What technology content and values emerge in the teaching of climate change?

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Abstract

Today, many people live with climate anxiety, and both politicians and companies emphasize how important sustainable strategies and activities are for developing a society with less impact on climate change. Within education, it is central to implement themes dealing with such issues as well. As a technology teacher, one will be expected to have knowledge and ideas about teaching the climate issue, and to be prepared to manage climate anxiety among students. With the aim of supporting teachers, a group of climate researchers, professional teachers, and pedagogues from a science centre, have cooperated in developing a Climate Kit, including an instruction sequence, and teaching materials. This climate kit will be used in primary and secondary schools during 2018. When the kit will be (1) developed, (2) tested and (3) implemented to teachers within a course and (4) used in classrooms, a research study will be accomplished as well. Empirical data in this present study emerge from observations of (1) workshops with the actors when the kit is created and (2) tested in classroom as well. The observations will thereafter be analysed using a discursive perspective partly with aim to identify what knowledge content in relation to climate change that is highlighted in the technology teaching, and partly with a discourse analytical perspective focusing on the values and steering strategies within the teaching practice. The research question: What content, values, and strategies concerning technology and climate change emerge as important? The aim of the study is to investigate teaching content and teaching approaches within technology education, focusing on climate change, with an overall aim to analyse and describe technology education for social and environmental change. This paper presents the results emerging from analyses of empirical data, see above, from workshops and test of the climate kit. Both the collecting of empirical data and the analyses was completed during March 2018.

Key Words: technology education, climate change, discourse analysis.

1. INTRODUCTION

At the Paris climate conference (COP21) in December 2015, 195 countries agreed to a global action plan to limit the global warming. The success of COP21 rests on knowledge and awareness about our changing climate. Knowledge and awareness establish in school. The syllabus for the technology subject in Sweden contains goals for developing knowledge about the impacts of technology on the environment, society and human beings. Technology education should also make young people aware of the consequences of their own choices and equip them with skills, knowledge and dispositions to understand and make evidence-based decisions about both personal and global issues. In Sweden, and other countries, underlying science on these issues has been taught regularly in school (for example energy sources and greenhouse effect). However, linking to the global and controversial nature of climate change and the relationship with technology is rarely seen. Today, many young people live in fear of climate change. This generates a sense of hopelessness about our future, which undermines motivation to work towards a better future by taken positive action to limit climate change. Teachers must have the opportunity to extend their knowledge about the climate (Bryce & Day, 2014) and about argumentation in science and technology classroom (Martín-Gámez & Erduran, 2018). As a support to teachers, some actors (climate researchers, in-service teachers, and pedagogues from a science centre) have the intention to develop a climate-kit that will help teachers make knowledge about climate more accessible to their pupils. The aim with that project is to create fact-based optimism among teachers and pupils. Scientists work together with pedagogues to design a professional development course and teaching kits. In-service teachers will ensure that the climate-kit is useful for the target group. In total 120 practicing teachers will participate in the course. The course would result in skills related to the climate kit and knowledge about climate change. After completion of the course, all participants will receive the kit for implantation in their own practice.

This present study will investigate technology teaching within the project, described above. In this paper, phase one of the study is presented; investigation of the development and tests of the climate kit. The course and implementation in classes will be investigated in phase two of the study, during autumn 2018. The aim with the study in total is to investigate the teaching content and teaching approaches related to technology education with the focus on climate change, emerging in the project. With an overall aim to analyse and describe technology education for environmental and social change. This is an example of future educational challenges from a technology perspective. Chang & Pascua (2017) argue; "given the complexities and uncertainties of a climate changing world, children who are unable to engage climate change issues will likely miss the benefits of CCE (climate change education). Hence, it is the /…/ educators' job to continue working on research that will impact the way the topic is taught and learned, with a view to helping children succeed in a climate changing world" (p.179).

