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SCIENCE AND TECHNOLOGY EDUCATION IN FINNISH COMPREHENSIVE SCHOOLS: FOUR CASES

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Abstract

Science-Technology-Society (STS) approach has been found to be an effective framework in science education. STS-approach is expected to increase citizens" abilities to carry out the social responsibility in collective decision making concerning issues related to science and technology. At school, the teacher can view, especially after practising STS-instruction her/himself, that it is an integrated curriculum that promotes students" scientific knowledge, process skills, citizenship behaviours, and decision-making abilities. Science and Technology Education at the University of Joensuu has been planned in order to increase primary school teacher students" knowledge about science education including science contents, science pedagogy as well as environmental and technological education. STS-approach is applied in planning Science and Technology Education for teacher students. After theoretical studies about STS-approach, primary school teacher students also have to practice STS-teaching themselves in the lower level of the comprehensive school (primary school, grades 1-6). In this paper, four cases of these STS-approaches in Finnish primary schools are presented. The cases include learning about plastics, electricity, water and air, and human body, and the cases are planned and carried out by several primary school teacher students in teams. The cases presented here are planned for and carried out with fifth or sixth graders (age of 10-12) in rural schools.
Keywords: *science and technology education, teacher education, primary science, STS-approach.*

Introduction

In most European countries, the curriculum for science teaching in primary and lower secondary education refers to science in context, either in terms of the history of science or contemporary societal issues, or both. Almost everywhere (29 education systems), primary school pupils discuss science in relation to society and to everyday life. Reforms carried out in Europe during the last years, concerned with curricular content, often mean that changes have to be made at a prior stage in teacher education. The way in which science is taught in schools depends on many factors related mainly to the training received by teachers. Teachers in primary education have training in science which has generally been limited and can not meet the latest requirements of the curriculum (see Eurydice Report 2006).

In Finland the view on science education as continuum, starting at pre-primary, is a basic feature of the new curriculum which was implemented in 2004. The revision has along changes to science education at the primary level. During the first four years pupils (ages 7 to 10) undertake environmental and science studies as before, but during the last two years (ages 11 to 12) at the primary level science studies are divided into biology/geography and physics/chemistry studies. These changes have put pressures on reorganising primary school science education and on changing its characteristics. Also in Finland contemporary societal issues are included in the curriculum as well as discussions related to issues of everyday life.

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The pupils themselves are very interested in the socio-economic, practical and personal aspects of science (see e.g. Sjųberg 2000). These results have been used to design teaching units that have led to cognitive and affective benefits in the medium term, particularly in the case of girls. For girls, context is particularly important, with boys being more focused on the task itself, independent of context (see e.g. Sjoberg 2000, Juuti, Lavonen, Uitto, Byman, and Meisalo 2004). Girls also show a preference for collaborative styles of working and for discussion. The professional working practises are matters of debate. (see Eurydice Report 2006).

Lots of resources have been given for the development of science education. One alternative in making science more interesting and more understandable also for the future pupils is the use of the STS-approach in science education. Fundamentally, STS- science teaching is student oriented. Students strive to understand their everyday experiences about their social environment, their artificially constructed environment, and their natural environment. (Aikenhead, 1994, 47-49.) STS-approach might be, according to Mbajiorgu and Ali (2002) affecting other variables in the science classroom than in turn affect achievement in the sciences. Tsai (2001) has found that STS-oriented instruction group of students could perform better in terms of the extent, richness and connection of cognitive structure outcomes, than traditional group students do. He also states that STS-instruction could be especially beneficial to students with its epistemological views being more oriented to constructivist views of science, particularly at an early stage of STS-instruction. According to him, STS-instruction is a clear and appropriate way of practicing constructivism. Solbes and Vilches (1997) have found that the introduction of STS-interactions in physics and chemistry classes can help students to develop an improved comprehension and a more real image of these sciences, which allow students to understand better the role of scientists and how they work. According to them, STS-interactions together with the teaching/learning model of science as research generate positive attitudes toward the study of physics and chemistry and increase the students“ interest in their study.

STS-science is also expected to fill a critical void in the traditional curriculum – the social responsibility in collective decision making on issues related to science and technology. The pervasive goal of social responsibility in collective decision making leads to numerous related goals: individual empowerment; intellectual capabilities such as critical thinking, logical reasoning, creative problem solving, and decision making; national and global citizenship, usually "democracy" or "stewardship"; socially responsible action by individuals; communication skills in a variety of forms; and an skilled work force for business and industry (Aikenhead, 1994, 49; Aikenhead, 2000, 53; Rannikmäe, 2002). These goals emphasize an induction into a world increasingly shaped by science and technology, more than they support an induction into a scientific discipline. Already at an early age in the education, it is important to develop skills of natural inquiry, critical thinking, and decision making about science and technology and the links to the world they encounter (Pedretti, 1999).

