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The project is funded by the Swedish Research Council, started in 2007, and will continue for at least three years. The research group is called SISC (Science in Social Contexts) consists of Britt Lindahl and Maria Rosberg at Kristianstad University, Margareta Ekborg, Christina Ottander and Mikael Winberg at Umeå University, and Malin Ideland, Claes Malmberg and Agneta Rehn at Malmö University.

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Science for life – a conceptual framework for construction and analysis of socio-scientific cases

Abstract
The aim of this paper is to describe a conceptual framework to be used as a tool for analyzing work with socio-scientific issues (SSI) and for constructing SSI cases in secondary school. The framework consists of six components describing the more detailed characteristics of SSI. The components were chosen to reflect what we know from research about what might have an impact on students' learning and interest in science. Six socio-scientific cases were then constructed and these are discussed in the article. The cases are relevant in that they both display the characteristics of SSI and meet the requirements of the Swedish national curriculum. The components and the cases are described in a table. This work is the first step in an evidence-based research project aiming at investigating if, how and why students and teachers in secondary school develop knowledge and interests when working with SSI.

Introduction

In this paper we will describe a conceptual framework, based on research, to be used for the construction and analysis of socio-scientific cases. The work was initiated by the construction of six of socio-scientific cases for science in upper secondary school in Sweden as part of a research project – *Socio-scientific issues – a way to improve students' interest and learning?*.

You cannot open a daily newspaper, listen to news on radio or watch TV without meeting numerous examples of topics which include science. They deal with climate change, gene therapy, health issues, environmental issues etc. You also encounter science in advertisement for food, cosmetics and cars. Such information is –we maintain – often unstructured and ambiguous and poorly contextualized. It raises the question of how young people can be prepared for life in a complex world, and what role school science has in helping students develop necessary skills, e.g., ability to critically scrutinize information and to make decisions about their personal and professional lives in the future.

The Swedish curriculum states that students should develop the ability to orientate themselves in a complex world. The Swedish syllabuses for science subjects are organized as one syllabus for science and one syllabus for each of the subjects biology, chemistry and physics. The goals in all syllabuses for science are collected into three sections – knowledge *concerning man and nature,* knowledge *concerning scientific activity* and knowledge *concerning the use of knowledge.* One goal is that students *should be able to use their knowledge of nature. Man and his activities as arguments on issues concerning the environment, health and inter-personal relations* (Skolverket, 2000). The syllabuses are goal-driven and not very detailed, which has the consequence that teachers are free to choose content and teaching methods as long as their students reach the goals (Skolverket, 2000).

Students' experiences of school science

Students often express interest in science but they find science in school difficult and without relevance for them (Lindahl, 2003; Lyons, 2006). They are critical both to the content of the school subject and to the way it is taught. The students feel that the content is set and that there is nothing to discuss or to negotiate as in other school subjects such as civics, history and religious education. During the later years of compulsory schooling, the interest of both girls and boys decreases. At the same time, they feel that they are not doing well in science – even if they have good marks. This is not the case for other school subjects (Lindahl, 2003; Osborne, Simon & Collins, 2003).

Results from ROSE (Jidesjö & Oscarsson, 2005) indicate that there is a gap between what students are interested in learning about and what is taught in science in school. In general, people are more interested in science if it deals with inventions, explorations and health and environmental issues (Ratcliffe & Grace, 2003).

In international assessments such as PISA and TIMSS, Swedish students perform around the mean for students in OECD countries (Skolverket, 2007). The latest national evaluation – NU-03 – shows that many students do not reach the goals for conceptual understanding, as described in the national course syllabuses in science for school year nine. Other aspects described in the syllabuses – concerning scientific activity and use of knowledge – seem to be taught to a lesser extent in school, which is reflected in the Swedish PISA results (Skolverket, 2007).

Socioscientific issues

New strategies for increasing young peoples' interest and knowledge in science and their ability to use science outside school are needed (EU, 2007; Osborne & Dillon, 2008). Aikenhead (2006) argues that one way to increase students' interest in school science is to bring in a humanistic perspective. Research shows that students are interested in working with issues in which you take your starting point in an authentic issue and work with scientific knowledge appropriate for the situation, instead of starting from scientific concepts which are explained and exemplified (ibid). Examples of issues with a humanistic perspective are socio-scientific issues (SSI). Ratcliffe and Grace (2003) have described some general characteristics of such issues. They are important for society and have a basis in science, involve forming opinions, are frequently media-reported, address local, national and global dimensions with attendant political and societal frameworks, involve values and ethical reasoning, may involve consideration of sustainable development and may require some understanding of probability and risks, and there are no “right answers”. Zeidler, Sadler, Simmons and Howes, (2005) emphasize that in SSI, it is crucial to deal with moral and ethics.