2. LITERATURE REVIEW

The herein presented case study focus on teaching content, and what attitudes and values that follow the content imbedded in the teaching when the climate-kit is used. Science and technology education researchers have argued that socioscientific issues ought to be used as contexts for learning (for example Sadler and Dawson, 2012). In particular, climate education must allow children to engage in climate change discourse, critically and accurately. Climate change is characterized by complexity and uncertainty, and schools need to teach the issue of the latest climate change, especially global warming, to equip students to mitigate and adapt to the expected global conditions. Such education is believed to be the most important strategy for building climate knowledge (Kagawa & Selby, 2012). When deciding on, and arguing about climate change issues, individuals may need more than scientific evidence. They may need to identify and analyse social, economic, ethical or political aspects and claiming that recognition of the complexity of the problem and investigating the issue from multiple perspectives are important aspects of decision-making (Sadler et al., 2007). Some studies have investigated explicitly climate change education (Bravo-Torija and Jiménez-Aleixandre 2012; Klosterman and Sadler, 2010). There occur a teacher-led classroom education where technology cases or dilemmas are included within a science topic (Klosterman and Sadler 2010). The teaching may include explicit argumentation and conceptual understanding. The approach to inclusion of social scientific issues, for example climate change, in classroom is varied but research supports the imperative role of the teacher in the success of the intended outcomes (Marin & Halpern, 2011).

Within technology and science education, earlier research founds specific subject content that promotes action competence for the future among the adolescents. Action competence is considered as being related to confidence in one's own influence, knowledge of action possibilities, and a willingness to act (Breiting & Mogensen, 1999). However, research shows how education on climate change usually will face low-impact actions, hoping to cause individuals to change behaviour later in life (Thøgersen and Crompton, 2009). Wynes and Nicholas (2017) have identified four recommended high-impact actions to highlight, which they believe to be especially effective in reducing an individual's greenhouse gas emissions: having one fewer child, living car-free, avoiding travel with aeroplane, and eating a plant-based diet. When Wynes and Nicholas (2017) analyses educational texts, they show that education books embraces more of naïve examples and do not focus on high-impact actions and controversial issues. Wynes and Nicholas want to emphasise that education creating a limiting gap between educational content and individuals willing to align their behaviour with climate targets. Their results show the important role of more high-impact aspects in education and they argue, "high-impact actions (through providing accurate guidance and information, especially to 'catalytic' individuals such as adolescents) could be an important dimension of scaling bottom-up action" (p. 7).

Theoretical frame

The present study arise the research question; *what content, values, and strategies concerning technology and climate change emerge as important?*
The analyses are based both on identifying what knowledge content in relation to technology that is occurred in the climate kit, and somewhat a discourse analytical perspective (Gee, 2014) focusing on the values and governance strategies within the climate kit (Öhman, 2010). The theoretical frame of the study is inspired by the notion of "big D" (Gee, 1990); "Discourses are ways of being in the world, or forms of life which integrate words,

acts, values, beliefs, attitudes, social identities, as well as gestures, glances, body positions and clothes" (s. 142). Inspiration from Öhman (2010) as well, and her arguments about school subject's practices and the relation to power. Öhman (2010):"A school subject's practices, traditions and customs are often deeply rooted in the teaching practice, and often regard content as natural and obvious. With the aid of [a Foucauldian power perspective], it becomes possible to study how the knowledge, norms and values included in an activity render certain ways of acting more reasonable and others less reasonable and thereby benefit certain ways of acting and being"(p. 406).

3. METHODOLOGY

Results to be presented in June 2018, at the PATT-conference (Pupils attitude towards technology) will be obtained through: (1) observations of workshops with actors developing the climate kit and (2) observation of test teaching sequences in a classroom. Actors that develop the kit are climate scientists, science centre's pedagogues and primary school teachers. When tested in the classroom, one climate scientist and two science centre pedagogues were teaching. Observations of workshops and classroom tests were made, and those sessions were audio recorded and transcribed as well. The aim of the study in total is to investigate teaching content and teaching approaches within technology education. Further, what values and governance strategies that emerge. All these aspects will be searched for within the workshops and test teaching practice. The observation notes and transcripts were analysed in an iteratively process with aim to generate empirical data about the subject content, values and steering strategies.