STS-science courses differ widely because of their different goals. However, this variation reflects differences in the balance among similar goals. The goals of STS-education are: *acquisition of knowledge* (concepts within, and concepts about, science and technology) for personal matters, civic concerns, or cultural perspectives; *development of learning skills* (processes of scientific and technological inquiry) for information gathering, problem solving, and decision making; *development of values and ideas* (dealing with the interactions among science, technology, and society) for local issues, public policies, and global problems or *cognitive competency* – standardized knowledge and skills needed for reading and speaking accurately about STS-issues; *rational/academic* – a grasp of the epistemology and sociology of science required for understanding the dynamics at play in STS-issues; *personal* – students understand their everyday lives better; *social action* – students participate in responsible political action. All goals may have a place within a single curriculum, but some goals have higher priority than others. For example, the goal – social action – is usually a high priority in some environmental courses. (Aikenhead, 1994, 50-51.)

After practising STS-instruction, the teacher can view STS as an integrated curriculum that promotes students“ scientific knowledge, process skills, citizenship behaviours, and decision-making abilities (Tsai, 2001). Tsai states that the teacher can possess many constructivist-oriented teaching approaches recommended by science educators, for instance, cooperative learning, discussion activities, and conceptual change strategies. The actual implementation clearly helps the teacher conceptualize the rationales and strategies of STS-instruction, and then demonstrate a considerable pedagogical knowledge growth about STS (Tsai, 2001). However, Rannikmäe (2002) found that some science teachers find it difficult to understand the meaning of social issues. According to her, it is not easy to change teachers" perceptions of science teaching, especially towards the inclusion of social components interrelated with, and aiding the acquisition of conceptual science.

In this paper, four cases of the applied STS-approach at primary school are presented. The primary school teacher students have planned the teaching units during Science and Technology Education and tested them in rural primary schools. This article concentrates on describing the teaching units. Some remarks on research results related to these units are shown, but they will be discussed in more detail at other forums (Keinonen, 2007, Havu-Nuutinen and Keinonen, 2007).

Methodology of Research

The context of this paper, Science and Technology Education in Joensuu is an application of STS-approach. The Basic Studies in Science and Technology Education forms minor studies mainly for primary school teacher students. When entering this education, the students already have finished their pedagogical studies. Teachers" pedagogical studies include three training periods at the training school and one training period at a rural or country school. At the training school the students concentrate in some subjects, only a minor part of the students train in science. The Science and Technology Education, total of 25 credit points, consists of six separate courses shown in Figure 1.

The aim of the Basic Studies in Science and Technology is among other things to acquire scientific understanding and to widen the worldview, to understand the most central concepts and the general features of the structures of theories in science, to understand the teaching of these subjects on different levels of the education and to understand the mutual relations between basic sciences, technology, society and people. The courses aim to help primary school teacher students develop a theoretical framework for teaching science at the elementary level, a repertoire of methods for teaching science, favourable attitudes toward science and science teaching, and deeper understandings of some science content area and of the relations between sciences, technology and society.

The Science and Technology Education is conducted in co-operation with the Faculty of Science and the Faculty of Education. Science and Technology studies start with an introductory course arranged by the Department of Applied Education. The courses of geography, biology, chemistry and physics will follow after that and these are arranged by the respective departments. The last course, arranged by the Department of Applied Education considers the interrelations between science, technology and society. The science discipline courses contain mainly subject contents and less STS-content, whereas the courses carried out by the Department of Applied Education include mainly STS-content. The pedagogy of science is discussed and practiced during the first and last course.

The scientific and technological knowledge and action, childrens", teachers" and adults" attitudes towards science as well as pedagogical aspects of science instruction are discussed in the introductory course of "Science and Technology as a knowledge and action". Hands-on experiments and inquiries are especially pointed out. During the course, in a given period, the students also have to read newspapers and collect all the articles which they think concern science and/or technology. Then, following the given questions the students explain why each article, in their opinion, concern science or technology. Finally, the articles are presented to the other students, the results are compared and the ideas are discussed in seminars.

After the introductory course, the students pass the subject courses which deal with the STS-issues mainly as technological applications and as everyday phenomena. The subject courses include also practices, field or laboratory work. During the geography course, the students make a visit to Koli, the famous Finnish national park near Joensuu where the tracks of the Ice Age can be seen. The biology, chemistry and physics courses include laboratory practises. For the last course the students return back to the Department of Applied Education. Then, STS-approach in science education and sustainable development questions are discussed. The