Research about students and SSI

In research studies about SSI, students have usually been working with an issue which typically includes a dilemma. Empirical data have been gathered through observations and/or interviews and students' written reports have been analysed (Aikenhead, 2006). Jiménez-Aleixandre and Pereiro-Munoz (2002) e.g. found that students working with an authentic issue discussing if sewage pipes should be drawn through a protected marshland in Spain, drew upon both values and conceptual understanding when taking a standpoint. Grace and Ratcliffe (2002) reported that students drew more upon values than upon biological concepts when working with an issue about biological conservation. Other studies report on how students value the trustworthiness of information from different sources (Kolstø, 2001, 2006) and how students interpret media reports (Ratcliffe, 1999). Lewis and Leach (2006) report that students can engage in issues about gene technology with relatively modest scientific knowledge, if the content is well-designed and contextualised. One conclusion from research is that it is not enough to teach conceptual understanding if you want students to develop skills for participation in society (Ekborg 2005, a, b). In a longitudinal study she investigated how student teachers reasoned about a socio-scientific issue dealing with the question if it is ethical to use heat from a crematorium for district heating. The student teachers did generally not draw upon the scientific knowledge which they have encountered during their teacher education to clarify the situation. A conclusion is that students need to work with such issues to develop the ability to analyze and understand the situation, and to make informed decisions (ibid).

It seems as though topics with social relevance are more motivating for the students. On the other hand they are often complex, and therefore more difficult to understand (Aikenhead, 2006). Research has revealed that such issues challenge students' rational, social and emotional skills. However, several problematic factors are identified, such as that the students can easily be distracted when they are working with complex issues where the outcome is often not clear (Zeidler et al., 2005). This means that there might be a conflict between the dilemma-based issues' potential for motivating pupils and for making them focus on the scientific content. An interesting question is whether or not the students develop conceptual understanding in science when working with SSI. Research results do not give a clear answer. He concludes that students working with SSI generally sought few scientific facts, weighing values more heavily than scientific findings. Sadler, Barab and Scott (2006), on the other hand, argue that SSI can be a platform for learning the scientific content. They refer to a few studies showing that students gain both conceptual knowledge as well as an understanding of the nature of science when working with SSI. They also state that significant work remains to be completed in documenting the link between SSI curricula and the learning of science knowledge content.

Research about teachers and SSI

Research shows that the way teachers teach depends in a collective way on factors such as content knowledge, views on the nature of science, teaching beliefs and pedagogical knowledge (Roehrig & Luft, 2004). Teachers often feel insecure and find it difficult to start working with SSI in science. Newton (1999) for example reports that teachers often do not have faith in their ability to conduct teaching and organize activities in which the students engage in argument-based discussions. Mitchener and Anderson (1989) define five concerns for teachers working in courses with humanistic perspectives on science; concerns over reduced canonical science content, discomfort with small-group instruction, uncertainties over student assessment, confusion of the teacher's role, and frustration with the non-academic type of students attracted to the course. Teachers also experience tension between educational arguments for devoting time to developing students' understanding of scientific processes and the classroom reality (Bartholomew, Osborne & Ratcliffe, 2004).

Aim

In this paper we will describe a conceptual framework, based on research, to be used for analysis and the construction of socio-scientific cases in relation to curriculum, as well as everyday practices in the lower secondary school science classroom. Researchers have developed frameworks for SSI or controversial issues, e.g. Levinson (2006) and Zeidler et al. (2005). Levinson (2005) developed a theoretical framework in which nine categories for formulation of disagreement in controversial issues are described. He also gives a number of examples from all sorts of life situations to illustrate the categories. Some of the categories involve a lot of science while some are more oriented towards significant problems in society. Zeidler, et al. (2005) describe a conceptual framework, based on research, with four areas of pedagogical importance central to teaching of SSI – Nature of Science, Classroom Discourse Issues, Cultural Issues and Case-Based Issues. They refer to research in these areas to support their claim of the importance of these factors associated with reasoning about SSI. Both frameworks (Levinson, 2006; Zeidler et al., 2005) deal with the issues in general overarching way.