4. RESULTS

4.1. Workshops for to develop the climate kit

From observations of workshops, the first results that emerge from analyses show how the different actors (scientists, pedagogues, and teachers) communicate content and signal values. Climate scientists communicate basic concepts that underlie our current climate understanding. They argue to motivate with knowledge and a sense of hope for our individual and joint efforts to combat climate change. First of all, knowledge about the greenhouse effect and the role of carbon dioxide. They also highlight that a series of natural feedback mechanisms regulate the climate. Climate feedback can be negative or positive. Albedo (referring to the Earth's ability to reflect solar energy back into space) is an example of a positive feedback. Snow and ice have high albedo and reflect solar energy back into space. If there is less snow and ice, the earth's albedo reduces, less solar energy reflects in space, and the earth gets even warmer. Climate scientists stress the importance of the knowledge about the greenhouse effect and albedo. In addition, our contribution to climate change must be seen in the context of natural feedback mechanisms. In addition, daily efforts from individuals to mitigate climate change, based on knowledge about the climate system, are important. The scientists emphasize actual knowledge as a fundamental reason for understanding how technology activities (human activities) will interfere with the climate. They claim that knowledge primarily develop through inquiry-based experiments.

The science centre's pedagogues communicate how the technology activities affects the climate. They have developed educational themes about food, clothing, transports and use of technology in household with the aim of challenging students' understanding of aspects that interfere with the greenhouse effect. Focus is the amount of carbon dioxide contributed in the activity. The activity aims to force students to choose and to value, be a "good or bad" climate person and appreciate the possibility of using less carbon dioxide. The important content is the amount of carbon dioxide produced in various technical systems, processes, materials and agricultural methods. In addition, the students will have to evaluate and argue.
The in-service teachers communicate how important it is that the students think that the activities and the experiments are fun and interesting. They also want the students to use digital tools when they work with themes, activities and experiments.

4.2. The test sequence

The climate kit test can be described consisting of two parts. Part 1 – investigation of carbon dioxide (CO_2) and the relation to a higher temperature. The climate scientist (CS) was guiding two one-hour lessons, a group of 20

pupils with age 10, each hour. In total 40 pupils. They were sitting around two tables and expected to make an experiment. At one table they had a source of CO2 (with C-vitamin tablets), figure 1, and at the other table there were no CO2 source, figure 2, otherwise the same condition apply at the two tables. The CS was initiating with questions about CO2 and a relation to a warmer climate. CS was focusing very clearly on one issue; can we see it with our own eyes, how CO2 makes it warmer? Thereafter CS introduced the experiment. When the experiment was completed, CS summarized and concluded in a statement about how CO2 make the climate warmer. After that, CS was arguing for that individuals have to produce less CO2, thereby leading into Part 2.

