EVALUATION OF CARBOSCHOOLS
Students', teachers' and scientists' opinions on authentic science projects in a European context

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Executive Summary

CarboSchools
The data presented in this report was collected as part of an evaluation of the CarboSchools project. CarboSchools is a European collaboration of nine research institutes in seven countries and aims at implementing environmental topics inside or outside science classrooms which are closely connected to students' everyday life. The basic idea of CarboSchools is to promote direct partnerships between secondary school teachers and global change scientists for young people to learn about climate change, gain a positive experience of scientific research and act locally to reduce emissions of greenhouse gases. A total of about 2500 pupils, 230 teachers and 220 scientists took part in this experience from 2008 to 2010 with a great variety of approaches and projects of all topics, ages, duration etc.

Objectives of the evaluation
The objectives of the evaluation study were realizing an in-depth external evaluation measuring the improvement of student attitudes towards different aspects of science and climate change during participation in CarboSchools, and evaluating the regional projects on aspects like organization, difficulty, enjoyment, and impact. Further, we wanted to know how projects like CarboSchools are integrated in the school curriculum and in what way teachers collaborate with scientists in the projects.

Opinions of students
For measuring students' opinions about the projects the Self Evaluation Tool (SET) was developed and administered at the end of a project. The outcomes of the evaluations (n=1370) provide evidence for the success of CarboSchools. A large majority of the students thought the project was well-organized, enjoyed the project very much, realized that people can affect climate change thanks to the project, and would like to work on projects like CarboSchools more often. The activities in which students have a more active role (literature research, computer work, hands-on experiments, presentation by students) are appreciated more than activities in which students have a more passive role (frontal lectures, site visit, lab visit). Further, students like projects with an inquiry based approach much better than projects with predefined problems and experiments.
We found that girls score better on impacts and that they have a slightly better overall opinion on the project than boys, but boys had less trouble with difficulties of the project. Younger students and volunteers have better opinions on almost all aspects than older students and students who participated compulsory. Further, students' science background is important: students with a positive science background (high science grades, much interest in science etc.) appreciate the projects better than students with a more negative science background.

Attitudes changes
For measuring changing attitudes we developed the Attitudes Questionnaire (AQ), which is implemented before the project starts and again after the project ends. In this way we can see whether attitudes towards science and the urgency of climate change have

changed. The results show that students' (n=413) attitudes are already at a positive level when they begin a project. Overall, younger students, students with highly educated parents, and students with high science grades, score better on the science related attitudes than the other students.

However, CarboSchools is not able to enhance students' attitudes towards science and climate change. In stead of enhancing students' attitudes, some science related attitudes even slightly declined. The attitudes towards climate change and environmental awareness stay at the same level during participation in CarboSchools. The declining science related attitudes are not what we expected since students' opinions are very positive on the projects. It is important to realize that attitudes - measured by external observers - and opinions on the projects - directly expressed by participants themselves - are different categories, which do not necessarily correspond. It is possible that students have positive opinions on the projects, but that their images of science (i.e. their attitude towards science) remain unchanged. An additional reason for finding no improvement of attitudes is that the attitudes of participating students were already at a high level before the projects started; meaning that our student groups did not reflect average student groups and leaving little chance for improvement.

We found no differences in attitudes changes for different types of projects and activities. A positive result is the increase of climate change knowledge during the project. After the projects students became more confident about their climate change knowledge.

Relation with curriculum

The interviews with teachers (n=5) and regional coordinators (n=5) from different countries have provided important information about the relation of CarboSchools within the school curriculum. Most projects are part of a school subject, and in some cases it is a multidisciplinary project taking place throughout the curriculum. The tasks of the teacher in CarboSchools depend a lot on the teacher, but are usually supervision and guiding of students and integrating the subject topic into the curriculum. The aim for participating in a project from teachers' perspective is diverse: doing a research project, making students interested in science, and show students they are important. Teachers experience several problems when realizing a project in the curriculum: time schedules of both students and teachers, little support from administration, motivation of students, money for trips, and attitudes of colleagues.

Collaboration between schools and institutes

The contacts between schools and research institutes vary considerably, ranging from no contact between scientists and teachers (only via RC), to a real partnership without help from the RC. In a few projects other actors are involved in the collaboration, for example the regional inspector. This depends on regional and national policy differences. Both teachers and scientists are positive on the collaboration. However, an important problem in the collaboration is the little available time of scientists, while the collaboration can be highly improved by more visits from the scientists to the school. Also little interest of scientists may play a role. They do not see working with students as part of their job. The RC's are essential for the conductance of CarboSchools in the schools. They intermediate between the schools and the institutes.

Foreword

CarboSchools has been a complex project with a large variety of activities carried out at nine locations in seven countries. CarboSchools links researchers from several leading carbon science laboratories in Europe with secondary schools. In these partnerships, young Europeans conduct experiments on the impact of greenhouse gases and learn about carbon cycle research and the reduction of emissions. Scientists and teachers co-operate over several months to give young people practical experience of research through true investigations and interactions with real scientists. The pupils also have the opportunity to inform the wider community about climate change by producing a final output of articles, exhibitions, conferences etc.

Right from the start of CarboSchools, our wish to learn from our projects has been a major consideration. Were outcomes as expected? How do participating actors experience the projects? What were most important constraints? What do students think of our projects? Can we influence students' feelings towards science and climate change? How can we improve our projects? So, CarboSchools is not only aiming at implementing projects as part of school practice, but also at evaluating their effects and identifying their benefits.

In this report, we will describe how we addressed these questions. We will show that not every student thinks the same about the CarboSchools projects. Some important differences in the students' opinions will be explained. Moreover, we will give some insights into their feelings about science and climate change. Since it is well-known that most teenage students have deep-rooted negative opinions on science and school science, we wished to see whether our projects could influence these opinions. We believe that this evaluation can contribute to research in authentic science teaching and in out-of-school science learning, in the hope that our results can be used by those policymakers and teachers interested in the setting up of a project like CarboSchools.

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1 Introduction

1.1 Low interests in science among young people: a European concern

Europe has a serious problem in attracting young people into science studies. During the last decades much research in science education has shown that students' interests in school science and science careers is declining considerably (e.g., European Commission 2004; Osborne & Collins 2001; Jenkins & Nelson 2005; Sjøberg & Schreiner 2006; OECD 2006). As can be seen in Figure 1, absolute numbers of science and technology (S&T) university students across most OECD countries increased over 1993-2003 (OECD 2006). However, relative numbers of S&T students (Figure 2) as proportion of the total student population has decreased during the same period.

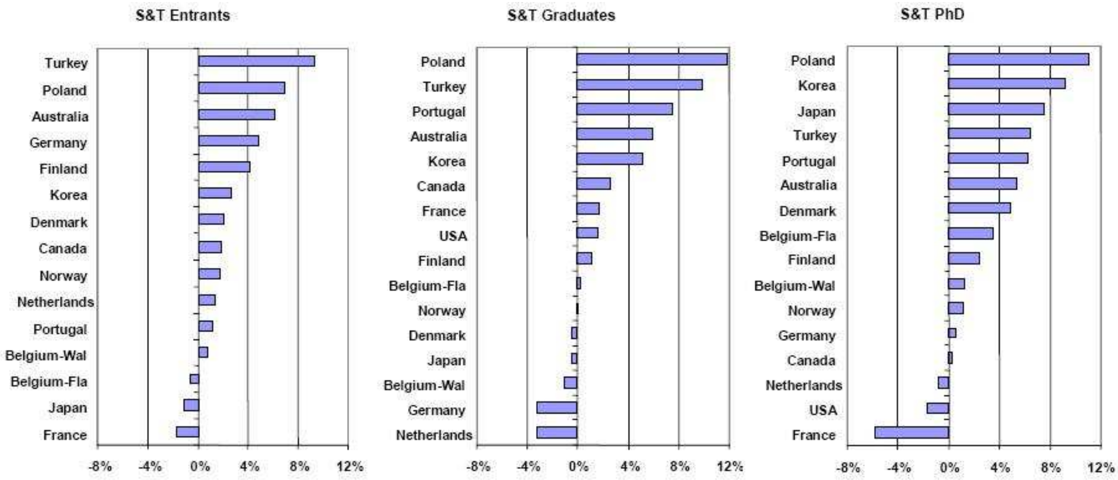


Figure 1: Average annual change of number of S&T students (percentages) 1993-2003

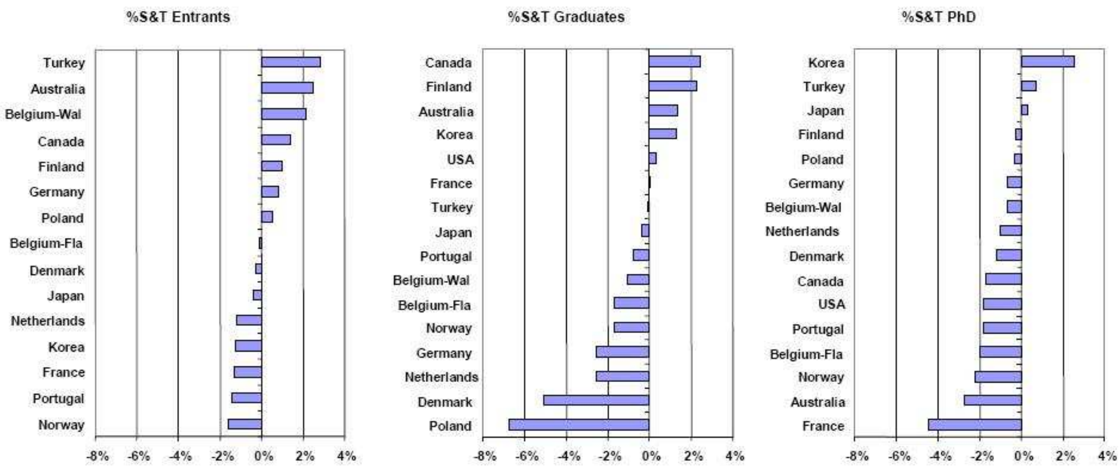
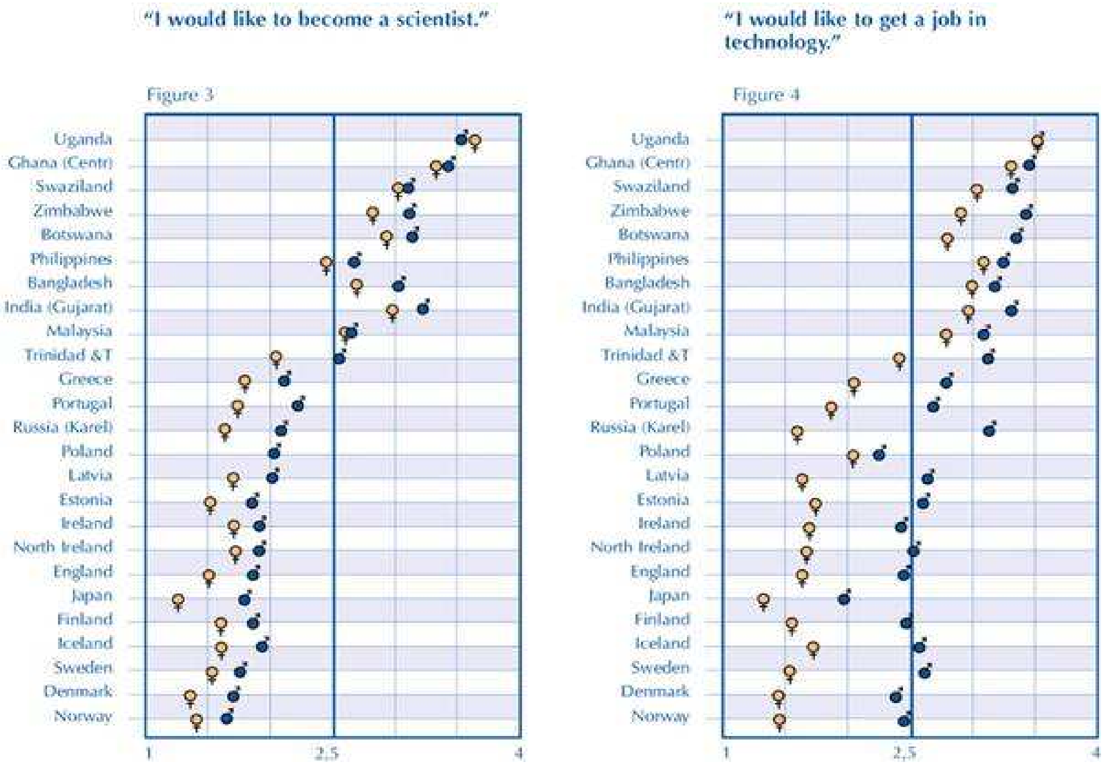


Figure 2: Average annual change of percentage of S&T students (percentages) 1993-2003

It is hypothesized that because of a stabilization of student numbers accessing tertiary education in some OECD countries, absolute numbers of S&T students will decrease in a couple of years. Striking differences occur between disciplines. Decrease of student numbers is most apparent in physics and mathematics. In some countries the proportion of students in these disciplines was halved between 1995 and 2003. Life sciences and engineering, by contrast, have a stable numbers of students.

Especially girls are underrepresented in S&T studies. Girls increasingly choose an S&T study, but their number is still lower than that of boys. Only life sciences is chosen more by girls than by boys. The fact that girls are less interested in most S&T studies is a well-known and well-documented fact (e.g., Weinburgh 1995; European Commission 2004; Miller, Slawinski Blessing, & Schwartz 2006). The Relevance of Science Education (ROSE) studies, a survey conducted in twenty developing and developed countries conducted by Sjøberg and Schreiner (2006), showed that school science is less popular among students than most other school subjects, and that girls like school science even less than boys (see Figures 3 and 4).



