What will students learn when working with a soci-scientific issue as "Are cell phones hazardous?

Britt Lindahl, Kristianstad University, Sweden, e-mail: britt.lindahl@hkr.se

Maria Rosberg, Kristianstad University, Sweden, e-mail: maria.rosberg@hkr.se

Abstract

This paper presents results from one part of a study about lower secondary students' and teachers' experiences and learning when working with a socio-scientific issue in science education. The case: *Are cell phones hazardous?* started from two articles from the same newspaper – one saying that there are no risks associated with the use of cell phones and another saying that the risk for developing a brain tumour is considerable. Data was colleced using observations, tape and video recording, interviews and questionnaires. Both boys and girls found this case very interesting and related to a current issue. Almost all students claim that the introduction to the case aroused their interest and that they learnt new facts during the work. The more interesting the students found the case, the more they claimed they have learnt. We also have results indicating the importance of the teachers' way of introducing and structuring the work. Further analysis will give us more information about what is crucial and how we can improve this way of working.

Subject/Problem

According to many documents (Osborne & Dillon, 2008, Tytler, 2007) there is a strong need to renew science education. Arguments for change are that young people's interest in choosing a scientific career is declining, scientific ignorance in the general populace is extensive, economic importance of scientific knowledge is inclining and last but not least students' opinion that science in school is boring and not relevant for them. In the past decade, there has been mounting evidence that this problem has become more acute. Studies (Osborne, Simon & Collins, 2003, Lyons, 2006, Sjøberg & Schreiner, 2006), have indicated that most youth expressed positive attitudes on the importance of scientific and technological issues to society but also that new strategies for increasing young peoples' interest and knowledge in science and their ability to use science outside school are needed. One way could be to bring in a humanistic perspective (Aikenhead, 2006), to focus more on *scientific literacy* than *science literacy* and work with socio scientific issues (SSI) in science education. Ratcliffe and Grace (2003) describe general characteristics of such issues as: 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.

SSI are said to be vehicles, not only for raising students' interest in science, but also for strengthening generic skills as team-work, problem-solving and media literacy. At the same time these skills are a presumption for successful work with SSI (Jarman & McClune 2007;

Ratcliffe & Grace 2003). Research has showed that such issues challenge students' rational, social and emotional skills (Sadler, 2004). However, several problematic factors are identified, such as students easily can be distracted when they are working with complex issues where the outcome often is not clear (Zeidler et al., 2005) and that there is still significant work to do in order to ascertain the link between SSI curricula and the learning of science content (Sadler et al.,2007).

Teachers working with SSI experience there is a tension between educational arguments for devoting time to developing students' understanding of scientific processes and the classroom reality. They often find it more important to reproduce scientific facts than to develop the idea that scientific knowledge has a degree of tentativeness associated with it (Bartholomew et al., 2004). Teachers often feel insecure about the extent to which they should be involved in the classroom discussions (Bryce, 2004).

Several researchers as Limón, (2006) argue that we need a multidimensional approach to understand the effects of educational interventions since much of the ambiguity in education research is due to a failure to account for the complexity of factors that influence cognition as well as motivation and the forming of attitudes. Examples of such factors are; student *emotions* (Pekrun et al, 2006), the *instructional design*, student *attitudes toward learning science* (Osborne et al, 2003), *epistemological beliefs* (Hofer, 2001), and *social belonging*, *self efficacy*, and *sense of autonomy/locus of control* (Ryan & Deci, 2000). Windschitl and Andre (1998) found that student epistemological beliefs functioned as predictors of learning outcomes only if the degree of autonomy in the learning situation was considered simultaneously. Similarly, students' persistence on a difficult task is considered to be a result of an appraisal of the attitude toward the task/behaviour and self-efficacy and locus of control (Carver & Scheier, 1990). Depending on the result of this appraisal, different emotions occur (Schutz & DeCuir, 2002). Hence, motivated behavior as well as cognition and emotions during learning from SSI are probably dependent on a wide range of factors.

Out of this background we have designed a large research project to learn more about both students and teachers' experiences and learning when working with socio- scientific issues in science education at senior level (age 13-16). The project started in 2007 and will continue for at least four years. In this paper we will present the results from one SSI-case in the project with the following research questions

- What do the students learn when working with the case "*Are cell phones hazardous?*
- How do interest, engagement and self-efficacy develop in the work?

