Societal Aspects of Technology

The Swedish Lower Secondary School Curricula in International Comparison

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The future of humanity depends heavily on the technological decisions and choices we make. To prepare the young generation for participating in these decisions the Swedish school technology curriculum includes study of societal aspects of technology. However, evidence coming from the classroom observations shows that teaching of these aspects is almost absent in lower secondary school (age 13-15-year) technology education in Sweden. In order to give an international perspective on the presence and emphasis on societal aspects of technology a comparative curricular study has been made. The comparison has aimed at describing the corresponding content in the curricula, in which subjects it is found, how it relates to design and making and finally how much flexibility the syllabi offer to the teachers contentwise. The Swedish curriculum has been compared with Norwegian, Finnish and Estonian curricula. The study shows that in Finnish Educational Sloyd and Norwegian Arts and Crafts the societal content is closely linked to design and making. The findings also reveal there are apparent similarities between the content regarding societal aspects of technology in the Estonian, Norwegian and Swedish Technology subjects, but the Swedish content stands out both as the most extensive and the least design related.

Keywords: Technology education, curriculum, design, framing, educational sloyd.

Introduction

Our lives, our society and our technology are deeply intertwined. Our future depends heavily on the technological decisions and choices we make. Therefore, societal aspects of technology (SaT) become an important part of technology education internationally (ITEA, 2007), and in Sweden (Swedish National Agency for Education 2018). The possibility of substantial technological change in the decades ahead deeply impacting our society (Brynjolfsson & McAfee 2014, Fölster 2015, Häggström 2016, Schwab 2017) underscores the urgency of preparing the coming generation for decision making informed by an understanding of SaT.

Learning about the relationships between society and technology is emphasized in the Swedish technology education curriculum. It is a compulsory subject area, but problems were reported with inclusion of the SaT in daily school practice (Skolinspektionen 2014). In fact, the report from Skolinspektionen states that the societal aspects are almost absent from the classroom observations of technology education in lower secondary schools (age 13-15).

The findings of a recent study by Fahrman, Norström, Gumaelius and Skogh (2019) propose a mechanism by which the SaT absence can be understood. The study describes a teaching practice common to the four interviewed experienced technology teachers. This practice was centered around design and making in a way that excluded mandatory content not closely linked to design projects.

Skolverket - the Swedish National Agency for Education – has taken a concrete step for improvement of the situation. They dedicated the first technology education module of a national ongoing teacher professional development program to SaT (Rehder 2016). Curricular initiatives would be another

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possibility. Norström (2014) documented a need for more guidance among some technology teachers in his dissertation. He suggested that explanatory supplements to the curriculum should be created.

In order to bring international perspective to the Swedish SaT situation this study will explore the SaT content of a range of national technology related curricula. The relation between the SaT content and a design centered teaching practice as well as the amount of guidance in the SaT part of the curricula will be described. The next section deals with the theoretical foundation and terminology for these descriptions.

Theoretical framework

The theoretical framework for this study consists of four main parts. The first revolves around how the concept of SaT is used in the study. The second deals with the relationship between SaT and design centered technology teaching. How the study employs the concept of framing to describe the level of prescriptiveness is the theme of the third part. The last part explains the rationale for directing the study at the most specific levels of the curricula.

By saying that technology have societal aspects we mean two things. First, technology usage and technological development has effects that goes beyond the individual user or designer. Second, phenomena at the societal level impact on technology usage and development. In their article about what questions from the literature on the Nature of Technology that would be wise to incorporate in the Technology offering of STEM education Pleasants, Clough, Olson and Miller (2019) discuss possible content as having differing value for personal and societal decision making. Our interpretation is that SaT content could be taught with two slightly different "curriculum emphases" (Roberts 1982). One is more directed toward personal decision making when designing or using technology. The other centers societal decision making when exercising informed citizenship around technological issues. Klasander (2010) describes this later as learning about technology by relating it to acting as an informed citizen, making choices and developing understanding related to technological impact on society.

The slight difference between SaT content taught with an emphasis on personal or societal decision making could become more pronounced when combined with the findings from Fahrman et al. (2019). They discuss how a teaching method centered around design projects is highly time consuming. Therefore, there is a need for excluding curricular content and especially content that is perceived by teachers as "ill-suited" for teaching specific design and making projects. The teaching method they describe includes teaching concepts and vocabulary. Concepts are however chosen for their relevance in the design project and this limits the domains they can be drawn from. Lind, Pelger and Jakobsson (2020) gives an example of such a design project and how the participating students bring input from the non-design activities regarding emerging technology and sustainability into the design process. This happens by discussions centered on the models the students are designing. Together this suggests that if there are vocabulary, concepts and phenomena that are useful in societal decision-making regarding technology but have loose linkages to artifacts produced in design projects such content might be missing.