Our framework consists of a number of components which are based on more detailed characteristics of SSI. The framework is constructed as a tool for two purposes. The first purpose is to use the framework as a research tool for the analysis of different dimensions in pupils' work with socio-scientific issues. The intention is to connect outcomes in learning and interest to the different components, and to investigate how complexity is dealt with in using the different components. The second purpose is to give teachers and curriculum developers a tool for constructing cases for students. By analyzing a specific issue with this tool, the teachers can gauge what kind of work can be expected. They can then construct cases with realistic outcome goals and determine what to assess.

Methodology

The work with the construction of the conceptual framework was abductive. We started by collecting a number of SSI from media – newspapers, magazines, movies stories, TV programmes, advertisements, etc. The first step was to exclude examples which cannot be characterized as SSI according to Ratcliffe and Grace (2003). Then we tried to find differences and similarities between these issues. After that we turned to research literature about interest in science, learning in science and about teaching SSI. We identified a number of components and compared these with the collection of examples. After more analyses we decided that six components were appropriate for further work. These are described in the following section. To exemplify the variation in the components, six cases were then constructed from our collection of ideas. They are described in the following sections. The six components and the six cases are described in a table (Figure 1).

Components

1. Starting-point

Socio-scientific issues (SSI) are authentic real life situations and often media-reported (Ratcliffe & Grace, 2003). Therefore one component is the authentic setting – the entry point. Dilemma-based real life issues are a viable tool to engage and motivate students (Christensen, 2000; Breiting et al., 1999). The starting points can be both fictive and non-fictive. We do not find it necessary to draw a line between fiction and non-fiction, since the border between the categories is not strict. Haraway (1989) even suggests that fiction reveals reality better than factual narratives, since it describes the world in a more authentic way than for example scientific reports or newspapers articles. In several situations it is obvious that it is not possible to separate between fiction and non-fiction. On a personal homepage a young woman tells the story of her nearsightedness, her personal experience of the handicap and the laser treatment she decides to undergo. It is a real-life story but it is not necessarily all true. The same is valid for TV programmes and newspaper articles. Novels can, since they offer a context and a possibility to understand people's considerations, appear to be reality.

A newspaper articles, a personal homepage, a TV-show, an excerpt from a novel, an everyday family or school situation. All situations are authentic; in the sense that we have not adapted the context to school. The novel is a story about a young woman who is deaf and discusses the benefits of a cochlea implant (Boyle, 2007). The newspaper articles (Aftonbladet, 2007) and the personal homepage (Sussie, 2007) are available on the web, and the TV programme was on TV on Thursday nights during the project. The ambition has been to use common situations and to work with a limited number of case rather than covering all sorts of situations.

2. School science subject

According to Aikenhead (2006), humanistic science is integrated with nature. In Sweden school science is defined as the subject's biology, chemistry and physics. We know that biology is better liked by students than other science subjects (Lindahl, 2003). Issues related to health or the environment usually are of interest to the general public (Ratcliffe & Grace, 2003). As research shows that there are many constraints for teachers in using humanistic perspectives, we have chosen to use content that is familiar to teachers (eg. Bartholomew et al., 2004). The teacher should recognise some content and feel secure in working with goals acceptable in terms of the national curriculum.

Therefore the six cases are chosen so that their subject content is a combination of a doorway into an interdisciplinary topic, and traditional school science. All cases include different aspects of biology, chemistry, physics and technology, but there is an attempt to introduce chemistry and physics in these particular examples. The scientific content includes concepts, theories and processes that are found in most science syllabuses all over the world.

3. Nature of scientific evidence

This component draws upon the various kinds of scientific evidence. Ratcliffe and Grace (2003) write that it is characteristic for SSI is that there are no "right answers". However there are different reasons for disagreement – interpretation of the science content, values or financial reasons etc. It is risky to talk about what is true and what is false in science. We know that scientific knowledge is tentative and that research develops over time and thereby, theories and models. But some explanations are better than others in explaining phenomena from a scientific perspective. There are scientific theories and laws that have been tested many times and can be tested again. But there is also new research which is not yet established. Sometimes there are contradictory reports from researchers.

