

INQUIRY IN EDUCATION FOR SUSTAINABLE DEVELOPMENT – RESEARCH ON ENERGY CONSUMPTION INCLUDING STUDENTS AS RESEARCH PARTNERS

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Abstract

Reform efforts around the world stress the importance of developing images of science that are consistent with current scientific practices. However, many inquiry activities found in schools fail to capture important characteristics of authentic scientific inquiry and transport a naive vision of the activities that scientists engage in while conducting their research. One way to address the lack of authentic inquiry in the classrooms is Research-Education-Collaboration (REC). REC are transdisciplinary research projects involving schools as active partners in the research process. We accompanied and evaluated two REC for two years by methods of quantitative and qualitative research. In this paper, especially the project “Able Youth” will be presented, its outcomes and impact discussed and, on the basis of the experiences made, core challenges and potentials of REC will be identified.

Keywords: Research-Education-Collaborations, intergenerational knowledge transfer, energy consumption, sustainability

Background: Research-Education-Collaborations

Reform efforts around the world stress the importance of developing images of science that are consistent with current scientific practices. Students should develop an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to culture (Schwartz et al. 2004). However, many inquiry activities found in schools fail to capture important characteristics of authentic scientific inquiry and transport a naive vision of the activities that scientists engage in while conducting their research (Chinn and Malhotra 2002). Authentic inquiry bears little resemblance to the cookbook experiments found in many science classrooms or to the very simple forms of inquiry found in many textbooks. To address the lack of authentic inquiry in Austrian classrooms the Federal Ministry of Science and Research launched the program “Sparkling Science” to fund transdisciplinary research projects involving schools as active partners in the research process (Research-Education-Collaborations, REC). The program seeks to integrate research and educational objectives by tackling those issues related to the lifeworld of young people.

REC activities involve more than 'just' science communication, lab-visits of the participating school classes or a set of talks designed to motivate children and young adults. In REC students and their teachers assist the researchers in conducting research and the activities have to yield a genuine scientific output in form of scientific publications or presentations.

From 2009-2012 the Austrian Institute for Sustainable Development (OIN) coordinated the Research-Education-Collaboration "SustainAble Energy Youthers" (short: "Able Youth") on the impact of energy consulting on energy related behaviour and attitudes. "Able Youth" was recently honoured as a UN decade project for Education for Sustainable Development.

Objectives and Methods

The project lasted for two years and was accompanied by a science education researcher (first author), who focused his research on i) the potential benefits of such cooperation for students, teachers and scientists and ii) challenges for the teachers and scientists working in REC.

To capture the experiences that researchers and teachers made with the REC activities, as well as the challenges and opportunities that REC would offer, the project was followed over the two years using participative observation, informal talks and individual in-depth interviews with the researchers and the teachers, who were mainly in charge of the REC activities. The transcribed interviews and the noted observations were analysed following the grounded theory approach (Glaser and Strauss 1967) using the software Atlas.ti. The goal was to identify a set of core challenges and potentials experienced by all researchers and teachers in the project.

How Research-Education-Collaborations work: the project "Able Youth"

In the project Able Youth, pupils of two Viennese secondary schools (78 pupils aged between 16 and 22, of which 42 participated actively, 36 were part of the control group) surveyed the energy related attitudes, knowledge and behaviour of their parents, localized energy saving potentials in households, advised their families on energy saving and assessed the final outcome at the end of the project.

The main goals of the project were to 1) raise awareness regarding, 2) educate about and 3) promote sustainable energy consumption practices in the households of the pupils.

The evaluation of the project was carried out with participation of the pupils: they developed, in collaboration with the scientists, surveys for their parents dealing with questions on energy consumption behavior and attitudes towards energy saving. In order to measure the actual energy consumption of the pupils' households, energy bills and counter readings for electricity and gas were collected and analyzed.