An example of content relevant for societal decision making about technology issues might be a carbon dioxide tax. It is a policy device intended to steer technological development towards low carbon dioxide emissions. A general demand of low emissions is easy to incorporate into design specifications for an educational design project. However, from the designer's point of view, the policy mechanisms behind that demand are much opaquer.

This tension between some SaT content and design-centered teaching methods could be a possible cause of the absence of such content in the lesson observations of Skolinspektionen (2014) in Sweden. Design is a common priority in many different national versions of Technology and technology related subjects as argued by for instance Buckley, Seery, Gumaelius, Canty and Pears (2020) and evidenced by Rasinen (2003). Therefore, the study will describe the SaT content found in the national curricula in terms of how easy it seems to incorporate it into educational design projects. Another aspect to consider is that some SaT content might be more suited for inclusion into subjects such as social studies. These subjects will therefore be included in the study.

To analyze the curricular content in terms of how prescriptive it is, we have employed Bernstein's (2003) concept of framing. Framing relates to the amount of control teachers and students have over the knowledge that is to be taught and learned. Strong framing means a low amount of control and freedom of content choice for teachers and students. As the amount of control the teachers and students have over the knowledge that is to be taught and learned grows the framing is said to become weaker and weaker.

Finally, we will explain our decision to aim the study on the most specific parts of the curricula. This is built upon a general picture of what it means to know something and how the learning of that can be organized in a classroom setting. Here we recognize the value of the multifaceted strand of educational thought that emphasizes vocabulary (Hirsch 2019) and knowledge about concepts and phenomena (Young 2013). We regard learning domain relevant vocabulary, concepts and phenomena as one important part of preparing students to understand information and act as an informed citizen in societal decision making about sociotechnical issues.

Aim and research questions

In order to explore potential curricular remedies to the situation regarding the SaT content in the Swedish technology subject an international curricular comparison has been carried out. This study investigates and compares how SaT content are constructed in the syllabi of the lower secondary school curriculum of Sweden and those of Estonia, Finland and Norway.

To do this, for each national curriculum the study aims to describe:

1. What specific content is mandated that deals with societal aspects of technology?
2. In what subject syllabi is that content situated?
3. What is the relationship between that content and designing and making?
4. How do the different parts of the content relate to each other in terms of framing?

Method

The four national curricula were chosen partly because of convenience and partly because of the close resemblance between the structure of the Swedish school system and the other three. The similarity between the lower secondary section of the obligatory school consisting of three years taken between 13-15-year-old and common to all pupils was an important factor facilitating comparison.

The curricula were obtained from the websites of the national school authorities during the autumn of 2019 (Estonian Ministry of Education and Research n.d., Finnish National Board for Education 2016, Norwegian Directorate for Education and Training n.d., Swedish National Agency for Education 2018). Colleagues from the corresponding countries were consulted in order to include all syllabi potentially relevant for the SaT focus. These syllabi are shown in table 1.

Table 1. National syllabi included in the study

Country	*Subject*
Estonia	Technology, Social studies (Civics and History)
Finland	Educational sloyd, History, Civics
Norway	Arts and crafts (the Design and architecture strand), Sciences (the Technology and design strand), Social Studies (the History and the Civics strands)
Sweden	Technology, History, Civics

In Estonia the Technology subject includes both general technology studies as well as home economics and in younger years crafts. Social studies include both civics and history. The closest Finnish resemblance of the Technology subject in Sweden and Estonia is Educational sloyd so it was chosen for comparison together with History and Civics. In Norway Sciences include Technology and design as one strand and Art and Crafts include the strands of Design and Architecture while Social studies includes History and Civics as strands. Sweden has Technology, History and Civics as separate subjects. All these subjects and strands resemble each other even though the organizational levels differ somewhat in the four countries.

These syllabi were read and content concerning SaT was identified, thus responding to research question 1 and 2. The headings for the content used is the most specific level given in the syllabi and it is shown in table 2.

Table 2. Headings for the most specific content in the national syllabi.

Country	*Most specific content heading*
Estonia	Learning content
Finland	Core content
Norway	The aims of the training
Sweden	Core content

In order to address research question 3, the collected content was analyzed by categorizing the content in three classes by the first author. The classes are shown in table 3.

Table 3. Classes for categorization of SaT content after ease of incorporation into design projects.