In the third component we have defined four categories to describe scientific content. The first category includes issues in which the scientific content is well-known and it is possible to check facts and to find out how the processes work. Tabloids and weekly magazines frequently report about how to become more fit, what to eat to loose weight, how to exercise etc. Our experience is that very often such information is misleading. Scientific facts and concepts are used in a way which is not supported by what is actually known. Here scientific knowledge can be helpful for understanding the issue, for detecting misleading or incorrect information and in that way be important for the decision taken. The second category includes issues in which the scientific knowledge is well-known and often correctly described but the decision is based on emotions, values and/or other knowledge areas such as economy. We argue that scientific knowledge might be helpful for understanding the issue. Examples are found in gene technology. The third category includes a kind of issue in which you have to review sources and decide who to trust to come to a decision. The reason can be that the scientific content is at the frontier of scientific knowledge and not yet agreed upon. One example is information about how nuclear power affects your health. Finally, the forth category includes issues in which scientific content is not controversial but it can be difficult to judge what is accurate, for example in issues containing figures or statistics. Examples are life cycle analyses.

To evaluate evidence is a part of the nature of science which is an important aspect of scientific knowledge. Goals for school concerning the nature of science include understanding natural science as a human enterprise, as well as knowing that in science you work with experiments and investigations. In the Swedish syllabuses these goals are expressed as two aspects of science; knowledge *concerning scientific activity* and knowledge *concerning use of knowledge* (Skolverket, 2002).

The nature of science is embedded in the concept off SSI. All the cases deal with human activities in different ways with opportunities to compare scientific claims etc. It is also possible to perform experiments and investigations related to all of them. As this framework is a tool for planning and analysis, we have not explicitly expressed how the teachers should work or how the students should report. Therefore all these aspects are not included in the framework. Instead we focus on one aspect of the nature of science – the scientific evidence.

4. Social content

In society today science is integrated with politics, economics, ethics etc in a complex way (Nowotny et al., 2002). Studies, however, show that school science is often a preparation for studies in science and not for the use of science in society (Aikenhead, 2006). Aikenhead therefore suggests the use of humanistic science which, besides scientific knowledge, includes other aspects of society and everyday life, such as forming of self-identities, recognizing socio-political power and perhaps practical or social action (Aikenhead, 2006). By stressing the social content knowledge, science can be used as a tool for the students to participate in social and political life and to understand and act in an increasingly complex world (Ratcliffe & Grace, 2003; Elam & Bertilsson, 2003). But also the subject "social content" may be complex, and we will try to discuss how this component might vary. The cases therefore include different kinds of social content, where science is integrated with values, human concerns, critical thinking and cost-benefit evaluations.

Zeidler et al. (2005) make a distinction between SSI and STS (Science, Technology and Society.) They argue that the purpose of STS is to make science more interesting and the purpose of SSI is to stimulate and promote intellectual development in morality and ethics as well as awareness of interdependence between society and science. Ethical aspects are essential in the component "Social Content". One type of social content therefore deals with values and understanding of my own and others' personal situation and identity. Questions about what is normal in our culture and what a handicap might mean for your identity are raised, as well as questions concerning body ideals and different diets. Furthermore, all the cases stress – in one way or another – personal responsibility for the environment or for personal health. Some cases also raise questions about social belonging and what everyday sacrifices you are ready to make to avoid risks on both individual and global levels.

The skill of critically examining media reports on science is vital in ethical decisions and cost-benefit-evaluation. Two cases clearly raise media literacy and critical thinking as one social aspect. Media literacy is an important skill in a society where mass media has a great impact on values, politics and identity-forming. Journalists are often scientific illiterate (Nelkin, 1995) and the critical evaluation becomes the responsibility of the media consumer. The reader must therefore consider what interests are behind the different medial presentation of the (more or less) scientific results. Media literacy, understanding of the construction of medial messages and its impact, is one social aspect on the work with socio-scientific issues (Jarman & McClune, 2007).

On another level of critical thinking and stand-taking, the component include political decision-making and economical factors, which go hand in hand with media literacy, since the politics and the base for the cost-benefit evaluations are mostly presented to the students through mass media. Science and economy are nowadays closely related (Nowotny et al., 2002), and the cases are constructed to highlight this complex relation. Economy seems to be a relevant aspect in all the cases. In one case it includes personal stand-taking about who – the individual or the society – should pay for eye laser treatment. Another case stresses the question about which economical and comfort-related sacrifices individuals – or society – are willing to make for the environment.