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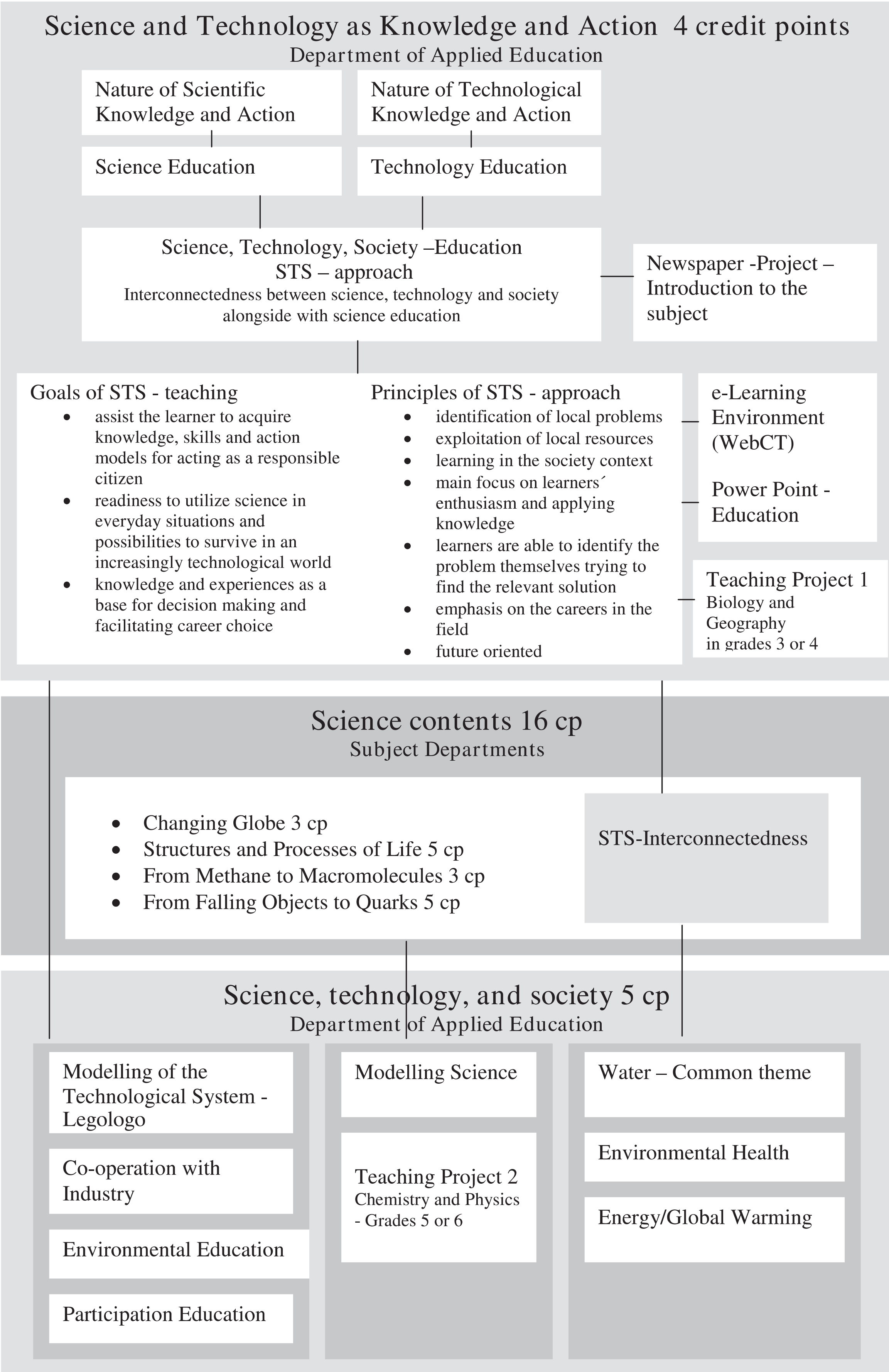

Figure 1. Basic Studies in Science and Technology.

students also carry out an industry project, during which they visit an industrial company. Finally, the students carry out a technology project in which they design and construct a washing machine by the aid of LEGOs and the Logo Programming.

During the first and last course the students also plan teaching entities for primary school according to STS-approach and carry out the planned teaching units in rural schools. The starting point for the teaching projects has been to provide pupils an authentic learning environment. In authentic learning situations, the learning of contents and process skills are joined together in a suitable proportion. Solving problems that are related to pupils“ everyday life reinforces pupils“ inquiry skills more than pure scientific problem solving situations do (Lee and Songer, 2003). The latter demands such a content knowledge and scientific thinking which pupils do not yet possess. The authenticity of the projects was increased by visits to companies and scientific institutions and by working in these places. The other starting point for the teaching projects was to approach science issues in the historical-societal and technological context. Furthermore, according to the STS principles, the environmental effects were considered, and the learning by inquiry was chosen most often as the pedagogical framework.

The aim of the projects was that teacher students familiarize with STS-approach (planning and realizing), project work, co-operation with enterprises, and arranging visits to them, as well as with scientific inquiry in teaching-learning process. The aim was that students“ knowledge about the ways to work in science, their self-motivation and abilities to arrange learning situations outside the schools, will develop. The final aim was that pupils will get interested in science studies and get positive experiences about science and industry. They were also expected to see science as a large and multifaceted entity.

The data collection in the related researches included pupils“ writings and drawings, the interviews of pupils, teachers and partners, video recordings, field notes, and discussions with different participants. The data varied depending on the case. There were 12 to 56 pupils and 9 to 12 teacher students depending on the case. The cases were carried out during years 2002-2007.

Results –Teaching projects at schools

The cases presented here include learning about plastics, electricity, water and air, and human body.