Figures 3 and 4: Average scores on two ROSE questions (1 = strongly disagree, 4 = strongly agree; yellow = girls, blue = boys)

Students' low interests in science is cause for great concern to many European countries. In the report *Europe needs More Scientists* from the European Commission (2004) the concern is voiced that the knowledge economies, which heavily depend on science and technology, will be in danger due to a decreasing supply of scientists. In 2001 the number of scientific researchers per 1000 of the workforce was 5.7 for the EU countries, compared with a value of 9.14 for Japan and 8.08 for the USA. In Europe, only Finland, Sweden, and Norway reach that standard. Therefore, Europe is not waiting for a diminishing interest of students in science.

1.2 Authentic science education: the solution?

What mechanisms cause such a low and even falling interest in school science and science careers? Researchers often point to the way science is taught in schools (e.g., Braund & Reiss 2006; Van Langen 2005; European Commission 2007). School science is all too often not sufficiently appealing, experienced as boring, irrelevant, and outdated; designed only to educate a minority of future scientists, rather than equipping the majority with the scientific understanding, reasoning, and literacy they require to engage as citizens in the twenty-first century. Further, science education does not connect with students' interests and experiences (Goodrum, Hackling & Rennie 2001). Overall, it seems that school science is not as interesting for most students as required.

A sharp contrast occurs between school science and science experiences outside school, which are often seen by students as exciting, challenging, and uplifting (Braund & Reiss 2006). A study by Cerini, Murray, and Reiss (2003) showed that "going on a science trip or excursion" was top rated as the most enjoyable way of learning over ten other strategies for learning science. Therefore, Braund and Reiss (2006) argue for a more authentic science curriculum in which out-of-school science learning is integrated. Such a curriculum can contribute to the learning of science in several ways (Braund & Reiss 2006):

- It improves the development and integration of concepts.
- Further, extended and authentic practical work is possible, which gives students the opportunity to engage in activity that would not be possible in the normal school laboratory. The access to less accessible material and to 'big' science, like radio-telescopes or climate research equipment, has direct implications for the pedagogy and learning in science.

In this way out-of-school science is more authentic, as it provides experiences that are more in line with the sorts of activities that scientists and technologists do in the real world of science; moreover, such experiences include student-directed tasks and more open-ended inquiries (Bencze & Hodson 1999).

In addition to these direct implications, such a curriculum has two implications which are concerned with wider dimensions of learning:

- Students' attitudes towards school science are said to be stimulated for further learning by out-of-school science learning that is integrated within a more authentic science curriculum (Braund & Reiss 2006). Unfortunately, the research literature falls short when it comes to the question of how authentic science experiences may mediate students' attitudes towards science and scientific career choices (Van Eijck & Roth 2009).
- Finally, we should not forget the social implications of authentic science education. Collaborative work and responsibility for learning are the main ways to influence students' learning. Authentic science education creates opportunities for pupils to take responsibility for themselves and others by working in teams and for active consideration of the environment (Braund & Reiss 2006).

In sum, a more authentic science curriculum in which out-of-school science learning is integrated offers opportunities for improving students' social skills and attitudes towards science and a career in science.

1.3 Girls are more attracted to authentic science education

The way science is taught at school is also associated with gender differences in science interest. Authentic science education seems to catch more of girls' interest than regular science education. Van Langen (2005) points to differences in learning styles of boys and girls. It seems that girls flourish in a cooperative learning environment. The usual instruction in mathematics and science, in contrast, typically fits the competitive lifestyle of boys and may therefore explain gender differences in subject enrolment. Girls like a more connected, rather than distanced, way of learning and focus on the group process more than on the subject matter itself (Volman & Van Eck, 2001). So, the same classroom may be experienced very differently by boys and girls.

Furthermore, girls tend to prefer subject matter for which they can see social relevance and/or applicability to their daily lives (Van Langen 2005). In a study regarding gender differences in secondary school students' views about science (Miller, Slawinski Blessing, & Schwartz 2006), it turned out that female students were more people-oriented in their interests than males were. They tended to select a 'people-oriented' major, and they often explained their choice of this major or other majors, including science, in terms of their desire to help other people or animals. Above all, science in school fails to address issues of interest to most girls (Thom 2001; Middlecamp & Subramariam 1999), like showing the relevance of science to everyday life such as chemistry in the home; ecology in the community park; or the consequences of climate change.

Other factors pointed out by Miller, Slawinski Blessing, and Schwartz (2006) related to females' interest in science are that many girls have negative views of scientists, have few positive female role models in the sciences (Koballa & Glynn 2007), and do not perceive science as a profession that combines well with raising a family and establishing other social relations. In conclusion, gender differences in science interest are at least in part explained by curriculum-related factors.

1.4 CarboSchools

In order to give students an authentic science experience and to enhance students' attitudes towards both science and climate change a European project called CarboSchools was established in 2006. The data presented in this report was collected as part of an evaluation of the CarboSchools project. CarboSchools aims at implementing environmental topics inside or outside science classrooms which are closely connected to boys' and girls' everyday life. CarboSchools started in March 2005 as a call launched by a group of scientists and educators gathered in Sainte Croix (France) by CarboEurope and CarboOcean, two leading EU research projects investigating the carbon cycle on land and ocean respectively, who felt that "they not only have a contractual, but a moral obligation to contribute the results of this research to the public discussion on global change".

Following this call, a growing number of school projects flourished in several of the ca. 100 research institutes involved, leading to inspiring presentations during annual science meetings. In 2007, a field-tested concept, a first set of resources and an enthusiastic human network gave confidence and institutional support to submit a more ambitious proposal to the Science in Society programme of the EU. From 2008 to 2010, nine institutes joined this initiative to „make science learning more engaging and challenging for young people as future workers, consumers and citizens", and in response to the growing decrease in the number of pupils choosing scientific studies. The participating institutes are listed in table 1.1. More information can be found in Appendix 5.

Table 1.1: Participating research institutes in CarboSchools

Research Institute	***Region***	***Country***
Max-Planck-Institut für Biogeochemie	Jena	Germany
Teacher Scientist Network	Norwich	United Kingdom
Rijksuniversiteit Groningen	Groningen	The Netherlands
Leibniz-Institut für Meereswissenschaften an der Universität Kiel	Kiel	Germany
Commissariat à l'Energie Atomique	Gif-sur-Yvette	France
Universitetet i Bergen, Geophysical Institute, Bjerknes Centre for Climate Research	Bergen	Norway
Institut National de la Recherche Agronomique	Bordeaux	France
Consiglio Nazionale delle Ricerche - Istituto di Biometeorologia	Florence	Italy
Fundació Parc Científic de Barcelona	Barcelona	Spain

The basic idea of CarboSchools is to promote direct partnerships between secondary school teachers and global change scientists for young people to learn about climate change, gain a positive experience of scientific research and act locally to reduce emissions of greenhouse gases. The two main goals are (i) to stimulate students' interest for science & scientific studies and (ii) to equip them with basic understanding of this major scientific challenge and its interaction with society. The strength of partnership projects is that pupils get involved in a process over several weeks or months, or even years, built on a direct relationship between scientists and teachers to enable them to gain practical experience of research. The stakes here are no longer only to inform or transfer knowledge, but also to encourage questioning among young people and to increase their desire for understanding and their will to build a future which will enable us to manage the challenge of global change.

Partnership projects can feature different activities, such as real-time experiments (in the lab or field, or at school), site visits, lectures, debates, access to research results, communication by e-mail etc. A final output, such as an article, an exhibition, a conference, a webpage, a set of measurements and their interpretation, concludes the students' work by sharing the findings with a wider audience (parents, friends, local community, city…). Thus, in contrast to many climate change education projects essentially based on delivering information via the internet, CarboSchools is first and foremost based on human contact and on placing scientific issues in their wider social and citizenship context. Young people are overwhelmed with information about climate change, but not with offers of meaningful activities in their school education, or with personal connections with real scientists working on a topic which remains fascinating and tremendously concerning, and graphically illustrates first-hand the uncertainty of science.

School science is often perceived as boring, theoretical, disconnected from social issues and real life and not related to real science. Climate change research, on the other hand, is highly international, systemic, interdisciplinary and full of unknowns investigated by passionate people in often remote, exotic areas; it influences decision-making more and more at every political and economical level, directly impacting everyone‘s daily life; it is exceptionally popular as a science topic in the press and television. Based on this contrast CarboSchools connects school education with authentic scientific learning based upon:

- questioning and experimenting rather than on transmitting pure knowledge,
- addressing a complex issue that affects all of society,
- developing close personal contact with researchers to discover how they work to challenge the stereotype and see scientists as real people.

Although the projects are very diverse within the nine regions, we will indicate some common characteristics that make it an authentic science project.

First, one or more researchers from a carbon cycle research institute are involved in each regional project. Several types of engagement are possible. The role of the researcher varies from developing educational materials, giving presentations for students at school, to supervising students during the project. The partnerships also aim at establishing cooperation of scientists with science teachers, although the interpretation of these partnerships varies between regional projects.

Second, all project topics concern the carbon cycle and climate change or other consequences of rising CO_2 concentrations. Examples of regional projects are a cruise in the Norwegian fjords to measure CO_2concentrations in the water at different places and times of the year, or measurements of CO_2consumption in a box with plants to show the relation between CO_2levels and plant growth.

The SchoolCO2 web (http://www.carboeurope.org/education/schoolsweb.php) is an important feature for a large part of the regional projects. Schools have a CO_2meter and a weather station on their roofs and send the data to a central database. Data is publicly accessible, can be displayed in a graph or spreadsheet and can be used for educational and scientific purposes. At the moment approximately 18 schools in 5 different countries are connected to the SchoolCO_2 web. This emphasizes the international nature of greenhouse gas science and opens up possibilities for project cooperation between pupils from different countries.

In addition, project topics are linked to the research taking place at each carbon cycle research institute. Scientists expect that results of some projects can be used for research aims, in particular results from the SchoolCO_2 web.

Finally, the projects make use to a greater or lesser extent of inquiry-based learning. Essentially, inquiry-based learning engages students in investigations to satisfy curiosities (National Research Council 1996, 2000). One implication is that regional projects begin or at least involve stimulating curiosity or provoking wonder.
A total of about 2500 pupils, 230 teachers and 220 scientists took part in this experience from 2008 to 2010 with a great variety of approaches and projects of all topics, ages, duration etc.

1.5 Research Questions

A lot of effort has been put on the popularisation of science by national, European and even world-wide programmes. Most of these programmes aim at influencing public understanding and the image of science, and - particularly to young children and school students - influencing images of science, providing information on the work of scientists and to promote career choices in science and technology. However, there is not much research on the effects of these programmes and the factors which are most critical.
CarboSchools will give insight into the effects of local initiatives on students' images of science and their ideas about what scientists do. Because of the international character of the project, comparisons can be made between different strategies and the influence of context-dependent (activities in the project, relation with the curriculum etc.) and context-independent variables (gender, age etc.).

Our objectives were realizing an in-depth external evaluation measuring the level of educational effectiveness of the various regional projects that will be activated in different countries (impact on teaching practices, on students' learning and representations) and providing project participants with evaluation tools that they can then use in an autonomous way. Our main research questions are:

1. *What are secondary school students' opinions on participating in CarboSchools?*
2. *To what extent do students' attitudes towards science and climate change improve during participation in CarboSchools?*
3. *How is CarboSchools integrated in the schools?*
4. *How do schools and research institutes collaborate in CarboSchools?*

Chapter 2 describes the evaluation of CarboSchools by answering research question 1. A literature review on authentic student inquiry places this evaluation in a science education context. The attitudes research and corresponding research question 2 is discussed in Chapter 3. This chapter also includes a section on the development and validation of a research instrument used to measure students' attitudes towards different aspects of science and climate change. Chapter 4 addresses the interviews with different actors in CarboSchools by answering research questions 3 and 4. In chapter 5 our main findings will be presented. The appendices include the questionnaires, the evaluation of the Spring School in Jena (April 2010), the Manual on the Implementation of Questionnaires (2009/2010), and an overview of all projects.

2 Regional CarboSchools Projects: Evaluation Study

2.1 Introduction

The main objective of this part of the study is to evaluate students' opinions on the regional projects they participated in. Accordingly, the main question that will be addressed is.

- *What are secondary school students' opinions on participating in CarboSchools?*

More specific research questions related to the main question in this study are:

- *What are the differences between boys and girls in their opinions on participating in CarboSchools?*
- *To what extent does science background influence students' opinions on participating in CarboSchools?*
- *To what extent does the type of activities influence students' opinions on participating in CarboSchools?*

Because of the contextual nature of the projects, huge diversity (e.g., in topic, student age, length of project) occurs between the regional projects. Therefore, we will try to take both a look at the CarboSchools project as a whole and also make comparisons between projects. This study will be published in 2011 (Dijkstra & Goedhart, 2011), so we refer to that publication for further information.

2.2 Methodology

We designed a Self-Evaluation Tool (SET) that provided important information for regional coordinators on the benefits and difficulties of each specific project and, regarding CarboSchools, it gave valuable information on the question "What do students think of our projects?". Despite the variety in projects, we developed just one questionnaire for all projects, which can be found in Appendix 1.

The questionnaire consists of three parts. Part A contains 12 questions concerning the student's background like age and gender. Also included is students' science background: science grades, interest in science, enjoyment of science lessons, what they think of scientists etc. Part B (14 questions) measures the student's opinions on the science projects and also consists of closed questions in 4-item Likert scales, with options 'strongly disagree', 'disagree', 'agree', and 'strongly agree'. The aspects measured in this part of the questionnaire are: opinions on organization, appreciation, difficulty, and impact of the regional projects. An example of a question in part B: *The instructions for the project were clear.* The third part of the questionnaire, part C, consists of 4 essay questions. The regional coordinators can reorganize these questions according to their specific projects. Items in this part may include the students' personal ideas on the project etc. The answer to these questions may help the regional coordinator to improve the project.

