer, (2004a) suggest advancing research on this matter by studying students’ understanding of the nature of science; to focus on their understanding of reliability and trustworthiness and to interpret their use of epistemological resources in different contexts and situations.

Purpose and research questions
As mentioned, several research studies in recent decades have explored the understanding of the nature of science in students, as well as other individuals: scientific trustworthiness and issues related to the personal epistemology of individuals. The results from most of these studies report that a majority of students in the compulsory, as well as in upper secondary school find it difficult to evaluate and assess the scientific trustworthiness of texts and other sources related to contemporary science (e.g. Kolstø, 2001; Erduran, Simon, & Osborne, 2004). Cobern (2000) argues that the ability to understand issues related to the nature of science and scientific trustworthiness is influenced by the individual’s epistemological macrostructure, consisting of different interpretations of the world. On the other hand, from a different perspective, Hofer (2004a, b) and Hammer and Elby (2003) refer to personal epistemology as different epistemological resources that individuals are able to use, dependent on what encounters they have previously experienced and that these resources can be utilized in different contexts or discourses. Further, Hofer (2004a) argues that these resources may constitute a methodological suggestion for a framework for describing and analysing an individual’s personal theory of knowledge and knowing and their understanding of issues related to scientific trustworthiness.
In this study we intend to use Hofer (2004a) and Hofer and Pintrich’s (1997) frameworks in order to explore what kind of epistemological resources upper secondary students actually use when they discuss issues related to the human body and health. The student assignment is to assess and evaluate the scientific trustworthiness in texts and articles that are related to scientific, as well as non-scientific explanations. The research question in this study is:

- In what ways may students’ considerations and perceptions of scientific trustworthiness be expressed through their use of different epistemological resources?

Methodological considerations and analysis
This study is a part of a larger research project where the understanding of Swedish upper secondary students’ ideas about the nature of science and the relationship between scientific and non-scientific explanations are investigated. The first study explored nearly 300 students’ ideas of issues related to the human body and health and the relationship between the students’ knowledge and their perceptions of scientific trustworthiness. The study had a quantitative design, where the students were requested to answer questions about the human body and to evaluate the trustworthiness of statements related to scientific, non-scientific as well as pseudo-scientific explanations. The result displayed no obvious correlation between the students’ content knowledge and their tendency to agree or disagree with non-scientific explanations and statements. The design of this first study has made it possible to describe what kind of statements the students believed were–scientific trustworthy or not. However, it did not actually succeed in explaining the students’ underlying argumentation or their use of different epistemological resources. As mentioned, Hofer (2004a) and Hammer and Elby (2003) refer to students’ personal epistemology as the different epistemological resources that the individuals are able to use and that these resources may be utilized differently dependent
on the contexts or discourse. Thus, one important conclusion from the first study was; to come close to the students’ active use of these kinds of resources requires quite different research methods than used in the first study. In other words, to be able to capture students’ reasoning and their use of epistemological resources requires carefully conducted observations during active, argumentative problem-solving situations in an everyday classroom discourse (e.g. Jakobsson, Makitalo and Saljö, 2009). This implies that the focus in the second study had to be on the students’ use of epistemological resources in action, when they make sense of the assignments and also on their thought processes and perceptions of trustworthiness in relation to these assignments.

The two different assignments were intentionally chosen as examples of scientific as well as non-scientific explanation models of issues related to human body and health. The aim was to explore what kind of epistemological resources the students actually use when they are involved in discussions about different explanation models. The first assignment (Case A) consists of a person’s description of her allergy. She wants to know what causes her problem and two alternative explanation models are presented. The first is a text that relates allergic reactions to the immune system and anti-histamines, and a description of the medicine was given to the students. The second alternative uses a non-scientific explanation which assumes that her allergy is the result of unresolved conflicts and a suggestion that a “cure pendulum” may ease the symptom. Some people and pseudoscientific organisations claim that the pendulum responds to “electromagnetic energy that radiates from everything on Earth “ and that it can cure illnesses. A pendulum and a description of how to use it were enclosed with this assignment. In the second assignment (Case B), the students were requested to discuss different factors that may have an impact on an individual’s state of health. The first explanation model consisted of a medical text that suggests that human health may be understood from of a combination of the individual’s lifestyle, environment and genes. The
second explanation uses a non-scientific model including astrology and a predestined view of human health.

31 students (aged 16-17) in their first year of the science programme in upper secondary school in Sweden were chosen to participate in the study. The selection of science students can be regarded as typical case sampling (Patton, 2002) because all of the students, to some extent, belong to a similar culture in that they are enrolled in the science programme. The students worked with the assignments (Cases A and B) in mixed and single gender groups, with 3-5 students in each group. Each group was videotaped during all of their discussions and excerpts of these discussions constitute the total empirical material in the study. The usual teacher moved between the groups and made comments or asked questions in order to facilitate the discussions, which aimed to create an authentic everyday classroom situation (see Goldman-Segall, 1998).

However, according to Mork (2005), the main focus of research on argumentation on controversial issues in science education has usually been the process of argumentation rather than the factual content of the arguments used in the discussion. The dominating analytic tool used has been Toulmin’s (2003) argument pattern (TAP). This model assumes an analysis of the different types of utterances, such as the declarations or the rebuttals people use in argumentation in order to underpin their statements. Several researchers like Erduran et al. (2004) and Mork (2005) argue that the problem of using the TAP-model is that the model does not include an analysis of the content of the argument. Additionally, Driver, Newton, & Osborne (2000) argue that the semantic and situational contexts are important when analyzing arguments and that Toulmin’s TAP does not take this into account. We have considered these arguments and the criticism carefully, especially as the focus of our research concerns, above all, the content of the students’ argumentation. From this starting point, the analysis of the students’ arguments and use of epistemological resources followed a two-phase model. In the
first phase, the thematic patterns (Lemke, 1990) of the discussions were identified. Lemke describes thematic patterns as a pattern of connections between the meanings of words. In this way the pattern may be ‘semantic relationship that describes the thematic content, the science content, of a particular area’ (Lemke 1990, 12). He argues that there is always more than one thematic pattern woven into discussion, where sometimes alternative patterns may be those of common sense or everyday language. The purpose with this phase has been to find the themes or patterns that most of the students frequently expressed. When different arguments were analysed, utterances and statements related to judgements of the scientific trustworthiness in the explanation model became particular thematic patterns to focus on in this first phase.

The next phase of the analysis has been to identify, transcribe and categorise what kind of epistemological resources the students actually used during the discussions. In this phase the transcripts were read several times, looking for the typical or the unique, and for similarities and differences. The categories are in this way constructed from the material and not predefined. After this first categorisation, the authors tested the validity by rearranging the different statements in new groups in order to find new categories until the stage where the two interpreters reached consensus. It is important to understand that the categories are not to be seen as hierarchal, but rather grounded on different aspects of students’ use of epistemological resources and their arguments about the scientific trustworthiness related to the assignments. Additionally, we neither claim that the described categories constitute the only ones possible, but acknowledge that continuing studies probably will complement the image further.
Results

As mentioned, the main task in this study has been to explore in what ways students’ considerations and perceptions of scientific trustworthiness may be understood through the analysis of their use of different epistemological resources when discussing trustworthiness in relation to scientific as well as non-scientific explanation models. In the first example from the empirical material (Excerpt 1), four students, two girls (Gucci and Sonja) and two boys (Grebe and Gaban) are involved in a discussion about what kind of factors that may affect human health in general. The assignment (Case B) the students are engaged in is formulated as a dilemma where two different explanation models about what may influence health are presented. The students are requested to discuss and consider the scientific trustworthiness of the two explanation models and come to a joint decision. In the introductory part of the dialogue, Sonja expresses the idea that it is actually not possible to be sure if the movements of the planets may affect humans in some way or not. This statement seems to stimulate the discussion and to explicate what kind of epistemological resources the students use in this specific situation. The first excerpt constitutes an example of this discussion.

Excerpt 1

1 Gucci: What do you think?
2 Sonja: I think that the movements of the planets affect us, ... yes.
3 Grebe: In what way?
4 Sonja: I don’t know, but everything affects us in some way...and the earth rotates...
5 [Pause 2.0]
6 Sonja: ... you don’t really know if it is true. Nobody knows. But it sounds a little... [shakes her hands] it sounds like a movie, that the stars...
7 Gaban: I’ve never heard of it.
8 Sonja: That the stars and...
9 Gucci: But if you read your... when you read in the newspaper...
Sonja’s first statement (turn 2) that the movements of the planets may have an effect on humans leads to a demand for clarification from Grebe by asking In what way? (turn 3). The question seems to cause some uncertainty and Sonja avoids answering by saying I don’t know, but everything affects us in some way. (turn 4). One possible interpretation of this statement is that Sonja expresses a kind of ‘anthropocentric’ view where everything that happens in the universe is in some way related to or connected to humans. But this statement may also be understood as an expression of a philosophical holistic concept. However, Sonja does not clearly explain her view of how humans and planets could be interrelated. Her statement might also constitute an example of a situation, in which she uses an epistemological resource that assumes that it is not possible to be absolutely confident about the trustworthiness of any statement related to these issues, and the idea that everything is possible. This interpretation may be reinforced when Sonja in the next utterance (turn 6) ...you don’t really know if it is true. Nobody knows. On the other hand, she simultaneously expresses hesitation about her own statement by shaking her hand and saying But it sounds a little ... (turn 6). The discussion goes on when Gucci adds a statement about horoscopes and claims that sometimes they’re right (turn 11). In doing so, she seems to support Sonja’s reasoning that the planets and the stars may influence or have an impact on humans in some way. Grebe also expresses some confidence in horoscopes (turn 13) and Gucci ends the discussion, confirming Grebe’s statement, by saying Yes, sometimes it’s right. (turn 14).
The first excerpt constitutes an example of a situation where some of the students and Sonja in particular uses a category of epistemological resources where it is not possible to make any confident or reliable statements about the scientific trustworthiness of the explanation models at all. This may also include situations where the students use epistemological resources which express a view that everything seems to be possible and that it is impossible to be absolutely sure of anything related to these kinds of issues. The use of this epistemological resource occurs on several occasions (especially in relation to case B) in the total data material and has therefore been categorised as a situation where students use relativistic epistemological resources. This does not imply that the students who use these recourses in this specific situation will necessarily use similar recourses in other situations.

In the next two examples (excerpts 2-3) the students in different groups discuss the causes of allergies and different explanation models related to allergy (Case A). The discussion in excerpt 2 is to some extent initiated by the teacher, when she is trying to encourage the students to compare the different explanation alternatives related to the case. The dialogue starts when Aslan takes the pendulum in his hand and says:

**Excerpt 2**

15 *Aslan:* This? [holds the pendulum]
16 *Teacher:* Hmm!
17 *Aslan:* It is ridiculous. It only glows!
18 *Mossa:* That method is ridiculous.
19 *Nob:* All you get is a tired arm [laughs]

In excerpt 2, Aslan (turn 17) and Mossa (turn 18) express the view that the pendulum and the method are ridiculous. Even if the group is requested to give explicit arguments or a justification for their statements, no one in the group takes the discussion further on. A
possible interpretation of the lack of discussion may be that the students are agreed on the
negative value of the pendulum, which seems to result in a situation where further discussion
seems unnecessary. However, it is also possible to interpret the situation as though the
students are actually displaying a lack of ability to express why they not consider the
pendulum a serious alternative. The next excerpt (3) constitutes one of the examples where
one of the students tries to take the discussion a step further by asking the others in what ways
the pendulum possibly may have an impact on the human body.

Excerpt 3

20 Per:   This pendulum doesn’t work. Do you think it works?
21 Elle: Why?
22 Per:   How can it affect your body...?
23 Per:   ...there’s nothing in the pendulum that goes inside and kills the bacteria. How
can it [the pendulum] kill them?

The discussion begins in a similar way as the discussion in excerpt 2, but Per tries to find a
possible solution to the assignment by asking the others How can it [the pendulum] affect
your body? (turn 22). No one in the group reacts to his invitation so he finally chooses to
answer the question himself by seeking a logical connection between the pendulum and the
body. But no one in the group takes the opportunity to discuss the issue further. Per’s
reasoning about allergies and bacteria is of course not scientifically satisfactory (turn 23) but
the statement clearly indicates a cause-effect view which may be seen as a kind of logical
reasoning, despite the erroneous conclusion.

Thus, excerpts 2-3 may constitute some examples of an approach that several of the
students display when it comes to relating their explanations to arguments about scientific
trustworthiness. This lack of scientific reasoning is relatively common in the total empirical

material, and the students often express what they believe in through the use of everyday language or with the help of normative statements without any clearly expressed justification. In this way, this kind of reasoning has been categorised as the use of normative epistemological resources. In this category, the use of resources above all seems to be related to traditions, preconceived opinions or general normative reasoning and rarely consists of references to scientific knowledge or trustworthiness at all.

However, some of the students use epistemological resources as they relate arguments to some kind of justification. In excerpt 4, the students discuss the scientific explanation model that was given in the case about allergies (Case A). The students are requested to read the text used to explain the scientific view of the disease and the possible cure. The excerpt (4) starts when Mossa expresses a general statement of what he thinks of the scientific explanation model, without any further justification.

Excerpt 4
24 Mossa: I think it’s right.
25 Jenny: It’s good
26 Bast: It looks right to me.
27 Aslan: Justify your answers!
28 Mossa: It seems reasonable.
29 Jenny: Because it’s scientists that have put it forward. We’re studying the science programme in order to know things like that.
30 Aslan: But is it only researchers that can be right... and not other people?
31 Jenny: Yes.
32 Aslan: How is that?
33 Jenny: What do you mean by...?
34 Aslan: But answer the question.
35 Jenny: Can you cure allergy with that thing that hangs... [Refers to the pendulum]
36 Aslan: No, it’s quite ridiculous.
The first statements in this example actually only display some general statements of what the students think of the scientific explanation. The discussion gathers some speed when Aslan asks the group to justify their answers (turn 27). This call for justification seems to produce the use of other kinds of epistemological resources and Jenny clearly articulates her view; because it’s scientists that have put it forward (turn 29). Additionally, she asserts their own responsibility to know things like that as students at the science programme (turn 29). She uses this kind of resource on several occasions throughout the discussions and by that asserts the idea that the students have to be sceptical about non-scientific explanations. Jenny seems to use the argument that scientists put it forward as a strong motive to trust one of the proposed answers in the case. This is an obvious reference to an authority, which seems to be relatively common in the discussions throughout the data material. Other examples of the use of these references to authorities are found in excerpts 5 and 6. In these excerpts the reliability of the prescribed medicine, mentioned in case A, is in focus.

Excerpt 5

37 Elle: They work [the tablets] because they sell them at the pharmacy.
38 Teacher: How do you know they work?
39 Per: Because people buy them. If they didn’t work, people wouldn’t buy them.
40 Teacher: But how do you know that they work?
41 Per: Because people buy them and get well.

Excerpt 6

42 Rocky: If this [the pendulum] had worked they would have sold them in all the pharmacies. Have you ever seen this in a pharmacy?
43 Annelie: No
44 Per: Good argument, Rocky!
In the excerpts it is obvious that the argument - if a medicine is sold at the pharmacy or not - seems to be important for the judgement of the level of trustworthiness, as Elle (excerpt 5, turn 37) and Rocky express (excerpt 6, turn 42). However, it seems to be possible to use this argument in different ways. In excerpt 5, Elle argues that they [the tablets] *work because they sell them at the pharmacy* (turn 37) and in excerpt 6 Rocky uses the same argument in a discussion about the pendulum by saying *If this had worked they would have sold them in all the pharmacies.* (turn 42). In this way they seem to express the view that when a prescribed medicine is allowed to be sold at the pharmacy, it automatically implies that the medicine is trustworthy. The students do not exactly describe what this means or what testing procedures the medicine has to go through before becoming licensed to be sold at the pharmacy, despite the fact that the teacher asking for more information. In this way it is possible to assert that the students’ use of the argument - if the medicine is sold or not at the pharmacy - as an authoritative argument without describing the scientific process behind the development of the medicine. The term “authoritative arguments” may be understood here in the students’ references to different actors engaged in scientific procedures, traditions or cultures, without giving any further explanations of the trustworthiness. This may also include the reference to people’s own market evaluation and behaviour as Per argues in excerpt 5 (turn 39 and 41) that *people buy it and If they didn’t work, people wouldn’t buy them.* By this statement he seems to point out that people buying them is a sufficient argument for evaluating the trustworthiness of the medicine and its effect.