5. Use of scientific knowledge

Jensen and Schnack (2006) argue that the aim of education should be for students to attain the ability and desire to act according to their decisions. They distinguish between actions and activities in school. An action is described as a result of decision-making in which the learner is taking part. On the contrary, an activity is often an outcome of what the teacher has decided to do. The actual act might be the same but the planning and decisions about what to do have different origin. To be able to act well, students need to develop competence in analysing complex and controversial issues in the community, to judge information, to analyse different persons' or groups' arguments and values, to negotiate and to make decisions. To act as a result of decisions also requires knowledge about different ways of acting.

It might be argued that people usually do not draw upon science when making a decision or to take action in a SSI. For example, the students who discussed an article about heat from a crematorium might not use science to make a decision. The reasons for an opinion in this case can be emotional, ethical or economical (Ekborg, 2005b). However, to understand and to clarify the situation there is a need for conceptual understanding. It is clear that students who understood the situation argued differently from students who did not have a conceptual understanding of energy, matter, combustion and degradation (ibid). Bell and Lederman (2003) showed that university professors with a good knowledge of nature of science used reasoning based on personal commitments rather than scientific evidence in issues about heath and life-style. On the other hand, Swedish statistics show that well-educated people in general smoke less and are healthier than people not as educated (Statens Folkhälsoinstitut, 2007). In other words the relationship between knowledge and behaviour is complex. Here we argue that knowledge in natural science is needed for different purposes in different situations. Zeidler et al. (2005) also states that knowledge and understanding of interconnections among science, technology, society, and the environment are major components of developing scientific literacy, even if these interconnections do not exist independently of students' personal beliefs.

In this conceptual framework we have identified for the activities in which the students need knowledge in science. It might be that scientific knowledge affects a decision. But it might also be that the decision in it itself is not based on science but science is needed to clarify the situation and to understand different alternatives. It is important to emphasise that these activities should not be interpreted as actions. It is not possible to describe actions as we do not know in advance what the students find appropriate to do. But these activities might enhance learning and prepare the students to take action. The activities are all in accordance with goals in the syllabuses. We have chosen to highlight science, as the work is valid for school science. Naturally these activities require knowledge from other areas as well (component 4).

6. Level of conflict of interest

Issues defined as SSI are complex and contain conflicts of interest (Jensen & Schnack, 2006), which means people will argue, make decisions and act from different interests as well as from different bases of knowledge. Mogensen and Mayer (2005) identify three levels of conflicts, the individual, the societal and the structural level. On the individual level, conflicts can be expressed as personal dilemmas between needs and wishes. On the societal level conflicting interests exist between various groups and/or individuals. At a structural level of society, conflicts may be described as a tension between political decisions and market forces, or economic mechanisms. Almost all SSI can be discussed in different levels of conflict. Decisions can in this way be taken on different levels. Depending on the level of conflict, personal involvement differs. Among the six

Table 1. Conceptual framework with six components. The table also shows how the components can vary in six examples of SSI-cases.

Component			
Case	**1. You are what you eat?**	**2. Laser treatment and near sightedness**	
1. Starting point	TV-programme	Personal homepage	
2. School science subject	Biology and chemistry	Biology and physic, technology	
3 Nature of scientific evidence	Well-known, but information is often misleading and science is used incorrectly.	Well known and the scientific content is often correctly presented.	
4. Social content	Media literacy Economy Self-identity Ethics	Social lif e Econ- omy Self- Identity Ethics	
5. Use of scientific knowledge	Critical thinking Scrutinize information	Decision –making Clarifying Risk assessment	
6. Level of conflict	Individual	Individual Societal	

cases developed in this project it is possible to identify conflicts on these different levels. As teenagers are quite focused on themselves, most of the cases start on a personal level, but they reach out to other levels in different ways – family, school, region, society.