The questionnaire was translated into all native languages of the students (Norwegian, Catalan, Italian, German, Dutch, French, and English). SET was implemented near the end of a project, no later than one week after the last activities. Additional information about the projects (number of visits to the research institute, amount of time spent on the projects by the students etc.) was provided by the regional coordinator. They were later on by email asked to fill in a restricted choice questionnaire about the type of activities in the projects, topics, partnerships etc. The questionnaires and cover pages were sent to the researcher for analysis. Results were reported to the regional coordinator, as feedback on the conducted project.

Table 2.1: Evaluated CarboSchools projects 2008-2010

Projects	54
Students	1370
- Girls	722
- Boys	637
Student age	12 – 21 years (mean = 16.2)
Schools	60
Research Institutes	8
Countries	6
Time spent on project	1 – 100 hours per student (mean = 33)
Visits to the research institute	0 – 8 per project (mean = 1.0)
Scientists visits to school	0 – 20 per project (mean = 4.3)

As can be seen in table 2.1, we evaluated 54 projects, in which a total number of 60 schools and 1370 students participated. The projects differed in a variety of aspects, such as the age of the students involved, and the number of hours that they spent on the projects. Both one hour experiments or presentations and long-term intensive projects are included in the evaluation. We found many differences in the extent of the collaboration between research institutes and schools: in the vast majority of cases students visited the research institutes at least once, but in some cases considerably more often; and on average scientists visited the schools six times per project, but in some cases up to 20 times.

Further differences (not represented in table 2.1) deal with topics, the nature of the projects (open-ended research projects or more standardized classroom experiments), and how the projects were linked to the science curriculum.

For answering the main questions we make use of analyses in SPSS 16.0. In the preliminary screening of the data, it turned out that not all the assumptions for using parametric statistical methods are met. The outcome variables are measured on ordinal level (no interval/ratio level). Furthermore, the Kolmogorov-Smirnov test of Normality showed the answers on all evaluation questions (A7-A12 and B1-B14) are not normally distributed ($p<.01$). Therefore, we used nonparametric tests such as the Chi square and the Spearman rank order coefficient for correlations. For differences between groups, we used the Mann-Whitney U-test and the Kruskal Wallis H-test.

2.3 Results

First, we discuss the science background of the students. Then we analyze students' opinions on the projects (organization, enjoyment, difficulty, impact), and finally we check to what extent students' background variables (general and science background) and project variables influence students' opinions on the projects.

2.3.1 Students' science backgrounds and opinions on regional projects

Part A of the SET measures the science background of the students. Results are presented in table 2.2. It seems that the students have a positive image of science. Most (at least 70%) of the students are interested in science topics, consider their grades for science subjects as high, do a lot of science at school, and do not think that scientists are boring. However, 43% of the students think that scientists are difficult to understand. In sum, most students are positive about science and scientists in general.

Table 2.2: Science background of students (n=1370)

		Strongly disagree	*Disagree*	*Agree*	*Strongly agree*
	Question	%	%	%	%
1	My interest in science topics is low.	33	47	14	6
2	My grades for science subjects are high.	4	22	52	22
3	We do a lot of science at school.	5	19	48	28
4	I like science lessons more than other lessons at school.	10	23	35	33
5	It is difficult to understand scientists.	10	45	36	9
6	Most scientists are boring.	22	51	22	5

Part B of the SET invites students to indicate the extent to which they agree with a series of 14 statements about the project. The 14 statements and students' responses to them are given in table 2.3.

The results show that our students are very positive about participating in a CarboSchools project. A large majority of the students thought the project was well-organized, enjoyed the project very much, realized that people can affect climate change thanks to the project, and would like to work on projects like CarboSchools more often. Most students were satisfied with the difficulty of the project, but about a fifth of the students thought that the project was too difficult. Apparently, student appreciation of teaching science in this way is very high. The projects' positive impacts on student interest in a scientific career and ideas on climate change are worth noticing, especially considering the main aims of CarboSchools. Nearly half of the students (46%) declared that the project made them more interested in choosing a scientific career.

An inspection of Spearman's rank order coefficient (rs) matrix of correlations between all the items suggests a pattern of overall agreement. With the exception of item 10 (which is negatively phrased in comparison with all the others), all the responses to the statements correlate positively.

Table 2.3: Students' opinions on the regional projects (n=1370)

		Strongly disagree	*Disagree*	*Agree*	*Strongly agree*
	Question	%	%	%	%
	Organization				
7	This project was well organized.	4	13	50	33
11	The instructions for the project were clear.	4	18	53	25
15	The supervisor's explanations helped me to understand this project.	4	13	59	24
16	My overall opinion on this project is good.	2	10	53	35
	Enjoyment				
8	I enjoyed this project very much.	4	15	53	28
13	I would like to work on projects like this more often.	7	21	47	25
14	I like learning science in this way.	4	13	46	37
	Difficulty				
10	This project was too difficult.	21	59	16	4
17	My knowledge was sufficient to understand this project.	4	22	49	25
	Impact				
9	I learned many new things from this project.	3	15	51	32
12	This project made me understand that climate change studies are very important for human future.	4	11	42	43
18	I learned very much from the scientist(s) in this project.	3	17	53	27
19	This project made me realize that people can affect climate change.	4	15	44	38
20	This project makes me more interested in choosing a scientific career.	18	36	33	13

2.3.2 Student-dependent differences in opinions on regional projects

We also wanted to know whether gender, age, science background, and being a volunteer in the project would have an effect on opinions. This perspective on students' responses to the statements is shown in table 2.4. By using the nonparametric Mann Whitney's U-test it is possible to make comparisons between responses of two groups. The test is carried out with gender as grouping variable and the opinion questions as test variables. The first column in table 2.4 indicates the significant effects for gender on opinions, and the interpretation of the effects is shown for girls. The results of the test carried out with relation to curriculum (compulsory or voluntary) as grouping variable and the opinion questions as test variables are presented in the last column. We mention the significant effects on opinions, and the interpretation of the effects is shown for voluntary students. The second column concerns the effect of age on opinions. This effect is measured by using the Spearman rank order correlations matrix. Only the significant directions are presented in the column. The correlations are considered as 'small, because they were not larger than .25. ($p<.01$). When a box is empty, it means we found no significant differences or correlations for that particular question. For the complete tables 2.4, 2.5 and 2.6 including Z-values and significances, see Appendix 8.

There are some small significant gender differences in students' opinions. In particular, girls think they learned slightly more new things from the projects than boys do (item 9). Boys experience the projects as slightly less difficult than girls (10). The impact of the projects on the opinions on climate change is larger with girls than with boys. The projects make girls more than boys understand that climate change studies are very important for human future (12). Finally, girls have a slightly better overall opinion on the project than boys (16).

Age of students seems an important factor that relates to opinions of students. The older the students, the worse their opinions are on the projects. This goes for all aspects: organization, enjoyment, difficulty, and impact.
The students, who participated in the project voluntary, score better on organization, enjoyment, and impact of the projects than students who participated compulsory. They even score better on “This project makes me more interested in choosing a scientific career” (20). The volunteers also score lower on difficulty, indicating they experienced the projects as less difficult than the compulsory students.

Table 2.4: Students’ opinions compared for student characteristics (n=1370)

		Gender	*Age*	*Relation with Curriculum*
	Question	Girls (n=716)	Older students	Voluntary (n=813)
	Organization			
7	This project was well organized.		-	+
11	The instructions for the project were clear.		-	
15	The supervisor's explanations helped me to understand this project.		-	+
16	My overall opinion on this project is good.	+	-	+
	Enjoyment			
8	I enjoyed this project very much.	+	-	+
13	I would like to work on projects like this more often.		-	+
14	I like learning science in this way.		-	
	Difficulty			
10	This project was too difficult.	+		-
17	My knowledge was sufficient to understand this project.	-	-	-
	Impact			
9	I learned many new things from this project.	+	-	+
12	This project made me understand that climate change studies are very important for human future.	+	-	+
18	I learned very much from the scientist(s) in this project.		-	
19	This project made me realize that people can affect climate change.		-	+
20	This project makes me more interested in choosing a scientific career.		-	+

For assessing the effect of students’ science background on their opinions on the regional projects Spearman rank order correlations are used. The correlation matrix is shown in table 4 in Appendix 6. The matrix of the science background items (questions 1 – 6, see table 4) shows some expected correlations. A low science interest correlates negatively with high science grades (rs = -.31, p<.01) and with liking of science lessons over other lessons at school (rs = -.45, p<.01). High science grades correlate positively (rs = .42, p<.01) with liking of science lessons over other lessons at school. Difficulties to understand scientists correlate positively ($r_s = .43$, $p<.01$) with the idea that scientists are boring. Overall, students' science background seems to be consistent in these items.

A few interesting correlations ($p<.01$) arise between opinions on the regional projects and science background items. The idea that scientists are difficult to understand (5), the idea that most scientists are boring (6) and a low interest in science topics (1) correlate negatively with (nearly) all evaluation statements. The minority of students scoring high on these questions have negative opinions on the project. Enjoyment of science lessons over other lessons at school (4) correlates moderately ($r_s = .43$) with the idea that this project made students feel more interested in choosing a scientific career (20). The other correlations were neither significant nor of an effect-size worth mentioning.

In sum, it seems that girls, volunteers, younger students, and students with a positive science background evaluated the projects (in a way) more positively than the other students. An interesting outcome is that students with a positive science background get more interested in choosing a scientific career thanks to the project.

2.3.3 Project-dependent differences in student opinions on regional projects

Diversity in regional projects is one of the cornerstones of CarboSchools. The results confirm this diversity. By using Chi-square tests and Kruskal Wallis H tests it turns out that students' responses to all evaluation statements differ significantly ($p<.01$) between the 8 research institutes and between the 54 projects. These results make clear the students evaluate the projects of the several research institutes in a significantly different way. Within research institutes the projects also differ significantly ($p<.05$) on several of the evaluation items. Further analysis made clear that time spent on the project, number of visits to the institute, number of visits of the scientists to the school, and the age of the students are project-dependent. These variables differ significantly ($p<.001$) between the projects, which might be an explanation for the differences found between projects.

We wanted to know whether we could identify characteristics of projects that are well appreciated by students. Therefore, comparisons of projects were done with independent variables: the activities carried out in the project, the topics of the project, the approach, the relation between the curriculum and the project, and the group size. The opinions of students were dependent variables. So in each test opinions of students were compared between projects with the characteristic and the group of students that did a project without that characteristic. We measured if that characteristic has a significant ($p<.05$) effect on the opinions had and what direction. The results of the effect of activities on opinions are presented in table 2.5.

From these results we see that the activities in which students have a more active role (literature research, computer work, hands-on experiments, presentation by students) are appreciated better than activities in which students have a more passive role. In particular, literature research and presentations by students show many positive effects on all aspects, most on organization and impact of the project. The more passive activities (frontal lectures, site visit, lab visit) have a negative impact on "This project makes me more interested in choosing a scientific career" (question 20). The projects with a lot of contact between scientist and students (site and lab visit) show as expected positive effects on "I learned very much from the scientist(s) in this project" (question 18). It seems that computer work is not very much enjoyed by students, because this activity has a negative effect on both question 13 and 14.

Table 2.5: Students' opinions compared for project activities characteristics (n=1370)

		Literature Search	*Computer Work*	*Frontal Lectures*	*Hands on Experiments*	*Presentation by students*	*Site visit*	*Lab Visit*
	Number of students	601	960	559	1145	665	581	103
	Organization							
7	This project was well organized.	+	+		+	+		
11	The instructions for the project were clear.	+				+		
15	The supervisor's explanations helped me to understand this project.	+				+		
16	My overall opinion on this project is good.	+	+	+	+	+		
	Enjoyment							
8	I enjoyed this project very much.	+				+		
13	I would like to work on projects like this more often.		-					-
14	I like learning science in this way.	+	-					
	Difficulty							
10	This project was too difficult.	+	+			+		
17	My knowledge was sufficient to understand this project.	+						
	Impact							
9	I learned many new things from this project.	+			+	+		
12	This project made me understand that climate change studies are very important for human future.	+		-		+		
18	I learned very much from the scientist(s) in this project.	+		+		+	+	+
19	This project made me realize that people can affect climate change.	+				+		
20	This project makes me more interested in choosing a scientific career.		-	-			-	-

We also compared the effects of the different topics of the projects on opinions. However, the topics are very institute dependent, and therefore this comparison was not very adequate for conclusions on topics. Another interesting comparison is the approach used in the project, the group size, and the duration of the project. In table 2.6 results are presented. The first column concerns the effect of duration of the project in hours on opinions. This effect is measured by using the Spearman rank order correlations matrix. Only the significant directions are presented in the column. The small correlations were not larger than .15 ($p<.05$). The Mann Whitney's U-test is carried out with approach (predefined problems and experiments versus inquiry based science education) as grouping variable and the opinion questions as test variables. Inquiry based science education is a teacher guided process where students construct knowledge themselves, which allows students to participate and experience the excitement of an authentic scientific inquiry. Moreover, this allows learners to form questions and hypotheses, find answers by planning investigations, make observations, perform experiments, use tools to

gather, analyze and interpret data, and do research in literature that leads to conclusions and new questions.
The second column in table 2.6 indicates the significant effects of approach on opinions, and the interpretation of the effects is shown for inquiry based science education (IBSE). The results of the test carried out with group size (small groups versus whole classes) as grouping variable and the opinion questions as test variables are presented in the last column. We mention the significant effects on opinions, and the interpretation of the effects is shown for small groups.