Case 1: Plastics – Mobile phones in our life

The Plastics -project was realized as a voluntary club for fifth graders after the school day. The pupils met in the club six times. The aim from the viewpoint of the school was to serve and develop club actions and to encourage pupils in science studies. A company, which participated in the project, aimed to develop school-company collaboration and to increase childrens“ interest in science, technology and industry, too. The reminders about industry and about the importance of industry lie about pupils every day. Yet the associations they have, despite all this information, are negative, and they assume that working in industry is boring (Cullingford 2004). The project aimed to change this kind of thoughts.

The project, called Mobile Phone – Club, started after the discussion concerning the history and use of phones (Figure 2). The aim was to consider the role of the mobile phone in our life from different points of view. At the end of the first meeting, the pupils planned future mobile phone.

Next week, the pupils“ drawings were considered. Attention was directed to the material of the cover of mobile phones - to the plastic. At first, the properties of plastics were introduced through the demonstrations held by the teacher students. After that, the pupils planned suitable questions for the visit to the company. Next week, the teacher students were responsible for the arrangements of the visit together with the personnel of the company. During the visit the pupils learned about the computer-aided design of the cover and were able to use the design program. The pupils also familiarized with the manufacture of covers in the factory.

After that, the pupils investigated plastics at school in small groups and in several workstations. The observations were written in the inquiry cards. At the fifth time, the

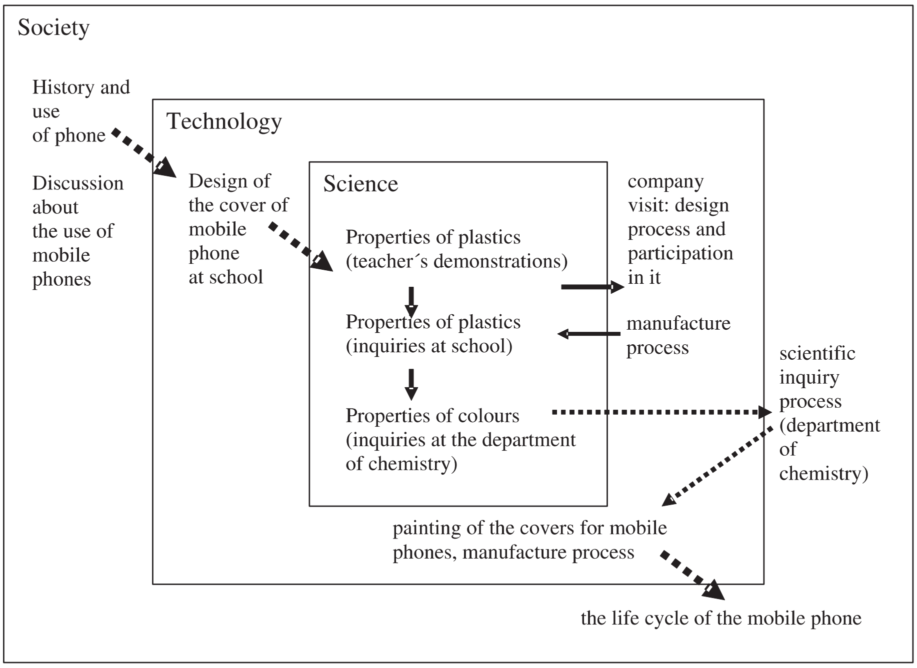

Figure 2. The units of the Mobile Phone – Club.

pupils visited the department of chemistry at the university. They saw similar machines as in the factory but in a smaller scale. They also learned how to model molecules with the aid of computers. After that, the pupils investigated at the chemistry laboratory the properties of colours making e.g. white and red paint. In the last time, the pupils painted the cover of their own mobile phone. The cover has been delivered to them by the project. The pupils also watched a video about the life of a plastics cup and made a mind map of the life of the cover of the mobile phone.

The personnel of the company planned together with the teacher students a visit where childrens" own action was in the main role. The aim of the company was to realize an interactive event, instead of the traditional power point presentation. Only a short presentation material was prepared for the visit. The presentation showed clearly the history of plastics, manufacture of plastics products and the action of the company. A visit, which was planned next year was even more interactive. Then, the pupils tested the cover in the company"s laboratory and used a robot in the factory. The company found childrens" action very positive. Also their co-operation between teacher education and schools, according to them, deepened. The views of the teacher students, the teachers and the pupils on the industrial company and it"s action widened. In addition, the project offered the personnel of the company a possibility for co-operation with the school and new experiences as tutors of young people.

The primary school was so positively surprised about the popularity of the club and about pupils" activity in the case that the club has been carried out in the afternoon after the normal school day. The teachers highlighted the different learning methods that have been used in the teaching units. The visits to the company and to the university were been especially beneficial. The pupils had an opportunity to see several different jobs and working people. The teachers reported that the pupils have acquired good ideas about the applications of science. The teachers also commented that every pupil has learned something about plastics and about the production of the covers for the mobile phones.

In pupils" feedback the visits can be considered as positive and successful. The pupils enjoyed the visit to the company because they had the possibility to participate in the activities ("We got to plan.., "..we made ourselves, not only looked beside."). They also experienced that they have learned new ("In Perlos we learned a lot...", "it was nice, when we visited Perlos and got information about its" history and about the production of the cover".) Also, the visit to the department of chemistry was regarded as interesting. The teacher students commented more the practical arrangements during the project than the instruction entity itself. They found, however, that they learned to teach and they got ideas for their future job.