Design/Procedure

The project can be described in three parts. First a conceptual framework for constructing and analyzing socio-scientific cases was developed (Ekborg, Ideland & Mallmberg, 2009). Six cases were constructed and published in a teachers' guide. The cases were introduced by current authentic situations, e.g. TV-programs, personal homepages and newspaper articles and deal with near sightedness and laser treatment, cell phones, climate change, cochlea implant and nutrition. Two student questionnaires were developed, the first aimed at describing the work forms that the students were accustomed to in science class and students personal characteristics from several aspects; learning goals, attitudes toward science in school and society, self-efficacy and beliefs about learning. The second aimed to measure the situational

characteristics of the SSI work and its cognitive/behavioral and affective outcomes (Winberg & Lindahl, 2008). A teacher questionnaire about working forms, assessment, learning and personal experiences was also developed together with an interview guide. The items in all questionnaires were collected from extant questionnaires or constructed based on theory within the field.

In the second step we invited teachers from lower secondary school to participate and 70 teachers volunteered. They were asked to choose one case and then free to organize their work in their own way but had to use our starting points and allow their students to discuss at least once. The data collection was mostly quantitative. For the analysis we have used SPSS and SIMCA for descriptive statistics and multivariable analysis. Results from this part have earlier been presented in different papers (see http://www.sisc.se, Ideland et al. 2011, Lindahl et al, 2011).

In the third step we continued with a more qualitative data collection in six classes. For this part we developed our questionnaires to have a stronger focus on what we found important in the quantitative part. We also added some questions to examine conceptual understanding, applied knowledge and trustworthiness. Besides questionnaires, all lessons have been observed and/or video recorded all discussions tape recorded and both students and teachers are interviewed.

This paper is about the case - *Are cell phones hazardous?*. The teachers got some instructions about how to introduce the case to the students. The case was introduced by two different articles from the same newspaper with less than two months between them. The first article saying that there are no risks associated with the use of cell phones and the other saying that the risk for developing a brain tumour is considerable. The students had to find out what information there was, how it was provided and by whom. The mission was to make a decision about the consequences for their own use of a cell phone and/or what choice they would make when buying a new one. To help the teachers we also developed several experiments about cell phones and radiation. Most classes worked about six hours with the case and mostly the teachers decided how the results should be reported.

Analyses and Findings

In part two of the project there were 20 classes and about 200 students (13-15 year old) working with this case. This was not the most popular case to choose among the teachers but the most interesting according to the students taking part in the project. On a Likert scale from 1-5 the mean was 3,5 with 5 as the most interesting alternative. They found the case as a question in point and not too difficult to work with. In the analysis it seems as work forms (i.e., issues are up to date, frequent discussions, equally shared work load, and autonomy), are most important to explain positive affective and cognitive outcomes. Students' achievement goals also seem important for predicting these types of outcomes. The teachers were satisfied with the work with SSI and appreciated getting a material with new ideas and experiments.

In part three there were three classes workning with this case. Here we will discuss one class with 20 students at the age of 15. As described above the students were asked to answer one questionnaire before starting to work and a second questionnaire after finishing a case. All questions used Likert scales with five steps where 1 is do not agree and 5 is fully agree. Students in this class think they perform well in school but also that they are not so good in Physics and Chemistry as in other subjects. 45% of the students fully agree or agree on the

statement that school science is interesting and 30 % find school science difficult. They do not think they will find any use of science learnt in school. It seems as science lessons are about things that do not interest them. On the other hand both boys and girls found this case interesting (85 % fully agree and agree) and related to a current issue (90 % fully agree and agree). Almost all students claim that the introduction to the case aroused their interest and they learnt new facts during the work. The more interesting the students found the case, the more they learnt (Table 1).

Table 1 Students self-reported learning outcomes. Numbers presented are mean values and (standard deviation) where 1 = do not agree and 5 = fully agree.

The case was interesting	I have learned new facts.	Improved search for information	Improved to scrutinize information	I have become better at school science.	I have learned more science working with the case than usually.
1 Do not agree (N=1)	4,00	1,00	3,00	1,00	1,00
2 (N=0)					
3 (N=2)	3,50 (0,71)	2,00 (1,41)	2,00 (1,41)	2,00 (1,41)	2,00 (1,41)
4 (N=5)	4,60 (0,55)	3,20 (1,30)	3,20 (1,48)	3,20 (1,48)	3,40 (0,89)
5 Agree (N=12)	4,58 (1,16)	3,83 (0,84)	4,17 (0,84)	4,08 (0,52)	3,92 (1,00)

The qualitative data consisted also of classroom observations. Two observers were present taking field notes and recording group discussions. A semi-structured observation protocol was used, which pointed out the direction for the observation into trying to understand what makes SSI as a work form successful (or not) with regard to students' interest, engagement and learning in school science. Almost all students claim that it was fun to discuss the questions to the case and also what they learned during the case are important for themselves. The student´s appreciated the experimental work. This is exemplified here by four of he students in the study:

"It was interesting. I thought that was great fun."

"Try our mobiles somehow."

"/…/ See for yourself how much radiation and stuff that was inside."