Table 2.6: Students' opinions compared for project general characteristics (n=1370)

		Duration of the project	*Approach*	*Group size*
	Question	Longer projects	IBSE (n=871)	Small groups (n=59)
	Organization			
7	This project was well organized.		+	
11	The instructions for the project were clear.		+	
15	The supervisor's explanations helped me to understand this project.	+	+	
16	My overall opinion on this project is good.	+	+	
	Enjoyment			
8	I enjoyed this project very much.	+	+	
13	I would like to work on projects like this more often.		+	+
14	I like learning science in this way.		+	
	Difficulty			
10	This project was too difficult.	+	+	
17	My knowledge was sufficient to understand this project.		+	
	Impact			
9	I learned many new things from this project.	+	+	
12	This project made me understand that climate change studies are very important for human future.	+	+	
18	I learned very much from the scientist(s) in this project.	+	+	
19	This project made me realize that people can affect climate change.	+	+	
20	This project makes me more interested in choosing a scientific career.		+	

The results show that longer projects relate to more positive opinions on all aspects, in particular on impacts of the projects. Even more positive opinions are found when we compare approaches of the projects. It seems that inquiry based science education is appreciated much more than predefined problems and experiments. IBSE projects score better on all questions. Further, we compared projects that worked with small groups of students with projects that work with whole classes. We found little differences; only "I would like to work on projects like this more often" was more positive answered by students who worked in small groups.

In sum, it seems that the activities, in which students have a more active role, are appreciated better by students. The same goes for longer projects and projects with an inquiry based science education approach.

2.3.4 Differences between regions in students' opinions on regional projects

In table 2.7 in Appendix 7 we present the results of 8 important questions of the SET for each institute. It seems that the Dutch students appreciated the projects least of all students. They score lowest on almost all questions. Also students from Bergen and Kiel score low. Students from Jena, Barcelona, and Bordeaux score very high on all questions. The students from Paris and Florence score in between both groups. A lot of these regional differences can be explained by the above mentioned student and project variables. For example the students in Kiel and Bergen were relatively old (i.e. 19/20 year), which is a negative factor influencing opinions on the project.

2.4 Conclusions

The study reported here provides evidence for the success of CarboSchools. Students were positive on the organization, the difficulty, the enjoyment, and the impact of the projects. 46% of the students is more interested in a science career thanks to the project. However, we are not sure all students fully understood this question (20). A large majority of the students thought the project was well-organized, enjoyed the project very much, realized that people can affect climate change thanks to the project, and would like to work on projects like CarboSchools more often. But we should be aware that the teachers and regional coordinators made a pre-selection of students and projects. They had to decide whether the project was appropriate for the students, and whether the students would show enough interest, enthusiasm and would have prior knowledge for the tasks ahead. In some cases, students participating in CarboSchools were volunteers. This means that our students were not chosen randomly and that our findings do not reflect opinions of "average students". We can confirm this by looking at the positive science background of the students. They are interested in science subjects and have high science grades.

Further, there are some differences between regions in students' opinions, but we can explain these differences by other variables, for example students' (science) background and type of activities. We give a short overview of the most important students-dependent differences:

- Gender: girls have a slightly better overall opinion on the project. Further, girls experience the projects as more difficult than boys, and impact on climate change ideas is also larger with girls than with boys.
- Age: the older the students, the worse their opinions are on the projects, with respect to all aspects.
- Being a volunteer: volunteers score better on organization, enjoyment, and impact of the project than students who participated compulsory.
- Science background: the more positive the science background, the better the opinions on the projects.

We also found many project-dependent differences:

- Activities in the project: the activities in which students have a more active role (literature research, computer work, hands-on experiments, presentation by students) are appreciated more than activities in which students have a more passive role (frontal lectures, site visit, lab visit). In particular, literature research and presentations by students show many positive effects on all aspects, most on organization and impact of the project.

- Approach: IBSE is appreciated much more than predefined problems and experiments.
- Duration of the project: the longer the projects, the more positive opinions on all aspects, in particular on impacts.
- Group size: students who worked in small groups would like to work on projects like CarboSchools more often than students who worked with whole classes on a project.

Some issues must be taken into account when interpreting the reported findings. As the results show, the appreciation by the students varies significantly between the authentic science projects. We gave several explanations, but we will suggest two more factors that might cause differences in appreciation which we haven't measured in this study.

First of all, cross-cultural differences in survey response style might influence the results. Response bias is a systematic tendency to respond to questionnaire items on some other basis than the specific item content. Cross-cultural research in Europe has shown that Spanish and Italian respondents score consistently higher on acquiescence (yea-saying) and extreme responses than British, German and French samples (Van Herk, Poortinga and Verhallen 2004). Indeed, the Italian and Spanish projects in CarboSchools are evaluated slightly more positively than most projects in other countries. So response bias might have caused some differences in appreciation between projects.

Furthermore, national science curricula might influence the possibilities and appeal of the projects. The *Science Teaching in Schools in Europe* report (Eurydice 2006) shows a wide range of science curriculum activities in European countries. For example, the amount of practical work in science curricula and the extent to which an authentic science project is a novelty to students differs considerably between countries. These differences in science curricula between countries might affect students' appreciation of the projects.

Nevertheless, we can conclude CarboSchools is a huge success. The appreciation of this kind of science teaching by secondary school students is very high. This positive evaluation confirms the research by Braund and Reiss (2006) about the success of out-of-school experiences and authentic science learning. Also positive outcomes for girls are in line with the results of Van Langen (2005), that a cooperative learning environment is more appreciated by females than by males. However, the girls in our sample are also positive about scientists, which is not in line with Miller, Slawinski Blessing, and Schwartz's (2006) results that females particularly have negative images of scientists. The volunteers in CarboSchools are also more positive on the projects than the compulsory students, which relates to other research which indicates that motivation could be an important factor influencing students' opinions and learning (e.g., Koballa and Glynn 2007; Pintrich and Schunk 2002).

3 Impact of CarboSchools on Students: Attitudes Study

3.1 Introduction

Students' low interests in science studies in Europe have been cause for a lot of research in the attitudes domain. Osborne, Simon, and Collins (2003) characterized students' attitudes towards studying science as an "urgent agenda for research". The underlying hypothesis has been that attitudes help to steer career choice and school performance. CarboSchools combines science education with environmental education, thus trying to influence both attitudes towards science and attitudes towards the urgency of climate change. Currently, environmental problems like global warming are much more becoming part of science curricula. Social responsibility for the environment has established space in science education (Oguz et al., 2004). Environmental education can be seen as the bridge between science education and social responsibility. This science education is considered as one of the most important factors for preventing environmental problems (Özden, 2008). Underlying idea is that students who know a lot about the environment have a positive attitude toward it and are likely to behave in an environmentally responsible manner (Kuhlemeier, van den Bergh, & Lagerweij, 1999).

The main objective of this study is to examine changing attitudes towards science and climate change during the participation in Carboschools projects. The according main question that will be addressed is:

To what extent do students' attitudes towards science and climate change improve during participation in CarboSchools?

First we discuss the theoretical background of the concept of attitudes, and take a look at previous empiric research concerning attitudes towards science and climate change.

3.1.1 Attitudes Research

An attitude is a predisposition to respond in a favorable or unfavorable manner with respect to a given attitude object (Oskamp & Schutz, 2005). A problem that has been raised by those studying attitudes towards science (e.g., Francis & Greer, 1999; Germann, 1988; Osborne et al., 2003) is the theoretical background of attitude itself. In the psychology attitudes are studied for a long time (e.g. Eagly & Chaiken, 1993; Petty & Cacioppo, 1981, 1986; Fishbein & Ajzen, 1975; Fazio & Petty, 2008), but there is still no agreement reached. Few science education researchers have developed theoretical models relating to the various components of attitude (Gardner, 1975; Ramsden, 1998). We use the latent process viewpoint in our research. An attitude in the latent process viewpoint might be conceptualized as a summary of all of a person's affective reactions toward, behavioural responses to, and evaluative beliefs about an attitude object (Oskamp & Schultz, 2005). Beliefs are statements indicating a person's subjective probability that an object has a particular characteristic. For example: this book is informative / my boss is easygoing. Evaluative beliefs are beliefs that state a value judgement about an object, for example: my boss is a nice guy / freedom of press is a good thing. As attitude researchers we should carefully define our attitudes objects concerning science and climate change. Osborne, Driver, and Simon (1998) mention the elements of science in society, school science, and scientific careers. We are also curious in the element of scientists, as the students work with scientists. Some background characteristics of the students and projects are importing factors influencing attitudes towards the different aspects of science. In this literature review we discuss the factors gender, age, knowledge, culture, and type of intervention program.

3.1.2 Effect of background variables on science related attitudes

Schibeci (1984) reported in a review of science education literature that of all the variables that may influence attitudes toward science, gender has generally been shown to have a consistent influence. It appears that girls have more negative attitudes towards science than boys. Girls' science-related interests are on average more focused on the biological than on the physical sciences. As Miller et al. (2006) point out girls tend to be more oriented to the human aspects of science, as girls consider biology as a helping, people-oriented science. Girls generally found science uninteresting and the scientific lifestyle (as perceived by them) unattractive. Furthermore, it is known that girls have more negative images of scientists than boys. Both boys and girls view science as a male-dominated school subject and consider science to be a male profession (Andre et al. 1999). Koballa and Glynn (2007) conclude that the most frequently given sociological reasons for girls having less positive attitudes toward science than boys include the differential cultural expectations placed on girls and boys by parents, teachers, and peers, and the different experiences in science, both in school and out of school, provided to boys and girls.

Student age is also important: children at the primary level have rather positive attitudes towards science, whereas attitude scores decline during the secondary school period (Osborne et al., 1998; Koballa, & Glynn, 2007; Barmby, Kind, & Jones, 2008). This decline is more pronounced for girls than for boys. Sorge (2007) found a precipitous drop in science attitudes between the age of 11 and 12, even if the students have only been attending middle school for a maximum of six weeks. The effect size is large, and the students do not recover their previously higher levels of science attitude in the later middle school years. Bennet and Hogarth (2009) also found that positive attitudes to school science decline significantly between the ages of 11 and 14 years. The sharpest fall occurs for student attitudes towards school science. Experiences in school science between the age of 11 and 14 are crucial in shaping student attitudes and subsequent behaviours in relation to subject choice. As pupils progress through school, the attitude towards learning science in school becomes a greater influence on attitudes towards future participation in science (Barmby, Kind, & Jones, 2008).

Further, knowledge seems related to attitudes. In a literature review Weinburgh (1995) calculated the mean correlation between attitude towards science and achievement in science was .50 for boys and .55 for girls. This is a moderate, positive relationship. The relationship between attitudes and achievement in biology is higher than in physics.

A lot of effort has been put in improving attitudes. However, not all interventions work very well. The results from intervention studies point to the success of particularly those that engage learners in hands-on science activities and that stress the relevance of science through issue-based experiences (Koballa, & Glynn, 2007). For example, a study by Jarvis & Pell (2005) among 10/11 year old students showed that their science attitudes increased during an hands-on science activity in a space center. This increase was even valid two months after the trip. Twenty percent of the students also showed an increased interest in scientific careers.

3.1.3 Effect of background variables on environmental related attitudes

Research literature tells us that attitudes and knowledge influence environmental responsible behaviour. Knowledge about the environment seems to be an important, but not sufficient, component for responsible environmental behaviour. Therefore, positive attitudes towards the environment are needed. Moreover, students environmental knowledge is often fragmentary and incorrect (Kuhlemeier, van den Bergh, & Lagerweij, 1999; Tosunoglu 1993). In a nationwide sample of more than 9,000 students (aged +/- 15 years) from 206 Dutch secondary schools the relation between environmental knowledge and environmental attitudes and behavior proved to be very weak (Kuhlemeier, van den Bergh, & Lagerweij, 1999).

It is known that girls show more concern for the environment than boys. In a study performed by Tosunoglu (1993) to determine the predictors of Turkish university students' environmentally responsible behaviours, girls seemed to be more willing to become actively involved in environmental protection. However, Makki et al. (2003) found that among Lebanese secondary school students' both boys and girls had favourable attitudes towards the environment, but lacked environmental knowledge.

To improve students' environmental attitudes, is considered as difficult. Research studies focusing on students' environmentally responsible behaviours and associated variables after exposure to an environmental education programme showed that these interventions impacted positively upon students' environmental knowledge, but they were not effective on their attitudes and behaviours towards the environment (Grodzińska-Jurczak et al., 2003). It was suggested that increasing students' knowledge is simple, but environmental attitudes and behaviours are difficult to change.

Nevertheless there are some interventions that work well with students. An example of an intervention to improve environmental attitudes is from Stern, Powell, & Ardoin (2008). They explored the influences of 3- and 5-day residential environmental education programs at the Great Smoky Mountains Institute at Tremont (TN) on participants' connections with nature, environmental stewardship, interest in learning and discovery, and awareness of the Great Smoky Mountains National Park and biodiversity. The authors found significant positive, short-term effects on all outcomes of interest. Also, 3-month delayed post-tests indicated retention of significant gains in environmental stewardship and awareness, whereas other gains faded. Longer stays and active engagement of visiting teachers in on-site instruction enhanced most outcomes.

3.2 Methodology

3.2.1 Construction of the Attitudes Questionnaire

For the purpose of measuring students' attitudes in CarboSchools the Attitudes Questionnaire (AQ) has been developed. This questionnaire consists of three parts. The first part contains 12 items concerning general background variables like gender, age, and educational level of parents. The second part contains 39 attitudes statements. The third part is a knowledge test about climate change, which contains 12 items (see table 3.1). The questionnaire can be found in Appendix 2.