Case 2: Electricity – Where electricity comes from?

Electricity was studied in a rural school at the sixth grade. The primary school teacher students were responsible for the instruction demonstrated in Figure 3. The phenomenon under study was the whole energy system of the town.

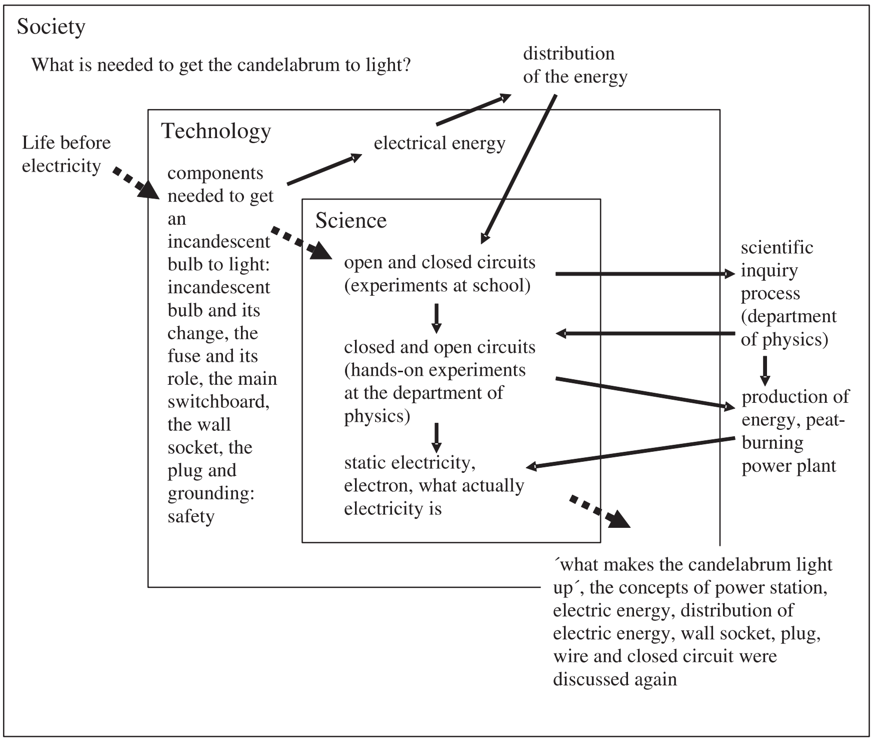

Figure 3. The units in the project "Where electricity comes from?".

Before the teaching units, the pupils were asked to write down their ideas about what electricity is. At the beginning of the first unit they were requested to write down "what they think is needed to light the candelabrum" present in the classroom. The aim of the two questions was to investigate the pupils" ideas about the origin of electric current, the way electric current is conveyed to homes from its origin, the need for a complete circuit for lighting, and other relevant ideas.

The first lesson dealt with the history of electricity, life nowadays and how it was before electricity. Two teacher students discussed with the pupils about electric appliances (the play mobile guided by radio waves, the microwave oven, the mobile phone, the washing machine, the candelabrum). The discussion concerned how the appliances work, and what has been used instead of these appliances before the foundation of electricity. The teacher student told the pupils about the history of electricity followed by a play in which pupils in small groups dramatized situations concerning the safety of electricity. Next, the pupils read the chapter in their books entitled "Home devices work with electricity", and after that the pupils discussed which components are needed to get an incandescent bulb to light, and how to get electricity from the net. The pupils became familiar with the incandescent bulb and its change, the fuse and its role, the main switchboard, the wall socket, the plug and grounding. The pupils worked in small groups and each group carried out their own hands-on experiments which also were tried out by the other groups. The teacher student explained how the main switchboard works.

The following week, the second pair of the teacher students focused their lessons on electric energy. The aim was to get pupils understand where electric energy is produced, the distribution and consumption of electric energy, and how it can be saved. The pupils had to find an answer to the question "where does the lamp get its energy from". The teacher stu-

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dents read aloud statements concerning energy, and the pupils showed with their blue or red cards, if the statement is correct or not. The teacher students discussed with the pupils about where electric energy comes from, and the pupils looked at a picture concerning the production of energy. In small work groups, they tried to find out energy sources, the action followed by a teaching period of collecting information and a short discussion on how energy comes to homes. With the aid of a picture, the teacher students explained the idea of the distribution of electric energy. Lastly, in the second unit, the consumption and saving of energy was discussed, and the pupils answered the question where the lamp gets its electricity from. Before the next lesson, the pupils were asked to follow energy consumption at home.

The third unit concerned the open and closed circuits. The pupils answered the question about what happens when one of the bulbs is taken away from the candelabrum. The teacher students presented simple circuit models, and respective circuits constructed from the concrete components. The pupils connected the circuit model to the concrete circuit. The aim was that the pupils will become familiar with the symbols used in electric circuits. The circuits were also dramatized by the pupils, who played roles of being different components in the circuits. The pupils made hands-on experiments on the conduction of electricity and connected bulbs in parallel and in series. At home, the pupils answered the question about what happens when one bulb is taken away and how the bulbs are connected, in series or in parallel.