After the first survey, carried out in October 2010, the active group of pupils was involved in many different energy-related activities during the school year 2010/2011 (the control group did not participate in such awareness-raising activities). The pupils had the assignment to pass on knowledge about energy saving to their parents and to try to implement energy saving measures at home.

One year later, in October 2011, the pupils of the control- and the test-group conducted a second survey with their parents. This second questionnaire had the aim of evaluating whether the project

had an impact on energy consumption, the behaviour related to it and the attitudes towards energy saving in the pupils' households. Beside the pre- and posttest, a comparison of the data provided by the "treated" test group and the "untreated" control group was part of the evaluation. Additionally, group discussions were organized with the pupils in order to find out how the energy consultancy at home worked for them.

This kind of *transdisciplinary social research* served on one hand as a means of self reflection for the pupils regarding the energy consumption in their own households and on the other hand introduced them to the work of social scientists. Another important aspect of the project was the approach of *intergenerational knowledge transfer*: pupils were the ones who transferred the knowledge they gained in the course of the project to their parents. The opportunities and challenges of this approach will be discussed in the conclusions of this paper.

The *activities in school* for the active group of pupils were manifold. The project started with a workshop aimed at raising awareness among the pupils regarding energy issues and the implications of their daily energy consumption habits for the environment. Following this general introduction, the pupils got input about the work of social scientists and had the possibility to actively participate in the research process: after an input about the basic rules of conceptualizing questionnaires, they developed, with the "world café"- method (Brown & Isaacs 2005), questions for the survey and practiced conducting the interview with the final questionnaire.

They attended an energy consulting workshop on energy saving potentials in households (focusing mainly on changes in consumption practices) with the final aim of passing on the insights they gained in the workshop to their families. Furthermore, the classes participated in various activities (a number of these activities were initiated by themselves) during the school year 2010/2011 (e.g. excursions, a graphic design workshop, where "freecards" dealing with energy issues were designed by the pupils and talks with Austrian entrepreneurs on sustainability).

The pupils also actively took part in the dissemination of the project, e.g. by writing a blog and presenting the project results in their school and at the Vienna university of economics and business.

Results of the survey and the impact of awareness-raising activities

In total, 82 parents were interviewed in the 2010 survey round; in 2011, 55 parents participated, which yields a total number of 137 interviews. 65% of the interviewed parents have a migratory background and a relatively large share (68%) of the interviewees graduated at a secondary school (Austrian Matura) or at a higher level.

The results of the quantitative data analysis clearly show that the energy consumption patterns of the majority of the parents could be described as energy efficient already before the start of the project. A large part of the participants showed previous awareness and knowledge about energy saving arrangements in their households. For example state 87% of the interviewees to be vigilant about energy consumption behaviour in their households in general and 79% keep low energy consumption in mind when buying new household appliances.

The parents also seemed to be relatively well-informed about the topic of energy in the household and demonstrated a certain appreciation of its relevance, as could be seen from the fact that only 19% of them agreed to the statement that they have not engaged at all with the topic so far.

However, about a third of the interviewees (33%) felt they were insufficiently informed about the possibilities of saving energy in the household. Another third (30%) agreed to the statement that it is hard to judge where exactly energy saving in the household should start. More than half of the people in the survey (54%) rates their knowledge about energy consumption in the household as good or quite good, but only 20% have already used energy consulting.

The *comparison of the data collected in 2010 and in 2011* showed (nearly) no effects of the project on energy consumption, energy consumption behavior and attitudes regarding energy savings of the households/interviewed *parents*. Therefore it has to be concluded, that the transfer of knowledge to the families by the pupils was only little successful.

But still, a few differences in the behaviour and attitudes of the parents interviewed surfaced from the comparison of the pre- and posttest (T-Test for paired samples): On the behavioural level, for instance, a significantly higher number of people stated in 2011 to leave on the light in the room fewer times or never (in 2010, 45% indicated this; in 2011, it was 86%) or to turn off the water while shampooing their hair (57% in 2011 as compared to 48% in 2010).