The following six cases are constructed so that they display the various components described above. The students get a work sheet with the starting point – e.g the TV program or newspaper articles – together with a short description of the problem and a mission or task. For more detailed information about the cases and about the teacher's guide please see www.sisc.se

1. You are what you eat?

Anna Skipper is the host of the Swedish version of the TV-production "You are what you eat". In each programme a person with weight problems, usually over-weight, is advised about how to change lifestyle to increase their fitness. The students' mission is to scrutinize the advice given and to compare the information about food, exercise and health with other sources. The students make decisions about their personal life style. Teachers and students decide together how the result should be reported.

2. Laser treatment and nearsightedness

On a personal homepage Susi (2007) tells about how much she hates wearing glasses and that she finally has gone through laser treatment for her nearsightedness. It cost a lot of money and the costs were not covered by the social insurance system. The mission is to decide if it is worthwhile to go through such treatment and about who should pay – the individual – or society. Teachers and students decide together how the result should be reported.

3. To hear or not to hear?	4. Me, my family and global warming	5. Are mobiles hazardous?	6. Climate-friendly food in school?
Excerpt from novel	Family situation	Newspaper articles	School canteen
Biology and physics, technology	Chemistry and physics, technology	Biology and physics, technology	Chemistry and physics, technology
Well known and the scientific content is often correctly presented.	Well known and the scientific content is often correctly presented. Difficult to judge.	Not agreed upon.	Difficult to judge.
Different cultures and belonging. Values Ethics	Social life Economy Politics Ethics	Social life Economy Media literacy	Economy Politics
Investigation and clarification	Decision –making	Decision- making Cost benefit Risk assessment Scrutinize information Critical thinking	Act to make a change
Individual Societal	Individual Societal Structural	Individual	Individual Societal Structural

3. To hear or not to hear?

In an excerpt from the novel *Talk, talk* by T.S. Boyle (2007), Dana who is deaf from birth and her hearing boyfriend Bridger discuss if a cochlea implant is a solution for Dana. She is very hesitant as she feels that hearing or not hearing has nothing to do with her identity. This is very difficult for Bridger to understand. The mission is to analyse different ways of judging this situation and to make arguments for different views. We do not find it appropriate to encourage the students to have a personal opinion on what Dana should do. They should be able to understand that you can see an issue from several perspectives. Teachers and students decide together how the result should be reported.

4. Me, my family and global warming

The mission is to find ideas for how the students' families can contribute in decreasing carbon dioxide emissions. The students start out by mapping the family's need for transportation, what kind of motor-driven vehicles they have, and how these are used. After that the students investigate different alternatives, considering ecological, scientific, economical and social aspects. The mission is to produce a realistic plan for how to decrease the carbon dioxide emissions of the family.

5. Are mobile phones hazardous?

Starting from two articles from the same newspaper – one saying that are no risks associated with the use of mobile phones and another saying that the risk for developing a brain tumour is considerable. The students should find out what information there is, how it is provided and by whom.

The mission is to make a decision about the consequences for their own use of a mobile and/or what choice they would make when buying a new one. Teachers and students decide together how the result should be reported.

6. Climate-friendly food in school?

The mission is for the class is to check how food, served in the school canteen, affects the climate and if there are better alternatives to some of the examples of food. The mission is to suggest a change and to write a letter to the headmaster and ask him to consider these changes.

Discussion

A conceptual framework is helpful in understanding what socio-scientific issues are about. We have drawn upon research to identify a number of components included in the concept SSI, and how these can vary. Then we have constructed a number of cases as examples to describe how the different components can be operationalized. To compare with other frameworks (Zeidler & Sadler, 2005; Levinson, 2006), the framework described here deals with more detailed features. One way to describe it is that we agree with Zeidler et al. (2005) that work with SSI should include the four components – Nature of Science, Classroom Discourse Issues, Cultural Issues and Case-Based Issues. These aspects are embedded in this framework, as well as the characteristics expressed by Ratcliffe and Grace (2003). Our research interest is to study the outcome in the classrooms and how the outcome is related to variations in the defined components.

Ratcliffe et al. (2005) have pointed out the difficulties of spreading research evidence to the classroom. One of the main problems is to translate findings into useful outcomes, e.g. teaching material. Teachers interested in working with SSI can not turn to textbooks as it is impossible to cover topical issues in resources like this. Teachers need a more general tool which they can use for topical issues such as whether it is economically defendable to vaccinate all cows against blue tongue disease or if raw food is something we should accept as healthy. *What is the starting point? What school science curriculum goals are approached? What is the nature of scientific evidence? What is the most important social content? Why is scientific knowledge important? What kinds of conflicts of interest are there?* Thereafter teachers can decide if it is an appropriate issue for a particular class at a particular time, how the work should be planned, what resources are needed, what learning goals can be set up and what questions are constructive and important. The framework becomes a tool in translating research results to evidence-based classroom practices.