The fourth unit was carried out at the university, four kilometres away from the school. The pupils familiarized with the research at the department of physics and made hands-on experiments in the laboratory. The experiments dealt with closed circuits and the concept on voltage was introduced. The current was also measured. The pupils worked in small groups in four workstations, each group in turn. The teachers from the department of physics helped the primary school teacher students at each station. The pupils answered the question about how the current changes in different circuits.

The following unit was carried out in the power station. The pupils visited the local peat-burning power plant in order to answer the question "how is electricity produced (its source and the phases of production) ". The question was discussed in the bus on the return journey.

At the beginning of the final unit, the pupils answered the question about "what makes the candelabrum light up". Then the concepts of power station, electric energy, distribution of electric energy, wall socket, plug, wire and closed circuit were discussed again. Finally, the question "what electricity actually is" aroused. Voltage and circuits were handled and the concept electron was introduced. There was a discussion as to whether the voltage source is necessary, and static electricity was studied with the aid of hands-on experiments. The concepts concerning electricity were collected on a concept map which was planned by the teacher students and was filled in by the pupils.

The pupils" descriptions before and after the instruction concerning electricity were categorized. After instruction electricity was described in several ways. It was net electricity, net current, electricity, and appliances such as a plug, wire, and a wall socket. The category concerning electricity and energy was described by net current or electricity. Electric energy was complemented with a wall socket, fuse or net current or electric net. Energy was changed in some cases to electricity, net current, or circuit net and components, or only components. The category of electricity and components was widened to include the electricity net, components and electricity, electricity and net current, only components, or electricity and kinetic energy. Although the pupils described what is needed in a more versified way than before the instruction, the descriptions concerned the use of electricity in daily life, what it is at home, not mentioning the things outside of the instruction period. The pupils wrote about several parts or components, but not much about the production or distribution of energy, nor did they mention the closed circuit at all. No one described the whole process starting from production to its use, as some did in the pre-knowledge questionnaire. The concept of current which was not previously used was used at the end, as well as the net current.

At the beginning of the STS-instruction girls thought that electricity is needed for the candelabrum together with components, while the boys supported more electric energy. The differences between the genders, however, were not significant. Afterwards, about half of the pupils thought that the net current or net electricity is necessary. Before instruction, there were no comments of the net. Circuit was also a new concept used after the instruction, being mentioned by one girl and four boys.

The pupils gave illuminating descriptions about electricity. Laura, who according to the pre-question had well-developed ideas about electricity, answered before the instruction that electric energy is needed to light the candelabrum. After instruction, she answered:

> A wall socket is needed. Electricity comes to it through the current network. The net circuit gets it from the main switchboard. There are fuses. If there is too much electric voltage, the fuse will burn.

Laura"s ideas were versified. She was the only one who mentioned voltage. Sara, who in the pre-questionnaire mentioned several components related to electricity, wrote before instruction that electricity is needed. After the instruction she wrote:

> The plug must be put into the wall socket. Electricity goes via the wire to the candelabrum, the filament warms and starts to light.

She wrote more about the processes concerning the phenomena. After instruction, Henry referred to his first answer which he had given in the pre-knowledge test previous to instruction. He was of the opinion that electricity, electric wires, and lamps are needed.   John who associated electricity with lighting and danger in the pre test, thought before the instruction that energy is needed to light the candelabrum. Afterwards, he wrote more precisely about electric energy instead of energy, but added nothing else.

Case 3: Water and air – What is the global warming and how can we influence on it?

The topic of water and air was studied by the fifth graders under the guidance of the teacher students. The global warming was investigated as a societal question. The structure of the teaching project is shown in Figure 4.

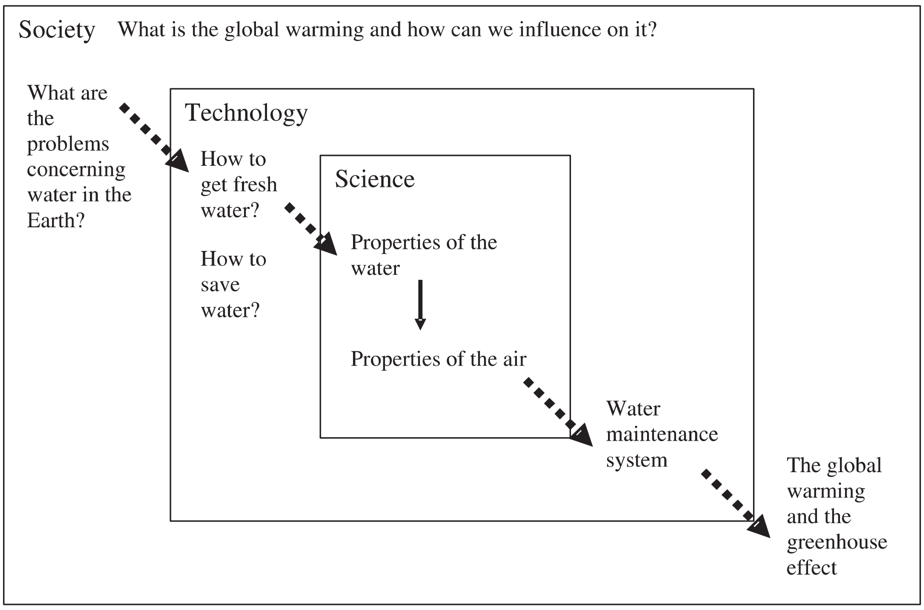

Figure 4.   The teaching units of the project concerning water and air.