The way the students use epistemological resources in these excerpts differs from earlier categories and is therefore labelled as the students’ use of *authoritative epistemological resources.* This category constitutes the use of epistemological resources that refers to scientific authorities or cultures without discussing what the actual scientific trustworthiness may comprise of.
On some occasions, the discussions of trustworthiness seem to evolve further and relate to different scientific activities, such as research, or the specific scientific content. In these situations, the students seem to use their epistemological resources in another way than in earlier examples. Excerpt 7 is the continuing discussion from excerpt 2. The teacher initiates the discussion about the explanation models in case A.

Excerpt 7

45 Teacher: What is the difference between these two? Which of them would you recommend and why?

46 Aslan: Answer two, because that is something professionals work with [referring to the scientific explanation model].

47 Jenny: Exactly!

48 Mossa: They have to know something, before they take out something. They can’t just… if they don’t know something, they have to do research.

49 Jenny: They know how the substances - the ingredients - react with the cells and so on.

In excerpt 7 where the students discuss the assignment on allergies (Case A), Aslan refers to professionals (turn 46) when he is requested to argue for which of the models he could recommend. Additionally, Mossa and Jenny use references that relate to the research process and to the scientific content (turn 48 and 49). This implies that Mossa argues that before professionals can make any statements about a substance they have to do research (turn 48). Jenny supports Mossa’s utterance by saying, they know how the substances - the ingredients - react with the cells and so on (turn 49). In this situation, she uses scientific terms or concepts such as substances and cells and doing so shows that she is able to use them in a relevant way. This type of argumentation which explicitly refers to scientific processes or content is relatively sparsely represented in the students’ discussions throughout the data material. One obvious explanation of this phenomenon may be that the teacher is present and her question to the students has an impact on the discussion.
In the next excerpt (excerpt 8) the discussion about the medicine and the pharmacy goes further in that some of the students refer to the scientific processes behind a new medicine.

Excerpt 8 is the continuing discussion from excerpt 5 and the teacher is present.

Excerpt 8

50 Per: Because people buy it and get well.
51 Teacher: But how did they know... before it was sold at the pharmacy?
52 Per: It was approved.
53 Annelie: Guinea pigs!
54 Per: It has to be approved before it can be sold, doesn’t it?
55 Teacher: But what do you do when you approve it then?
56 Elle: Guinea pigs!

When the teacher asks for a clarification or an explanation of the commoditisation process for medicine, Per and Annelie refer to the fact that the medicine is tested before it is approved (turn 52 and 54). By doing this, Per seems to use other resources compared to the arguments he used in excerpt 5 (turn 39 and 41). Annelie (turn 53) and Elle’s (turn 56) statements also indicate that they are familiar with a scientific process by referring to the use of *guinea pigs* in the research process of the approval of medicines. This situation, compared to the situation in excerpt 5 may constitute an example where the same students may use different argumentative or epistemological resources on different occasions. We will return to this discussion later on. In this specific case, it seems that the teacher’s demand for further clarification has an impact on the students’ use of new resources.

As mentioned, the use of a developed scientific language and explicit scientific explanations are relatively rare in the discussions between the students. The fact that they sometimes use scientifically accepted terms or words does not necessary imply that they were able to use them as arguments in the discussion. However, the examples in excerpts 7 and 8
may constitute situations where the students actually are able to use some scientific references, such as the approval of medicines, the scientific content, research methods and the use of laboratory animals. However, this does not imply that the students were able use all of these references in a scientific, relevant way, but rather that they are able to use some of them as an argumentative resource in this specific situation. When students use their epistemological resources in this way we have labelled them as they use scientific epistemological resources. Unfortunately, there are relatively few statements in the empirical material that can be placed in this category.

In all, four categories of the different use of resources were identified in the data material; relativistic, normative, authoritative and scientific epistemological resources. As mentioned, it is possible to conclude that the students may use different epistemological resources on different occasions or situations. For example, when the same students (in excerpt 5) at first used authoritative epistemological resources when discussing the case about allergy and later on, challenged by the teacher, changed direction in order to use scientific epistemological resources. These changes commonly occur in the total data material and most of the students use several of the described categories in different situations. Consequently, the use of different epistemological resources should not be understood to imply that the use of one of them automatically excludes the use of the others. Additionally, they may not be understood as individual or mental entities but rather as the repertoire of the epistemological resources students are able to use in specific situations. Further, the described categories should not be understood to be the only ones possible. They instead constitute the epistemological resources the students used in this study, and we can assume that more of them probably exist.
Discussion and implications

We have in this study used the framework of Hofer (2004a) and Hofer and Pintrich (1997) in order to explore what kind of epistemological resources upper secondary students in Sweden use when discussing different explanation models about phenomena related to the human body and health. The aim has, above all, been to analyse and assess the students’ understanding of the concept of trustworthiness and reliability in relation to scientific as well as non-scientific explanations. To some extent, this framework may be described as divergent from the commonly used frameworks in the science education research community. Coburn (2000), for example, argues that the individual’s world view is mainly established in early years and constitutes the fundamental organisation of the mind influencing how we view, act and argue in and about the world. From this perspective, students’ ideas and their understanding of issues about scientific trustworthiness are viewed as a kind of individual property, which constitute a rather stable, mental entity. In contrast to this view, Hofer’s (2004a) and Hofer’s and Pintrich’s (1997) framework describes the students’ world view and their personal epistemology being situated and embedded in the specific situation the students encounter, and that they may use different resources dependent on this specific situation.

From this perspective the epistemological resources the students are able to use may rather be understood as the repertoire of the resources students is capable of using specific situations or when working with specific issues. We argue that these ideas may, to some extent, be used in order to understand the phenomenon that students use different explanation models in, for example, school contexts and in everyday contexts, as several studies indicate (e.g. Shermer, 2003; Hansson, 2007 and Lundström & Jakobsson, 2009). It is possible to discover a similar pattern in this study. Most of the students use different kinds of epistemological resources on different occasions and in relation to different issues when discussing the trustworthiness of
the explanatory models. However, it seems to be necessary to carry out additional studies in order to address these issues further.

Nevertheless, the framework of Hofer (2004a) and Hofer and Pintrich (1997) has offered an opportunity to analyse what kind of epistemological resources the students actually use when they are involved in discussions related to scientific trustworthiness. In this way, the different resources have been categorised as relativistic, normative, authoritative and scientific epistemological resources. As mentioned, they are not to be understood as hierarchal, but rather grounded on different aspects of students’ use of different resources and arguments. Further, we argue, the categories should not be understood as the only ones possible. Rather, they constitute a starting point in order to develop an analytic tool that may contribute in deepening our understanding of how individuals perceive issues related to the nature of science and scientific trustworthiness. Such a tool may also help clarify issues related to the phenomenon that individuals are to be able to use scientific knowledge in a school context without making them their own, or as a part of their worldview, as Hansson (2007) reveals in her study.

The dominating category utilised by the students in this study has been the use of normative and authoritative epistemological resources. The students often express what they believe through the use of an everyday language, referring to traditions, preconceived opinions or general normative reasoning without any clearly expressed justification or references to scientific knowledge or trustworthiness at all. In addition, when they did not utilise normative resources they instead demonstrated a tendency to use authoritative resources. They refer to scientific authorities, cultures or other sources without discussing wherein the actual trustworthiness consists. The results may be seen as surprising, especially as the students in this study participate in the science programme in upper secondary school.

Several other current studies show a similar picture. For example, in Kolstø’s (2001) study it
was, above all, normative or authoritative statements that were utilised as sources of trustworthiness and these references were seldom challenged or criticised in the discussions. In addition, Sadler et al.’s (2004) study shows that nearly half of the students have the tendency to overestimate the scientific value of articles that supported their own original idea. Very few of the students in these studies raised questions about closely related research or if other research studies have come to the same conclusion.

The implications of this study could therefore be related to two different, but interrelated conclusions. Firstly, our study and several others, once again highlight the necessity to focus on issues about the nature of science and trustworthiness in science curricula and in science education at different levels. It is obvious that the students in our study express a lack of experience working with these kinds of assignments and that they need support and tutorials about how to evaluate the scientific trustworthiness of different explanation models. On some occasions, the teacher explicitly facilitated and deepened the discussion by raising open ended questions and by pointing to the differences in the explanatory models which probably had a positive impact on the discussion in these groups. This highlights the question of how to introduce and organise the instruction on these matters in science education. One possibility is to discuss pseudo-scientific issues in relation to science. If pseudo-scientific explanation models will be examined instead of ignored in science classrooms this could provide possibilities to enhance critical thinking and create opportunities to explore and develop an understanding of the nature of science.

Secondly, the study asserts the suggestion from Hofer (2004a) and Hofer and Pintrich (1997) of considering student’s interpretations of scientific trustworthiness in their use of different epistemological resources. We argue that this framework may contribute to further increase the understanding of how students experience issues related to the nature of science and scientific trustworthiness in the future.
References


To vaccinate or not to vaccinate: how teenagers justified their decision

Mats Lundström, Margareta Ekborg, Malin Ideland, Malmö University

Abstract
This article reports on a study of how teenagers made their decision on whether or not to vaccinate themselves against the new influenza. Its purpose was to identify connections between how teenagers talk about themselves and the decision they made. How do the teenagers construct their identities while talking about a specific socio-scientific issue?

Seven teenagers between 17 to 19 years of age participated in the study. The informants were requested to document in video diary situations in which their decisions about the vaccination were discussed. All the teenagers recorded their diaries during the weeks of the vaccination programme. The students were also interviewed 1-4 weeks after completing their diaries.

A discourse psychology framework (Potter and Wetherell, 1987) was used to analyze the video diaries and the interviews. In this context, decision-making on a socio-scientific issue must be understood as an appropriation and use of discursive repertoires, and also as meaning-making in relation to other fields, such as society and identity. It must also be understood in relation to the use of science repertoire – or actually, the school science repertoire – how available is this discourse in different contexts outside school?

The repertoires were categorized into two main types; experienced emphases and important actors. The first included the categories of risk, solidarity and knowledge. The second included family and friends, media, school and society. The school repertoire was seldom used by the students, indicating that school and science education seem not to be an interpretative repertoire available to them. Instead, the risk, solidarity, family and friends and the media repertoires were available in their talk about vaccination.

These results indicate the need to use media reports in dealing with scientific literacy and also in risk assessment discussions in school. It also indicates the importance of relating school science closely to the students’ daily life.

Keywords
New influenza, discourse psychology, health, risk, trustworthiness
Introduction

In 2009 and 2010, an influenza pandemic, “swine flu”, was given a great deal of media attention in many countries. Swine flu is a disease whose proper name is actually “the new influenza” and it is caused by a virus – A(H1N1). It is spread through airborne drops of liquid, for instance by sneezing or in saliva. In February 2009, the first reported cases came from Mexico and North America and shortly after that, newspapers, television, radio and various social media discussed the disease and how it influenced peoples’ health. In Sweden the first reported case occurred in May 2009. For several months, the new influenza was headline news both in newspapers and on television news broadcasts. Different aspects of the pandemic were discussed in the media, but the main theme was the government’s advice to the public to inoculate against the influenza. The Swedish government took the decision to distribute and offer free vaccination to all citizens. Despite the offer of free vaccination, not everyone chose to be vaccinated. However, more than 60 % of the Swedish population was inoculated against the influenza up to May 2010, by which time 29 Swedes were reported to have died from the illness. During the rest of 2010, fewer cases of infections or deaths were reported, but different kinds of side effects caused by the vaccination were also described, for instance narcolepsy (Swedish Institute for Infectious Disease Control, 2010). These reported side effects opened up a discussion in the media about the positive and negative effects of the vaccination. The new influenza and its associated vaccination gave birth not only to well-articulated reports and articles but also to a great deal of speculation and rumour. One of the examples is a clip from You Tube where an American news station reports about a girl who only could walk backwards, explaining this phenomenon as a side effect of an influenza vaccination.

The break out of a pandemic could be an interesting case study for biology education. It is an example of applied immunology and how knowledge and research in biology is used in society. But it is also an opportunity for research in science education to investigate in what ways people interpret scientific and other information and make decisions about their health. In recent decades it has been emphasized that science education must contribute to the public understanding of science or scientific literacy and by that facilitate an individual’s decision-making (see Roberts, 2007). By knowing more about the decision-making of individuals and how they justify their choices, it might be easier for science education to capture the interest of students and to promote decision-making where scientific knowledge may play a role.
The vaccination was offered to the whole Swedish population but it was up to the individual or in the case of minors their parents, to make the decision. In this way the message from the government was obvious; as many people as possible should be vaccinated to prevent a pandemic. This situation is an example of what Ulrich Beck (1992; 1999) calls the risk society, where individuals have to make decisions about how to handle a health problem. An inoculation gives protection against the disease but might cause side effects. This is also the case with other vaccinations, but the new influenza and the vaccination against it was given sharper focus in public debate at this time compared to what commonly is given to vaccination against measles or polio, even if there are some similarities in campaigns for vaccination. Information was divergent and sometimes contradictory because, for instance, of the richness of different sources on the internet. Nowadays, the media landscape gives plenty of opportunities of obtaining information. This fact raises questions about how people handle information and what impacts their decisions. In what way is a decision about an up-coming health issue made? What questions are of importance when an individual justifies the decision to have the vaccination or not, and in what ways does science education contribute to the decision?

This article reports from a study in which students in upper secondary school have documented what influenced their choice about the vaccination. They have already made their decision about the vaccination. The aim of the study is to analyse how students in upper secondary school justify their decision about the new influenza vaccination and how they at the same time talk about themselves and who they want to be. The students have mainly used video diaries to document their reasoning about the swine flu and its risks. They have also been interviewed about their decision about the vaccination and to what extent the school has paid attention to the pandemic. In order to analyse the data from a perspective where the student’s justification for his or her decision is of interest, discourse psychology (Potter and Wetherell, 1987) has been used as an analytical tool. In discourse psychology, the focus is on how individuals use language to construct versions of the world and of their “selves”; constructing an understandable world.

The risk society and students’ decision-making about risks
Beck (1992; 1999) discusses the contemporary society from a risk perspective. Beck states that civilization today has to face a lot of different types of risk. He defines risk as a “systematic way of dealing with hazards and insecurities induced and introduced by modernization itself” (Beck, 1992, p. 21.) Beck in this way distinguishes between risks and
dangers. He considers the judgment of risks as difficult but necessary for the individual. In the judgment, both for the individual and for society, different types of experts are central. Knowledge from natural sciences and human sciences are used and rationality, fact and interest are involved in the process of risk determination. Anthony Giddens (1991) also asserts that risk assessment is of great importance for the individual but emphasizes its associated difficulties, because there are always unintended and unforeseen outcomes.

According to Beck it is often science that has both caused the problem and provided the solution. Beck argues that the risk society is in a sense a science, media and information society. In that way risk is something for the individual to handle and decide about in his or her daily life. Giddens (1991) mentions that notions of risk and trust have particular importance in decision-making in late modern society. Giddens also talks about fateful moments, “when individuals are called on to take decisions that are particularly consequential for their ambitions, or more generally for their future life” (Giddens, 1991, p. 112). These fateful moments are not activities in day-to-day life but instead moments where the decision is felt to be very important for the individual, such as, for example, the risks of a possible deadly disease like the new influenza. These fateful moments are influenced by, and may influence, the individual’s sense of ontological security, including how the individual understands the risks connected to the moment. Aaron Wildavsky and Karl Dake (1990) discuss the different theories about what determines how an individual regards risks. They demonstrate how cultural biases are more decisive in risk perception compared to other suggested explanations such as knowledge, personality, personal economy or political opinion. In cultural biases they include factors such as views about egalitarianism, individualism and hierarchies. By contrast, Maria Powell et al., (2007) instead found that emotions (worry and anger) are strongly associated with the perceived likelihood of becoming ill. Both Wildavsky and Dake (1990), and Powell et al. (2007) emphasize the complexity and difficulties in analysing risk behaviour.

Stein Kolstø (2006) considers that making a decision in a risk situation is often about how to judge a disputed scientific claim. Kolstø thinks that there is almost always some science related to the question even if it sometimes is not obvious. Clare Christensen (2007; 2009) argues that the role of risk understanding and risk judgment not has been addressed sufficiently in different studies of socio-scientific issues. However, there are some studies that have investigated socio-scientific issues and risks. Kolstø (2006) investigated students’ decision-making arguments about a local power transmission line - whether it should be
buried in the ground because of the possible risk of increasing childhood leukaemia if the line is in the air. After group discussions and interviews Kolstø categorized the students’ reasoning patterns in to five categories. In the first category, students thought that the risk was too small to justify the high costs from underground lines. Kolstø calls this category the “relative risk”. The second category is the “precautionary argument”; students emphasize “safety first” even if the risk is small. There were also students in the study who could not come to a decision about what to do. In the fourth category were those students who considered that risks are a natural part of our life and not a big issue. Kolstø (2006) placed students who truly weighed the advantages and disadvantages before they made their decision in the fifth category. To certain extent, these advantages and disadvantages may be grounded in the individual’s view of science. In an earlier study, Kolstø (2001) demonstrated different “resolution strategies” when upper secondary students were interviewed about the power transmission lines. The different strategies were to evaluate, or accept in combination with the statement that was made, or to refer to authorities. The students did not consider the content; it was more common to evaluate the sources. In this way, authority is often treated as a surety of validity and reliability.