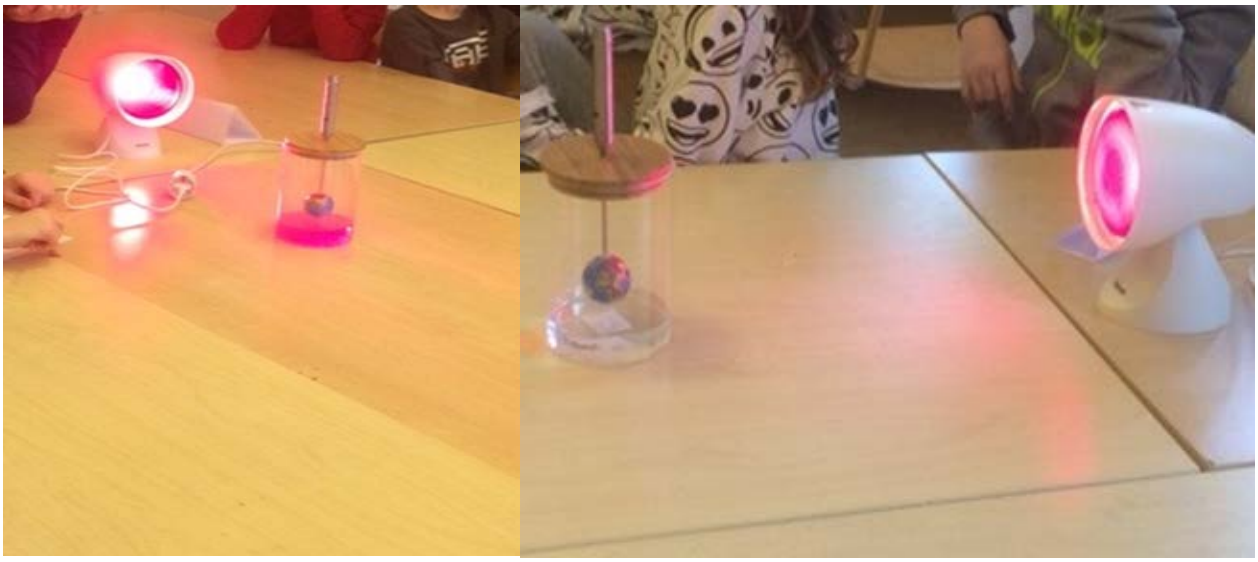

Figure 1 and 2. One lamp (the sun), one glass jar with lid (greenhouse), a thermometer fixed in a small globe (the earth). To the left, pink fluid (c-vitamin (CO2) and water), to the right only water. Two comparative experiments that were continuing at the same time.

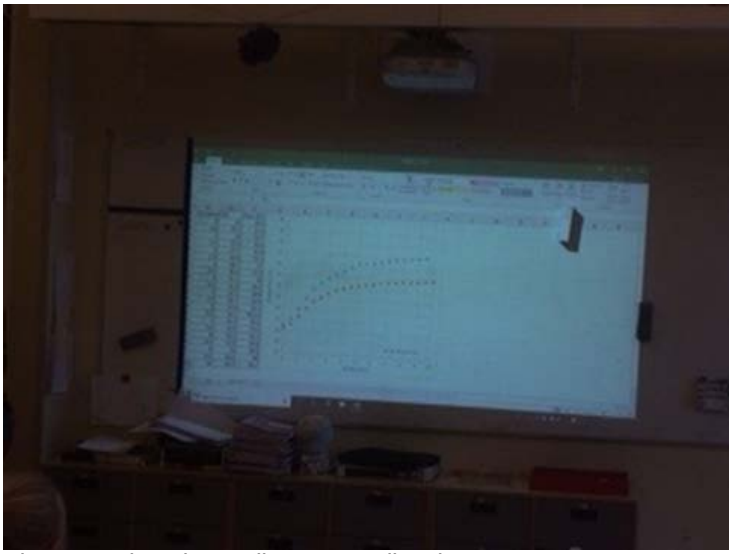

Figure 3. When the pupils were reading the temperature every 30 second during 10 minutes, CS wrote the amounts into the computer and two different curves appeared on the screen. The pupils could see how the temperature in the CO2-glass jar was increasing to a higher level.

Part 2 – two science centre pedagogues were guiding the same pupils as in part 1, in a four stations activity during one and a half hour (each group of 20 pupils). Five pupils in each subgroup rotated between these four activities:

- Activity 1) How far could you travel when using 1 kg CO2? With an aeroplane, a car, a train, a bus, a bike, a sailing boat? (six distance scenarios were given, places from real life, a picture of a map were included) the pupils were expected to rank the vehicles in order from shortest distance to longest, discuss, come up with arguments and write everything down. See figure 4.

- Activity 2) How much CO2, common household technology contribute with when being used? Make a ranking between; 15 minutes of a warm shower, one-hour use of an oven, one hour TV, one hour using an iPad, one search with google, one text message. The pupils were expected to rank, discuss, argue and write their answer down.
- Activity 3) to choose food and be a "good or bad" CO2-contributer! Choose from pictures of food (salad, tomatoes, potatoes, rice, meet, pork, chicken, fish, beans, root vegetables etc.) and then pick up CO2-weights for each specific food-piece (weights were marked with name of the food stuff and designed in a size proportional to CO2-contribution), then use a food scale to get a total CO2-weight for the whole meal. The pupils were expected to argue, explain, make their own choice and discuss and write their answers down. See figure 5.
- Activity 4) about the use of clothes. Be a "good or bad" CO2- contributor! When buying clothes? In a luxury boutique, in a cheaper boutique, in a shop with only ecological clothes, in a vintage/second hand shop or if you change clothes with a friend? The pupils were expected to argue, discuss, explain, and make their own well-founded choices. See figure 6.

Figure 4. Activity 1.

Figure 5. Activity 3.

Figure 6. Activity 4.