Significant differences could also be observed on the level of attitudes: in 2011, significantly more people than in 2010 believe that those who do not practice any energy saving measures bear co-responsibility for the destruction of the environment (93% agreed in 2011, opposed to 86% in 2010) and that fossil resources should not be exploited at the cost of the following generations (while in 2010, 86% agreed fully or largely to this statement, in 2011, the whole sample consented).

Significantly less people feel a lack of information about energy saving possibilities in the household (18% of the interviewees in 2011 indicated this, 39% in 2010).

No differences between 2010 and 2011 could be noted regarding the amount of energy consumed by heating and electricity. It therefore appears – as far as this could be deduced from the facts, considering the low return rate of energy bills - that the project did not have an impact on the de facto energy consumption in the households.

A comparison between the data of the test group and the control group was not possible due to the low return rate of questionnaires of the control group in the second survey.

On the other hand, however, qualitative data show partly a growing awareness about sustainable energy consumption on the part of the *pupils*. In the group discussions the pupils highlighted several positive effects of the project, observing – among other things – that they were sensitized in a certain way:

„I believe that it produced a bad conscience in me to a great part. Because, well, if I was home alone I always left everything on.“ (student)

It is interesting to consider the remark that the learning outcomes will especially become relevant to the practices in their own future households:

„At some points, we're also going to be parents, well, most likely. But we're certainly going to be adults who live in their own households. And it can't do any harm to already know something in advance, because, maybe we can't put it into practice now because of our parents or because we don't have that much money ourselves to buy a washing machine, but we can do that once we have our own flat or a house.“ (student)

Intergenerational knowledge transfer

Generally speaking, the approach of the project to transfer knowledge regarding efficient and sustainable energy consumption from the pupils to their parents has several positive aspects.

On one hand, the teenagers already have a comprehensive knowledge regarding the energy consumption habits in their family and could therefore give “tailored” advice to them. Furthermore, they can support the implementation of the advice in their households even after the project has ended. The possibility of “role change” in the transferring of knowledge, where children “teach” their parents, can be very empowering for teenagers, as one pupil puts it:

„I also like it because it's something very special that they can learn something from us once, and that it's not only us always learning from them. I mean it depends on how they grew up, which education they have, and it's just very different from 50, 60 years ago, it's just different what we learn today.“ (student)

Another important benefit of this approach is the assumption that energy counselling is much more efficient if the whole household is taken into account and not only a single person.

However, the impact of the project on the parents' behaviour and attitudes was only weak. This may have had several reasons, which will now be outlined. Difficulties in realizing the ambitious aim of „intergenerational energy consulting“ were met 1) in the knowledge transfer from school to the households, 2) in diverging interests and motivation on part of the students and the parents and 3) in varying competences and attributions regarding responsibilities in the family household.

The idea was to let students carry the responsibility of passing the knowledge they acquired at school through workshops, lectures and excursions on to their families. Therefore, parents were *exposed to the intervention to a considerably lesser degree* than the students themselves and could only be involved and motivated *indirectly* by the pupils. The “transfer” of the intervention on part of the students was therefore to a high degree dependent on their personal motivation and interest in the topic. What was measured by the questionnaire was not the impact of the project on the students' behaviour in the household, but the changes in knowledge, attitudes and behaviour of the parents.

Another obstacle to knowledge transfer could be identified in the fact that many parents already had, as shown above, a relatively *well-developed prior knowledge on the topic*. The group discussions revealed that the students, whose parents displayed less knowledge about energy consumption, felt much more motivated and empowered as energy consultants.