The importance of authority in risk assessment is demonstrated in several studies. For example, Margareta Ekborg (2008) also demonstrates that authorities are important, such as when students think it is difficult to consider risks. In her study upper secondary students in the science programme discussed GMO (genetically modified organisms). Ekborg found that risk was an important factor when making a decision about GMOs. When the students in the study were unable to judge the risk of the use of GMOs they instead evaluated the reliability of the researchers of GMO. There was no correlation in Ekborg’s study between knowledge about what GMO is, and opinion about it.

In the debate on the new influenza, many different types of authorities tried to make their voice heard, but the rich quantity of sources may have made it hard to take notice of all of them, and even harder to evaluate. There were many different messages about the risks of the disease and the vaccination that was offered.

Risk and vaccinations
Sandra Duggan and Richard Gott (2002) interviewed parents at a local child care centre on their view of vaccinations and personal decision-making about immunization. Duggan and
Gott categorized the parents’ answers into four “concepts of evidence” that were important in making the decision to vaccinate their children or not: risk, incidence of disease, efficiency of vaccine in preventing disease and validity of reports about risk. The precautionary principle is often emphasized. Mike Poltorak et al. (2005) found how important different personal histories are in determining the willingness to vaccinate one’s children against MMR (mumps, measles, rubella). These histories include parenthood experiences, knowledge, ways of validating and engaging with information and expectations of health professionals. In this way, when parents talk about MMR, they do not merely expose their scientific reading, but also their responsibility for the child, their trust in institutions and how they place themselves amongst their friends. Malin Ideland (2007) has made a study of Swedish parents’ decision-making concerning MMR. This study also shows that parents justify their decision to vaccinate their children or not by using personal experience. Relationship to families with an autistic child is highlighted in several interviews and is described as a motive not to vaccinate. On the other hand, parents who chose to vaccinate sometimes legitimize this decision with close relationships to persons who really could be affected by diseases like rubella or measles. Even if the mass media had put the issue of MMR vaccine and autism on the agenda, it was personal experience that was used in justifying decisions.

According to Duggan and Gott (2002), interest in an issue like immunization often starts in social concern about government intention behind a vaccination campaign. Suspicion and mistrust may lead to the start of action groups. This mistrust may be seen in a larger context as apprehension to science. Beck (1992) stresses that there is a strong difference between how individuals evaluate and think about side effects. While scientists only trust scientific proof, a lay person sees it in another way - perhaps when a child falls ill shortly after a new occurrence in the neighbourhood. Ellen Peters et al. (2007) agree that patients and consumers in some cases have difficulties with, for example, the likelihood of side effects. However, Peters et al. emphasize that health information has been demonstrated to make individuals understand risks differently and thus strengthens the health literacy among patients and consumers.

**Media reports about influenza and science**

This was not the first time a vaccine was discussed in a lively media debate. When the smallpox vaccine was introduced in the late 18th century there were many rumours about what could happen if you were inoculated with cowpox – a virus similar to the smallpox virus. In the late 20th century a criticized - and later withdrawn -scientific report on connections between MMR vaccine and autism caused concern and also a decrease in how many children
were vaccinated all over the western world (Ideland, 2007). The media “vaccine-genre” is, in other words, something recurrent; the fear of side effects is discussed in relation to the fear of the disease. In the latest case, the risk of getting narcolepsy has been discussed.

One aggravating aspect in understanding media reports is, according to Connie Korpan et al. (1997), that they are often brief and preliminary and sometimes contradictory, which make them hard to understand. This was the case with reports about the new influenza during the autumn of 2009. On the one hand, the influenza was reported to be a disease that could lead to death, while on the other hand there were reports that the vaccination against it could in some cases lead to unpleasant side effects. The different side effects were reported in different media, not only national broadcasting and newspapers, but also Facebook-groups and other websites where all users have the opportunity to comment. Kevin Burchell et al. (2009) talk about a shift characterized as moving from deficit to dialogue, from “top-down” communication to “two-way” dialogue, where a lot of actors participate in the media debate.

Despite these new media channels, the debate on the new influenza followed – as described above – an established genre for how to report on scientific and technological risks. Sheldon Ungar (2008) examined different media reports from the “bird influenza” outbreak from April 2004 to March 2006 and came to the conclusion that the reports follow the same pattern. Ungar identified three stages of discourse. In the first, fear-inducing claims dominate, sounding the alarm - something also reported by Birgitte Nerlich and Christopher Halliday (2007) as the “rhetoric of fear” in media messages about the avian influenza. In the second, the mixed message discourse, the threats are more moderate and include scientific messages and national plans against the influenza. The last, called hot crisis and containment, involves effort to ameliorate the most frightening elements of the disease and the spread of the virus.

The capacity to follow and evaluate discussions about science in the media is often emphasized and reported as a deficit in the scientific literacy among students (Jarman & McClune, 2010; Korpan et al., 1997; McClune and Jarman, 2010; Norris et al., 2003). These authors bring forward the necessity of being able to interpret and handle media information. Stephen Norris et al. (2003) reports about deficiencies in the capacity of university students to interpret and make appropriate judgments about media reports that describe scientific research. The students in the study also had an inflated view of their capacity to evaluate the five given media reports.
Since there are specific genres for media reporting on scientific issues in general - and vaccination in particular - the reporting naturally sheds light on some perspectives and hide others. One example is that science reporting often is not able to describe the whole research process including, for example, the review process (Korpan et al., 1997; León, 2008). This review process is important to validate research results but may vary in time depending on the issue. In the case of the new influenza, the review process was to some degree going on continuously through the vaccination period because of the short time between the break-out of the pandemic and the call for an effective vaccine. In this way the media consumer becomes a part of the evaluation of the vaccine, the media consumer has a responsibility to make the “right” decision for him-/herself and society. Responsibility for your own decisions is an important part of the “risk society” (Giddens, 1991) and many studies emphasize the importance of training students’ competence in decision-making without complete information (Christensen, 2009; Kolstø, 2006; Ratcliffe & Grace, 2003).

Russel Tytler et al. (2001) summarize the interaction between science and the public as a negotiation of different perspectives, both knowledge and values, where judgments about evidence are of great concern. This diverging image of how individuals think about and deal with science have been discussed for several years (Irwin and Wynne, 1996, Layton et al 1993). It is to some degree dependent on the individual’s ability to handle science knowledge, to be scientifically literate. Science is a complex field of knowledge and not easy to handle. Brian Wynne (1991) states that not even among scientists themselves is there any consensus about what science or scientific knowledge is. According to Wynne are the opinions about what science is differs, and is sometimes even contradictory among science experts.

Science education and daily life
The ability to use knowledge in science as an active citizen has been emphasized by both researchers (e.g. Kolstø, 2001; Laugksch, 2000; Levinson, 2010; Roberts, 2007; van Eijck and Roth, 2010) and organizations like OECD (OECD, 2007). Normally this knowledge is expressed as scientific literacy (SL) and describes “the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity” (OECD, 2003, p. 133). The phrase about understanding and help in making decisions indicates that scientific literacy is not only a matter of handling different concepts, but also being able to include in scientific knowledge as one important factor, as well as, for example, economical or social factors, when making a decision. Korpan et al. (1997) emphasize that
individuals must comprehend, interpret, and evaluate information and conclusions based on scientific research to be scientific literate. Wynne (1991) states that the capacity of the public to absorb science is not a matter of intellectual capability, but rather is dependent on whether it seems useful and in line with public or personal experience. Jonathan Osborne and Justin Dillon (2008) consider that science education today must educate students to be critical consumers of scientific knowledge. They also criticize school science for being so distant from the science reported in the media. The new influenza and the vaccination are seen here as one example where students and their parents must be critical consumers of information. The dilemma of the vaccination can be regarded as a socio-scientific issue, where the use of scientific knowledge is one way of dealing with the issue. This study does not directly investigate scientific literacy in a traditional way, but instead analyses if the students include any scientific knowledge when they justify their decisions about the new influenza and the vaccination against it, thereby meeting the demands reported above about an active citizen using scientific knowledge (Jenkins, 2006; Kolstø, 2001; Laugksch, 2000; Levinson, 2010; OECD, 2003; 2007; Roberts, 2007). This way of analysing the use of scientific literacy in an out of school-context also meets the demands from Michiel van Eijck and Wolff-Michael Roth (2010) who call for research about scientific literacy “in the wild”. By ‘in the wild’ they just mean in an everyday context, outside school.

Another way to look at science connections to everyday life is to talk about its role in students’ identity construction. This takes its departure from a social theory on learning (Lave & Wenger, 1991). The primary focus of this theory is that you learn when you participate in social practices and communities and when you are able to construct an identity in relation to these. Learning and identity building are in other words interdependent on each other; “meaning is constructed in relation to the community, specific practice and the identity” (Wenger 2008, p 5). Several researchers have emphasized the importance of increasing the knowledge on connections between students’ identities and their interest and learning in science. Nancy Brickhouse states that:

*In other words, in order to understand learning in science, we need to know much more than whether students have acquired particular scientific understandings. We need to know how students engage in science and how this is related to who they are and who they want to be.* (Brickhouse, 2001, p. 286)

Troy Sadler (2009) also emphasizes the importance of students attaining the ability to learn science in a community where they can be central participants and express their identities. In
an education departing from science culture and scientific work forms, students have few chances to participate and express their identities. But, according to Sadler (2009), if the teaching is framed by issues important to the students themselves, they become more central participants and the chance to make meaning, express their identities and learn increase.

Wenger (2008) highlights shared discourses as one aspect of a community. Sadler (2009) emphasizes the importance of being able to understand the cultural codes and use the discourses inside a community. Jay Lemke has also brought forward this aspect:

*In the sociocultural view, what matters to learning and doing science is primarily the socially learned cultural traditions of what kinds of discourses and representations are useful and how to use them, far more than whatever brain mechanisms may be active while we are doing so* (Lemke 2001, p. 298).

In this view, science learning must be understood not only as an appropriation and use of discourses, but also as meaning-making in relation to other fields, to society and to identity. It must also be understood in relation to what happens with the use of science discourse - or actually the school science discourse - when it is expected to be available outside school in different contexts; something this article deals with. Glen Aikenhead (2006) and Jim Ryder (2001) emphasize the difficulties of using canonical science outside school. Aikenhead describes this as a transformation where the content must be deconstructed and then constructed according the idiosyncratic demands of the context. Decision-making about the new influenza vaccination is one example where this transformation of content seems relevant.

**Vaccination as a socio-scientific issue**

All various information about the new influenza would lead to a decision about having the vaccination or not. The decision about the vaccination can in science education be regarded as a socio-scientific issue (SSI). Ratcliffe and Grace (2003) describe a socio-scientific issue “to be one which has basis in science and has a potentially large impact on society” (2003, p. 1). Socio-scientific issues have attracted attention in science education in recent years and proposed as an appropriate means to discuss and learn about the connections between science and society (Ratcliffe and Grace, 2003; Sadler, 2009; Sadler and Zeidler, 2005). The vaccination question has its origin in science, in knowledge about immunology and how to handle pandemics. Already included in the classification of a disease as a pandemic is a definition of potentially large impact on society thus meeting Ratcliffe and Grace’s (2003)
Ratcliffe and Grace (2003) mean that decisions are not only based on scientific facts, but also argue for the influence of our priorities, values, beliefs and role in society when deciding and eventually take action on a personal level. They demonstrate in a study about socio-scientific issues that increased exposure to different media reports combined with structured questions improve reasoning skills among students that initially operate at a low level in this sort of reasoning. This study investigates if the students include any scientific knowledge when they justify their decisions about the vaccination and what information or information sources they find trustworthy.

**Trustworthiness**

One key concept in the reasoning about scientific literacy, socio-scientific issues and how individuals handle evidence is trustworthiness. Kolstø (2001) has investigated what adolescents dealing with socio-scientific issues count as trustworthy and how they make personal decisions concerning what actions to make. Kolstø denotes the concept trustworthiness as the extent to which information and knowledge claims are seen as sufficiently reliable or not to be included in the pupils’ knowledge-base for decision-making. Decision-making is to a high degree grounded in trust in different sources. Disagreement among researchers in science is for many students frustrating even if this is common in research in science (Christensen, 2009; Ratcliffe and Grace, 2003; Kolstø, 2001). Christensen (2009) and Ratcliffe and Grace (2003) think this frustration may be due to the fact that science knowledge presented in school is often ready-made and presented as consensus. The process about how consensus is reached in the science community is according to Kolstø, an important epistemological question which is not always addressed in science education.

Kolstø (2001; 2006) demonstrates the importance of authorities even if the students considered information from those others than experts. Kolstø (2001) defines authorities as sources of knowledge, because the pupils in his study often seemed to look not at the content of the knowledge claims but instead at the sources of the claims. In his study about adolescents’ reasoning on power transmission lines and the fear that the lines might cause childhood leukaemia, authorities played an important role in the students’ reasoning about trustworthiness. Mats Lundström and Anders Jakobsson (submitted) also demonstrate the importance of authorities when reasoning about health issues. In that study students in upper secondary school discussed different web site answers to questions related to health. The students often referred to authorities as researchers or the pharmacy when deciding which answer was most trustworthy. In a study by Shu-Nu Chang and Mei-Hung Chiu (2008),
science major students at undergraduate level performed better in informal argumentation in different SSIs (for example about GMO, dioxins, and DDT and malaria) compared to non-science majors. The science majors use authorities in their reasoning to a lower degree than other students, indicating that authorities are less important if you have or at least think you have knowledge of the subject.

In this study, the authority-concept is replaced by actor. This is chosen because the entity that normally is included in the concept of authority was not easy to evaluate in this case. An authority is mostly associated with some kind of knowledge. Often there is agreement between the concepts, but not always. The actor-concept demonstrates that there is something that can be related to in the issue, but does not value the source as highly as the authority-concept does.

**Purpose and Research question**

The purpose of this study is to develop knowledge about connections between how students in upper secondary school talk about themselves and the decision they made about the new influenza and the vaccination against it. The purpose is also to investigate if the students cite school and science education as an available repertoire of a discourse on the new influenza.

- How are the decisions about the vaccination justified among upper secondary students?
- How can this decision-making be understood in relation to the students’ discursive constructions of themselves in a specific social context?

**Methodology**

Research on students’ scientific literacy and decision-making is often made in a school context. Different types of methods, like interviews or group discussions are normally connected to the daily activity in school or to some activity performed by the researcher. Kolsto (2006) considers that empirical research on rational reasoning has been experimental and based on tasks with structured problems. Often, the shortage of reasoning carried out by people has been in focus. However, not only rational reasoning has been considered. Troy Sadler and Dana Zeidler (2005) identified three patterns characterizing student decision-making: rationalistic, emotive, and intuitive informal reasoning. Despite this widening of the argumentation research, there has been criticism against this way of investigating reasoning because it differs from real-world decisions (Shafir et al., 1993) and decision-making in daily life (Kolsto, 2006). Even if the examples in studies made in school are real, there is a risk that
the students regard the tasks as unimportant and as inauthentic decisions or decisions not concerning them.

With that criticism in mind, the aim of this study was to leave the school context to a certain degree and instead focus on young peoples’ daily life and the process of decision-making in a current SSI. It is therefore also an attempt to meet the demands of Christensen (2009) about more research about risk assessment by individuals and from van Eijck and Roth (2010) about investigating scientific literacy “in the wild”. In this way, the ambition was to come closer to the informants’ life outside school. These ambitions led to the decision to use video diaries as a tool to collect data and in that way study decision-making in a context outside school, in a situation where making a decision affects life. The video diary is a form of visual ethnography (Pink, 2001) where the informant gets instructions, but chooses for him or herself what, where and when documenting is carried out. Andrew Noyes (2004) and Debby Cotton et al. (2010) assert that data from video diaries provide a fuller representation or description of social life. The challenge of recording, analysis and interpretation is magnified. The data is arguably richer than conventional interview transcripts. It can be discussed how “in the wild” any type of observation study is, even this one. The presence of a video camera affects the informant’s behavior (Pink, 2001) and the task was given by a researcher. However, an out of school context is regarded as more “in the wild” compared to the classroom. Thus a video diary study was regarded as an appropriate way of investigate everyday life. The video diary data collection was combined with interviews. Ruth Holliday (2004) suggests that video diaries are mainly a one-way conversation. She recommends follow-up interviews to achieve two-way conversation about the issues discussed in the video diaries. Dorte Buchwald et al. (2009) and Nuzhat Quadri and Peter Bullen (2007) also suggest that an interview after the making of a video diary gives the researcher the opportunity to understand more about the information given by the informants.

