Research and development projects aiming to increase young adults' knowledge of energy and energy efficiency

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Abstract
Children and young adults are important target groups in order to decrease the climate change effects and increase an energy-efficient end use. With increased knowledge and awareness these target groups could play a constructive role in the current and future transition of the energy system. The correlation between knowledge, awareness and behavioral change is central for improved energy efficiency in the society. Children and young adults and their interest in the natural and technical science are central to ensure the long-term capability needed to transform the energy system.

To support this development the Swedish Energy Agency started with young adults as a target group in research and development projects in 2008. Since then approximately 5 million EUR has been allocated for projects aiming to increase knowledge in these areas among young adults by developing practical methods and tools, educational material or in-service training for teachers. Around thirty projects have been supported and three of them, KNUT school development project, KNUT evaluation research project and The Energy Fall, will be discussed in this paper.

The KNUT school development project is a national school project aiming at increasing students' knowledge and interest in energy and energy efficiency. KNUT also stimulates learning and career choices related to energy, climate and resources and therefor strengthen Sweden's capacities and competitiveness future in these areas. To ensure the scientific base a research group from Linköping University (KNUT evaluation research project) has followed the project's activities. Best practices of methods and tools have been tested and disseminated within the project at both regional and national level.

The KNUT evaluation research project has identified and analyzed five success factors regarding energy, climate change and energy efficiency of importance for education:

- The relationships between the national, regional and local level.
- The function of education vary in time due to the development of society.
- Get to know the education content inside and outside of school.
- Successful meetings between different actors.
- The educational systems capacity to educate all and at the same time recruit some for specialization.

This paper will present an overview of the Swedish Energy Agency's work on research and development projects aiming to increase young adults' knowledge of energy and energy efficiency and the KNUT evaluation research project results, analysis and success factors.

Introduction
The Swedish Energy Agency's work aims to stimulate the use of renewable energy, energy efficiency, mitigation of climate change and the transformation towards a more sustainable energy system. Children and young adults are important target groups in order to increase energy efficiency and decrease the climate change effects from end use of energy. The correlation between knowledge, awareness and behavioral change is cen-

tral for increased energy efficiency. With increased knowledge and awareness these target groups could play a constructive role in the current and future transition of the energy system. Children and young adults and their interest in science, technology and sustainable development are of central importance to ensure the long-term capability needed for the transformation towards a more sustainable energy system.

To support the needed development the Swedish Energy Agency in 2008 started working with young adults as a target group in research and development projects. Since 2008 approximately 5 million EUR has been allocated for projects aiming to increase knowledge in these areas among young adults by developing practical methods and tools, educational material or in-service training for teachers. Approximately thirty projects have been supported and methods and results from three of them – the "KNUT school development project", the "KNUT evaluation research project" and "The Energy fall" – is discussed in this paper.

The challenges of energy transition and an updated educational system reflecting the society's development are issues of international character and these challenges will have a decisive influence on redeployment and competitiveness. To reverse the current trend of students' declining interest in science and technology local actors have a significant and important role to play. They are important parts in the creation of an educational system that is updated and where relevance is at the heart and engage schools to become part of the local and regional long-term development work. To have a long term impact projects with "outside of school activities" must be planned and developed in consultation between the actors and project ideas coming from outside must be adaptable and based on the conditions prevailing in each case. When society expresses a need for new content to be taught through the educational system teachers and students need to be included from the start and a more student-centered and inquiry-based learning involves students better thus adding a stronger commitment for the needed changes.

The current and future transition of the energy system needs expertise. Though there needs to be a balance between the educational systems capability to prepare for higher studies in science and technology while at the same time providing all students with the needed general knowledge about energy and energy efficiency. School projects that tackle these challenges need balance.

At an overall level the results from KNUT evaluation research project shows that energy, climate change and sustainability could form part of a new vision for education and contribute to students' inclusion in real challenges.