Habits regarding energy consumption are often bound to certain *roles* that each family member occupies in the household. Responsibilities concerning “economic” energy behaviour might also be perceived and attributed differently within one household. Parents in general have other tasks in the household than children or teenagers and therefore also consume energy in a different way. In the group discussions, for instance, the teenagers focused mainly on mobile phones, PCs and television sets, whereas the parents were described as having greater concern for the areas of cooking, doing the laundry and, partly, heating. It could be followed from this that students might not feel “responsible” for some of the areas in which they were given hints for energy saving (with the exception of those regarding the appliances they frequently use, as mentioned above) and thus may have been less motivated.

The implementation of the hints for energy saving was furthermore largely dependent on the parents' disposition, as they did not choose the consulting consciously and out of their own interest, but in the first place participated because their children took part in the school project.

Potentials and challenges of REC

All participating researchers and teachers described the project as very enriching and motivating. The researchers were encouraged to reflect on the importance of their work in the context of the wider society and gained experience in the communication of their research – both the methods and the results – to a non-scientific audience. In the projects the students were not only active researchers but they and their family were also the object of research. The topic investigated in the project was the behavior and attitudes regarding energy consumption in the pupils' families. Therefore, the participation of students was very helpful to get a comprehensive view on these issues. This approach facilitates the integration of the results of the REC activities in the work of the researchers and the production of new scientific insights.

The teachers could benefit from the project because of the fact that the researchers provided knowledge and insights, which they themselves couldn't offer to the students.

"In this project the students gained insights into the work of a social scientist. This is in normal lessons not possible or at least not planned. Especially the development of the questionnaire is something that we wouldn't be able to teach in this way. But not only the students gained new insights. For me the work they (the scientists) are doing is not completely new, but it is not daily grind. And it opened my mind for new things that I will pick up in other lessons as well." (participating teacher)

In her last sentence the participating teacher describes the expansion of her own understanding of the nature of scientific inquiry in social science. Some authors argue that teachers often lack sufficient knowledge about the nature of science (Abd-el-Khalick and Lederman 2000). We think that authentic research experience in REC can improve teachers' and students' understanding of the nature of science – especially when it is combined with a reflection on the nature of scientific work. Richmond and Kurth (1999) investigated the influence of a research apprenticeship on high school students' understandings of the nature of scientists' work and reported gains in students' conceptions of scientific processes, the role of evidence, and the tentative nature of science. However, the empirical research does not generally support the claim that engaging in scientific inquiry alone enhances conceptions of the nature of science. But combining authentic inquiry with a reflection on the nature of science seems very promising (Schwarz et al. 2004).

Three main *challenges* were identified during the project: the time-consuming interface management, the integration of the project and its results on both sides and the limitations within the educational and the research system.

Working at the interface: a REC brings together two systems - the school education system and the academic research system. There are, of course, many important differences between the two. Work routines, working hours and conditions, administrative processes and requirements and the physical working environment are only a few of them. The educational system in Austria is still mainly organized in units of 50 minutes. This short-term system contrasts with the long-term system in

scientific research. Developing questionnaires, analyzing data, writing reports is time-consuming. Fitting a long-term system in a short-term system is a lot of work and interface management needs to ensure that the REC activities fit the working dynamics of both systems. The large time-investment demanded by a REC needs to be properly acknowledged and accounted for in project budgets.

Integration on both sides: the REC needs to satisfy the demands of two systems. On one hand it should produce new scientific insight. On the other hand it should meet educational aims and the interest of the students. One plausible way to facilitate the integration of REC results into the wider research project would be to design the REC according to the needs of science. If the research process remains under the 'academic control' of the researcher, then it is much more likely to produce a result which complies with scientific quality standards.

However, the more specific and complex the research problem, the less flexibility the school has in designing or developing activities (Schwarzl 2005). Furthermore, the experiences made in the project "Able Youth" show that the complexity of the research had a bad influence on the motivation of the pupils. Even though the pupils were involved in the design of the questionnaire, the greater part of the conceptional work was done by the scientists due to the complexity of the topic (multifaceted nature of the topic of energy consumption in the household and wide range of related attitudes) and the project design (pre-post survey, control and test groups, additional necessary elicitation of electricity and heating data). Therefore, the pupils only partly perceived the survey to be "their own". In the case of the control group, which did not take part in the awareness raising activities, motivating the students was even more difficult.