The purpose of this study is not just to analyse the content in the argumentation as is the case in many studies of decision-making. Neither is it to analyse argument from StephenToulmin’s (2003) reasoning pattern: something that also is common in science education studies. Instead, the aim is to meet the criticism from Christensen (2009), Kolstø (2006) and Shafir et al., 1993) discussed above. Students’ justification or legitimization of the decision they make are in focus. To be able to reach this goal, a framework that focuses on the meaning-making of the individual is used. Using discourse psychology as an analytical tool for the way students construct their world, the justifications of decisions appropriate for themselves is
analysed. The use of discourse psychology in science education research has been proposed by Wolff-Michael Roth (2008). In studies of scientific literacy students are often categorized in subgroups and in that way seen as individuals with enduring, stable opinions or values (for example Kolstø, 2006). In this study, students’ opinions and values are seen instead as context-dependent and not necessarily as enduring and stable (Potter and Wetherell, 1987).

**Discourse psychology**

Potter and Wetherell (1987) include all forms of spoken interaction in discourse, formal and informal, and written texts of all kind. Discourse can be explained as a certain way of talking about and understanding the world (or a part of the world). This approach emphasizes that the way we understand the world is historically and culturally dependent and thereby contingent (Potter and Wetherell, 1987; Winther Jørgensen and Phillips, 2000). In line with ethnomethodology discourse analysis has its focus on how people use their language to do things (Potter and Wetherell, 1987). “People are using their language to construct versions of the social world. This construction implies active selection where some resources are included and some omitted” (Potter and Wetherell, 1987, 33-34). The language is both constructing and constructed and the aim is to investigate how people themselves manage, understand and use descriptions. By analyzing texts from the students in the study, an opportunity to understand how the informants construct their “new influenza world discourse” is possible. Their uses of language construct justification for their knowledge and decision-making. The new influenza vaccination decision was to a large extent a matter of handling, understanding and managing all diverging information. These circumstances make a discourse analysis proper as an analytical tool for decision-making.

Discourse psychology is based on the social constructivist assumption that the I is not an isolated autonomic agent, but is instead social and arises, transforms and is an object for negotiations in social practice (Potter and Wetherell, 1987; Wetherell and Potter, 1992; Winter Jørgensen and Phillips, 2000). Discourse psychology rejects the idea that individuals have a solid identity. When you talk you also construct an identity and individuals have several flexible identities. Different discursive resources are used in different social relations. However, one does not assume a new identity every time one talks; strata of earlier discursive practices are important in expressed identity (Wetherell and Potter, 1992; Winther Jørgensen and Phillips, 2000). Norman Fairclough (1992) emphasizes that texts are full of snatches from other texts. The new text assimilates, contradicts, and so forth, other texts. New texts stress
the historicity of texts and are reproduced even if the new text transforms. Sometimes this inter-textuality is manifested when specific other texts are obviously drawn in. In discourse psychology, the rhetorical organization is in focus: how text and talk are oriented towards social action.

Often, the concept “interpretative repertoire” is used instead of discourse to emphasize the discursive resources’ flexibility in social action. Evaluating action in terms of interpretative repertoires is an alternative way of comparing how attitudes, beliefs and attributes are described as mental constructions which are stable and hard to change (Potter and Wetherell, 1987). “Interpretative repertoires are recurrently used systems of terms used for characterizing and evaluating actions, events and other phenomena” (Potter and Wetherell, 1987, p. 149). The interpretative repertoire will be organized around specific metaphors and figures of speech. In this way, a repertoire is not connected to a certain social group and an individual may use different interpretative repertoires in different situations or contexts. Evaluating action will be of great importance when the aim is to analyse how decisions about the influenza and associated vaccination are justified. In our analysis, we can only analyse how the students construct a, for them understandable, world view about the new influenza at just that moment, not their attitude to it for a long period of time. In the analysis, we are also interested in how the informants justify their decisions at the same time as they talk about their “selves”, how they want to be perceived and how this role also strengthens their arguments.

Data collection

An email with a missive about the research project was sent to 20 upper secondary schools, asking for students that were interested in making video-diaries of their daily life and in what ways they think science education plays a part of their daily life. The different schools were asked to distribute the message further to the students at their school. After that, it was up to the students to answer our call. We also talked about the project in some classes where the teacher wanted us to do so. Finally, seven students were identified as interested in participating in the project. This way of asking for student volunteers entails questions about representation. Students who want to be heard and enjoy filming themselves may participate to a higher degree than shy students. The aim was to have a spread in the informants’ gender, study programme and school. The informants were four girls and three boys; they study five different programmes in upper secondary at five different schools. Two of the girls are
enrolled in the science programme. In this way, the informants are heterogeneous with regard to those three factors.

All students in the study were provided with a video camera and an mp3-player. One student chose to use a digital photo camera instead of a video camera. There was also the opportunity for the students to write ordinary diaries about the subject if they did not want to use the video camera in all situations. The informants were requested to document situations in which they consider science knowledge to be of importance in their daily life outside school. Besides that, all seven teenagers were asked to comment on their decision about the vaccination against the new influenza. All informants made their diaries during the weeks the vaccination programme was going on. The teenagers made their diaries in 1-3 weeks, and all of them had made their decision about the vaccination when they finished their diaries. They chose to talk about all aspects of the new influenza and vaccination in just one movie clip, which varied a lot in time, between 50 seconds and 5 minutes. After that, the material was transcribed and 1-4 weeks later, semi-structured interviews were conducted by one of the authors. During the interviews, some of the material was discussed with the youngsters, watching a small part of their video diary. The questions were about their vaccination decision and what they thought about their decision afterwards. There were also questions about what they thought about science and their education. The interviews lasted 20-40 minutes and were recorded and transcribed in Swedish and translated for this article.

Qualitative studies often result in a multitude of data. “The challenge of qualitative analysis lies in making sense of massive amounts of data” (Patton, 2002, 432). It is necessary to reduce the volume of data in an appropriate way to communicate the essence of what that data reveals. This challenge was to some extent limited in our study. At this stage, all the data could be transcribed and analysed. The other movie clips was mainly about exercise and food and will be analysed later.

**Ethical aspects**

The use of a video diary as a data collection tool raises some important ethical aspects. By letting the informant document their daily life, the researcher also runs the risk of getting material that can contain personal information about the informant that requires consideration of how it should be handled. This can for example be information about the family situation, self-destructive tendencies and drug habits. The form of the video diary and the fact that the informants have seen documentaries in video diary form may result in some informants...
exposing themselves very much. The special situation of looking into an individual’s life differs from, for example, an interview situation where that type of information can be handled immediately. With a video diary, the researcher is more dependent on the informants’ choices even if instructions on what to document are given. In this study, permission from the parents was collected from those students who were under 18 years old. The research followed the ethical guidelines outlined by the National Research Council (CODEX, 2010; Gustafsson et al., 2005). The interviews were closed with a short briefing where the teenagers were asked if they wanted to say anything more or needed help with anything mentioned in the diary. In the excerpts, the students’ identities are kept confidential.

Analysis
The video diary and the interviews were analyzed in similar way, even if the video diary data was analysed to a certain extent before the interview. In the beginning of the analysis the material was read carefully several times, looking for words that expressed justifications and other expressions about the influenza and the vaccination. These words and expressions were then brought together in themes, guided by the earlier-cited definition given by Potter and Wetherell of interpretative repertoires; “used systems of terms used for characterizing and evaluating actions, events and other phenomena” (1987, p.149), which sometimes were more explicitly expressed by the teenagers compared to “figures of speech”. For example, if words like “uncertainty”, “luck” and “never tested” were found in the description, it was categorized as a repertoire about risk, because the teenagers evaluated actions, events and other phenomena with focus on different aspects of risk. In the same way, important expressions or nouns were further categorized. Two more repertoires as well as risk were categorized; solidarity and knowledge. Statements about not only thinking of oneself were categorized in the solidarity repertoire. This includes both relatives and unknown people. In the repertoire of knowledge are gathered statements where knowledge is emphasized. This can be both some demonstrated knowledge or the asking for more knowledge. This first main type of interpretative repertoire including risk, solidarity and knowledge is labelled experienced emphases. Experienced emphases cover much of the action, events and other phenomena that are mentioned in Potter and Weterell’s (1987) definition of an interpretative repertoire. The teenagers express how they have acted and why. But there was also need for an analysis of what references the informants made to the actors involved. For that reason, a second major type of interpretative repertoires was created. The second type focuses instead on different
types of actors and is labelled important actors. In this second category, the reference to different actors gives origin to the different repertoires, these repertoires are more directly mentioned and thereby rather easy to categorize compared to experienced emphases.

If any relative or friend was mentioned in the reasoning about the influenza and the vaccination, the repertoire was called family and friends. When the teenagers mention anything from the media debate that was going on during the influenza period, the repertoire was labelled media. This can be from television, radio, newspapers and Internet. We were also interested on focusing in what ways school and science education were repertoires used by the teenagers. Since this was the case, school has been categorized into its own repertoire even if the video diaries contained only a single statement about school in connection to the new influenza. Finally, statements made with reference to governments, and also to an anonymous “they” or “it” was still left in the material. These references have been categorized as a society repertoire, even if it is sometimes difficult to identify who they or it are. In this way this major type consists of interpretative repertoires; family and friends, media, school and society.

These different repertoires, both within one main type and between the two different main types, are closely linked together, where reasoning starts in one of them and often ends in another, and they are also sometimes hard to differentiate from each other. The diary often starts in one interpretative repertoire and then goes further to another, searching for arguments. There is also an overlap between the two categories. For example, if a teenager talks about how they have talked a lot about risks in her family but they have decided to have the vaccination; this statement is categorized in both the experienced emphases- and the important actors-repertoire. But this overlap is not seen as a problem as it is not the aim to count how many times the different repertoires are used.

There is often a high degree of inter-textuality where different texts about the influenza and the vaccination are heard; it is often not possible even to see the origin of the statements. But the emphasis of what matters is different, both between the informants and in different parts of the diary or interview of the same teenager. The different repertoires are reported under different headings even if it is almost impossible to talk about one of them without mentioning one of the others.

Discourse psychology differs from content analysis. In discourse psychology the individual’s use of different discourses in the society is investigated. Discourse psychology also differs
from a content analysis in its aim, which in discourse psychology is to investigate how people use these different discourses to present themselves. The focus is on how they use language (Potter and Wetherell, 1987).

**Summary of categorized interpretative repertoires**

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After this first analysis where the use of different interpretative repertoires was categorized, we were interested in how the students construct their selves inside a socio-cultural context. We wanted to see how their decision-making on the new influenza and vaccination could be understood in relation to the students’ self construction in a specific social context. In this second step of the analysis we followed each student in both the video diary and the interview with the aim of seeing how they used the different repertoires to present themselves as informed and responsible citizens.

However, some important conclusions about the difficulties in this study must also be noted. The format of a video diary does not invite deep science content reasoning. Video diaries are not normally adequate in covering investigation into a definition of scientific literacy in which knowledge of science concepts is requested (Driver et al., 1996). Instead, a definition where use and participation is emphasized is more appropriate. For instance Roberts’ (2007) vision 2 of scientific literacy is more suitable to investigate using video diaries. This is in line with Wolff-Michael Roth and Stuart Lee’s (2004) urgent request for the rethinking of scientific literacy in terms of participating in society and Charis Brown’s (2010) emphasis on democratic aspects in research. In this way, the video diaries also can be used in a feed-back process as proposed by Quadri and Bullen (2007).

**Results**

**Experienced emphases**

In the examples of the first main type of interpretative repertoires (IR), the experienced emphases are *risk, knowledge, and solidarity.*

**Risk**

This risk repertoire dominates the material and has many different expressions. The risk
The repertoire becomes a reason irrespective of what decision is made about having the vaccination or not. It is used both to defend a decision to vaccinate and a decision not to. If the decision is made not to have the injection, resources that refer to the uncertainty of the knowledge about the vaccine result in a decision where the risks of having the vaccination and thereby the risk of some side effects dominate. In excerpt 1, Amanda chooses to not have the vaccination and her mainly used interpretative repertoire is risk.

**Excerpt 1 (video diary)**

*Amanda:* I chose not to, not have ehm the shot against the swine flu. Because you don’t know what will happen. You read and hear in the news that people have fallen into a coma, ended up in wheel chairs not able to move anymore. // But I don’t think anything will happen and if I get swine flu I will survive.

In this way Amanda weighs the risks for and against and expresses her conclusion that there is a higher risk having the injection than not having it. Amanda thinks that a vaccination is connected with more risk than catching influenza. Amanda refers to the flow of media reports, for instance in newspapers during the autumn of 2009, when more or less trustworthy stories about the vaccination were told. Amanda’s description of the risks demonstrates a fear of the risks, for instance fall into a coma, end up in wheel chairs. The inter-textuality with reference to media is obvious and this type of reference is common in the material but is handled very differently by different students. Excerpt 1 is also an example of figure of speech (Potter and Wetherell, 1987). In excerpt 1, Amanda tells her story in a very dramatic way. This breaking off or pausing speech for dramatic or emotional effect, was common in Amanda’s diary.

In the interview that was made after the video diary, Amanda also declares and confirms her choice even if her classmates that had the injection did not get any serious side effects.

**Excerpt 2 (interview)**

*Amanda:* They (those who had the vaccination) were lucky that they did not get anything serious. And if I had the injection, maybe something would have happened, but you never know. I did not dare to take the risk.

Amanda uses the risk repertoire here in the same way, even after a couple of weeks. The lack of serious side effects among classmates that had the vaccination is not seen as an important factor, thus using the risk repertoire in another way. Instead, Amanda talks about not taking the risk and also about luck and destiny. Amanda demonstrates the construction of a view where it is important to avoid risks and where destiny and luck are of great importance.

The large numbers of reports about side effects, and therefore risks, which Amanda uses as resources, are often discussed both in the diaries and in the interviews. But even if the
reference to reported risks and side effects are the same, they are used in totally different ways by some students. For example by Anders (excerpts 3), commenting on a YouTube-clip where a girl walks backwards.

*Excerpt 3 (interview)*

**Anders:** Everybody talked about it. There was a guy that pretended that he did it too. He said, oh no, no and started to walk backwards.

But Anders’ story is told with laughter and it is obvious that Anders has not taken the backwards-walking-clip seriously, despite this story and others about people that have fainted during the vaccination at Anders’ school. Anders constructs a totally different view of the risks compared to Amanda, even if they both talk about reported side effects of the vaccination. This is also the view of Sandra, one of the girls from the science programme who says that “it is just ridiculous that people believe that you would start walking backwards and die, bla, bla.” Both Anders and Sandra are aware of the stories about unexpected side effects, but they are not of great concern when constructing their view of the decision. Another example where the risk repertoire ends in a decision to have the vaccination is David. He has also debated with himself and with his mother, resulting in having the vaccination. He states that the positive effects are in favour and that “put safety first.” But to put safety first has a different meaning for David compared with Amanda. Both Anders’ no, no and Sandra’s bla, bla are examples of figures of speech used by the teenagers in this interpretative repertoire.

In the risk repertoire references are often made to the impact of others in decision-making about the vaccination. Different types of media seem to play an important part in some of them. It is not so common that the students justify their decision with references to the risk of becoming very ill with the disease. The risk repertoire is closely connected to the next interpretative repertoire; *knowledge*.

**Knowledge**

When the students talk about risks, they are sometimes reasoning about scientific and secure knowledge of swine flu and the vaccination. This debate on what was true of the vaccination and how these facts were proven was very prevalent for a period of several months. This debate was carried out not only in major newspapers and television news, but also in the schoolyard and in social media, like Facebook. When the data involve statements about how you know something or about science - for example, by testing vaccine - the texts have been labelled “knowledge”, which gives this knowledge a very broad repertoire. But this is more the use of a knowledge repertoire than a demonstration of using one’s own scientific
knowledge in this repertoire, even if there are some examples of students that use knowledge about immunology in decision-making. It is also the case in this interpretative repertoire that the vaccination is more discussed than the disease itself.