Before the teaching project was started, the pupils wrote an essay about the subject "Water around us". Ten of the 29 pupils were also interviewed in order to find out the possible conceptual change afterwards. The first lesson started by considering Earth"s water cycle. The pupils investigated a map showing sufficient amount of water and water consumption on the Earth. The pupils had to find answers to the questions given by the teacher students. After discussions, the pupils read an article about how the global warming influences the zone. Finally, a debate was arranged. The pupils discussed in small groups considering a pollution problem due to the

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factory in a fictional case. The groups discussed the problem from different points of view. One group thought the situation from the viewpoint of the director of the factory. The other viewpoints represented that of the city manager, the urbanite, the environmental activist, the researcher from the university, and the fish shopkeeper. In the debate, one of the group members represented the whole group. The pupils discussed about how the catastrophe should be solved and how it would influence everyday life. At home, they were asked to follow their own water consume.

Next time, the pupils marked their consumption in a diagram. Then, the pupils investigated properties of the water in small groups and in workstations. The subjects of the hands-on experiments were “sugar on the bottom”, “does wool get wet”, and “under the pressure of the water”. The pupils made hypothesis, observations in the experiments and then conclusions. Finally, the pupils filled in a paper collecting the properties of the water.

The third time, the pupils studied properties of the air. At first, the teacher students collected on the table a mind map discussing with the pupils. The issues related to the air were discussed. The pupils draw the mind map on their portfolio. Again, the pupils made hands-on experiments in small groups, the subjects being now: “can air be compressed”, “what happens when air warms”, “does the kleenex remain dry”, and “can you lift the paper with the aid of the liner”. Afterwards, the experiments have been discussed together.

In the fourth week the class visited the local water company. The water care system was introduced to the pupils. The pupils filled in a questionnaire concerning the water care system. The answers were discussed next week in the last time, when the pupils studied at school the global warming and the greenhouse effect. The teacher students gave the pupils two articles. One half of the class read the article “The warming of the Earth” and the other half the article “The global warming does not slow down by discussing”. The questions dealt with the following issues: what the greenhouse effect means, what is the global change, what are the influences of the global warming, and how can people influence on the progress of the global warming”. The water consumption and the ten choices of the climate“s friend were discussed at the end.

After the instruction the pupils again wrote about the subject of the water around us. The same pupils were interviewed before and after the instruction. The pupils mainly described the importance of water for human being. They also wrote about the clean and dirty water and water consumption. The data analysis continues in order to find out the possible conceptual change.

Case 4: Human biology – What“s the role of physical exercise for our body?

The fifth graders studied the structure and the functions of the biological systems of the human being in the context of the physical exercise. The structure of the teaching is shown in the figure 5. This entity differs from the others described above in the sense that in this case every unit starts from societal issues followed by technological issues and science contents.

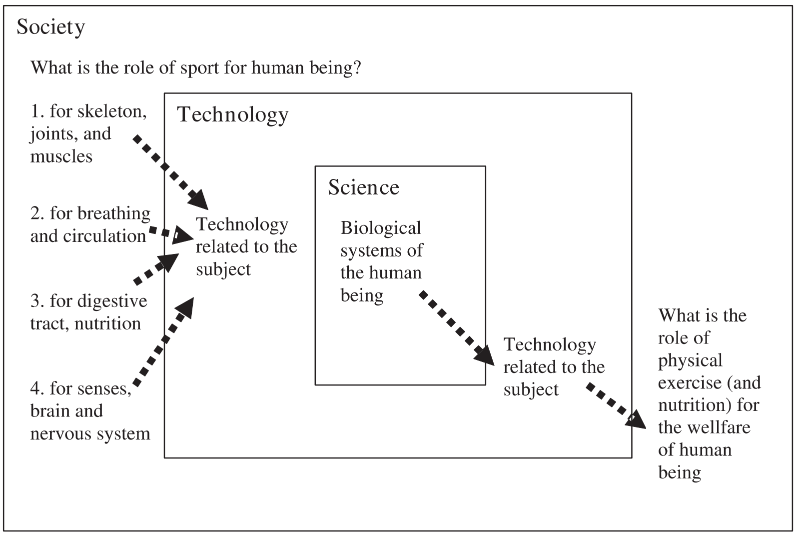

Figure 5. The units in studying the biological systems of the human being.