Table 3.1: Climate Change Knowledge Test

		True	*False*	*Don't know*
1.	Most of current Climate Change is due to greenhouse gases generated by human activity.	❑	❑	❑
2.	If my city has a heat wave this summer, it will mean that climate is changing.	❑	❑	❑
3.	Climate change is only defined as the rising in temperature of the earth's surface.	❑	❑	❑
4.	Climate change is a result of the ozone layer becoming thinner.	❑	❑	❑
5.	Climate Change is partly caused by the increase in the emission of heavy metals.	❑	❑	❑
6.	A rise in sea level and drought are some of the consequences of Climate Change.	❑	❑	❑
7.	There is a direct link between Climate Change and skin cancer.	❑	❑	❑
8.	The ocean can absorb CO_2 emitted by humans.	❑	❑	❑
9.	Because of Climate Change, an oxygen deficiency can arise.	❑	❑	❑
10.	Because of climate change, the water in seas and oceans will expand.	❑	❑	❑
11.	The acidification of forest is a result of Climate Change.	❑	❑	❑
12.	Because of climate change, certain plants and animals may become extinct.	❑	❑	❑

As part of this study, the following areas of attitudes to science and climate change were focused upon as being important: school science, social implications of science, scientists, career interest in science, climate change, and environmental awareness. All the attitude areas listed were chosen as areas that could possibly be affected by an initiative such as CarboSchools.

For scaling of the attitudes we use Likert's method of summated ratings. Each item is a component in a summated rating scale that consists of a number of opinion statements reflecting either a favourable or unfavourable attitude to the object being studied. The use of more than one response for the same construct greatly increases the reliability of the summated rating scores (Kind, Jones, & Barmby, 2007). A choice from the following five responses was given for each statement: "*Strongly disagree*", "*Disagree*", "*Neutral*", "*Agree*", and "*Strongly agree*". Having a limited set of meaningful (to the students) statements was regarded as crucial. Most of the statements were therefore adopted from existing questionnaires that have been proven to work with pupils. We will give a short description of the two questionnaires we have used most.

The ROSE, the Relevance of Science Education, is an international comparative project meant to shed light on affective factors of importance to the learning of science and technology (Schreiner & Sjøberg, 2004). The target population consists of students towards the end of secondary school (age 15). The research instrument is a questionnaire mostly consisting of closed questions with four-point Likert scales. The key feature of ROSE is to gather and analyze information from the learners about several factors that influence their attitudes to science and technology (S&T), and their motivation to learn S&T. Examples are their prior experiences with and views on school science, their views and attitudes to science and scientists in society, their future hopes, priorities and aspirations, and their feeling of empowerment with regards to environmental challenges. The scope of ROSE is still expanding, and numerous studies have already been published. We did not use all scales from this questionnaire, because we think CarboSchools is not influencing all attitude areas in the ROSE questionnaire.

A second test for measuring science attitudes, named Test of Science Related Attitudes (TOSRA), was initially developed in Australia by Fraser (1981). Seven science-related attitudes are measured among secondary school students, for example, social implications of science, normality of scientists, enjoyment of science lessons, and career interest in science. Since the 1980s this well validated questionnaire has been widely used in attitude research. We haven't used all scales from this questionnaire, because we think CarboSchools is not influencing all attitude areas in listed in the TOSRA questionnaire.

At this point, as suggested by the guidelines of Kind et al. (2007), let us be more specific about what we meant by the above constructs. The first four constructs aimed to examine pupils' attitudes towards science.

Attitudes towards school science – This scale measures the students' attitudes towards science in school. In this study biology, chemistry, physics, and science lessons are considered as 'science in school'. 6 of the 7 items are based on the 'Learning Science in School' scale from Barmby, Kind, & Jones (2008).

Attitudes towards the social implications of science – In this scale the students' attitudes regarding the significance of science towards society are measured. 6 of the 7 items were taken from the 'Social Implications towards Science' scale from the Test of Science Related Attitudes (TOSRA), developed by Fraser (1978). One item was added to include policy in this scale: 'Policy decisions should be more based on what scientists say'

Attitudes towards scientists – In this scale the opinions on a scientist's lifestyle is measured. Three of the six items were taken from the "Normality of Scientists" scale from the TOSRA (Fraser, 1981). Eurobarometer (2008) adds one item. Two items are added by the authors for a complete scale.

Attitudes towards a career in science – This scale measures how students think about a scientific career and consists of 5 items, taken from the "Career Interest in Science" scale from the TOSRA (Fraser, 1981).

The last two constructs aimed to examine pupils' attitudes towards the climate change.

Attitudes towards the urgency of climate change – In this scale the students' attitudes towards the urgency of climate change issues are measured. The 6 items are based on the 'Importance of Environmental Problems' dimension from Berberoglu & Tosunoglu (1995) and on the 'Me and Environmental Problems' scale from the Relevance of Science Education (ROSE) study conducted by Schreiner and Sjøberg (2004).

Environmental awareness – In this scale the students' awareness of individual responsibilities about climate change issues is measured. The 8 items are partly designed by the authors and partly taken from the 'Environmental Citizenship' dimension, developed by Stern, Powell, and Ardoin (2008).

There are a number of negative items of which the scoring is reversed. All items are randomly distributed throughout the scales. We piloted the attitude measures to check the internal statistical reliability of the different measures, and use factor analysis to check whether the measures themselves would in fact be unidimensional – that the items that we had put together would actually measure the same thing. Therefore, the constructed measures were put together into a paper questionnaire, which in turn was given out to 116 grade 10 students from a secondary school in the north of the Netherlands. Reliability calculations and factor analysis on the data collected, identified items that reduced the internal reliability of attitude measures or did not group together with other items were identified. These items were either removed from the measures, or their wording was modified.

The questionnaire was translated to the native language of the students and implemented twice: before and after the project. Altogether 671 students filled in the pre-test and 593 students filled in the post-test. Prior to the analysis of the attitude data, all the responses were coded numerically. Initially, the responses were coded as "strongly disagree" = 1, "disagree" = 2, "neutral" = 3, "agree" = 4, and "strongly agree" = 5. Subsequently, prior to the reliability analysis of the data, the responses were reversed coded for negatively phrased items.

3.2.2 Reliability Analysis of the Attitudes Questionnaire

Having established the unidimensionality of the various attitudes measures by using a factor analysis, we next examined the internal reliability of these measures. Table 3.2 presents the Cronbach's alpha values for each measure. Prior to carrying out the reliability calculations, all negatively worded items were reversely coded.

Table 3.2: Cronbach's alpha reliability values for each attitude measure

	Number of items	*Cronbach's alpha*
School Science	7	.87
Social Implications of Science	7	.74
Scientists	5	.76
Career in Science	5	.83
Urgency of Climate Change	6	.82
Environmental Awareness	8	.78

For all the attitudes measures, the internal reliability was calculated to be above the threshold of .70. In addition to examining the internal reliability, we also checked the spread of each measure in terms of mean values and standard deviations. These results are summarized in table 3.3.

Table 3.3: Mean values and standard deviation of each attitude measure

	Pre-test (n = 671)		*Post-test (n = 593)*	
Measure	M	SD	M	SD
School Science	3.60	.75	3.54	.78
Social Implications of Science	3.81	.54	3.75	.57
Scientists	3.71	.67	3.69	.74
Career in Science	3.45	.81	3.33	.85
Urgency of Climate Change	3.79	.71	3.75	.71
Environmental Awareness	3.78	.68	3.73	.64

From these results, we identified that all scales are reliable and well suited for the attitudes measures. Now we are able to take a look at the results of the attitudes measures, indicating students' attitudes towards science and climate change.

3.2.3 Data collection

Not all Carboschools projects were included in our analysis. We included only projects that last for at least 10 hours per student, because a certain amount of exposure is needed for changing students' attitudes. Further, we excluded those projects with unequal numbers of pretest and posttest questionnaires. It is important to note that the projects in Bordeaux are overrepresented (269 students). The characteristics of the projects that were included in the attitudes analysis are presented in table 3.4.

Table 3.4: Projects in attitude research 2009-2010

Projects	19
Students	413
- Girls	215
- Boys	198
Student age	12 – 21 years (mean = 15.5)
Schools	17
Research Institutes	5
Countries	4
Science lessons in a week	1 – 20 hours per student (mean = 7)
Time spent on project	10 – 90 hours per student (mean = 39 hours)
Visits to the research institute	0 – 3 per project (mean = 0.5)
Scientists visits to school	0 – 4 per project (mean = 1.4)

A total of 413 students participated in the attitudes research, of which 215 girls and 198 boys. Their average age was 15.5 years old, ranging from 12-21 years. They participated in one of the 19 projects in five institutes (Bordeaux, Bergen, Florence, Groningen, and Paris). On average they spent 39 hours on the CarboSchools project. The other institutes work on shorter projects or with younger pupils so that those were excluded in this part of the study. Further characteristics of the projects can be found in the overview in Appendix 5.

3.3 Results

3.3.1 Attitudes changes and knowledge changes

In table 3.5 the results of pre-test and the post-test are presented. All attitudes scores are very positive, as 3.00 is “neutral”. So our students are already very positive about science and the urgency of climate change before they start the project, and after the project they are still very positive. However, the knowledge test about climate change seems to be difficult for the students with on average 48 % correct answers. When we take a look at the attitudes *changes*, it seems that the average scores declined a bit for all scales. To test this hypothesis, we used Student’s T test. Only the attitudes towards schools science, attitudes towards social implications of science, and towards a career in science declined significantly ($p<.01$, 2-tailed). We found no significant change in attitudes towards scientists, the urgency of climate change, environmental awareness for the total group of students. The overall results show that knowledge about climate change significantly increased: the students chose the ‘don’t know’ option in the knowledge test during the post-test less often, so it seems students are more confident about their climate change knowledge.

Table 3.5: Results of pre-test (n = 413) and post-test (n = 385)

	Measure			
	Pre-test (n=413)		Post-test (n=385)	
	Mean	SD	Mean	SD
School science	3.73	.66	3.57**	.73
Social implications	3.86	.50	3.72*	.56
Scientists	3.76	.67	3.74	.75
Science career	3.54	.75	3.35**	.78
Urgency of Climate change	3.88	.70	3.80	.72
Environmental awareness	3.85	.64	3.79	.64
Knowledge	48%	16%	53%**	16%

* Significant change ($p<.05$, 2-tailed)
** Significant change ($p<.01$, 2-tailed)

Differences between boys and girls in attitudes changes are displayed in table 3.6.

Table 3.6: Gender differences in pre-test and post-test results

	Gender							
	female				male			
	Pre-test (n=215)		Post-test (n=201)		Pre-test (n=198)		Post-test (n=182)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
School science	3.67	.67	3.54	.76	3.80	.64	3.63*	.69
Social implications	3.86	.48	3.74*	.53	3.86	.52	3.71**	.59
Scientists	3.82	.67	3.86	.74	3.70	.66	3.60	.74
Science career	3.52	.76	3.30**	.83	3.56	.74	3.41	.73
Urgency of Climate change	3.93	.65	3.84	.68	3.83	.75	3.77	.75
Environmental awareness	3.93	.57	3.83	.62	3.77	.70	3.74	.66
Knowledge	47%	14%	51%**	14%	50%	17%	55%**	17%

* Significant change ($p<.05$, 2-tailed)
** Significant change ($p<.01$, 2-tailed)

Attitudes towards social implications decline for both boys and girls, but attitudes towards school science only decline significantly for boys. Girls only score lower on attitudes towards a career in science after the project than before. Both boys and girls gained knowledge; they score better on the climate change knowledge test than before participation in CarboSchools.

The T-test results for differences between institutes in the attitudes changes are displayed in table 3.7. Florence and Groningen were not included in this analysis, because of very small sample sizes.

Table 3.7: Institute differences in pre-test and post-test results

		Institute					
		Inra Bordeaux		Bergen		LSCE Paris	
		Pre-test (n=268)	Post-test (n=258)	Pre-test (n=81)	Post-test (n=71)	Pre-test (n=36)	Post-test (n=33)
School science	Mean	3.72	3.53**	3.86	3.78	3.72	3.49
	SD	.64	.70	.73	.75	.62	.83
Social implications	Mean	3.84	3.66**	3.99	3.92	3.71	3.62
	SD	.50	.53	.52	.61	.48	.53
Scientists	Mean	3.81	3.74	3.58	3.73	3.78	3.69
	SD	.67	.73	.63	.74	.66	.86
Science career	Mean	3.60	3.38**	3.43	3.29	3.58	3.32
	SD	.73	.78	.80	.83	.67	.72
Urgency of	Mean	3.99	3.86*	3.83	3.81	3.53	3.37
Climate change	SD	.69	.71	.68	.68	.61	.64
Environmental	Mean	3.99	3.91	3.51	3.44	3.93	3.90
awareness	SD	.58	.58	.60	.63	.66	.57
Knowledge	Mean	47%	52%**	51%	55%	41%	46%
	SD	14%	14%	19%	19%	12%	14%

* Significant change (p<.05, 2-tailed)
** Significant change (p<.01, 2-tailed)

We only found significant differences between pre-test and post-test in Bordeaux. There, students’ attitudes towards school science, social implications of science, a science career, and the urgency of climate change declined during participation in CarboSchools. However, their knowledge on climate change increased significantly. For students from both Bergen and Paris we couldn’t find any significant changes, but this might be due to the relatively small sample sizes.

We are also interested the differences in attitudes changes between different types of projects. It is possible some types of projects are more successful in improving attitudes than other types of projects. Analyses were carried out on the pre-test and post-test scores with as independent variables: voluntary/compulsory projects, approach of the project, literature research, computer work, frontal lectures, hands-on experiments, presentation of students, site visits, and lab visits.
No difference was found in attitudes changes between voluntary and compulsory projects. Both student groups showed a decline in attitudes towards school science, social implications of science, a science career, and an increase in knowledge on climate change. We also didn’t find a difference between the “predefined problems and experiments” approach and the “inquiry based science education” approach. The types of activities in

the project (literature research, computer work, frontal lectures, hands-on experiments, presentation of students, site visits, and lab visits) did not show any deviant effect on attitudes: all projects score the same on the attitudes changes: that means significant declines ($p<.05$) in attitudes towards school science, social implications, science career, and an increase in climate change knowledge.