Both in the video diary and in the interview, Jakob (excerpt 4) expresses certain scepticism about society’s knowledge about the vaccine. He is concerned about the tests of the vaccine and what has been proven. Helena (excerpt 5) also expresses doubt about the knowledge about the vaccine.

Excerpt 4 (interview)
Jakob: Of course, you don’t know what can happen but if it is not sort of scientifically (2.2) proved that it really does as it was written about, then it’s a hard decision but in the end I had it anyway.

Excerpt 5 (interview)
Helena: Well, you couldn’t know, the vaccine, you didn’t know if it worked or not, it had never been tested, we were guinea pigs.

By mentioning scientifically proved Jakob adds another level to the discussion: not only risk but the importance of knowledge about the vaccine. Jakob emphasizes this by using the expression really does, which can be interpreted as Jakob showing a certain scepticism about how public information about the vaccination was drafted. In a similar way, Helena refers to the scientific process (or lack of it) when she uses the metaphor herself as a guinea pig, ready to expose herself to the vaccination. The statements from Jakob and Helena demonstrate that they see scientific knowledge about the vaccine and its effects as insecure and not tested thoroughly enough. This question was also frequently debated in the media and different vaccines were used in different countries. But despite the desire for more testing and knowledge about the vaccine, both Jakob and Helena got the vaccination, showing that even if they not are satisfied with the available scientific facts about the vaccine, they are ready to test it for themselves.

In the same way as with risks, Amanda uses the same reference but makes a different decision. Amanda also refers to the lack of scientific proof and uses this to justify her choice to not to have the vaccination.

Excerpt 6 (video diary)
Amanda: Plus that I don’t think that they have done enough research on the injection. It’s only just been developed. They don’t know what can happen, like side effects and so on. So I don’t know, but I don’t trust it at all, at all.
Amanda’s reasoning is reminiscent of the resources used in the risk repertoire. Amanda expresses the same principle of being careful; she is not ready to test it before she is convinced that it is safe. She emphasizes this with the repetition of *at all*. The reference to research causes the justification to be classified in the knowledge repertoire, even if the reasoning also consists of risk-safety reasoning.

**Excerpt 7 (diary)**

Sandra: If people had thought like this about all vaccines, we would still have all the old diseases like rubella etc. Maybe it is wrong to say it, but honestly, it’s only ignorant people who choose to not get vaccinated here in Sweden.

Sandra, who attends the science programme in upper secondary school, reasons in another way than Amanda. She thinks that the long experience of earlier vaccination programmes demonstrates the importance of vaccinations and she trusts the scientific community and its knowledge about the issue. She expresses strong trust in science and in scientific knowledge: knowledge is very important and individuals that do not have the vaccination are ignorant.

**Solidarity**

Alongside the risk repertoire, the *solidarity* repertoire dominates. The fact that the teenagers do not vaccinate themselves for their own sake, but instead to protect others from getting the disease, is very often referred to. They refer to protecting close relatives, and also other people in general. Anders repeats his concern for others several times.

**Excerpt 8 (video diary)**

Anders: It’s not only not to get swine flu myself, but also maybe protect others. If I, don’t know, would be hospitalized or something, and then accidently infect innocent people. But it’s maybe mostly because I have cousins that are very young, so if I accidently see them and infect them ...so it was most for the sake of others that I really chose to have the vaccination.

Anders shows his concern for his relatives, saying *I have cousins that are very young, so if I accidently see them and infect them*. But he also expresses solidarity, saying *would be hospitalized or something and then accidently infect innocent people*. This way of portraying oneself as loyal may function as a very acceptable explanation in discussions about whether to vaccinate or not and it is an argument that is very hard to contradict.

By comparison, this interpretative repertoire involving solidarity is completely absent in Amanda’s diary and interview. Amanda, who was the only one of the students that chose not to have the vaccination, neither in the diary nor in the interview mentions anything about concern for others, even if she talks a lot about her family in the rest of the diary. But the construction of a world where it is important to care about others is obvious in many other
texts. This solidarity was one of the messages in the media and different types of information from governments during the pandemic. The results could also be discussed from the standpoint of Wildawsky and Dake (1990). Solidarity is connected to egalitarianism and individualism which Wildavsky and Dake demonstrate as important factors in risk perception.

The lack of a solidarity repertoire by Amanda, might explain that she see risks differently and chooses to not be vaccinated.

**Important actors**

The second main type of interpretative repertoire is labelled *important actors*. These repertoires focus on what types of different actors in society that are referred to in the diaries or during interviews. The purpose of analysing from this perspective as well is to capture texts that are not already captured in the emphasized experiences and in this way complete the analysis. By approaching the data from two different perspectives, the possibility of understanding how students talk about the new influenza and vaccination increases. But it will also give rise to an overlap in the data analysis as some of the data belongs to both types of interpretative repertoires. This double perspective is chosen despite this.

This second perspective in the analysis is mainly a way of analyzing the material from an authoritative perspective because earlier research in science education has demonstrated the importance of authorities in decision making (Kolstø, 2001; Kolstø et al, 2006; Lundström and Jakobsson, submitted). But the repertoire is labelled actors instead of authorities because the difficulty in analyzing if the actor mentioned also can be seen as an authority - someone who has the answers. An actor is regarded as important to the scenario but not always trustworthy.

The four labelled interpretative repertoires connected to actors are *family and friends, media, school and society*. None of these categories are sharply delineated from each other. The society repertoire encompasses the others and is sometimes vague, but despite that is labelled in its own interpretative repertoire.

**Family and Friends**

The most common repertoire in this main type is *family and friends*. The new influenza and the vaccination have been major subjects of discussion in the students’ homes. Several of the informants talk about lively discussions in their family. But these discussions have not led to the same decision for the entire family. For example Amanda and her father did not have the
vaccination, but her mother and brother did. In Jakob’s family there have also been discussions about the vaccination. Jakob (excerpt 9) had the vaccination.

*Excerpt 9 (interview)*

Interviewer: What did the rest of your family do? Did everybody in the family have the injection?
Jakob: Not my mother.
Interviewer: Ok, why not?
Jakob: On one hand because she is, I suppose you’d say, critical, in the way I am too. I don’t know why I had it. Maybe because I spend a lot of time with my grandmother, and my father has always said that, that it’s young people and the elderly that are in the danger zone. And that put some group pressure on, in a way, or family pressure. My mother did not have the vaccination because we have a family doctor that told her you don’t need the vaccination and so on. So she trusted him. So that’s how it went.

Jakob’s discussion demonstrates a repertoire in which Jakob has to adopt an opinion that accommodates the divergent views of his family. On one hand, Jakob identifies with his mother, saying *she is, I suppose you’d say, critical, in the way I am too.* On the other hand, Jakob feels pressure from his father, referring to his father’s concern about *grandmother and the elderly in the danger zone.* This pressure from his father outweighs other concerns and even in the video diary Jakob justifies his decision to be vaccinated by referring to his father’s wish in the same way as he does in the interview. Jakob also brings in an important actor with connection to the family - the family doctor. The family doctor seems to be decisive for Jakob’s mother’s decision but not for the rest of the family. This, despite the doctor’s recommendation is contrary to the main message from the governments, governments that Jakob both in the video diary and the interview expresses a critical view about.

As well as the family, friends have also been discussion partners in deciding and evaluating the effects of having the injection or not, and especially in discussing the different side effects. The discussion about the side effects is illustrated in excerpt 3, an excerpt that illustrates how the students refer to discussion among friends. While in excerpt 3 Anders demonstrates a rather relaxed attitude, Amanda and her friends, were according to Amanda (excerpt 10), really afraid. Amanda talks about this in a dramatic style also in the interview.

*Excerpt 10 (interview)*

Amanda: Almost nobody in my class has had the vaccination. They are all afraid of it too.
Interviewer: Ok, you think it was for the same reason that you had, that they thought there would be side effects?
Amanda: Yes, yes! Because everybody talked about it in the classroom. That things had happened and so on.
Both excerpt 3 and 10 demonstrate that discussions that students commonly refer to are often those in which they have discussed different side effects with their friends. They are not to any great degree referring to discussions with friends about swine flu itself. The interpretative repertoire once again focuses on the vaccination and not on the influenza.

**Media**

As reported earlier, the media coverage of the pandemic and the vaccination programme was massive. What dominates in this interpretative repertoire is the students’ stories of what the vaccination may result in. The types of statements demonstrated in excerpts 1 and 3 and associated results are common in the media repertoire. The statements in excerpt 1 and 3 are made emotionally. These emotions can be both fear (Amanda) and laughter (Anders). The media reports about possible side effects dominate, while the rest of the media reports have not been forceful enough to play an important role in students’ available repertoires. None of the students discuss, for example, the number of deaths or the symptoms of the disease. That type of media reporting has not influenced the students’ discussions about the new influenza. There is only one example where a student refers to the media in another way than connection to side effects. In excerpt 11 Jakob demonstrates an interest in media reports.

*Excerpt 11 (video diary)*

**Jakob:** This is very hard, because later, around the 20th of February 2010 I read in the newspaper that all this about the influenza was fake and that it just earned money for the industry producing the vaccine.

In this way, Jakob expresses doubt about how necessary the mass vaccination was, referring to newspapers. The media repertoire seems to a high degree also to be the origin of other repertoires, like the risk repertoire (see excerpt 1 and 3). The previously-mentioned solidarity repertoire was frequently emphasized in the media. However, even if it is used by the informants, they seldom explicitly refer to media in such reasoning like this. It also seems as if the different stages in Ungar’s (2008) established genre for how to report on scientific risks are differently interpreted by the different student’s, even though the video diaries and interviews were made during a short period. Amanda often refers to the first stage, sounding the alarm, while the other teenagers refer more often to the other stages.

**School**

One of the purposes in this study was to investigate if the students referred to school and science education as an available repertoire of their new influenza discourse. However, there is only one student that comments about school in the video diary; Anders mentions school
briefly as the place for the vaccination. This fact indicates a lack of information or discussion in school, at least in a way that prompts the students to express a “school agenda” in their diaries. But the interviews give a different image of school and the discussions about the vaccination. Interpretative repertoires involving school are common in the interview material because the interviewer asked about activities in school connected to the new influenza and the vaccination. In excerpt 12, Amanda talks about her mentor or teacher responsible for them in a general way, who brought up the discussion about the vaccination when he met the students he is responsible for.

**Excerpt 12 (interview)**

Amanda: No, our teacher doesn’t try to influence us very much, he just tells it how it is

I: Yes

Amanda: And he thought we should do it. He said that I think that you should have it but I cannot as said, force you.

Amanda is fond of her teacher who she thinks is a good person who only tells the truth; he just tells it how it is. But at the same time while she understands the teacher is trying to demonstrate a neutral view, she also refers to him in the same sentence I think that you should have it and also, but maybe not so obviously, in I cannot force you. These two statements may be interpreted that Amanda also in a way sees him as an authoritative actor, trying to affect the students’ choice. This authoritative voice from school is seen also in other interviews.

This “vaccination message” is one of the two themes that can be found in the school repertoire; the other one is the information about hygiene that students see as the major message from school.

**Excerpt 13 (interview)**

I: Was it something you talked about in school? In lessons or so on, with the teacher?

David: Well, it was brought up sometimes in lessons. And then they brought it up in the meeting about washing our hands carefully, properly with soap and so on, after going to the loo. And before we ate and after we had eaten and so on.

David and other students in the study are influenced by this repeated hygiene message; washing our hands carefully, with soap and so on. This message was also dispersed in the media during the pandemic. But the lack of any lessons connected to the disease, immunology, is clear. The students are not in any case talked to in any “ordinary” lessons where the subject is highlighted. The vaccination or hygiene message is delivered by any teacher, not necessarily the science teacher. Often it is students’ mentor or a teacher responsible for them in a general way. The teenagers’ stories demonstrate that even if the
influenza was not discussed in lessons, the school served as a venue for discussions about the disease and vaccination among the teenagers.

Society
Some of the students reason at a level that is national or abstract. Often the students using this repertoire demonstrate an engagement in understanding why the decision about offering free vaccine has been made. This interpretative repertoire is a mix of different actors, either where it not has been possible in a clear way to define what is meant in a statement about they or when the discussion is on a level above nearby actors, like family or teachers. Jakob reasons about the government’s policy to offer free vaccination for all citizens.

Excerpt 14 (video diary)
*Jakob:* The vaccination was a flop but at the same the government could not have done anything else. Because if they had not bought in the vaccine then it would have been a disaster for the government. Because everybody had started questioning… no, it was not possible. No, they had to offer a bit of protection for the public.

Jakob, who has earlier demonstrated an interest in social matters, is critical but at the same time understands the reasoning of the government. He emphasizes his opinion by repeating “no” in the last two sentences.

This repertoire is closely connected to the knowledge repertoire, reported in excerpts 4-6. The students mean that society has a great responsibility to test the vaccination to ensure it is alright.

Identity constructions
The interpretative repertoires reported above are used by the students to justify decisions about the vaccination against the new influenza. Often, several repertoires are used by the students to justify their opinion on the issue. But how do the different interpretative repertoires stand against each other? Are certain repertoires more important for some of the students and how do the students in the study express what is of greatest concern in their decision-making? In order to investigate more deeply an individual’s decision-making and the individual’s self-presentation in a socio-scientific issue, we also follow three students’ argumentation through the video diary and the interviews. Every teenager constructed their own identity. We have chosen Amanda and Sandra because they constructed opposite identities. The third student is Jakob, who was chosen because he on several occasions talked about himself as critical, which is of interest for this study.
Amanda

We have seen examples of Amanda’s reasoning in excerpt 1, 2, 6, 10 and 12. Why Amanda’s diary and interview are so interesting is primarily because of the reason she decided against the vaccination, but also because of how she talks about her decision-making. Amanda uses different repertoires in her video diary. Among the experienced emphases she uses both risk (excerpt 1) and knowledge (excerpt 6). The risk repertoire is important for Amanda, who describes herself as a girl who does not take any risks. The risks of having the vaccination are greater than not having it, Amanda thinks. But equally interesting is the lack of a solidarity repertoire in Amanda’s video diary. Even in the interview, despite the interviewer bringing her family into the discussion about the vaccination, she did not mention anything about concern for others in relation to catching influenza. Amanda sees the vaccination as a fateful moment (Giddens, 1991) where she hopes she will be lucky, talking about her destiny and showing in this way that she also sees something in this subject that she cannot control.

Amanda’s use of the important actors-repertoire strengthens the picture we have of her decision. She refers to media where she has read about various serious side effects. This reasoning takes much more space than establishing the fact that her mother and brother have had the vaccination without getting any serious side effects, something mentioned only very briefly. The school repertoire is not used by Amanda in her video diary. The society repertoire is represented by they in a statement made by Amanda (Excerpt 15). But who they are is not explicit.

Excerpt 15 (video diary)

Amanda: They do not know what can happen, with side effects and things like that. So I don’t know, but I don’t trust it at all, at all.

The image Amanda gives of herself is that of a girl who controls her life by being sceptical to what other actors tell her about the vaccination, with the exception of the media. Amanda refers to the media which have told a story about risks and what can happen when you decide to be vaccinated - an image that is consistent with her own about luck and destiny.

Jakob

Jakob describes himself as an individual who is concerned about social issues. He demonstrates in his video diary a suspicion against the whole vaccination project, referring to newspapers and using the media repertoire diligently. In this way he also demonstrates that he is a citizen that follows media reports but is critical (excerpt 11, 14). He uses the knowledge
and risk repertoires only briefly to emphasize society’s lack of knowledge about the vaccine. Jakob is one of the informants who reports some types of forced solidarity where he is critical about having the vaccination but mentions a pressure from others that seems to convince him to go ahead with it. Jakob thinks that his father had great influence on his decision. His father’s influence is more important than the family doctor’s who recommended Jakob’s mother not to have the vaccination. In this way, the family and friends repertoire is demonstrated as very important for him, as it is for several students in the study. Jakob does not mention school at all in his video diary. Jakob demonstrates that school and science education have not been important actors for him. In the interview Jakob mentions the school’s contribution as one teacher brought it up but it was not an in-depth lesson, only about how many that had been vaccinated. School and science education has not, according to Jakob, contributed in helping him make an informed decision.