Research and development projects with young adults as a target group – The Swedish Energy Agency's strategic guidelines

In 2008 The Swedish Energy Agency started research and development project with young adults as a target group. To ensure the project initiatives' sustainable impact some strategic choices were made to guide the work. The Swedish Energy Agency prioritized projects channelling activities through the educational system and with teachers as knowledge transfers, primarily teachers in middle and high school. A central prerequisite was project activities anchored in policy documents (Curriculum 2011), framing the energy issue thematically and contextualizing by providing current event knowledge.

Since 2008 the Swedish Energy Agency has allocated approximately 5 million EUR to projects that enhance young people's knowledge and interest for energy and climate change. Some thirty projects have been granted support, and the project portfolio covers a wide range of initiatives at local, regional or national level with varying focus; research, practical school development, regional or national climate and energy exhibitions and activities. Projects focusing on practical school development cover a wide range of methods addressed to apply teachers at different levels in the educational system and schools different pedagogical approaches.

The Swedish Energy Agency aims to obtain an equal regional distribution to complete national coverage in research and development project initiatives. Though, The Swedish Energy Agency has over a longer period of time supported two central initiatives, the KNUT school development project and The Energy fall. These two projects were carefully chosen to complement each other as they cover different methods and approaches. The KNUT project has resulted in development of practical methods and tools in concrete execution by working qualitatively in the classroom to give hands-on support in teachers' work. The Energy fall project has utilized and integrated previous project initiatives from the Energy Agency's project portfolio to launch an interactive web-based national platform for teaching material and practical exercises to support teachers in accomplishing the requirements of the curriculum. The project's last phase (2013–2014) concentrated on communicating and disseminating the platform to all Swedish elementary schools with a target of 40 percent of all the schools to practice the material.

There are clear synergies between the two projects and cooperation has taken place and together with other stakeholders working with education and sustainable development a national network was established. One landmark for the network was a dialogue meeting in November 2013, addressed to relevant authorities and ministries in order to discuss the educational systems role in sustainable development. Altogether the web-based national platform (Energy fall) and the more practically oriented KNUT project represents a good base to generate development, learning and dissemination.

Previous research framework to KNUT research results

Previous research describes students' difficulties in learning science and technology through compulsory education. Lyons (2006) shows that many students perceive teaching as transmissive and de-contextualized leading to unnecessary difficulties for students to relate to the content, leading to students' alienation from these fields of knowledge. Particularly affected are girls. Dawson's (2000) compiled research from the 1980s and onwards indicates that students under this social period developed more negative attitudes towards science and technology. Dawson believes that what happened during this period were changes in society that allowed young people to care about other things than they did before and that the education system concerning the specific content of school subjects had been fixed and did not evolving in line with the society. Daw-

son emphasise that selection and arrangement of teaching content is the absolutely most critical thing to work with. Vetleseter Bøe (2012) shows that prior research provides a good empirical basis for claiming that young adults interest in these areas of knowledge is low and decreases as students move through the educational system. Furthermore, girls more often than boys do not think they will cope with studies in the academic disciplines of science, technology, engineering, and mathematics and associate studies in these fields with high personal costs and less often identifies with role models in these academic disciplines.

Osborne, Simon and Collins (2003) have compiled previous research on students' interest in and attitudes towards science and technology and discuss its importance for future recruitment. One of the reasons for concern, regarding future recruitment within these areas, is that many researchers for a long time have indicated a relationship between a high number of scientists and engineers in a population and the degree of how modernized and economically developed a country is. The assumption is that there are important links between these areas of education and economic growth. The authors also show statistics in educational choices from the 1990s onwards underpinning that there is an escape from these training areas (see also EU Commission 2004).