3.3.2 Differences between students in attitudes

Because the attitudes did not change drastically, we wanted to know what variables influence attitudes. For this purpose, we selected the pre-test data (n=413). We are interested in the differences between countries in students' attitudes. In table 3.8 differences between regions in students' attitudes can be found.

Table 3.8: Institute-dependent differences in students' attitudes (pretest n = 413)

	Institute									
	Inra Bordeaux (n=268)		CNR-IBIMET Firenze (n=10)		Bergen (n=81)		LSCE Paris (n=36)		RUG Groningen (n=17)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
School science	3.72	.64	3.62	.68	3.86	.73	3.72	.62	3.45	.67
Social implications	3.84	.50	3.93	.42	3.99	.52	3.71	.48	3.94	.30
Scientists	3.81	.67	3.47	.51	3.58	.63	3.78	.66	3.94	.69
Science career	3.60	.73	3.73	.82	3.43	.80	3.58	.67	2.95	.82
Climate change	3.99	.69	3.72	.62	3.83	.68	3.53	.61	3.26	.73
Environmental awareness	3.99	.58	3.56	.56	3.51	.60	3.93	.66	3.26	.81
Knowledge	47%	14%	56%	11%	51%	19%	41%	12%	57%	17%

Students in Bergen have best attitudes towards school science and social implications of science, whereas the students from Groningen score lowest on school science. However, the Dutch students score high on attitudes towards social implications of science and on the climate change knowledge test, but low on both urgency of climate change attitudes and environmental awareness. Students from Bordeaux score best on the environmental related attitudes. Paris students have least knowledge of climate change. So there are many differences between students from different institutes in the way they think of science and climate change.

Other student-dependent characteristics, like the amount of practical work in science lessons, students' age, education level of their parents, and students' science grades, were also checked for significant effects on attitudes. First, we measured the effects of the amount of practical work in science lessons on attitudes. The results, presented in table 3.9, show the significant results ($p<.05$).

We see that both attitudes towards school science and a career in science are most positive for students doing practical work at least once a week. Students, who seldom or never do any practical work in science lessons, show less positive attitudes towards school science and a science career. This indicates that the science curriculum influences students' attitudes towards science. The amount of practical work did not show a significant effect on the other attitudes.

Table 3.9: Effect of practical work on attitudes (pretest n = 411)

	Amount of practical work					
	at least once a week (n=258)		at least once a month (n=126)		seldom or never (n=27)	
	Mean	SD	Mean	SD	Mean	SD
School science	3.78	.62	3.73	.71	3.33	.71
Science career	3.63	.72	3.47	.77	3.07	.76

We used an ANOVA test to measure the differences in attitudes between three age groups (12-14; 15-16; 17-19). The significant results (p<.05) are presented in table 3.10.

Table 3.10: Effect of age on attitudes (pretest n = 411)

	Age					
	12-14 (n=69)		15-16 (n=258)		17-19 (n=84)	
	Mean	SD	Mean	SD	Mean	SD
Scientists	4.03	.63	3.74	.67	3.60	.62
Science career	3.79	.69	3.56	.72	3.27	.84
Climate change	4.10	.63	3.90	.70	3.65	.69
Environmental awareness	4.09	.52	3.92	.60	3.43	.66
Knowledge	50%	14%	46%	15%	53%	18%

It seems that the older students, the worse their attitudes towards scientists, science career, the urgency of climate change, and environmental awareness. However, the older students have more climate change knowledge than the younger students. No significant effects were found on attitudes towards school science, social implications of science, and the climate change knowledge test.

We used the ANOVA again to measure the effects of students' science grades on attitudes. The mean scores for each group on attitudes are presented in table 3.11 (only significant results p<.05).

Table 3.11: Effect of science grades on attitudes (pretest n = 405)

	Science grades					
	High (n=141)		Moderate (n=242)		Low (n=22)	
	Mean	SD	Mean	SD	Mean	SD
School science	4.10	.59	3.57	.58	3.33	.83
Social implications	3.99	.50	3.80	.48	3.77	.58
Scientists	3.86	.69	3.73	.64	3.28	.57
Science career	3.80	.76	3.42	.70	3.32	.78
Knowledge	51%	16%	47%	15%	44%	16%

The students with high grades score better on all science related attitudes than students with moderate or low science grades. They also have more climate change knowledge. Interesting result is that science grades do not relate to the urgency of climate change attitudes or environmental awareness.

Further analyses, not represented in a table, made clear that students whose parents graduated from higher education, score significantly (p<.05) better on attitudes towards school science, social implications of science, and a career in science than students whose parents graduated from secondary school. These students score also better on the climate change knowledge test. Students, whose parent(s) had a science diploma, have more positive attitudes towards school science, social implications of science, and a science career, than students whose parents don't have a science or engineering diploma. And here again we see that the education level of parents does not influence attitudes towards climate change or the environmental awareness. Comparing attitudes for different education levels of the students themselves would be very interesting. However, this was unfeasible because of the international differences in educational systems.

3.4 Conclusions

The results show that students' attitudes are already at a positive level when they begin a project. This result is confirmed by the interviews with teachers, students, and regional coordinators (see Chapter 4), and by comments or regional coordinators during project meetings. Further, we found some background characteristics of students which influence their attitudes:

- Gender: boys' attitudes towards school science decline and girls think less positive about a career in science after the project than before. Our girls are very positive on science and the urgency of climate change, the same as the boys. These results do not correspond with research on gender differences. The strong gender difference generally found that girls are less positive or even negative on science was not confirmed by this study.
- Age: older students have more climate change knowledge but have less positive attitudes towards scientists, science career, the urgency of climate change, and environmental awareness than younger students. Younger students are more concerned about the environment than older students. This is similar with findings from research literature.
- Institute: many differences were found in the way students think of science and climate change. Cultural differences might have an effect on attitudes.
- Amount of practical work in science lessons: the more often students do practical work in science lessons, the more positive their attitudes towards school science and a career in science. This indicates that the science curriculum might influence students' attitudes towards science. The importance of practical work is shown by our results.
- Science grades: The students with high science grades score better on all science related attitudes than students with moderate or low science grades. They also have more climate change knowledge. Interesting result is that science grades do not relate to the urgency of climate change attitudes or environmental awareness.
- Education of parents: students whose parents graduated from higher education, score significantly ($p<.05$) better on science related attitudes than students whose parents graduated from secondary school. These students score also better on the climate change knowledge test. Also a science or engineering diploma in the family, relates to more positive science related attitudes.

However, CarboSchools is not able to enhance students' attitudes towards science and climate change. In stead of enhancing students' attitudes, some science related attitudes even slightly declined. The attitudes towards climate change and environmental awareness stay at the same level during participation in CarboSchools. We found no differences in attitudes changes for different types of projects and activities. A positive result is the increase of climate change knowledge during the project. After the projects students became also more confident about their knowledge.

The declining science related attitudes are not what we expected since students' opinions are very positive on the projects (see Chapter 2). So, the students' increased knowledge about climate change did not result in changes in a higher feeling of urgency related to climate change nor in a higher level of environmental awareness, as literature describes in other contexts. It is important to realize that attitudes - measured by external observers - and opinions on the projects - directly expressed by participants themselves - are different categories, which do not necessarily correspond. It is possible that students have positive opinions on the projects, but that their images of science (i.e. their attitude towards science) remain negative. Particularly, this applies to the scale measuring student attitudes towards school science. It is not likely that this will be influenced by our projects, despite the fact that these projects are much appreciated by the students.

We know from literature that attitudes are rather stable - therefore difficult to change by external factors - and they become more negative as teenage students get older. This frequently found decline among high school students is caused by a number of factors, the most important one being probably their experience in science lessons. Despite the positive judgments of the students in CarboSchools projects this trend remains unchanged. An additional reason for finding no improvement of attitudes is that the attitudes of participating students were already at a high level before the projects started; meaning that our student groups did not reflect average student groups and leaving little chance for improvement.

4 Perceptions of Participants in CarboSchools: Interview Study

4.1 Introduction

There are two aims for this interview study. We would like to gain more in-depth knowledge about the regional projects, in particular what one thinks on CarboSchools. We also need to know more on constraints in the organization of CarboSchools in both schools and research institutes. Therefore, we conducted an interview study for getting (more specific) answers on the following research questions:

1. *What is the impact of CarboSchools on students?*
2. *How is CarboSchools integrated in the schools?*
3. *How do schools and research institutes collaborate in CarboSchools?*

We decided to use interviews for this part of the evaluation, because an interview study has proven to be a good method to discover new relationships, deepen the answers, and get detailed information on what causes problems or benefits. The interviews are conducted with different actors in CarboSchools: students, teachers, and regional coordinators/scientists. This descriptive, exploratory research is structured in three themes according the research questions. An interview protocol is drawn up for each group, using the following themes if applicable:
Theme 1: Regional projects: form, content, and impact
Theme 2: Relation project and curriculum
Theme 3: Collaboration schools and research institutes
In the last paragraph we will answer the research questions.

4.2 Methodology

The minimum number of interviewees was set at five students, five teachers, and five regional coordinators/scientists in order to get diverse images of the projects. Most regional coordinators (subsequently abbreviated to RC's) also fulfill the role of scientist. Because the regional coordinators also work at the research institute and have a good knowledge of things going on there, we decided not to interview "scientists" as a separate group. The participants were asked for an interview on basis of a convenience sample during the Spring School in Jena in April 2010. That also implicates not all regions are necessarily included in the interview study. We were able to interview actors from 5 different regions, of which we interviewed students, teachers, and the RC of 4 regions. A list of exact interview dates is included in appendix 9. All participants were involved in at least one long-term regional CarboSchools project within the last school year. Most of the interviews were individual, but some interviews were with two or more participants at the same time. The total number of interviewees is 18 in a total number of 13 interviews, see table 4.1. Females are overrepresented in this sample: seven out of eight students, all teachers, and three out of five RC's were female. For better understanding of the interview questions, some teachers and students read the interview protocol before the interview took place. They had some difficulty with the English language, but they got help with translations from other students or teachers. The average interview time was 44' for RC's, 39' for teachers, and 6' for students.

Table 4.1: Overview interviewees

Interviewees	*Paris*	*Bordeaux*	*Florence*	*Bergen*	*Kiel*	*Total*
Students	1	4*	2*	1		8
Teachers	2*	1	1	1		5
RC's/scientists	1	1	1	1	1	5
Total	4	6	4	3	1	18

* Group interview

We asked participants questions on the three themes, like "What do you think is the impact of this project on the students?", "Were there any obstacles in realizing the project within the school?", and "How did you experience the collaboration with the scientist?". Students were asked on themes 1; teachers were asked on all themes; and RC's were asked on themes 1 and 3. In addition, we asked if participants had more comments that were not covered in the interview questions in order to get more valuable information on the projects.

The interviews were audio-recorded and all relevant parts were transcribed verbatim and summarized. The interview questions and the summarized answers can be found in appendix 9B for the RC interviews, 9A for the teacher interviews, and 9C for student interviews. The answers from all participants in one group (e.g., students, teachers, or RC's) were then summarized to get a clear picture of the projects.

4.3 Results

These results will be grouped by theme in the following sections and be illustrated with relevant quotes of participants, for reliability of the themes and for validation of results. The quotes are anonymized for privacy reasons.

4.3.1 Regional projects: form, content, and impact

The projects are very diverse both in form and content. In most regions various projects are conducted on several schools at the same time. Most projects are long-term (e.g. at least 3 months), but in Florence and Kiel students also work on short-term projects, like a seminar by a scientist. Individual projects may also be part of CarboSchools, in particular in Kiel where scientists work with students in the lab. Because of the majority of long-term projects, we will focus on these projects in this interview study.

Topics of the projects included various aspects of the carbon cycle and environmental education. The interviewees mention the following topics: measuring CO_2, temperature change, photosynthesis, acidification of oceans, ocean currents, changing the ecological footprint and reducing CO_2 emissions. In the vast majority of the projects students conduct experiments, analyze data, write a report, and present their results in their class or on a conference. This can be part of releasing information to a wider public (Paris). In a few projects students conduct interviews with relatives or scientists, and even a role play or a game can be part of a project (Florence). In some projects students visited the research institutes, but this is often not possible because of limited capacity to receive groups at the institute. Site visiting for measuring CO_2 is more common. The students in Bergen for example go on a boat trip in the fjords for measurements.

Four of the five interviewed RC's fulfill also the role of scientist in the projects. They give an introduction when the project starts, go on trips with students to research institutes and sites, and help students with the experiments. They visit the schools multiple times, depending on the kind of project. One RC illustrates this double role:
"I always meet the teacher before with no pupils. So we discuss how to conduct the project. And I propose some experiments. It is very important this meeting between me and the teacher. And after I spend in class to begin the project. And I was at the end of the project for the presentation, I corrected some slides. And I always said I can come to the classroom if someone that wants. Sometimes it is important that I come back, because of the subject." (RC)

RC's also give lectures, but sometimes other scientists from the research institute give lectures and the RC has a more coordinating role:
"The role is to coordinate the CarboSchools project in our region, from the very beginning to the end. So we have to actually start the project, find the partners, put the project together with them. I have to follow the project though with them. Organize everything, in my project particular I have to organize site visits, organize scientist activities or lectures. I'm not a scientist. I don't often do activities, but sometimes I give a little lecture on CarboSchools, what is it, to introduce CarboSchools. And also I might do some activities with the CO_2 *sensor. I know how to do that. I also do sometimes some English lesson in fact. (…) I always accompany the scientist and help them with the activities; I will participate or take photos. (…) Make sure things are okay."* (RC)

Tasks of the teacher are normally supervision and guiding the students, and integrating the subject topic into the curriculum. However, the involvement of teachers varies considerably in the projects. During site visits the role of teacher can differ very much, as one RC experienced:
"*When they go on the site visits, it really depends on the teachers what they do. Some teachers are really well prepared and want their kids to do special activities and they organize it well with me, (…), to the other extreme the teachers may also be tourists and just want their students to have a good time. They listen but do not take any notes, and mess around during the activities*." (RC)
This teacher problem is found in more regions. One region has a creative solution to get teachers involved. Teachers are asked to at least contribute in public outreach activities of the research institute:
"All the projects at the institute are done in the philosophy that the institute also has to profit from it. (…) So what we demand from every group we work with that they support us with our public outreach. (…) One of the ways we are doing that is by contributing to open days of the institute, where the students present their work, and the teachers help them prepare for that. And this has been very successful." (RC)

A short overview of the most important tasks of both teachers and RC's can be found in table 4.2.