Class	*Abbreviation*	*Description*
Closely related to design	D+	SaT content with strong links to design or making that explicitly suggest its teaching to be incorporated into design- or making-based activities.
Less related to design	D0	SaT content that easily can be incorporated into design projects
Least related to design	D-	SaT content "Ill-suited" for specific design projects

To relate the different parts of content to each other in terms of framing and thereby answer research question 4 each single content description was placed on a piece of paper. The content descriptions were compared two at a time based on how much control teaching of them would lend to the teacher and the students by the first author based on his teaching experience. This process continued until a stable equilibrium had been established and all content descriptions were sorted along an axle of stronger and weaker framing. The abbreviations F+, F0 and F- denotes stronger, medium and weaker framing.

The classification and sorting regarding research questions 3 and 4 were validated by the second author.

Results and analysis

Tables 4-7 show the found content that directly relates to societal aspects of technology presented per country and subject. Every part of the content is marked to show how it was categorized with regard to relationship to design and framing. Specific subparts of the subjects that included SaT were elucidated in some country's curricula, for clarity.

Table 4. Estonian content.

Subject	*Subpart of subject*	*Learning content*
Technology	Technology in Daily Life	Analysis of technology: positive and negative influences. (D0F0) Ethical convictions in application of technology. (D0F0) Sustainable consumption of resources. (D0F0) Consumption of resources. (D0F0) World of work and work planning. (D-F0) Raw materials and production. (D0F0) Perspectives in the world of technology. (D0F0)
Social studies	History, The world from 1815–1914	The formation of industrial society, industrial revolution, manufacturing, urbanization, social face of industrial society. (D-F0)

Table 5. Finnish Content.

Subject	*Core content*
Educational sloyd	Awareness and participation: The students inquire into different meanings that crafts and crafted products can have from an individual, a societal and an environmental perspective. The students reflect over how crafts can promote sustainable development and well-being in everyday life. The students learn to participate, influence and communicate through crafts. (D+F-)
Civics	-
History	The origin and development of industrial society: The student goes into depth with a phenomenon that has changed daily life, the relationship between human and nature, and the world. (D-F-)

Table 6. Norwegian content.

Subject	*Subpart of subject*	*The aims of the training*
Arts and craft	Design	Describe the life course of a product and evaluate the consequences for sustainable development, the environment and value creation (D+F0)
Sciences	Technology and Design	Develop products based on specifications that use electronics, evaluate the design process and assess product functionality, user friendliness and sustainable development (D+F+) Test and describe the characteristics of materials used in a production process and evaluate the use of materials from an environmental standpoint (D0F+) Describe an electronic communication system, explain how information is transferred from sender to recipient and give an account of the positive and negative consequences related to this system (D-F+)
Social studies	History	Explain technological and social changes due to the industrial revolution (D-F0)

Table 7. Swedish content.

Subject	*Core content*
Technology	The internet and other global technical systems. The benefits, risks and limitations of these systems. (D-F0) The relationship between technological development and scientific progress. How technology has enabled scientific discoveries to be made, and how science has made possible technological innovations. (D-F0) Recycling and reuse of materials in different manufacturing processes. Interaction between mankind and technology, as well as mankind's opportunities to create technical solutions that contribute to sustainable development. (D0F0) Security when using technology, for example storing and protecting data. (D-F0) Consequences of choice of technology from ecological, economic, ethical and social perspectives, such as in questions about development and use of biofuels and munitions. (D-F0) How cultural attitudes towards technology have an impact on men's and women's choice of occupation and use of technology. (D-F0)
Civics	The importance of digitalisation for social development in different areas, for example the impact on the labour market and infrastructure, as well as changes in attitudes and values. (D-F0)
History	Industrialisation in Europe and Sweden. Various historical explanations for industrialisation, as well as the implications for different social groups and people's standards of living in Sweden, the Nordic area, Europe and some other parts of the world. (D-F0)

Figure 1 contains the analyzed results regarding research question 3 and 4. The ellipses show where the content in the different subjects was placed during analysis. The area of the ellipses has no relationship to the amount of content, larger areas only correspond towards societal aspects of technology related content that is more varied in the two dimensions. The Technology and Design related subjects are shown in white while history and in the Swedish case also Civics are shown in grey.