KNUT school development project

The KNUT school development project (2009–2014) is carried out on a national level and regionally in seven counties targeting all levels from pre-school to high school with a total project budget of 1.6 million EUR. KNUT started in 2009 as an initiative to gather various regional projects under a larger joint effort in order to take a holistic approach regarding sustainable development in the educational system. The initiative was taken in talks between The Swedish National Agency for Education, The Swedish Energy Agency and four regional projects. The project covers nine counties and activities are conducted in collaboration with actors at local, regional and national level thus making KNUT a unique school project in terms of size and coverage. The project has engaged approximately 16,000 teachers and 480,000 children and students from 343 schools and universities in 60 municipalities. Within the KNUT project practical methods and tools with interdisciplinary focus, educational material, in-service training for teachers and support the progression from pre-school to university level has been developed. To stimulate choices of higher education in science, technology and sustainable development and to ensure the educational systems subject contends relevance and timeliness KNUT has increased the schools collaboration with universities and the local community. Activities have been carried out in close collaboration with NGOs, regional organizations, municipalities and private companies and a total of 222 companies have engaged in project processes or activities. KNUT has served as a national platform for sub-projects around the country and the national platform is used to create positive spill-over effects by dissemination local and regional results and good practices on a national level.

In the ongoing project phase efforts have focused on strategic work in collaboration with county councils, regional councils, academia and municipalities to clarify the role of the educational system for a sustainable society and engage school to become part of the local and regional long-term development work.

KNUT evaluation research project – two of the case studies

In the following the research groups results from the Girl Journey project and the Energy challenge, two activities in the KNUT school development project, are presented as well as some more theoretical perspectives used for interpretation and broader setting.

GIVING GIRLS BETTER OPPORTUNITIES TO LEARN ABOUT ENERGY, ENVIRONMENTAL AND SUSTAINABILITY

The "Girl Journey project" in Kalmar has focused on issues related to the lack of female applicants for higher education in the academic disciplines of science, technology, engineering, and mathematics (STEM). The project is still ongoing and the evidence is based on the results as up to date. The Kalmar region has a strong demand for well-trained staff in energy and technology sectors to meet future generation shifts. The regional Energy Agency SydOst (South East), together with other regional actors (Regional Council in Kalmar County, Swedish Nuclear Fuel and Waste Management Company (SKB) and the Linnaeus University) addressed the problem and in 2011 they started the project Girl Journey. 101 upper-secondary students from four schools participated, and the students visited actors outside of school working in the fields of energy, resources and climate change issues to stimulate the girls' interest in education in science and technology. Positive role models constituted an important element in this project. In cooperation with SKB the students visited Äspö laboratory to learn about the Swedish nuclear waste management and sample robot programming. The students were given the task to build and programme their own repository robot in miniature. Furthermore the students visited Linnaeus University, Department of Engineering, to take part of ongoing research on biogas and water treatment. The project activities had a strong focus on experimental teaching and to encourage the students to act and make individual choices. Networking was an important part and students from a nearby university were invited to inspire for higher studies in science and technology. (Jidesjö 2014.)

Empirical data was collected through a questionnaire as well as participation by observation and interview methods. The qualitative data from girls in upper secondary education indicate that connections with actors outside of school had a positive impact and realized the relevance of school work. Teachers' competence to make use of such experiences and to include them in learning environments in school is identified as critical aspects since the result indicate that such qualities can have an effect on educational choice. When giving girls, who have chosen any STEM educations for upper secondary level, a chance to put school instructions in relation with working life and societal relevance they were positive and said that those activities made them understand why the things they learn in the classroom was important. Some of the respondents mentioned this as important for their interest in the subject and for possible future educational choice in STEM. What seem to be lacking is to make those experiences part of continuing work in the classroom, i.e. as part of subject teaching. (Jidesjö 2014.)