The six cases are chosen to exemplify how the components can vary, in certain respects, in order to find out what works and what does not work in school. There is no ambition to cover the curriculum. It is also important to emphasize that all components are of the kind that can be described in advance. For some of the components this is quite simple, for example the starting point. For other components such as use of knowledge, we have made assumptions of what obvious signals the mission gives in each case. That is what is described in the framework. But there is also an outcome, which is not described in the framework. What do students actually work with? What resources do they use? Do they make active decisions?

The framework will be used and tested in a research project which is conducted in three steps. Step one – the conceptual framework – is reported in this paper. Most studies are small-scale studies involving only a few volunteer science teachers to initiate the novel project. Aikenhead (2006) concludes that most work attempting to change school practice has failed as a result of problems arising when researchers try to transfer the success of one research project to a new context. Therefore in step two there is a quantitative research approach. Step three has a qualitative approach and we study classroom work with SSI in more detail.

References

Aftonbladet, 2007. http://www.aftonbladet.se/kropphalsa/article480971.ab [2008, 09-01]

Aikenhead, G. (2006). *Science Education for Everyday Life: Evidence-Based Practice.* New York: Teachers College Press.

Bell, R.L. & Lederman, N. G. (2003). Understandings of the Nature of Science and Decision Making on Science and Technology Based Issues. *Science Education*, *87* (3), 185-201.

Bartholomew, H., Osborne, J & Ratcliffe, M. (2004). Teaching Students "Ideas-about-Science": Five Dimensions of Effective Practice. *Science Education, 88* (5), 655-682.

Boyle, T.C. (2007) *Talk, Talk*. London: Bloomsbury Publishing.

Breiting, S., Hedegaard, K., Mogensen, F., Nielsen, K., & Schnack, K. (1999). *Handlekompetence, intressekonflikter og miljøundervisning – MUVIN -projektet*. Odense: Odense Universitetsforlag.

Christensen, A, A. (2000). *Projektarbejde i en nysgerrighedskultur*. Köpenhamn: Undervisningsministeriet.

Ekborg, M. (2005a). Student-teachers' Learning Outcomes during Science Subject Matter Courses. *International Journal of Science Education 27* (1), 1671-1694.

Ekborg, M. (2005b). Is heating generated from a crematorium an appropriate source for district heating? Student teachers reasoning about a complex environmental issue. *Environmental Education Research, 11* (5), 557-573.

Elam, M. & Bertilsson, M. (2003): Consuming, Engaging and Confronting Science. The Emerging Dimensions of Scientific Citizenship. *European Journal of Social Theory 6* (2), 233-251

EU (2007). *Science Education NOW*: *A Renewed Pedagogy for the Future of Europe.* http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf [2008, 03-08]

Grace, M, & Ratcliffe, M. (2002). The science and values that young people draw upon to make decisions about biological conservation issues. *International Journal of Science Education, 24* (11), 1157-1169.

Haraway, D. (1989). *Primate Visions. Gender, Race and Nature in the World of Modern Science.* New York: Routledge.

Jarman, R. & McClune, B. (2007). *Developing Scientific Literacy. Using News Media in the Classroom.* Maidenhead: Open University Press.

Jensen, B.B. & Schnack, K. (2006). The Action Competence Approach in Environmental Education. *Environmental Education Research, 12* (3-4), 471-486.

Jidesjö, A. & Oskarsson, M. (2005). What Science Teachers Teach and Its Relations to Students' Interest in Science and Technology. Paper presented at ESERA-conference, Barcelona, August 2005.

Jiménez-Aleixandre, M-P., & Pereiro-Munoz, C. (2002). Knowledge producers or knowledge consumers? Argumentation and decision making about environmental management. *International Journal of Science Education, 24* (11), 1171-1190.

Kolstø, S. D. (2001). 'To trust or not to trust,...' – students' ways of judging information encountered in a socio-scientific issue. *International Journal of Science Education, 23* (9), 877-901.