From these experiences it can be concluded that REC is possible if the research design and content is simple in order to ensure the greatest possible participation of the pupils. Some research topics are more suited for this approach than others. With this in mind, it has to be admitted that the consumption field of energy has certain limitations to its suitability: the scientific investigation of energy consumption behaviour and attitudes requires a consideration of many aspects and complex relations.

Given this dilemma, the teachers and the researchers have to find ways to satisfy both systems. Therefore it is necessary to start the cooperation as early as possible (when starting with the project proposal) to ensure that the research topic fits to the subject matter of the classes involved. Otherwise the project work has to be done additionally to the work planned in the school year, which leads to stressed teachers and frustrated students.

In schools, where the integration of the project in regular subjects could be achieved more easily (for example due to the ecological focus of one involved school, where the pupils also had to produce final project works dealing with environmental issues), more motivation of the pupils and more synergies with the project were the consequence.

Limitations within the educational and the research system: packed curricula, 50 minutes units, angry colleagues (because you need their lesson again to conduct the project) and a general lack of flexibility to organize project work are the main challenge to overcome when organizing a REC for the teacher. The prevailing "publish or perish" culture, the narrow disciplinary boundaries, traditions and requirements (Wiek 2007) and the limited academic recognition accorded to REC might limit the researcher's commitment to cooperate with schools. Due to these restrictions, flexibility, additional

effort and commitment is required by the researchers, but especially by the teachers, who have to integrate the demands of the REC as well as the demands of the school system.

Conclusions

The aims of the project were quite ambitious: to bring about changes towards a more economic and efficient energy consumption in family households by involving the teenage students living there and at the same time to enable the active participation of pupils in processes of social research.

Regarding the approach of intergenerational knowledge transfer it can be concluded, that it implies a number of prerequisites from various points of view and is therefore challenging to put into practice. Direct interventions or awareness-raising measures and activities only took place within the system of the school in this project. The system of the family could therefore only be influenced indirectly – through the students – by the scientists. Therefore, it would be recommendable for future projects to involve the parents more directly in the project.

Furthermore, it should be considered that the field of research chosen also lies within the pupils' own area of responsibility, competence and interest. The project results demonstrate clearly that even highly motivated students were only capable of putting the knowledge acquired during the project into practice in their own areas of responsibility, for example, regarding mobile phones, chargers, etc.

The results of the project suggest that the choice of the target group might also co-determine whether a change in energy consumption behaviour can be brought about successfully or not. It would be advisable, therefore, to select target groups which are more unfamiliar with the topic. The finding that families with a migration background displayed less knowledge about and awareness for the issue, as well as the fact that those teenagers were more motivated as energy counsellors whose families started out with less previous knowledge about the topic might prove valuable here but still have to be examined in more detail.

Working in Research-Education-Collaborations bears different challenges and opportunities. Like many transdisciplinary approaches, REC face obstacles that might limit the broader implementation and deeper integration of such projects in the education and research system. The first is the time-consuming interface management when bringing together two different systems: the school education system and the academic research system. The second is the methodological challenge associated with the satisfying integration of the projects on both sides. And the third is the limited academic recognition accorded to Research-Education-Collaborations on one hand and the still very inflexible structures in most schools to conduct project work on the other hand.

Many inquiry activities found in schools fail to capture important characteristics of the authentic scientific inquiry process scientists conduct in their research. We believe that Research-Education-Collaborations are an innovative way to provide students with a better understanding of how science works and what scientists do. Science education research plays an important role in identifying these

challenges. Further research on factors limiting or facilitating REC will assist in bridging the gap between research and school science.

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