Sandra
Sandra is the student that argues most strongly for the vaccination. She constructs herself as an enlightened girl, supporting the scientific community and its ideas. Both in her diary and the interview she is consistently positive to science, without any doubts. This lack of doubt separates her from the other students who sometimes express doubts about the vaccination or the information about it. Sandra suggests that diseases are more dangerous than vaccinations. She uses the media repertoire only as instances of what is, according to her, stupid examples of what people believe in. Sandra is intolerant towards individuals that choose not to have the vaccination (see excerpt 7). However, these intolerant statements should not be confused with solidarity. Sandra justifies her decision about the vaccination not only using the knowledge repertoire, by demonstrating some knowledge of biology, but also by using the solidarity repertoire. She asserts that for instance elderly individuals are more in danger than younger, and that the implication of this is that younger people have the responsibility to be vaccinated and thus not infect the elderly.

Discussion
This study differs from many other studies conducted about scientific literacy and decision-making because the decision under investigation was made outside school. All the informants had to justify their decision, thus presenting themselves as rational individuals, capable of handling dilemmas. By using discourse psychology and the concept of interpretative
repertoire (Potter and Wetherell, 1987) we have strived to analyse students’ justifications for their decision - for example how they describe themselves shortly after the decision about having the vaccination or not. However, the students’ arguments are not regarded as stable, but instead as constructions that might change in another context, under other circumstances, but despite that of interest for science education.

As we have demonstrated was the vaccination decision justified in many different ways by the teenagers. They often used more than one repertoire to justify the decision. As mentioned in the results, the different repertoires were differently emphasized in the teenagers’ reasoning. The result demonstrates that the students see the vaccination decision to a high degree as a risk assessment. The concern about risks as discussed by Beck (1992; 1999) and Giddens (1991) is very obvious in the study, at an individual level. All individuals in the study use the risk repertoire and try to deal with the issue from their perspective. We can see how the risk repertoire is used by the students, but that the outcome of their reasoning results in different decisions. Often, the risk is connected with the vaccination and not with the disease itself unlike Duggan and Gott’s (2002) study where parents emphasized the incidence of the disease. Even if the teenagers in this study are often of age, as teenagers their parents still had a large impact on their decision. The conclusion is that parents’ influence over children’s vaccinations and importance of personal experiences reported by Poltorak et al. (2005) and Ideland (2007) also seems to be valid for adolescents. But the fact that six of the seven students in the study vaccinated themselves indicates that the consideration of the effects of the disease has been important to the students. When the risks are discussed, side effects seem very important. For example, both Amanda and Jakob talk about the risks of side effects and the lack of testing as discussed in the media, but they value the information differently and come to different decisions. This is not surprising; the likelihood of side effects are difficult for patients and consumers (Peters et al., 2007). In the case with the new influenza vaccination this discussion about side effects took place amongst scientists and in newspapers more than a year after the vaccination campaign. Amanda says she is really concerned about risks, seeing the vaccination as a fateful moment (Giddens, 1991) that may have very large consequences, while Sandra, Jakob - and also for example Anders - have a more relaxed, but concerned view. Why this difference? Jakob speaks of discussions about the new influenza and vaccination using the family and friends repertoire. In Jakob’s family, they came to different decisions about the vaccination. This is also the case in Amanda’s family, but the sort of family discussion reported by Jakob is not reported by Amanda. Amanda does not use
the solidarity or family and friends repertoires, two repertoires that are closely connected. It cannot be said that Jakob has made the right decision and Amanda the wrong one, but discussion with the family seems to be of importance for Jakob and Anders but not for Amanda in decision-making about the vaccination. The family and friends repertoire seems to contrast some of the most spectacular media reports. Several of the students think about the media reports and their conclusions about the reports indicate that they have a critical view of media reporting but find them hard to evaluate, as reported by Korpan et al. (1997). The media repertoire seems available to use by all students, but it is also the repertoire that is used in very different ways and not always explicitly expressed. Anders uses it as an anecdote among class mates, Sandra as not something to trust in, Jakob as source for discussion about social issues and Amanda as a trustworthy information source. These diverging uses of this repertoire demonstrate its importance.

The school repertoire is represented through two main messages; the students’ reception of the teachers’ message about having the vaccination and the hygienic message, where the importance of washing hands is emphasized. The influenza and vaccination have not been in focus in ordinary lessons, led by a science teacher: instead the two received messages come from any subject teacher. The school repertoire is not expressed in the video diaries, only in the interviews, indicating that school and science education are not important actors for the decision.

Implications
How can science education take advantage of these results? The importance of solidarity and family and friends when making the vaccination decision is obvious. We are arguing for a science education that has its point of departure in questions that impact the student’s life or the life of his or hers relatives. By starting close to the student’s daily life when working with socio-scientific issues, it is possible to understand what arguments the student meets outside school. Looking for and discussing Gidden’s (1991) fateful moments may be one way to begin. This conclusion supports Ratcliffe and Grace (2003) who assert that on a personal level values and beliefs are of great importance in decision-making. When this is the case, the arguments from family and friends are central and must be discussed by school and science education. However, we think that science education must find a way to reason from this personal level but with the help of scientific reasoning. We also emphasize the importance of working with media reports and media critics in socio-scientific issues as media reports are cited diligently. As demonstrated by, for example, Kolstø (2001; 2006), Korpan et al. (1997)
and this study, media reports can be complex and interpreted in different ways. The result in our study indicates the need to use media reports in dealing with scientific literacy, but also the need to analyze media in general in a critical way, discussing the presented facts and conclusions. For example, Anders and Amanda interpret the media reports in totally different ways, despite the fact that they refer to the same reports. This result is in line with the suggestions from McClune and Jarman, (2010) who suggests that a “media awareness” must be considered in science education in the future. To be scientific literate will include being media literate, to understand how media functions.

Christensen (2009) says that an individual’s lack of personal control in risk situations and poor confidence in participating in decision-making can be explained by that individual’s schooling. We agree with her suggestions about a science education where risk analysis and the sometimes uncertain results of scientific research are discussed. This will, according to Christensen (2009) lead to challenges for science education, such as presenting science in a social context and dealing with uncertainties in science. Edgar Jenkins (1999) also argues for a science education where risk assessment is one important part of the activities and means that risk is one of the situations where a citizen will be confronted with science.

As in studies by Ekborg (2008), Kolstø (2001; 2006), other important actors/authorities are shown to be important to decision-making. In this study, actors such as family and friends, teachers, governments, scientists and the media are mentioned as carriers of information that the students must deal with. Which important actor repertoire is possible to use in making the decision differs between the informants, but raises the question of how these important actors in some way can be a part of the agenda in science education? We mean that science education must be able to help students evaluating actors involved in a socio-scientific issue, to become citizens that use a scientific repertoire as well as other repertoires.

One of the purposes with this study was to investigate if the students show that school and science education are useful/possible repertoires in the new influenza discourse, amongst others. There is only one student in the study, Sandra, who reasons with clear use of scientific knowledge and present herself with an identity connected to the scientific community (Brickhouse, 2001). She refers to the history of medicine and how vaccinations have exterminated some diseases that some hundred years ago killed many in pandemics. The other students do not explicitly demonstrate deep knowledge of immunology in the diaries or interviews, even if they are enrolled in the same programme in upper secondary school.
However, the solidarity with others, not wanting to infect others, may demonstrate knowledge of how to avoid passing on the new influenza. The use of scientific concepts is not common, but this may be explained by the fact that the video diary format does not support a scientific vocabulary but encourages instead an everyday language. The difficulty of using scientific concepts is not surprising and this agrees with other studies about using scientific concepts in other contexts (Aikenhead, 2006). The construction of the different identities did not in our analyses demand any deeper scientific reasoning. Instead the talk about science has been of interest even if it mainly has been talk about what the scientists really know about the vaccination. In this way, everyday language has not been an obstacle in our study. However, seen from another perspective the lack of being able to use scientific knowledge in different contexts is a problem for science education (Irwin and Wynne, 1996; Layton et al., 1993; Roberts, 2007). The results cannot be explained by study programme. The other girl enrolled in the science programme, Cornelia, constructed a completely different identity compared to Sandra. Cornelia did not express any scientific knowledge as the basis for her decision. The teenagers did not clearly demonstrate that they control the scientific knowledge that was appropriate when making a decision about the vaccination. The results support Jenkins (2006) who suggests that the need for science knowledge as a part of an active citizenship has been discussed for many years, to not avail. The scientific knowledge was not explicitly investigated and should not be over emphasized but the results questions the results obtained by Ryder (2001) about being able to learn appropriate science in situations that demands it. Jenkins (2006) emphasizes that this view of science education as a part of an active citizenship requires a wider knowledge base than what is provided by traditionally school disciplines in biology, chemistry and physics - something the results in this thesis support.

The vaccination decision was an example where scientific knowledge could support the decision, but for example Amanda, Sandra and another girl named Helena, did not demonstrate any knowledge connected to the issue, neither in the video diaries, nor in the interview. Despite that, six of the teenagers made the decision that was proposed by most of the scientists involved in Swedish health care. The school repertoire was, as reported, uncommon in the material. One explanation for this can be the design of the upper secondary school where different courses are studied over three years. If the curricula of the courses do not include this issue during the period of the vaccination, the school is not able to treat the problem from the science teacher’s perspective, but instead has to deal with the issue in another way. These organizational and further problems of dealing with current topics may be investigated in further studies.
This study does not claim that the interpretative repertoires found in this study are the only ones possible in a study on a socio-scientific issue concerning health. The students did not talk about the disease and its consequences as if the world would have stopped - something that might have been the case if the study had been made in another country, where the new influenza claimed more victims. But we think this study has opened up the possibility for more studies about focusing on different interpretative repertoires, not just in science education, but also in daily life outside school. We also think that the use of video diaries may be a starting point for investigating scientific literacy “in the wild” (van Eijck and Roth, 2010) even if a request from a researcher cannot be regarded as completely “in the wild”.

The study raised important methodological questions. The video diary format may attract certain types of informants who enjoy its expository nature. The teenagers in our study were different personalities, but all had a willingness to expose parts of their life to a researcher. We see the video diaries as an appropriate tool when studying scientific literacy and identity construction (Sadler, 2009). The participatory possibilities of video diaries can be used to investigate how decision-making and reasoning can be shared with others in the construction of a discursive identity (Brown et al., 2005). However, we agree with Gibson (2005) and Pink (2001) who argue that the informants present themselves in accordance with what is expected of them, but also how they want to be perceived in relation to those expectations. These two views can sometimes be in line with each other, sometimes in conflict. The connection to personal health made our video diaries even more problematic and raised ethical considerations of how to act and what reactions this type of data collection provokes. These methodological and ethical considerations will be more discussed in a separate article (Lundström, et al., in progress).

References


Lundström, M. & Jakobsson, A. (submitted) Students perceptions about scientific trustworthiness


Using video diaries in studies about scientific literacy

Mats Lundström, Margareta Ekborg & Malin Ideland, Malmö University (manuscript)

Introduction

The importance of encouraging scientific literacy (SL) in individuals has been called for by both academics and politicians for a number of years. Many studies (for reviews, see Laugksch, 2000; Roberts 2007) have demonstrated that SL among students does not fulfil the demands of academics or organizations like OECD (2003; 2007) to a satisfactory extent. One result is that individuals are not always able to use science content knowledge in an “appropriate way”. Driver et al. (1996) describe SL as knowledge about science knowledge and concepts, processes involving science and situations or context. Several researchers (Driver et al., 1996; van Eijck and Roth, 2010; Roberts, 2007) emphasize that the focus should be the use of knowledge, not just its reproduction. Ryder (2001) also emphasizes functional SL and Roberts (2007) calls for SL Vision 2, a vision about SL that “derives its meaning from the character of situations with a scientific component, situations that students are likely to encounter as citizens” (Roberts, 2007, 730). This definition and aim of SL stresses the use of scientific knowledge outside school, in daily situations, making decisions and acting. Scientific knowledge is to be useful in supporting important decisions in everyday life.

Despite this emphasis on using scientific knowledge in different situations, the majority of research and evaluations of SL have been made in a school context, using methods such as questionnaires, interviews and observations (Roberts, 2007). In those studies, students have normally solved problems with science content; sometimes on their own, sometimes in a peer-group. However, in some studies the information the students have dealt with, has been more uncertain or contradictory (Christensen, 2009; Kolstø, 2001; 2006). The ambition has been to investigate knowledge and skills necessary in life, where the available information is complex and the science content not obvious accessible.

The knowledge and skills learned in science education are according to Roth and Lee (2004), often presented as necessary in order to be able to handle a future, adult life. They question if science education really offers the possibility of becoming a participant in society. They emphasize the importance of “rethinking scientific literacy” and instead of preparing for a future life see scientific literacy as participating in society. In a similar way, van Eijck and Roth (2010) emphasize that scientific literacy does not mean doing well on a test. They also
criticise research practice that tests SL as though it is a substance or mental structure. We agree with the criticism from van Eijck and Roth about the discrepancy between the definition of SL and the research on SL, especially when it comes to in what context scientific knowledge is used. By this we mean that most of the research about the SL of the individual has not taken sufficient account of the use of scientific knowledge in everyday life. However, research that investigates scientific literacy in everyday life also needs the use of research methods that are close to the participants’ “everyday life” (van Eijck and Roth, 2010; Roth and Lee, 2004). In this article we will argue that scientific literacy which aims to function outside school in everyday life must also be investigated outside school and with methods that analyse the daily life of the participants. We will propose and describe the use of video diaries as a research tool in investigating the everyday life of individual and in particular with respect to decision-making and scientific literacy.

This article discusses the methodology of investigating SL outside school. The theoretical basis is the use of discourse analysis, especially discursive psychology (Potter, 1996; Potter and Wetherell, 1987; Wetherell and Potter, 1992), a framework proposed by Roth (2008) as suitable in research about scientific literacy. Roth sees discursive psychology as an appropriate theoretical framework for understanding the nature of the students’ talk. In discourse psychology the use of available interpretative repertoires, as science, are analysed to develop knowledge about how individuals construct an identity through talk. Discourse psychology is interested in how discourse is used as flexible resource in social action (Potter and Wetherell, 1987; Wetherell and Potter, 1992).

The article is introduced with a brief discussion about investigating SL. After that, the following sections take a broad perspective of the methodology of video diaries. A review of the use of and the possibilities opened up by the use of video cameras - especially in the forms of video diaries in research about individuals’ daily life – is given. After that what types of data a video diary collect is discussed. Then some ethical considerations are raised. This is followed by a short review about a study where one of the authors used video diaries as research tool to investigate the decision-making processes used by teenagers with regard to the vaccination against the new influenza. Connections are then made between the video diary methods, analyses and theoretical perspectives. The article ends with a summary and conclusions about using video diaries in studies about scientific literacy.
The purpose of the article
The purpose of this article is to discuss and bring forward the possibilities of using video diaries as a tool in science educational research outside school. We will bring up methodology including theoretical considerations about the use of video diaries in studies about scientific literacy in an everyday and out-of-school context.

Investigating scientific literacy
As mentioned in the introduction, the need for scientific literacy has been emphasized for several years (Roberts, 2007). However, the performed studies have to large extent been conducted in a school context. Many aspects of SL have been investigated, sometimes triggered by the shifts in perspective of what SL is (Roberts, 2007). Scientific literacy has also been the focus of PISA-studies (Programme for International Student Assessment) (OECD, 2003; 2007). Studies about SL have had the goal of examining knowledge that will be useful in everyday life, but despite that the research has mainly been carried out in different school situations (Roberts, 2007). However, there are exceptions to this. Ryder (2001) reviewed studies about using science knowledge in different situations where scientific knowledge is appropriate. He reviewed 31 published case studies where individuals not professionally involved with science interacted with scientific knowledge or science professionals. Ryder reports that much of the science knowledge relevant to individuals in the case studies was knowledge about science: knowledge about the use of scientific knowledge rather than scientific knowledge itself. Ryder also suggests that this knowledge is possible for the individuals to acquire if the situation demands it. For instance if facing a severe disease or buying a drug. In the same way as Ryder, we are also interested in research about the use of scientific knowledge in different situations. But the interest here is to develop research tools that able investigation close to the participants, both in time and space, and in that way develop research about scientific literacy.

The development of a research tool that is used close to the participants meets the call from Gee (1999) and van Eijck and Roth (2010) about investigating SL outside school. Gee (1999) and Aikenhead (2006) emphasize that scientific knowledge learned in school cannot easily be transferred to other, more complex situations outside school. Science will seldom appear in pure forms in the society, but instead mixed with other forms of knowledge or values. Individuals have to deconstruct their science knowledge and then construct it in a new way dependent on the context and together with other information. Van Eijck and Roth (2010) emphasize that “there is not so much understanding of ways in which we actually can describe
scientific literacy “in the wild” in terms of knowing and current review studies are remarkably limited in this respect” (van Eijck and Roth, 2010, 186). By ‘in the wild’ they mean in an everyday context, outside school. However, studies investigating SL in an out-of-the-school context cannot without question be performed in the same way as studies in a school context. Therefore, developments of different research methods that investigate scientific literacy “in the wild”, close to the participants, are important. We will argue for one such possibility, video diaries, since video cameras today are easy to handle and use for the informants.