Before the teaching project the pupils were asked to draw what they think that is included to the human body. They were given the outlines of the body where they draw the parts they wanted. The pupils also read a short article concerning childrens" physical exercise and made in pairs a mind map of the influence of the physical exercise for the human being. Pupils" drawings were categorized according to their knowledge of the structure of the human body. Ten pupils (out of 29) were chosen for the interviews to sketch out more exactly their knowledge of the structure and functions of the human being.

The first unit started by a drama presented by the primary school teacher students. The drama discussed the importance of the physical exercise and the most useful ways to drive it. The teacher students discussed also some professions related to the physical exercise and it"s role for the well-being of the human being. Next, the teacher students showed pupils X-ray of a hand and discussed with the pupils other technological systems related to skeleton, joints and muscles as well as to the physical exercise. The science content included the structure and the functions of skeleton, joints and muscles. Technology and finally, societal issues like the physical exercises of today were discussed. The pupils also started to follow their own physical exercises according to the instructions.

Next week, the pupils made experiments concerning breathing and circulation. They measured pulse, breathing frequency, volume of the lung, and blood pressure. Based on the experiments, the circulation (heart and blood) and breathing were discussed. The teacher students demonstrated the function of the heart and the lung. The technological devices helpful in dealing with the problems and finally, the ways how to take care of the circulation and the lung were considered. Pupils" follow-up study concerning the time used for physical exercise was collected and the time used for the exercises was marked on the poster. This was done in the next lessons, too.

The third unit focused on digestive tract and nutrition. The teacher students illustrated the digestive tract by a T-shirt which they had drawn of the system. They discussed with the pupils what happens to a banana which the teacher student had eaten. Then, the pupils built on a paper a digestive tract by using the available materials; balloons, rubber bands, string, thread, paperboard, straw (Figure 6). They worked in small groups. Finally, the learning was tested by a small competition. The pupils also reflected their own group working.

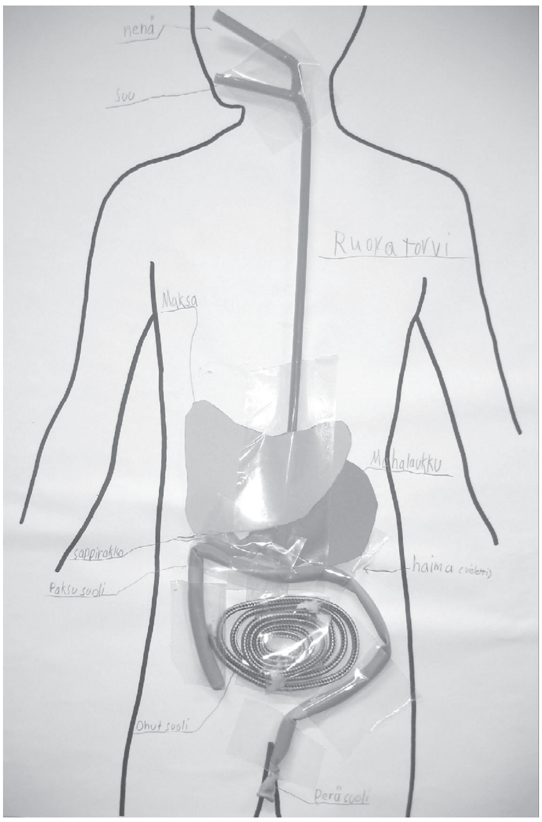

Figure 6. Example of the modelling of the digestive tract.

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Last time, the senses, the brain and the nervous system were studied. The lesson included a demonstration of the motion of the nervous impulse by using the pupils. The senses were studied in small experiments. Finally, the subject was discussed. The time used for the physical exercises was collected again. The results which were collected on a poster showed that the pupils had exercised much more than the teacher students and thus had won the competition.

After the teaching project, the pupils draw again what they think is inside the human body. The same pupils as before the instruction period were interviewed. The researcher discussed with them the structure and functions of the human body. The possible conceptual change, due to the instruction was sketched out. After the instruction, more pupils than before draw the structure of the human being more exactly. Their knowledge was to some extent broadened. They also seem to have learnt most of the digestive tract. They also pointed out the modelling done during the lesson. In the test, the pupils also managed best in the question concerning the digestive system.

Conclusions

The primary school teacher students trained STS-approach at schools. The cases 3 and 4 were carried out in the same fifth class. The case 1 was carried out in an afternoon club, but the others in the basic training groups. During every teaching project research was also carried out in the context of the STS-instruction. However, this paper focuses on presenting the teaching periods as models of the STS-approach. To become a STS-teacher has been found to take time (Tsai 2001). In this sense, these cases are too short to show changes in the primary school teacher students" behaviour.

The feedback from the rural schools was mostly positive. Although some problems existed in the arrangements all the time, they were not remarkably difficult from the viewpoints of the realization of the STS-approaches by the primary school teacher students. The two class teachers in the school in the cases 3 and 4 commented the teaching project especially positively. They felt that they got some new ideas for their profession. In addition, they had got positive feedback from the parents. Thus, the co-operation with the rural schools and the local companies was successful, and at the same time the primary school teacher students got useful experiences in the STS-teaching.

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