"It´s always fun to do something else instead of reading /…/ it may be sometimes sit a whole lesson and just looking for facts."

Contribution/General Interest

The data analysis is still going on, but so far we can see that students in lower secondary school appreciate working with SSI. However, the work with SSI might not so much raise students' interest in school science, but it can strengthen generic skills as team-work, problem-solving and media literacy. We notice that students are ill-prepared to work autonomously. The teachers in this study confirm that students are interested in working with socio-scientific issues. Results suggest that SSI work forms are more important than personal factors for explaining outcomes. Relevant (current) issues, autonomy and functioning group work (good discussion climate and equally distributed workload) seem to be important aspects of successful SSI work. Structure provided by the teacher, and information that challenges previous knowledge also seems to be aspects of SSI work that contributes to positive affective and cognitive outcomes. In general, SSI seems to be most efficient for students who believe they learn from presenting and discussing their knowledge, focus on 'the large picture', acknowledges own responsibility for learning, finds school science personally relevant and are self-efficacious. It seems that the outcomes from SSI work are much in the hands of the teacher.

The teachers were satisfied with the work with SSI and appreciated getting a material with new ideas and experiments. They saw benefits beyond the actual work, e.g. an interest in the content among the students. We also have results indicating the importance of the teachers' way of introducing and structuring the work. Further analysis will give us more information about what is crucial and how we can improve this way of working.

Bibliography

Aikenhead, G. S. (2006). Science Education for Everyday Life. Evidence-Based Practice. Teachers College Press.

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

Bryce, T (2004). Tough Acts to Follow: The Challenges to Science Teachers Presented by Biotechnological Progress. International Journal of Science Education 26 (6), 717-722.

Carver, C. S., & Scheier, M. F. (1990). Origins and Functions of Positive and Negative Affect: A Control-Process View. Psychological Review, 97(1), 19-35.

Ekborg, M., Ideland, M., & Malmberg, C. (2009). SCIENCE FOR LIFE – a conceptual framework for construction and analysis of socio-scientific cases. *NorDiNa, 5*, 35-46.

Hofer, B. K. (2001). Personal epistemology research: implications for learning and teaching. Journal of Educational Psychology review, 13(4), 353-383.

Ideland, Malin, Malmberg, Claes, Winberg, Mikael (2010) "Culturally Equipped for Socio-Scientific Issues? A comparative study on how teachers and students in mono- and multiethnic schools handle work with complex issues" *International journal of science education*, epub ahead of print [DOI]

Jarman, R & McClune, B (2007) Developing scientific literacy: Using news media in the classroom. Maidenhead: Open University Press

Limón, M. (2006). The domain generality-specificity of epistemological beliefs: A theoretical problem, a methodological problem or both? International Journal of Educational Research, 45(1-2), 7-27.

Lindahl, B., Rosberg, M., Ekborg, M., Ideland, M., Malmberg, C., Rehn, A., Ottander, C., Silfver, E., & Winberg, M. (2011) Socio-Scientific Issues – A Way to Improve Students' Interest and Learning? Accepted to be published in *US-China Education Review Vol.8,No.9.*

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

Osborne, J. & Dillon, J. (2008) Science Education in Europe: Critical reflections. Nuffield foundation.

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.

Pekrun, R. Elliot, A. J. & Maier, M. A. (2006). Achievement goals and discrete achievement emotions: A theorethical model and prospective test. Journal of Educational Psychology, 98(3), 583-597.

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

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. Contemporary Educational Psychology, 25(1), 54-67.

Sadler, T. D., Barab, S.A. & Scott, B. (2007). What Do Students Gain by Engaging in Socio-Scientific Inquiry? Research in Science Education. 37, 371-391

Sadler, T. (2004). Informal reasoning regarding socio scientific issues: A critical review of research. Journal of Research in Science Teaching 41 (5), 513-536

Schutz, P. A., & DeCuir, J. T. (2002). Inquiry on Emotions in Education. Educational Psychologist, 37(2), 125-134.

Sjøberg, S., & Schreiner, C. (2006). How do learners in different cultures relate to science and technology? Results and perspectives from the project rose (the relevance of science education). Asia-Pacific Forum on Science Learning and Teaching, 6(2), 1-17.

Tytler, R. (2007). Re-imagining Science Education. Engaging students in science for Australia's future. Australian Council for Educational Research.

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

Winberg, M. & Lindahl, B. (2008). Science for Life - development of a multi-concept instrument to study the impact of socio-scientific issues on student interest in science. Paper presented at The 9th Nordic Research Symposium on Science Education 11th -15th June 2008. <www.sisc.se>

Windschitl, M., & Andre, T. (1998). Using computer simulations to enhance conceptual change: The roles of constructivist instruction and student epistemological beliefs. Journal of research in science teaching, 35(2), 145-160.