**Videotaping as a tool in science education research**

In the last few years the possibility of using the video camera as a tool in educational research has become more apparent. It gives the opportunity not only to make field notes or audio tape different situations, but also to document more about what the students are doing during their talk. They can collect a lot of data in short time easily. Videotaping has been used to collect data from the classroom for a lot of purposes; analysing argumentation (Berland and Reiser, 2009; Bricker and Bell, 2008; decision-making (Brown, 2010), evaluation (Ødegaard and Arnesen, 2010), lab work (Nyström, 2007), scientific literacy and identity building (Brown et al., 2005).

But the use of video camera as a research tool for data collection has mainly been conducted in the science classroom. The videotaping has been controlled by the researcher. Sometimes the situations have been constructed by the researcher, sometimes the video camera has recorded ordinary lessons, but still, the researcher has had some control over the settings and the filming. For example, it is the researcher who decides when to start and when to stop, or how the movie clips are to be edited. In such studies the video camera may be regarded as a fly on the wall, to be ignored. It is just there as a tool to recall what happens more easily. In the future these types of studies can also contribute to research about science education, but there are some limitations in what those studies can examine. They are not able to capture decision-making at the very moment decisions are made in everyday life. Observation studies performed in school which investigate SL are normally performed as cases from everyday life (e.g. Kolstø, 2006) but may be regarded as school tasks. There are exceptions where video cameras have been used outside the classroom. Roth and Lee (2004) followed students’ engagement in environmental problems and water supply in the neighbourhood. They demonstrated how engagement in a scientific issue can be documented. However, the main context was still a school task in the compulsory school, even if it demonstrated engagement from the students.
There are alternatives to this way of using the video camera for research. It can be used closer to everyday life where the informants are regarded as participants, controlling more of the videotaping and situated in another, non-institutional context. In the next section we will briefly review some studies from different research fields where the informants were more involved in the research, making video diaries.

**Earlier video diary studies**

Buchwald et al. (2009) draw attention to the fact that there has so far not been a widespread use of video diaries for research purposes. However, some research fields have to a certain extent used the video camera in ways different than the traditional, where the researcher operates the cameras (Buckingham, 2009). There are studies, mainly about media (Voithofer, 2005), health (Buchwald et al., 2009), consumer research (Brown, 2010) and sexuality (Holliday, 2000; 2004), where the informant manages the video camera. Buckingham (2009) mentions areas such as health care, social policy and childhood where participatory methods have been particularly apparent. Brown (2010) describes these fields of research as research about vulnerable groups, such as medical patients, school children or disabled patients. There are clear democratic aspects of video diaries. The aim has been to give informants the opportunity to raise their voice, improving our understanding of their arguments and thus also improving treatment or policies. The forms are diverging but the overall purpose of this research is to allow the informants to participate in the collecting/making and sometimes too the analysis of the material. Holliday (2004) suggests that the use of video diaries makes the participants very active and reflexive in representing their own identities. These different studies and the conclusions drawn from these video diary studies will be discussed further later in the article where the possibility of using video diaries for investigating scientific literacy is considered.

**Video diaries in education**

There have been few studies in educational research where the informants have had the possibility to be participants in the research process and producers, as they can be in video diaries. Two relevant video diaries will be reviewed, but none of them have connections to scientific literacy. Despite that, the use of video diaries in education is regarded as an appropriate way to focus on how students talk about themselves. In the first one, Noyes (2004) used a video diary room, where it was possible for the pupils to be on their own, and comment on anything they wanted to. However, the pupils’ attitudes to mathematics were focused on in the study. The video camera was installed in a video diary room which was
located close to the classroom. The purpose of the study was to know more about the children’s experiences’ of school, their attitudes to education and learning dispositions, their personal beliefs, who their friends were, what life was like at home and so on. The pupils, 10-11 years old, were asked to comment on mathematics, lessons, difficulties and the use of mathematics outside school. Video diaries complemented participant observations and interviews. Noyes’ intention was to encourage the children talk more freely about their unseen day-to-day experiences. However, in the way the study was designed, the children did not have the opportunity to edit the material, even if they had the possibility to prepare themselves before entering the diary room beside the classroom. In another video diary study, Quadri and Bullen (2007) let five university students reflect and give feedback on their education, during one week at the university. They had few restrictions on the content. The students were equipped with camcorders and they commented on their education at least twice every day, such as their learning and teaching preferences, perspectives on using technology in learning and how the learning environment was an aid in learning. The teachers were often mentioned in the video diaries, somewhat focused the students’ expectations of help from the lectures. The authors regard the data from video diaries as much more in depth compared to interviews. Quadri and Bullen regard this possibility for the students to give feedback as very suitable. The students review and report what they mean is of importance for their education and learning.

**Video diary studies in the field of science education outside school**

Video diary studies connected to school education but performed outside school are not conducted to any great extent. We will more closely review one study, Cotton et al. (2010), using the video camera as video diary in an educational setting but outside school. Later we will review our own video diary study (Lundström et al, accepted), but then with comparisons to other video diary studies of different kinds and with regard to different aspects such as data collection and theoretical standpoints.

Cotton et al. (2010) used the video camera in field work where the students were told to document their experiences and discussions in field, during excursions. During a field trip to South Africa 12 students filmed their daily work for one week. Cotton et al. stress the engagement the students demonstrated during their work and mention how the video diary made it possible to catch their first-hand “lived experience” of the field course and in this way gain deeper insight into the students’ experience. Video diaries are in this way a sort of non-participant observer where the researcher discusses the settings with the participants but is
then not so involved in the videotaping. Cotton et al. (2010) stress that the video diaries meet some of the criticism against the use of surveys and interviews as methods of investigating students’ experiences and behaviour. They also suggest that with video diaries, memory limitations that may be apparent in interviews can be minimized. Cotton et al. describe such memory limitations in students who don’t remember details about experiences, and post-hoc rationalization, where the participants provide rational explanations for the actions after the event.

**Important factors in designing a video diary study**

Brown (2010) discusses the low number of earlier video diary studies and therefore the limited number of guidelines laid down about doing video diary research. Despite this shortage, Brown (2010) and Pink (2001) argue that the diversity of the research field where video diaries have been used can contribute to the understanding of how to carry out this type of research. Earlier studies where different types of diaries or images have been used may be a guide (see Goldman-Segall, 1998; Pink, 2001) as well as other video diary studies. Pink emphasizes that the instructions about presenting their life may be the same in video diaries as in ordinary diary studies including photo studies.

One initial fear of using video diaries might be to truly succeed in collecting data that can be used to answer the research questions of the project. When the data collection to a high degree is left in the diarist’s hands, the fear of not collecting enough or not enough “correct” data arises. Brown (2010) managed this problem by encouraging the informants to make the video diaries in a regular basis, kept them on the topic and had contact with the informants every week. Holliday (2000; 2004) solved the same problem by directing some themes for the informants to talk about. However, handing over the video camera will not automatically produce new, interesting, independent data. Buckingham (2009) emphasizes the importance of understanding how research establishes positions from where it is possible for participants to speak. The possibility to speak and participate is often emphasized in diary studies and other forms of “creative methods” (Buckingham, 2009). The informant creates the data. The data in a video diary will in this way be important to analyse from the participants’ view.

**What kind of data, what does it tell?**

*The empowering parts, the possibility to speak*

Buckingham (2009) discusses different ‘creative’ methods, such as video diaries and in what ways the possibility for informants to express their views more directly is empowering for the
participants. Buckingham means that this empowerment part should not be emphasized, but that the collaborative production of a video diary gives the informants the possibility to create representations of their own experiences. The video diary also, according to Buckingham, explores issues and areas of experience that might be difficult to access using words alone. Buckingham means that video diaries also, like other types of data “creates positions from which it is possible for the participants to speak, to perform or to represent themselves” (Buckingham, 2009, 648). Holliday (2000) describes video diaries as more complete than other methods, which she means makes the construction and display of identity easier. The informants in a video diary will, according to Holliday, collect data or participate to a high degree, thereby increasing the likelihood of gathering rich material for the researcher.

The quality of video diary data
The quality of the data in a video diary compared to other methods is frequently discussed by researchers who have used video diaries. According to Quadri and Bullen (2007) it would not have been possible to collect their data through surveys or interviews. Noyes (2004) says that data from video diaries provide a fuller representation or description of social life. It enables the informants to make links to other aspects of their broader daily experiences. The data is arguably richer than conventional interview transcripts, which leads to a challenge. The possibilities of recording, analysis and interpretation are increased (Holliday 2000; 2004, Noyes, 2004). The method may not only be suitable for the investigation of strict educational aspects, but also of other perspectives of importance for learning (Noyes, 2004). There have been discussions if the format of the video diary, addressing the camera alone and in private, in some way opens up for a more truthful or confessional mode. Holiday (2004) means that this can be the case, for instance when talking about sexual identity, while other researchers (e.g. Pink, 2007) reject this idea. Cotton et al. (2010) think that the video diaries captured more of the first-hand “lived experience” compared to the other forms of diaries (written and audio taping) that were made during their project. Students were neither as self-conscious as they were in the audio diaries which also were made during the video diary project during the geology studies. Cotton et al (2010) also suggest that observational methods like video diaries limit some of the risks of interviews, such as that the informant only reports aspects that fit in to the researcher’s perspective or that the informant provides rational explanations for their actions after the event. But this suggestion is countered by the possibilities the video diary method opens up. One of the largest differences from many methods is the possibility of preparing and editing the material, something discussed by Brown (2010), Buchwald et al.
(2009) and Holliday (2004). Holliday says that “video diaries afford participants the potential for a greater degree of reflection than other methods, through the processes of watching, recording, and editing their diaries before submission” (Holliday, 2004, 1603). Buchwald et al. (2009) and Brown (2010) also emphasize the possibility for the informants to prepare themselves but also to edit the diaries. Editing may also be a way for the informant to choose not to participate in some parts. Control is in some way in the hands of the video-diary maker. But the importance of these editing possibilities is questioned by Quadri and Bullen (2007). They consider that the information will be more honest with fewer restrictions compared to other forms of evaluation or feed-back. Cotton et al. (2010) also de-emphasize the editing possibilities and consider that video diaries have the advantage of enabling data to be collected on events occurring in real-time, in a natural situation, rather than through the more artificial context of an interview, focus group or questionnaire. The data will be less influenced by the researcher’s own agenda and will be (at least in the raw form) relatively free from bias.

Buchwald et al. (2009) describe the informants’ use of the camera as a receiver, somebody to talk to. Noyes (2004) discovered the use of ‘You’ in the pupils’ video diaries about mathematics and discusses who ‘You’ is when the students talk to the camera. Sometimes the camera is a third person, who shows the recordings to the researcher. Sometimes it is a TV-camera; the student talk to an audience. This relation to the camera shifted during the weeks it was in the school (Noyes, 2004). Brown (2010) discovered large differences in how personal the informants were about their consumption, but also the rest of their lives. Holliday (2000) was also surprised by the frankness of the diarists’ responses, documenting really personal routines and experiences. This frankness is hard to explain but Holliday argues for the strong intention from the participants to talk about and explain their life to others. It also varies a lot in how much the diarist involve other people. This varies both between the diarists and between different themes by the same diarist (Holliday, 2000; 2004; Lundström et al., accepted). Some informants keep a diary of their own; some of them involved family and friends. To summarise, the data in video diaries will vary in several aspects. Some of these variables are, for instance, length, thought receiver, frankness and the individuals involved or mentioned (Brown, 2010; Lundström et al., accepted; Quadri and Bullen, 2007).

Combination with other methods
Many researchers emphasize the importance of combining methods. Video studies may be combined with other forms of methods which intertwine and overlap or link conceptually as
the research proceeds (Cotton et al., 2010; Pink, 2001). Holliday (2004) suggests that video diaries are mainly a one-way conversation. She recommends follow-up interviews to achieve two-way conversation about the issues discussed in the video diaries. Buchwald et al. (2009) and Quadri and Bullen (2007) also suggest that an interview after the making of a video diary gives the researcher the opportunity to understand more about the information given by the informants. In the same way, Goldman-Segall (1998) also emphasizes the possibility of combining different methods, in order to have insight, for example into what to record in order to get a richer description about the topic or informant.

**Ethical aspects**

The ethical aspects of participatory research in general and video diaries in particular are emphasized by several researchers in the field (Buchwald et al., 2009; Pink, 2001; Rees, 2009). The truthful, confessional mode reported by Holliday (2004) has consequences for what type of material can be collected and how it is handled. For instance, Buchwald et al. (2009) suggest that being alone with the video camera might provoke uncontrollable emotions when talking about his or her innermost thoughts and feelings. This will, according to Buchwald et al. (2009) and Noyes (2004) introduce restrictions such as the confidentiality of the informants. By asking the informant to document their daily life the researcher also runs the risk of receiving material that can contain sensitive information about the informant: careful consideration must be given to how such information is to be handled. This can, for example, be information about the informant’s family situation, self-abuse or drug habits. The form of the video diary and the fact that the informants have seen documentaries in video diary form may result in that some informants expose themselves to a great extent. The special situation of looking into an individual’s life differs from, for example, an interview situation where that type of information can be handled immediately. With a video diary, the researcher is more dependent on the informants’ choices even if instructions what to document have been given. If not careful ethical considerations are made, the participants and the public will lose its confidence to research (Shamoo & Resnik, 2009). The research should follow some ethical guidelines or rules in the same way as all other research (Pink, 2001).

The video diary format also has one advantage compared to other observation methods. It is the diary maker who collects the data. She or he can choose situations to record and even edit or delete if they afterwards not are satisfied with the material. In this way the video diary format is appropriate in ethical aspects even if it is close to the participant’s life (Lundström et al., accepted).
Analysing and theoretical framework

Pink (2001) emphasizes that video images are interpreted in different ways by different individuals at different times. This makes analysis difficult. Analysis involves examining how different producers and viewers of images give meaning to their content and form (Pink, 2001). Data should be analysed reflexively to examine how visual content is informed by the intentions of the individuals involved (Pink, 2001). Rees (2009) suggests that video diaries offer an exciting opportunity to explore the visual character of construction and performance of identities through the “triadic interaction between participant, camcorder and researcher” (Rees, 2009, 5).

Video diaries have been analysed in different ways. However, identity is often in focus in video diary analysis (Brown, 2010; Gibson, 2005; Holliday, 2004). Identity is not described in the same manner in all these studies, but in most cases the identity is regarded as discursive, dependent on the situation. The different frameworks use identity as a key concept and then often combine it with other theories. For example Brown (2010) combines identity with critical theory and Gibson combines it with Bourdieu’s theories. Gibson (2005) has developed a “movie method” using metaphors drawn from the film industry. The questions analyse the video diaries using the following movie metaphors; audience, scene, director, role and cut. All questions used in the analysis can reveal “different aspects of how participants locate themselves and claim or resist various identity positions” (Gibson, 2005, 5). The framework Gibson uses in the analysis is ethnomethodology in a Bordieusian framework. Gibson argues that the informants present themselves according to what is expected of them, but also how they want to be perceived in relation to those expectations. Noyes (2004) also used Bourdieu’s framework to analyse pupils’ statements. Noyes argues that children’s dispositions in the classroom are very closely related to those enacted elsewhere. But there have been other forms of analyses besides them using identity as the key concept in the analysis. Cotton et al. (2010) argue for the use of grounded theory (Glaser and Strauss, 1967). Cotton et al. mean that the identification of themes or categories is appropriate. Each new piece is compared to others already coded to find similarities and differences. After that, the meanings of the different categories, subcategories and potential links are analysed.