Table 4.2: Overview tasks teachers and RC's

Tasks teacher	*Tasks RC*
Guiding students	Guiding students during site/institute visits
Supervision during the project	Helping students with experiments
Collaboration with other teachers	Coordinating/matching scientists and teachers
Preparation of project	Preparation of project
Integrating subject into curriculum	Giving lectures

But what do students think of the projects? The interviewed students experience the project very positively. All students would like to work on projects like CarboSchools more often. Most students do not think the project was difficult. The projects were interesting. Students like experiences outside school best, for example a boat trip or scuba diving; but they also like to work with people (scientists). The interviewed students liked almost everything of the project, except for one student who did not like writing the report (that was boring). In the majority of the projects students worked in little groups, which they like very much. The students learned very much about the carbon cycle and the environment. Most of the interviewed students think of studying a career in science, but only for one this was stimulated thanks to Carboschools. Most of them were already interested in science. However, they like the projects a lot, because now they get the chance to do experiments or work in a different way:
"I liked working in a group, and realize our own project. And working with scientists, and see how they work. It is a different way of working; it is very interesting, a new way." (student)

Not all interviewed students have visited the research institute; this varies from none (Florence and Paris) to three visits (Bordeaux). However, the scientist visited the school of the students in all projects at least one time, which is very much appreciated by the teachers:
"It was very useful, because the topic is very actual, we are talking about now. The scientists are dealing with it, they are up to date, it was good they come to the school to keep us linked to the actuality, what is going on now. (…) And also it was nice because our students do not get many occasions they can meet scientists." (teacher)

Because students work in groups, teachers mention that students' social skills increased during the projects. They had to keep appointments and trust each other. One teacher notices the motivation of the students for the project increased:
"They are involved in all aspects; they can make links between subjects. In France we have one topic or one subject attention. So sometimes, this topic, you can see a social problem and an economy problem. For example, deforestation, it is an environmental problem, but also economical. So they can learn the issue by two approaches. I think after this year they don't see the different topics the same anymore." (teacher)

Teachers differ in their answers on whether the project increased the attractiveness of school science and they do not know for sure whether this is because of the project:

"In the first year we have sort of a campaign for the different subjects. And when I say I have this collaboration with the university, being able to go on fieldwork, stuff like that, I can see that: okay, that makes a difference. And I know from students I have talked with, that makes a difference. But it is not only because of CarboSchools, because I teach geosciences in two difference years and in the first year we go to the mountains (…). And the last year is CarboSchools. So I tell students that when they choose geosciences, they will have one trip to the mountains and a trip to the ocean (…) But then again, it is hard to separate, how much is because of CarboSchools, and how much is because I take students out." (teacher)

Teachers also differ in their answers on whether the project increased the attractiveness of their school for other students and parents. Most teachers find this hard to say. One teacher indicates that this is the case if the project was more promoted, but another teacher strongly agrees that the project increased the attractiveness of the school:
"I know that parents ask the headmaster that their children can be in this class. They know it is an original class. So it has an impact outside the school." (teacher)

4.3.2 Relation project and curriculum

Teachers integrate the subject topic into the curriculum. Some projects were part of one school subject, for example science or geosciences. In both Paris and Bordeaux teachers collaborated with each other in a more multidisciplinary project, as the teachers illustrate:
"There were many teachers involved. To show students there is not one point of view, but many points of view, political point of view, economy, scientists, and also language. (…). The math teacher did the scientific aspect, the English teacher, because all the documents were in English, so it made them realize that English was useful, (…), there was also the commerce teacher, because they study commerce, he helped with fundraising (…). The French teacher, to explain the questions, the arguments, which went around the topic. The art teacher, to make the poster, and also the sports teacher because they took some samples in the sea, so they had to scuba diving." (teacher)

The aims for participating in the projects from teachers' point of view are very divers as can be seen from table 4.3.

Table 4.3: Teachers' aims for participating in CarboSchools

Aim	*Aim of N teachers (max. 5)*
Conducting a research project	2
Increasing students' knowledge	2
Making students interested in science	2
Helping students make the right choice for further study	1
Showing students they are important and that the project is rewarding	2

Most of the subject matter was new to the students, but in some projects students already knew some basic knowledge about the carbon cycle. For some teachers CarboSchools was a totally new way of teaching science. The teacher and RC in Florence illustrate this innovativeness of experiments:
"In Italy it is not simple, in the school study with laboratory activity. So only in the few years, we have laboratory. And I tried to start the program with experiments, only in the

past 3 or 4 years. So we have only theoretical lessons, and internet review, or library. Very theoretical. I teach since 18 years, so this is a new style for me." (teacher)
"This is very useful for the students/teachers because they get some devices they normally do not get." (RC)

Teachers experience several problems when realizing such a project in the curriculum. In Paris the motivation of pupils was a problem, but that might be caused by the fact students were studying commerce. The school was in the inner city, with a lot of absents, violence etc. Other obstacle is getting the money for trips and transportation. Moreover, in Paris, teachers got little support from administration in school:
"And we didn't get much support from the administration in the school. It sounded a bit: why do you do that when students do not come to class every day, they hardly can speak French, you're wasting their time, you are too ambitious. So it was difficult to be heard and defend the project." (teacher)
Time schedules of students were difficult too, which also was a problem in Florence and Bergen.
"The principal obstacle is the time. In Italy the lessons are very organized. If I want to make an experiment, I must ask a teacher for his time, it's not easy." (teacher)

The teacher in Bergen did not have problems with the administration, because such a project benefits the students and the school. The principal and department leader were very supportive for the project, which is the same in Bordeaux. However, in Bordeaux the colleagues sometimes see the students participating in CarboSchools as privileged pupils. The teacher in Bergen notices that she had a lot of freedom in CarboSchools, in such a way that she could connect the project easily into the curriculum. The constraints are summarized in table 4.4.

Table 4.4: Constraints mentioned by teachers in realizing CarboSchools in the school

Constraints	*Mentioned by N teachers (max. 5)*
Motivation students	2
Money for trips and transportation	2
Little support from administration	2
Time schedules of students	4
Attitudes of colleagues	1

Teachers learned some important things for future projects: the importance of actual and practical experiments (Paris and Florence) and the collaboration with other teachers and positive contact with students (Bordeaux):
"For me, it was the first time I worked with all my colleagues in a multidisciplinary project like that. And the contact with the pupils is quite different than with the other classes. Because we are always working on something, the contact is very different. (…) The pupils like to talk to me after the lessons or they ask me about measurements, they always have a lot of questions on what they should do. (…) My pupils, the first class of CarboSchools, at the end of the year they asked the headmaster to go on in a higher class. (…) So we decided that the group can go on and work with a scientist." (teacher)

4.3.3 Collaboration between schools and research institutes

In most projects the RC is involved in the development of the project, together with the school inspector (Paris), the teacher (Bergen, Kiel, Bordeaux, Florence), or only the scientist in collaboration with the teacher (Bordeaux). There are different types of partnerships between scientists and teachers, ranging from no contact between scientists and teacher, to a real partnership without help by the RC. Sometimes the inspector is involved in the collaboration between teacher and scientist. Moreover, the RC in Paris organized a teacher training before the projects.

All interviewed teachers collaborated with scientists, but this collaboration was less intensive in Bergen, because the teacher had a research background and therefore a scientist was less necessary for conducting the project in a proper way. Collaboration between scientist and teacher is often concentrated in the preparation of the program. Teachers are very positive on the collaboration. In both Bergen and Bordeaux the teacher and scientist already knew each other before the project started. But all teachers mention contact is easy with the RC or the scientist. In Bergen, there is no authority gap between scientist and teacher, which makes the contact easy:
"In Norway the distance between scientists and other people... there is not a big distance. And between teachers and students neither. (…) There is not a big gap between students and teachers. (…) You don't have that authority gap that you do in most other countries. And that of course affects the contact between teachers and scientists as well. You don't feel that you are very below the scientist. You know that you have different skills. (…)And the good thing about it is that when scientists come to the schools, students think that is just a person doing her job like every other person. They are not afraid to ask questions." (teacher)

One of the obstacles the teacher in Bordeaux mentioned in the collaboration with scientists is the fact that scientists are often busy. The collaboration can be improved by more visits of the scientists to the school. All teachers are still in touch with the scientists, because the projects are still running. Teachers hope the contact with scientists will be permanent, for possible future projects. The RC's are also positive on the collaboration between teacher and RC or scientists, but the RC is essential for the contact between teachers and other scientists. Time can be a problem:
"Of course the challenge is, one of the challenges is that, I have my job, they have their job, we have to find the time. We have to think of, okay, now I'm talking to the teacher, who is very busy, so you don't always get the fast response you want. We are doing our own job and this is something in between. But I must say that I am very satisfied with the teachers we have contact with, it's very positive and helpful." (RC)
So, the contact between scientist and teachers is good. But there are hardly any real partnerships, in that scientists and teachers really collaborate with each other, without the RC:
"I thought it was a shame that so many partnership were like at a distance, were not direct. Because sometimes the teacher gets lost, does not get any support. (…) I think they need extra support from the scientist, for information (…) But on the other hand, kids get to know different scientists, with different jobs, different scientists world.

Teachers are actually happy about that, they like that. (…) But I would like more direct partnerships, real partnerships." (RC)

The research institutes differ in their school activities policy. In some institutes there is no policy for secondary school projects (Paris, Bergen, Bordeaux), in others there is policy that is implemented in some activities (Florence, Kiel). Thanks to CarboSchools all institutes conducted school projects in the last three years. The RC's are not sure whether this will be sustainable implemented after CarboSchools. However, there is some impact on scientists concerning their awareness:
"I think it can give them a new vision. For example after the final conference, all the scientists said that they have not imagined that pupils can get so far with the carbon cycle. They were very surprised by the degree that teachers and pupils reach. So I think it changed the view they have about teachers and pupils." (RC)

The amount of projects in the institutes is ranging from just some written fact sheets to many different projects (Kiel). The objectives for projects in Kiel are to give students knowledge on climate change, and give them a taste of scientific life. In this way they hope to get students interested in science. Or as the RC in Florence says:
"I'm happy when the pupils run measurements. Let them know what we really do in the office and in the field. Bring the science to the students. And of course if they remember something, that is important as well. (…) In Italy we suffer from little applications for scientific universities." (RC)

Most RC's do not have any difficulty to establish contacts with schools for such projects. Schools like to do this. The contact starts for example by the school inspector, but some institutes (Kiel) have partner schools for collaboration. However, the RC in Bergen was a bit surprised about the small number of schools who wanted to participate:
"And in 2008 we got this independent project, and we had an information meeting for all the schools in Bergen. And as far as I've heard a mailing list of 1000 persons got that information. And 4 teachers shown up... And it also turned out to be fine. Because these 3 schools and 4 classes we are cooperating with, is what we are able to handle. Since we are so few scientists working with it. So in a sense it's fine, but on the other hand it's amazing how few that were interested." (RC)

The RC's mention several hampering factors for the conductance of school projects in the institute. Most important factor is time of the scientists. They often do not have the time for the conductance of these projects, or they are not interested in the projects. Scientists do not see working with schools as part of their job, especially when it is not the primary goal of the unit. Further hampering factor is money, for buying the materials. The time of the RC's is also a problem. They need more time for their job. A 20-50% base is not enough. One of the RC's actually does not have an official task in CarboSchools. The RC in Florence mentioned also the little knowledge on data analysis by teachers as a hampering factor. The outreach obligations of the EU are a stimulating factor. For a lot of EU projects outreach activities were demanded. A topic related hampering factor that was mentioned by one RC:

“The topic of greenhouse effect is oversaturated. (…) The subject of greenhouse effect, and climate change, is been around for too long time. I think in some cases it is part of the standard syllabus, (…). So we found it difficult to actually convince students about getting enthusiastic about greenhouse gases and the carbon problem.” (RC)
The constraints mentioned by the RC’s for the conductance of school projects in the institute are summarized in table 4.5.