THE ENERGY CHALLENGE

The Energy challenge initiative started in 2009 in the county of Värmland. Later on the project spread to the county of Dalarna and the counties of Akershus and Hedmark in Norway and a total of 3,500 students has engaged in the project's activities. The Energy challenge is part of the FEM project which is a Swedish-Norwegian interregional cooperation project. FEM is an abbreviation and stands for renewable energy, energy efficiency and environment and is a forum for business development based on smart use of energy. The aim is to contribute to new and greener products, services and workplaces in the FEM region. The Energy challenge aims at developing regional knowledge and research in renewable energy and energy efficiency. The target group is students from six to twelve years and the participating classes are offered free training sessions for teachers, experimental materials, energy challenges for students and learning materials for both teachers and students. The content is closely following the new curriculum and supports students to achieve a variety of the learning requirements. Each school initially put up five goals and activities to contribute to the project objectives, for example, save electricity or increase the share of using locally produced food in the school canteen. The project also encourages and supports schools to apply and implement the Green Flag certificate. The Green Flag certification is administered by the NGO "Keep Sweden Clean". The school commits to work with sustainable development based on self-defined action plans for one-two years with documentation and a follow up on their efforts. Nordic Council of Ministers for sustainable development use the number of pre-schools and schools certified by Green Flag as an indicator on measure to achieve the strategy of sustainable development (Jidesjö 2014).

Results from the research show increased interest and awareness on energy and environmental issues and participating children and students claim that they have come to understand energy efficiency in everyday life and describe concrete actions. However, there are very few voices from students or observations that can be linked to entrepreneurship. Regarding teachers' commitment the evaluation shows that this factor is important. Some of the schools had achieved the certification "Green Flag" before the project commenced, however all schools received this award after the project ends. One of the identified factors of success was that the involvement of the entire schools students and all staff. Together a learning community was established with development across schools (Jidesjö 2014).

General critical factors in school development projects

This part aims to summarize the research group's general results for school development. Five framework factors were identified which constitute critical perspectives that can contribute to school projects improvement. The factors also make up a basis for interpretations and conclusions.

RELATIONSHIPS BETWEEN THE NATIONAL, REGIONAL AND LOCAL LEVEL

Previous research results indicate that changes at the national level, the educational mission, have limited impact on what happens in the classroom. The intended mission, as described in the form of various policy documents, is rarely ever directly implemented in the classroom. Various factors displace the education assignment in different directions and there is a historical documented problem in the relationship between "Local-National" which shows difficulties to control education and subject content only through changes in the assignment. When society express a need for new content to be taught through the educational system, required changes has to be implemented in the school's mission. However that is not enough. One option, recently discussed more frequently, is an approach starting with those that are affected - the students. Gibson & Chase (2002) show how a more student-centred and inquiry-based learning involves students better thus adding a stronger commitment for the needed changes. Bencze, Bowen & Alsop (2006) emphasize the importance of a development in which teachers work is understood and interpreted in relation to the students' perspective. Teachers and students need to be included from the beginning to create meaningful projects and development.

Without such an approach teaching about energy, the environment, resource and climate based on the need from a changing society has limited possibilities for success because those who should do the job lack foundation. To use individual teachers as ambassadors to return and inform colleagues will tend to marginalize students, and focus attention in one direction which does not leave a sustainable footprint in the classroom (Jidesjö 2014).

THE FUNCTION OF EDUCATION VARY IN TIME DUE TO THE DEVELOPMENT OF SOCIETY

To help teachers understand the purpose of education and how education function varies in time is an additional framework factor which also creates the rationale for the importance of education in the areas of energy, resource, climate change and sustainability. A historic anchoring is important to understand the education system as it is today. If a school development project starts with the ambition to change then the historical anchor can involve actors in why such work is urgent. If the purpose of different initiatives instead is unclear, measures tend to sometimes become aimless in the sense that they lack support and anchor. The anchoring should help to keep a direction. One way to make this more concrete is to initiate discussions and reflections on the teaching content, to create a shared understanding of its identity and legitimacy. If such more basic conditions are unreflective, it is difficult to understand and interpret the educational mission (Jidesjö 2014).