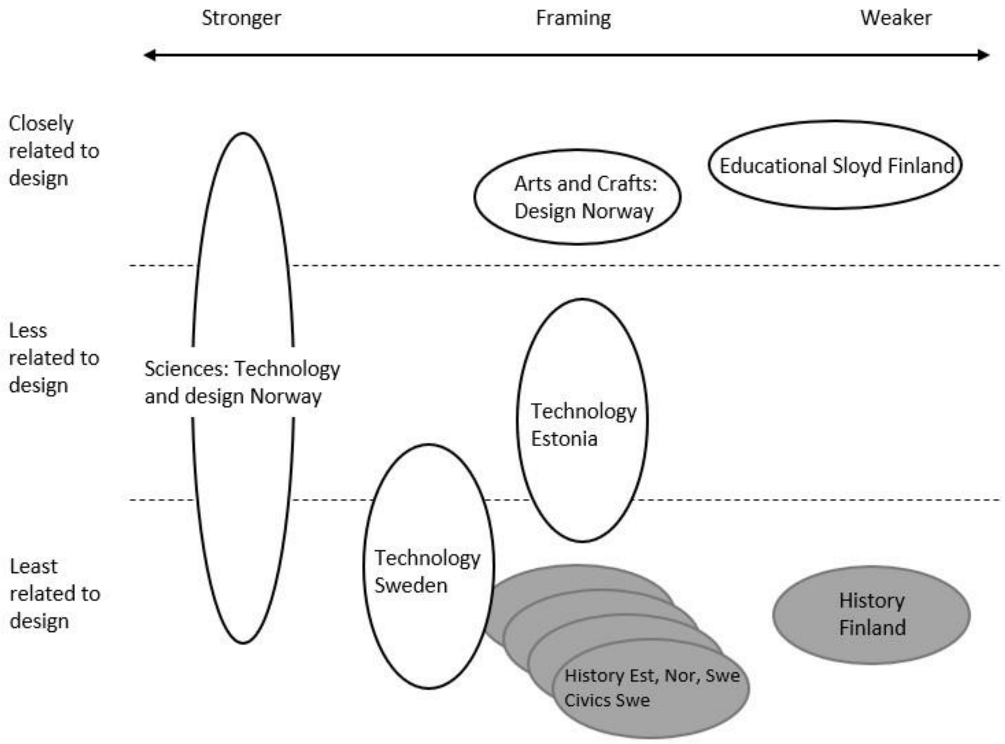

Figure 1. How the content in the different subjects relate to design and framing

With regards to framing the Norwegian Design and technology strand in Sciences and both the Finnish subjects stand out in each direction. In the Norwegian Design and technology case this is not because the SaT content in itself is more defined than in the Swedish and Estonian cases but rather because it is tied into defined blocks of other content. The content in the Finnish subjects contain wordings such as “inquire”, “reflect over” and “goes into depth with a phenomenon” that signal the desirability of some student control. Such clear signals are lacking in all other countries content descriptions.

Norwegian Arts and Crafts and Finnish Educational Sloyd share a common tradition centered on making that the societal content seems closely related to. In the other direction all four History subjects mandate content dealing with the industrial revolution and while some of that content certainly can be related to design assignments most of it would be a bad fit. This seems to be the case with the technology related content in the Swedish Civics subject as well.

The SaT content in three Technology subjects, the Estonian, the Norwegian and the Swedish have a lot in common. All three subjects mandate content about environmental dimensions of materials and evaluating technology. The Estonian content is described summarily and with the exception for the work life part all of it seems to integrate easily into design projects such as those described by Fahrman et al. (2019) and Lind et al. (2020). In comparison the Swedish content is both more defined and less suited for integration into design projects. For example, the content regarding understanding consequences following technological choices taken as such would integrate seamlessly into a design project. The examples however, munitions and biofuels, makes it clear that the ambition with the content goes beyond only evaluating artefacts designed in educational design tasks. The Swedish SaT content are more extensive than the corresponding content in both the Norwegian and the Estonian curricula.

Discussion

This study was motivated by the apparent lack of teaching of the SaT content in Sweden (Skolinspektionen 2014) even though the syllabus clearly mandates it. The findings indicate that the Swedish Technology subject stands out in comparison with the others. As with regard to the other three countries and their curricula there seem to be of little inspiration about how to handle the heavy emphasis on societal aspects.

The methods used for the content comparisons and the results should be regarded as tentative. They do however have a strength in their large degree of transparency. Since there is relatively little SaT content available in the syllabi can the interested readers easily verify the categorization by themselves. No ethical conflicts can be registered in the data collection.

Fahrman et al (2019) makes a qualitative description of an inconsistency between a teaching centered on design projects and attending to some curriculum content. It would be valuable to inquire quantitatively into to what extent that picture is representative for teaching of Technology.

We described a theoretical reason for expecting that there would be especially visible tensions regarding SaT content with an emphasis on societal decision making when teaching is focusing on practical design and making projects. The results show that there is reason to believe that the SaT part of the Swedish lower secondary Technology curriculum is comparatively more exposed to this tension. To investigate this issue further could turn out valuable for handling the SaT content problem in Swedish Technology education.

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