In part 1 the CS guide the pupils to evolve a knowledge content, not mainly technology content rather natural science content. With well-planned open questions, specific and exact aims, they will make the experiments, and thereby be trained in inquiry-working routines and principles. The CS has a clear focus on the specific issue as well: we must see, with our own eyes, if CO2 contribute to a higher temperature. In this context, it seem to be important to be convinced about the fact of greenhouse effect. The subject content that emerge are inquiry-work skills and the knowledge that CO2 make the temperature rise. The CS makes connections to the own profession as a researcher, how exciting it is and how important the researcher is for making evidence undoubtedly and statements truthful. Great valuing of scientific knowledge arises, thereby highlighting the role of research in searching for convincing truth. Many of the pupils seem to follow the CS´s guiding and the very plain instructions. Some pupils answer on questions very ingeniously and many seem to get an interest for inquiry. Nevertheless, it seems to be a lack of similarities between different pupils pre-knowledge, and to what extent they can follow and participate in the discussions.

In part 2, it emerge a lot of specific technology subject content. The pedagogues highlight content such as:

- There are most contributions of CO2 in transport systems and in food processing
- A strategy to find out CO2 contribution could start with analyse of energy usage
- Knowledge about energy sources and amount of energy usage are relevant. How the electricity is produced, what kind of fuel and technique
- Knowledge about the systems function seem to be necessary as well, for example differences between a google search and a text message, about the use of internet (electricity usage) or the mobile network (less electricity)

Therefore, knowledge about energy systems, energy sources, energy usage, are important content for understanding the CO2-contribution. In addition, material production, the origin of different materials and energy usage for recycling compared with new production. Food processes comprises agriculture, animal farming

(including the aspect of cattle and their methane production), breeding and transport systems as well. This make the CO2-production very complex and very focused on system understanding and especially about energy.

The pedagogues had to guide the pupils in every activity. The tasks seem to be rather difficult to grasp, it requires an understanding of the complexity, a broad holistic view and a deep understanding of some technology systems. However, in this session it became very clear for the pupils that individuals have to contribute with less CO2 and they seem to understand how to do it, the challenge is how to argue, when deep and specific knowledge is required. Some of the pupils have a well-developed understanding of all these aspects, they refer to attitudes and habits in their own families, for example; eating vegan food, avoiding car-transports, buying clothes at second hand, showing pride of their impact. Other pupils also refer to personal experiences but emphasize a more worried approach. They ask if their long travel habits is a problem. In this session, it will become very clear for pupils that there is a distinction between being a "good" and "bad" climate individual.

5. DISCUSSION

During the observations of the climate kit developing workshops, there are divergent aims and views between climate scientists, science centre pedagogues and primary school teachers. When it comes to important subject content and how to use the climate kit, with a technology perspective. The high valuing of fact knowledge (greenhouse effect and albedo effect), and how that will become understandable for pupils through experimental work are views encouraged by climate scientists with a great power and scientific status. The science centre's pedagogues focus more on activities with "high-impact" (Wynes & Nicholas, 2017), and seem willing to point out the quantity of CO2-contribution in relation to technology as important knowledge. They focus on pupils own choices as well and argue enthusiastically for sustainability and individual action competence. The professional teachers do not seem to have entrance to establishing the subject content or the teaching methods, and they take an inhibited position. The specific content occur in consensus, with different actors taking different views. The attitudes and roles present, shows a hierarchic structure with differences between scientific status and teacher status.

During the observations of the test sessions, the climate scientists could transform their intentions and aims within the teaching situation. A clear focus on one defined issue, and highlighting the relevance and the importance with inquiry-work, seem to give expected result. The climate scientists take advantage of the researcher role and could thereby guide the pupils with authority. For the pupils, the researcher role and the inquiry-work are something familiar. They could recognize the procedures for the lesson but also imagine the special conditions that are available this day.

During part 2, when more of technology content was taught, the complexity and the diversity in the technology subject emerged. The intention with the sequence seemed to be that pupils were expected to view and reflect over "high impact" aspects, and therefore the pupils met four different technology areas with great impact on CO2-contrubution. It seem to be possible, in a normative way, to explain how humans have to act and what decisions one should take. However, it seem more complicated and more time consuming to develop pupils knowledge for understanding the complexity and underlying aspects, and thereby realize and really understand choices and action strategies. Knowledge content emerge during the session, but the normative intentions to influence behaviour appear to be more important.

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