Kolstø, S. D. (2006). Patterns in Students' Argumentation Confronted with a Risk-Focused Socio-Scientific Issue. *International Journal of Science Education, 28* (14), 1689-1716.

Levinson, R. (2006). Towards a Theoretical Framework for Testing Controversial Socio-Scientific Issues. *International Journal of Science Education, 28* (10), 1201-1224.

Lewis, J. & Leach, J. (2006). Discussion of Socio-scientific Issues. The Role of Science Education. *International Journal of Science Education, 28* (11), 1267-1287.

Lindahl, B. (2003). *Lust att lära naturvetenskap och teknik? En longitudinell studie om vägen till gymnasiet.* Göteborg: Acta Universitatis Gothoburgensis.

Lyons, T. (2006). Different countries same science classes: students' experiences of school science in their own words. *International Journal of Science Education, 28* (6), 591-613.

Mitchener, C. P. & Anderson, R. D. (1989). Teachers' Perspective: Developing and Implementing an STS Curriculum. *Journal of Research in Science Teaching 26* (4), 351-69.

Mogensen, F. & Mayer M. (2005). *A Comparative Study on Ecoschool Development Process,* ENSI/SEED, Wien.

Nelkin, D. (1995). *Selling Science. How the Press Covers Science and Technology.* New York: W.H. Freeman and Company.

Newton, P. (1999). The place of argumentation in the pedagogy of school science. *International Journal of Science Education*, *21* (5), 553-576.

Nowotny, H., Scott, P., & Gibbons, M. (2002). *Re-Thinking Science. Knowledge and the Public in an Age of Uncertainty.* Cambridge: Polity Press.

Osborne, J., Simon, S. & Collins, S. (2003). Attitudes towards science: review of the literature and its implication. *International Journal of Science Education, 25* (9), 1049-79.

Osborne, J. & Dillon, J. (2008) *Science Education in Europe: Critical reflections. A report to the Nuffield foundation.* http://www.nuffieldfoundation.org/fileLibrary/pdf/Sci_Ed_in_Europe_Report_Final.pdf [2008, 03-08]

Ratcliffe, M. (1999). Evaluation of abilities in interpreting media reports of scientific research. *International Journal of Science Education, 21* (10), 1085-1099.

Ratcliffe, M., & Grace, M. (2003). *Science Education for Citizenship. Teaching Socio-Scientific Issues*. Maidenhead: Open University Press.

Ratcliffe, M., Bartholomew, H., Hames, V., Hind, A., Leach, J., Millar, R. & Osborne, J. (2005): Evidence-based practice in science education: the researcher-user interface. *Research Papers in Education*. *20* (2), 169-186.

Roehig, G.H. & Luft, J.A. (2004). Constraints experienced by beginning secondary science teachers in implementing scientific inquiry lessons. *International Journal of Science Education*. *26* (1), 3-24.

Sadler, T. D., Barab, S.A. & Scott, B. (2006). What Do Students Gain by Engaging in Socio-Scientific Inquiry? *Research in Science Teaching. 37*(4), 371-391.

Simon, S., Erduran, S. & Osborne, J. (2006). Learning to Teach Argumentation: Research and Development in the Science Classroom. *International Journal of Science Education*. *28* (2-3), 235-260.

Skolverket, The national agency for education. (1994). *Curriculum for the Compulsory School System, the Pre-School Class and the Leisure-time Centre. Lpo 94* [2008, 10-17].

Skolverket, The national agency for education. (2000). *Syllabuses for the compulsory school*. Available: http://www.skolverket.se/sb/d/493/a/1303 [2008, 10-17].

Skolverket. (2007). The national agency for education *PISA 2006 – svenska femtonåringars förmåga att förstå, tolka och reflektera – naturvetenskap, matematik och läsförståelse. (*Rapport 306) Stockholm: Skolverket.

Statens Folkhälsoinstitut (2007). Swedish National Institute of Public Health. http://www.fhi.se/default_1417.aspx. [2008, 10-08]

Sussie (2007) http://www.geocities.com/sussie_mad/laser.htm [2007, 10-01]

Zeidler, D.L., Sadler, T.D. & Simmons, M.L. & Howes, E.V. (2005). Beyond STS: A Research-Based Framework for Socioscientific Issues in Education. *Science Education 89* (3), 357-377.