Pink (2001; 2007) argues that visual representations always are constructed; they should not be seen as a means of objectively documenting reality. This perspective emphasizes theoretical frameworks that are built on views where the social world is seen as constructed
and dependent on context. A constructionist perspective (Potter, 1996) emphasizes that the world is not categorised in a certain way that all are forced to accept, but instead that descriptions of the world are human practices and that the world is constituted as people talk it, write it or argue it. Language, together with actions and interactions, build and rebuild our world (Gee, 1999). How we regard and construct the world will therefore change, both for an individual and over time. One such perspective is discourse analysis, e.g. discourse psychology (Potter & Wetherell, 1987, Wetherell & Potter, 1992). Discourse psychology is close to the informant’s everyday life and therefore, gives us, a suitable framework for developing knowledge about the video diarist’s life. Discourse psychology gives the opportunity to analyse the diarist’s use of different discourses. Roth (2008) proposes discursive psychology as one appropriate framework in analysing scientific literacy because discourse psychology theorizes the function of talk and language itself. This focus on talk is publicly available and therefore “accountable, situated and embodied” (Roth, 2008, 32). The term literacy indicates the importance of being able to act in different situations. Both researchers as Driver et al. (1996), Jenkins (2006), Levinson (2010), Norris and Philips (2003), Norris et al., (2003), van Eijck and Roth (2010) and organisations as OECD (2007) emphasize the importance of not only being able to use scientific knowledge in the science classroom but also in different situations in daily life. This emphasis on use in different situations in daily life agree with Roth’s description of talk and language and therefore appropriate when investigating scientific literacy.

The proposed follow-up interviews (Buchwald et al., 2009; Holliday, 2004; Quadri and Bullen, 2007) give the possibility of checking thoughts and interpretations of the video material with the informant. Cotton et al (2010) refer to stimulated recall (Bloom, 1953), which can be used as a way of combining observations with interviews, for example by using a transcript of a teaching session as a prompt or stimulus for discussion during an interview with students, or by getting tutors to review a video of their lecture. Cotton et al. (2010) also emphasize the importance of data triangulation by combining methods. In this way, different statements in different situations - video diaries and interviews - can be analysed. Cotton et al mean that the changes to normal behaviour that occur in a video diary can be analysed through respondent validation. But Cotton et al’s statement about “normal” behaviour, demands a theoretical standpoint where the way individuals talk about the world can be described in terms of true, normal or long lasting and stable. Theories about identity often instead describe identity as dependent on the situation and flexible (Gee, 1999; 2001; Potter
and Wetherell, 1987). With a more flexible view of identity, it is not possible to detect “normal” behaviour if normal behaviour is described in terms of a solid and inflexible identity.

One main question in the analysis is how the informant meets the researcher’s expectations or what expectations the informant thinks the researcher has and how to meet them? This is closely connected to Noyes’ (2004) question about who ‘You’ are when talking to the camera. Reflexivity is often emphasized in analyses in qualitative studies (Pink, 2001). She describes reflexivity as important in different kind of ethnographic studies, such as in video diary studies. Buckingham (2009) also emphasizes the importance of reflexivity; how to understand how research itself establishes positions from which it become possible for participants to speak. Pink (2001) suggests that a reflexive approach “recognises the centrality of the subjectivity of the researcher to the production and representation of ethnographic knowledge” (Pink, 2001, 19). She emphasizes that ethnographers must be self-conscious about how they represent themselves and that they “ought to consider how their identities are constructed and understood by the people with whom they work” (Pink, 2001, 20). The relationship between the subjectivities of researcher and informants will, according to Pink (2001), produce a negotiated version of reality. Research is in this way trying to make research with people and not on people (Pink, 2001). She also thinks that ethnographers are themselves subjective readers with certain aspirations. A reflexive approach to “classifying, analysing, and interpreting visual research materials recognizes both the contractedness of social science categories and the politics of researchers’ personal and academic agendas” (Pink, 2001, 94). Video diaries are in accounted studies proposed as an appropriate method to investigate individuals’ different aspects of both everyday life and more formal situations. We will now discuss our own video diary study from the standing points from above accounted research.

Our own study: To vaccinate or not to vaccinate

The design of the study

Our own video diary study was performed by the first author of this article during the outbreak of the new influenza (swine flu) pandemic in 2009. The purpose of the study was to develop knowledge about the connections between how teenagers talk about themselves and the decisions they made about the new influenza and the vaccination against it. The purpose was also to investigate if the teenagers expressed school and science education as one available discourse or repertoire when they talked about the new influenza and vaccination. In
this way, the ambition was to come closer to the informants’ life outside school. These ambitions led to the decision to use video diaries as a tool to collect data and thereby study decision-making and scientific literacy in a context outside school, during the making of a decision that may affect an individual’s health. The seven teenagers’ in the study were provided with a video camera and an mp3-player. The informants were requested to document situations where they considered science knowledge to be of importance in their daily life outside school. Besides that, all the teenagers were asked to comment on their decision thoughts about the swine flu, for instance, the decision they made about the vaccination against it. All the informants made their diaries during the weeks the vaccination programme was ongoing. The teenagers made their diaries in 1-3 weeks and everybody had made their decision about the vaccination when they finished their diaries. After that, the material was transcribed and 1-4 weeks later semi-structured interviews were conducted by the first author of this article. During the interviews, some of the material was discussed with the youngsters, watching a small part of their video diary. The interviews lasted 20-40 minutes and were recorded and transcribed in Swedish and after that translated to English. So far, only the material regarding the new influenza and vaccination decision has been analysed. The rest of the material, science knowledge of importance in daily life has just been watched briefly.

Empowering: the possibility to speak
We think it is hard to follow students’ reasoning in different situations outside school. The aim with our video diary study was to come close to the decision-making of the participants, both in time and room. In other words, if the students had the possibility to immediately document situations, the data may be different compared to data collected later. However, a large difference compared to other methods is the earlier mentioned ownership of the data collection. The collaborative method achieved by means of a video diary collects data that is relevant for the participant. However, when some themes or research questions are important for the study, Brown’s (2010) and Holliday’s (2000; 2004) theme instructions may be relevant for collecting relevant data. We used the new influenza as one main theme. One important fact that occurred to us very early in this study using video diaries was the willingness of the informants to contribute material - something that may not have happened to the same extent if the informants were expected to write. Video diaries may be easier to make than written diaries. For some individuals, it is easier to talk than to write. The teenagers seemed to be comfortable with the format. The skill of formulating themselves in writing may be an obstacle for some individuals, while the video diary overcomes that obstacle.
In our study there were also large differences in the openness of the teenagers. Some of the teenagers only talked about the given subject, others to a higher degree imitated the format of video diaries that they might have seen on television or the Internet. Those teenagers were also prepared to describe their innermost thoughts and dreams. There were also the same differences in what type of style they used in their diaries. Both formal and informal styles were used even if the formal style dominated, in which the talk seemed rather edited or prepared. However, one person in our study that used the video diary format similar to video diaries in television was very informal, talking to the camera as a friend. The teenagers in our study talked about how different actors or situations had influenced their decision to vaccinate or not. We agree with Buckingham (2009) about collaborative production of a video diary gives the informants the possibility to create representations of their own experiences. Even if we have prescribed the instructions, the teenagers took the possibility to share their experiences of the new influenza pandemic.

Combination with other methods
As proposed by several researchers (Buchwald et al., 2009; Holliday, 2004; Quadri and Bullen, 2007; Cotton et al., 2010), stimulated recall was used in our study. The interviews were introduced by watching a small part of the informant’s video diary. There are advantages and disadvantages with stimulated recall. In his study Noyes (2004) seems satisfied with the fact that none of his informants were interested in changing their story from the diary when they were interviewed. This consistency between video diary and interview was common in our study. However, this persistence of an opinion can be regarded differently. An interview puts the student on track again, but there is also a risk that the interview takes a direction where the interviewee interprets the situation as an interrogation where it is important to maintain consistency with the original statements on an issue. In a perspective where the context is regarded as important for what repertoires are available, it should not be surprising if some stories are different in an interview compared to the diaries. In our study, stimulated recall might have had the consequence that the teenager felt it important to stay with their original story. Another interpretation is that the teenagers had considered their decision deeply and by that were more certain and solid about their decision.

Ethical aspects
The truthful, confessional mode of a video diary reported by Holliday (2004) also appeared in our study. With the requested information followed in some cases information that not obvious related to the given subject. One of the video diaries contained material which was
different compared to the others’. Despite the instruction of talking about science-related situations, including the vaccination decision, it contained a lot of material which had not to do with school or science. Instead the person talked a lot about her social life, friends and family. Some of the information was considered as emotionally, where she talked about problems in her life. After consulting legal experts and supervisors, the interviewer decided to talk with the girl about these problems. In the end of the interview the interviewer asked her about this part of the video diary and if she needed some helps to manage the situation. Since she explained that it was not a problem and that she was not in need for any help, the interviewer decided not to act.

The connection to personal health made our video diaries even more problematic and raised ethical considerations of how to act and what reactions this type of data collection provokes. One of the participants in the study had chosen very unique situations when she documented situations where science knowledge could be important. Her diary contained comments where blood, alcohol and tobacco dominated. The participant had chosen material that had connections to science, but expressed in a way which felt as provocation against the adult world. One part of her diary told a story about a Saturday evening when she and her friends met. When the interviewer asked her about her spare time and her diary, she told that this was the first time she had smoked. This result strengthens the importance of combining methods and that the truthful, confessional mode can be hard to analyse. It also focuses which theoretical framework that is appropriate and how this choice of framework is decisive for the interpretations and conclusions that can be made.

Another ethical aspect of video diaries is who will be involved in the diaries. Even if the participants or their parents had permitted the teenagers’ participation, the video diary clips might include individuals who not have been asked about involvement. It can be both individuals directly filmed in the diaries but also people mentioned in the material. For instance, one of the teenagers wanted to document the vaccination, but was not allowed by the nurse. She explained this through explaining that he had to be calm during the vaccination. This can happen also in interviews and observation studies but the confessional mode the diary format invite to should be noticed. To not reveal the identities of all individuals involved, confidentiality will be important in the process handling the data.

*Analysing and theoretical framework*

The data material was analysed with a framework of discourse psychology (Potter and
Wetherell, 1987). Potter and Wetherell include in discourse all forms of spoken interaction, both formal and informal, and written texts of all kinds. This approach emphasizes that the way we understand the world is historically and culturally dependent and thereby contingent (Potter and Wetherell, 1987). In line with ethnomethodology, discourse analysis has a focus in how people use their language to do things (Potter and Wetherell, 1987). “People are using their language to construct versions of the social world. This construction implies active selection where some resources are included and some omitted” (Potter and Wetherell, 1987, 33-34). The aim is to investigate how people themselves manage, understand and use descriptions and the facts they contain. By analysing the data from the video diary and the interview from the teenagers in the study we had the opportunity to understand how the informants constructed their “swine flu world discourse”. Their uses of language construct justification for their decision-making. The new influenza vaccination decision was to large extent a matter of handling, understanding and managing all available and diverging information. These circumstances made a discourse analysis proper as an analytical tool of decision-making. Often, discourse psychology uses the concept interpretative repertoire instead of discourse to emphasize the flexibility of discursive resources in social action (Potter and Wetherell, 1987). Teenagers’ use of different resources could be analysed, for instance, if they used interpretative repertoires from a scientific discourse.

In our study, we in the first part categorised different interpretative repertoires that were used by the teenagers in their decision-making about the new influenza and the vaccination. In this step two main categories of interpretative repertoires were categorised; experienced emphases and important actors. The use of the different repertoires was then in the second part used to analyse how this decision-making can be understood in relation to the students’ discursive constructions of themselves in a specific social context. Scientific literacy will in these terms be a matter of constructing an identity and understood as an appropriation and use of discourses, but also as meaning making in relation to other fields, for instance the society. It must also be understood in relation to what happens with the use of science discourse or actually the school science discourse when it is expected to be available outside school in different contexts. This is in line with Sadler (2009) who emphasizes the importance of that students get the ability to learn science in a community where they can be central participants and express their identities. The teenagers in our study used the different interpretative repertoires to construct an identity. Only one of the teenagers expressed an identity where science seemed to be very important for her decision-making. However, the importance of
knowledge about the influenza and vaccination was emphasized by several of the participants, indicating that the teenagers try to understanding science as a field of knowledge even if a scientific repertoire not is completely available. In this way scientific literacy was not totally reached in this context among all teenagers. This result questions the conclusion from Ryder (2001) if individuals really acquire the scientific knowledge they need to make an important decision.

Conclusions and implications

We have in this article discussed different aspects of using video diaries in research on individuals’ everyday life, with scientific literacy and decision-making as an example. The starting point has been the call from Van Eijck and Roth (2010) for research on the scientific literacy of individuals or groups. They discuss scientific literacy from the concept ‘in the wild’. Scientific literacy will in this way, according to van Eijck and Roth (2010) be collectively shared with others and used to improve our lives. We argue that from this it follows that research about scientific literacy must be carried out on this “shared with others”. The sharing will include all different kind of texts, either in written or in spoken forms. We claim that a perspective where context is regarded as decisive for action implies in its extension research methods where the investigations about decision-making in daily-life must be performed in daily-life. “Focus in science education should be on participation in collective activities from which scientific literacy emerges in a process of knowing as distributed, situated and dynamic processes” (van Eijck and Roth, 2010, 192). By using video diaries, the gap in time between a decision and the reasoning about the decision decreases. It will also decrease the gap between the participant and the researcher. In this way, video diaries meet the call from Roth and Lee (2004), who emphasize the importance of participating, both in the society and in science education research.

We have also argued for analyses and theoretical framework that are in agreement with this context-dependent, participating and dynamic view of knowledge. In our own study we used discourse psychology, which was appropriate for our study. Even other forms of discourse analysis and identity construction theories have been successful in video diaries studies (Brown, 2010; Gibson, 2005; Holliday, 2004). In this way it also meets the concerns of Pink (2001) who warns of the belief in video filming as documenting the “truth” or knowledge of other minds. Discourse psychology analyses what individuals do; it is not trying to capture some essentials of the mind. We have given examples, both from our own study (Lundström
et al., accepted) and from literature (Buchwald et al., 2009; Buckingham, 2009; Brown, 2010; Holliday, 2004) of the participating possibilities of video diaries. Decision-making and reasoning can be shared with others in the construction of a discursive identity (Brown et al., 2005).

As mentioned, Gibson (2005) and Pink (2001) argue that the informants present themselves according to what is expected of them, but also how they want to be perceived in relation to those expectations. These two views can sometimes be in line with each other, sometimes in conflict. This is a part of the reflexivity process which according to Pink (2001) results in a negotiated version of reality. The video diary may as reported above, both include formal reasoning about the topic given by the researcher and resistance against the adult world (Lundström et al., accepted). Therefore, data in video diary studies of this type is different compared to studies in a school context where the researcher often is present during the data collection. This presence is different compared to the non-presence in video diaries even if Noyes (2004) reports about a receiver in video diaries, which demonstrates the consciousness of the research process. Holliday (2004) brings in the question about how the diarist’s present herself. Holliday suggest the video diarist’s as truthful and confessional, something Pink (2001) disagree with. Our conclusion is that this truthful, confessional mode may occur, but is mostly dependent on which identity the diarist constructs.

However, some important conclusions about the difficulties must also be noticed. The format of a video diary does not invite to deep science content reasoning. They will not normally cover to investigate a definition of scientific literacy in which knowledge of science concepts is requested (Driver et al., 1996). Instead a definition where the use and participation is emphasized is more appropriate. For instance Roberts’ (2007) vision 2 in scientific literacy is more possible to investigate with the use of video diaries. This is in line with Roth and Lee’s (2004) urgent request of rethinking scientific literacy in terms of participating in society and Brown (2010) emphasis on democratic aspects in research. We have in our study demonstrated how scientific literacy can be regarded as participating in social practices and constructing an identity (Lave and Wenger, 1991). This participating and identity construction is difficult to completely describe in a school context.

The editing possibilities of the video diaries are decisive for what type of data that is collected. Cotton et al. (2010) recommend “live” video diaries that are collected and then immediately handed over to the researcher. Cotton et al. regard this way of using video as
interesting and emphasize for instance that memory limitations of what happened can be excluded. However, the majority of the referred articles emphasize the possibilities editing and therefore reflecting gives. Two different types of data occur, dependent on if the video diaries are “live” or edited.

In our view, the design of data collection will to a high degree influence what type of speech the participant will use. Goldman-Segall (1998) sees the use of video images as a collaborative authorship and co-construction; all participants construct an identity even if this is done in very different ways. An interesting next step would be involving the participants even more in the analysis. They were in our study to certain extent involved through the interview about the video diaries. It would also be of importance to use more texts from the participants to see how the complexity in different knowledge, values and emotions influence decision-making and scientific literacy.

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SAMMANFATTNING

In everyday life, we make many decisions about our health. These decisions are made using information from many different sources. This information may be contradictory, uncertain and be very different in regard to its scientific validity. Having access to all this information means that individuals have to judge its quality and make decisions about how to act in different situations in everyday life. In this doctoral dissertation young individuals’ reasoning and justifying concerning trustworthiness and decision-making in issues connected to health are investigated.