GET TO KNOW THE EDUCATION CONTENT INSIDE AND OUTSIDE OF SCHOOL

Development of the society creates new opportunities for learning. In several of the KNUT case studies questions about cooperation between schools and other actors in society is one that recurs. Breakwell & Beardsell (1992) pointed out that student attitudes to how they meet the content in the classroom do not have to be the same when they encounter it outside of school. This highlights the importance of outside of school activities in project as a possibility to increase student's interest for a discipline when getting familiar with it outside of school. If the education continues to repeat historic experiments and lectures it will move increasingly away from what students perceive as important and the link between inside and outside of school content weakens. Moreover, the case studies shows result that there is not cooperation in itself which represents a success factor, it is how cooperation is implemented and linking back to school teaching, which is a critical factor. This is also evident

in scientific studies (Jarvis & Pell, 2005) and discussed early regarding development and investments of Science centers (Wellington, 1990; Russell, 1990). Cooperation between, and an understanding of how, the content is taken up in different ways by different actors in society and how it can be involved to become a resource for learning in schools is an important continuation in school development projects. Local actors have a significant and important role to play in the creation of an educational system that is updated and where relevance is at the heart (Jidesjö 2014).

SUCCESSFUL MEETINGS BETWEEN DIFFERENT ACTORS

The research shows that the results from projects have varied considerably between the participating schools. Prevalent school cultures, competing businesses and difficulty in seeing how content such as energy, resource, climate and sustainability fit in existing school subjects are examples of things that affect development. Different schools have different needs and the creation of new knowledge is based on the knowledge that already exists. One success factor is to incorporate project activities as part of a process for an example to prepare a meeting at a Science center with teaching both before and after the visit to conceptualize the knowledge and use the visit as inspiration for lessons inside the classroom.

For projects to have a long term impact it must be planned and developed in consultation between the actors. It's not enough to be parties, but to be partners and jointly own the project (Brulin & Svensson, 2011). It requires that the project idea coming from outside must have leeway for change and not be too locked but be adapted based on the conditions prevailing in each case (Jidesjö 2014).

THE EDUCATIONAL SYSTEMS CAPACITY TO EDUCATE ALL AND AT THE SAME TIME RECRUITING SOME FOR SPECIALIZATION

The current and future transition of the energy system needs expertise. Though there needs to be a balance between the educational systems capability to prepare for higher studies in science and technology while at the same time providing all students with the needed general knowledge about energy and energy efficiency. Project that tackles these challenges need balance (Jidesjö 2014).

Conclusions

The challenges of energy transition, an updated educational system reflecting development in society and sustainability are issues of international character and the challenges will have a decisive influence on the possibility of redeployment and competitiveness. Teachers need to understand their work more in relation to society development and education function and local actors have a significant and important role to play in the creation of an educational system that is updated and where relevance is at the heart and engaging schools to become part of the local and regional long-term development work. To have a long term impact projects with "outside of school activities" must be planned and developed in consultation between the actors. It is not enough to be parties but to be partners and jointly own the project. It requires that project ideas coming from outside must, to have a leeway for change, not be too locked but be adapted based on the conditions prevailing in each case. When society expresses a need for new content to be taught through the educational system teachers and students need to be included from the beginning to create meaningful projects and development. A more student-centred and inquiry-based learning involves students better thus adding a stronger commitment for the needed changes. To use individual teachers as ambassadors to return and inform colleagues will tend to marginalize students and focus attention in one direction which does not leave a sustainable footprint in the classroom.

The current and future transition of the energy system needs expertise. Though there needs to be a balance between the educational systems capability to prepare for higher studies in science and technology while at the same time providing all students with the needed general knowledge about energy and energy efficiency. School projects that tackle these challenges need balance.

At an overall level result from the KNUT evaluation research project shows that the energy, resource, climate change and sustainability could form part of a new vision for education and contribute to students' inclusion in real challenges.

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