Table 4.5: Constraints mentioned by RC’s for the conductance of school projects in the research institute

Constraints	*Mentioned by N RC’s (max. 5)*
Time of scientists	5
Motivation of scientists	2
Money for buying materials	2
Time of RC’s	3
Little knowledge of teachers	1
Over saturation of the topic	1

All RC’s also would like to work more on projects like CarboSchools if paid for. One RC mentions the “unmotivated scientists” as a constraint for continuing in CarboSchools. The RC’s also learned a lot from these projects. They experience an inconsistency between the aims of CarboSchools and the available staff and time. In any future project most RC’s would like more involvement of scientists in the projects. However, one RC indicates it is difficult to bring an agenda (like citizenship) in the schools by a scientist:
“CarboSchools was different in the sense that it had an agenda. (…) What was difficult for us, and still is, is the citizenship aspect of CarboSchools. Because this is somewhat more than a scientific agenda, it is starting to enter environmentalism. (…) We are trying to influence the opinion of people. And this is something not everybody likes. Research institutes say: we have to be impartial, because we will only be experts if we present facts. (…) Also the teachers in the schools have different approaches to that. (…) Teachers that are interested in environmental activism won’t come to a research institute. (…) Many of the teachers told us: look, we want you to stay neutral, just give our students the facts, the background knowledge, and the students decide what they want to do with it. (…) So I guess in any type of project, I would like to avoid that in the future, to build in a goal like that.” (RC)

Another problem is to keep students interested in the project. RC’s think the relations built up in CarboSchools are very important. One RC has some comments on the organization:
“I think there should be a tighter network of regional coordinators, who are shown that they are valued. And from the beginning someone is coordinating them, so that they communicate well together, that they feel like a team.” (RC)

4.4 Conclusions

In the last section a lot of information is given on project form, content and their impact on students, the relation between the project and the curriculum, and the collaboration between schools and research institutes. Now we are able to answer our research questions:

1. *What is the impact of CarboSchools on students?*

The CarboSchools projects are very diverse in both form and content. Most projects are long-term in which students conduct experiments, analyze data, write a report, and present their results in their class or on a conference. Students like the projects very much and learn a lot about the carbon cycle and the environment. Conducting experiments and working in a project is very attractive for them, especially in countries where the conductance of experiments is not very usual in science classes. In some projects students visit the research institute to meet scientists or a site for the conductance of experiments. These out-of-school experiences are mostly appreciated by students. They like to work with scientists very much. Students also like the group work very much, which is often part of the project. Teachers think students also increased their social skills thanks to the group work. CarboSchools often has an impact in the school for other students. In some cases, CarboSchools even has an impact outside the school. Finally, most interviewed students were already interested in a scientific career before CarboSchools started, but a few mention they are more interested in a science career thanks to the project.

2. *How is CarboSchools integrated in the schools?*

The regional projects of CarboSchools are mostly part of a school subject, and in some cases it is a multidisciplinary project taking place throughout the curriculum. The tasks of the teacher in CarboSchools are usually supervision and guiding of students, and integrating the subject topic into the curriculum. This really depends on the teacher: some RC's experienced unmotivated teachers who just want their students to have a good time, but other teachers are very well prepared. The aim for participating in a project from teachers' perspective is diverse: doing a research project, making students interested in science, and show students they are important. Teachers experience several problems when realizing a project in the curriculum: time schedules of both students and teachers, little support from administration, motivation of students, money for trips, and attitudes of colleagues. More positive comments were on the freedom concerning content of the projects in CarboSchools, as a result of which teachers got more possibilities to integrate the project into the curriculum.

3. *How do schools and research institutes collaborate in CarboSchools?*

The contacts between schools and research institutes vary considerably, ranging from no contact between scientists and teachers (only via RC), to a real partnership without help from the RC. In a few projects other actors are involved in the collaboration, for example the regional inspector. This depends on regional and national policy differences. Both teachers and scientists are positive on the collaboration; especially contact with the RC is easy. An important problem in the collaboration is the little available time of scientists, while the collaboration can be highly improved by more visits from the scientists to the school. Also little interest of scientists may play a role. They do not see working with students as part of their job. However, most teachers hope the contact with the research institutes will be permanent for arranging other projects in the future. The RC's are essential for the conductance of CarboSchools in the schools. They intermediate between the schools and the institutes.

Only two institutes have some policy concerning secondary school activities. The other institutes worked with schools in this way for the first time thanks to CarboSchools. The objective for this kind of projects from the institute's perspective is mostly to give students knowledge and to get students interested in science. It is not difficult to find schools to work with, especially when the school inspector is involved, or a network of partner schools is available for collaboration. In the specific case of CarboSchools RC's themselves also experience a time problem. They need more time to do their job properly, especially when they are the key player in the collaboration between the schools and the institute.

5 Recommendations

CarboSchools was a huge success. Three years with many projects and a big variety in topics, activities, and students is now evaluated and this has given us important insights. Students evaluated all projects positively (see Chapter 2) and many of them even say they are more interested in a science career thanks to the project. The results of the attitudes research show that our students in all regions have high environmental awareness and very positive attitudes towards several aspects of science and climate change, but despite their positive experience of CarboSchools, these attitudes follow the usual decline observed during teenage (see Chapter 3).

These findings do not mean that attitudes decline *because of* CarboSchools activities, i.e. that hands-on experiments and scientist involvement in schools influence attitudes negatively while, on the other hand, they are applauded by students. What they do indicate is that the proportion, duration and scope of these activities with respect to daily classroom activities (and broader external factors) have been insufficient to counteract the mainstream effect.

We can particularly support this with additional information we obtained from our interviews with students, teachers, scientists and regional coordinators (see Chapter 4). Interviews with students supported the results from the written evaluations. In the interviews, teachers and scientists commented positively on the projects. One of the impacts some of the interviewees referred to is the collaboration between schools and research institutes, and between scientists and teachers. This is a valuable result, which can have a big impact on the way science is taught in high schools. Expanding this kind of teacher-scientist-partnerships to regional and national levels will influence science curricula to a large extent. It will bridge gaps between school science and real science, and this may have positive effects on students' school and career choices.

However, the interviewees also identified many constraints. From the scientists' side the lack of time was mentioned as a constraint and they had the feeling that their efforts in outreach activities with schools were not always valued by their superiors. Teachers pointed out external projects are difficult to implement in the school curriculum. Schedules have to be adapted, which is not easy, and often, a lack of time and money plays a role here. Rules and standards for students and teachers may interfere with the projects' implementation within the school curriculum. Moreover, extracurricular activities, such as those offered by CarboSchools, may not be attractive for students who do not want to spend more time on school activities. School authorities did not always support the participation of schools in CarboSchools.

Altogether, developing project-based, hands-on activities with scientists' involvement currently remain a real challenge in highly constrained school systems. This shows the limits of such experiences within the existing school systems and their dominant culture. CarboSchools illustrates once more that to fulfill their promises (and subsequently to reach a large number of teachers) such activities should not be offered as an additional component to existing overloaded curricula and timetables, but should be properly integrated, thus requiring profound changes in the whole education system.

Despite these caveats, the findings presented above convey a number of messages for those with a policy, practical or academic interest in projects like CarboSchools. We noticed some important differences between different types of projects in appreciation and impact. Therefore, we will try to answer the following question: which characteristics contribute to the success of an authentic science project? This is difficult answering because of the huge diversity in characteristics in the regional projects. However, we can point to some factors that definitely contribute to the success of a project.

Active role for students - Type of activities in a project like CarboSchools is very important for students' appreciation of the project. The activities in which students have an active role, like presentations or hands-on experiments, are more appealing to students than activities in which they have a more passive role, like frontal lectures or visits to institutes. As may be expected, longer projects have more impact on students than shorter projects.

Group work - The use of group work in which students can express creativity while working on experiments increases the appreciation of CarboSchools projects. Their social skills improve by group work and students like working in small groups very much.

Out-of-school experiences - The inclusion of out-of-school experiences in the project enhances the appreciation of a project. Students like to go out of school, and see science in a different context than they are used to. However, it is essential students have an active role in these out-of-school experiences; otherwise they have difficulties to connect it to previous experiences and knowledge.

Authenticity - The introduction to authentic science is a novelty for most students that make them appreciate such projects more. The students learn about the practice of science, and they learn that science is not only laboratory work. Inquiry based science education is much more appreciated than predefined problems and experiments. Students are also very positive when they set up their own project, from beginning to the end. It makes them proud and gives them self-confidence.

Contact with scientists - The results of our study show students have learned a lot from the scientists and they get to know scientists as ordinary people that have interesting jobs. Contact with scientists changes traditional stereotypes of scientists students have. This influences students' ideas about scientists and the attractiveness to work in science in a positive way.

The activities, the personal contacts between students and scientists, the relevance of the issues addressed in the CarboSchools projects, the inquiry-based pedagogy, and finally, the use of group work all gave students a new and very positive experience in science. CarboSchools has shown to students that science is different from what they experience at school and can actually be interesting and important for their future, both as workers and citizens. However, it is clear from our results that we worked with advantaged group of students. Most of these students were already interested in science and climate change and some are even interested in a science career on forehand. The real challenge for projects like CarboSchools is to reach the other students: the ones that are neutral or negative on science, but who may not know what is really going on in laboratories.

We believe this study can contribute to research in authentic science teaching and in out-of-school science learning. All those concerned with the organisation of projects like CarboSchools should keep the success factors in mind. In addition, one should consider the appropriateness of the project to the students: it might for example be more difficult to awaken the interest of older students for a project. As we showed in the results, schools in cooperation with science institutes could make authentic science projects a success. Further research into these projects is necessary for the validation of success-factors of the projects.

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List of Appendices

Appendix 1: SET questionnaire

Project name or code (to be filled by the coordinator)

PROJECT EVALUATION QUESTIONNAIRE

Dear Student,
We need your help to evaluate the project that you participated in and completed. Your cooperation will improve our work.

A1.	**Your name (optional):**	..………………………………………………………..........
A2.	**Gender:**	❑ female ❑ male
A3.	**Year of birth:**	..……………………………………………………………
A4.	**Name of school:**	………………………………………………………………..
A5.	**Grade:**	❑1 ❑2 ❑3 ❑4 ❑5 ❑6
A6.	**Who took the initiative to take part in this project?**	❑ my parents ❑ school director ❑ a science teacher ❑ a friend ❑ myself ❑ other, please write..

For the following statements, please <u>TICK ONLY ONE BOX</u> corresponding to your response and <u>ANSWER ALL QUESTIONS</u>. When we use the words "science" we mean chemistry, physics and biology.

		Strongly disagee	**Disagree**	**Agree**	**Strongly agree**
A7.	My interest in science topics is low.	❑	❑	❑	❑
A8.	My grades for science subjects are high.	❑	❑	❑	❑
A9.	We do a lot of science at school.	❑	❑	❑	❑
A10.	I like science lessons more than other lessons at school.	❑	❑	❑	❑
A11.	It is difficult to understand scientists.	❑	❑	❑	❑
A12.	Most scientists are boring.	❑	❑	❑	❑

<u>Please see the back of the page</u>

Project name or code (to be filled by the coordinator)

		Strongly disagee	Disagree	Agree	Strongly agree
B1.	This project was well organized.	❑	❑	❑	❑
B2.	I enjoyed this project very much.	❑	❑	❑	❑
B3.	I learned many new things from this project.	❑	❑	❑	❑
B4.	This project was too difficult.	❑	❑	❑	❑
B5.	The instructions for the project were clear.	❑	❑	❑	❑
B6.	This project made me understand Climate Change studies are very important for human future.	❑	❑	❑	❑
B7.	I would like to work on projects like this more often.	❑	❑	❑	❑
B8.	I like learning science in this way.	❑	❑	❑	❑
B9.	The supervisor's explanations helped me to understand this project.	❑	❑	❑	❑
B10.	My overall opinion on this project is good.	❑	❑	❑	❑
B11.	My knowledge was sufficient to understand this project.	❑	❑	❑	❑
B12.	I learned very much from the scientist(s) in this project.	❑	❑	❑	❑
B13.	This project made me realise that people can affect climate change.	❑	❑	❑	❑
B14.	This project makes me more interested in choosing a scientific career.	❑	❑	❑	❑

Project name or code (to be filled by the coordinator)

Please, answer the following questions according to the CarboSchools' project that you participated in.

C1.	What did you like most during this project?

C2.	What did you dislike most during this project?

C3.	What did you learn during this project?

C4.	What suggestions do you have to improve this project?

Thank you for your cooperation

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Appendix 2: AQ questionnaire

Project name or code (to be filled by the coordinator)

ATTITUDE QUESTIONNAIRE

CarboSchools AQ1

Dear Student,

For the following questions, please TICK ONLY ONE BOX corresponding to your response and ANSWER ALL QUESTIONS. It will take about 15 minutes to fill in.

Part A

1.	**Name (optional)**	
2.	**Gender**	❑ Female ❑ Male
3.	**Age**	
4.	**Name of the school**	
5.	**Grade**	
6.	**What is the total number of science lessons in an ordinary week (sum of biology, chemistry, physics and/or science lessons)?**	….. science lesson(s)
7.	**How often is practical work (experiments etc.) part of science lessons?**	❑ At least once a week ❑ At least once a month ❑ Seldom or never
8.	**My grades for science subjects are**	❑ High ❑ Moderate ❑ Low
9.	**Mother education level (completed school)**	❑ Less than primary education ❑ Primary school ❑ Secondary school ❑ Higher education
10.	**Father education level (completed school)**	❑ Less than primary education ❑ Primary school ❑ Secondary school ❑ Higher education
11.	**Does anyone in you family have a higher education grade in science or engineering?**	❑ Yes, both parents ❑ Yes, one of my parents ❑ No one
12.	**Did you participate in a Carboschools project before?**	❑ Yes ❑ No

Please see the back of the page

Part B

For the following statements, please TICK ONLY ONE BOX corresponding to your response and ANSWER ALL QUESTIONS. When we use the words "science" we mean chemistry, physics and biology.

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1.	I learn interesting things in science lessons.	❑	❑	❑	❑	❑
2.	I am careful not to waste water.	❑	❑	❑	❑	❑
3.	Working in a laboratory would be interesting.	❑	❑	❑	❑	❑
4.	I would like to do less science at school.	❑	❑	❑	❑	❑
5.	People should care more about climate change.	❑	❑	❑	❑	❑
6.	Money used on scientific projects is wasted.	❑	❑	❑	❑	❑
7.	Scientists work for the good of humanity.	❑	❑	❑	❑	❑
8.	I look forward to science lessons.	❑	❑	❑	❑	❑
9.	I am careful not to waste food.	❑	❑	❑	❑	❑
10.	Scientific discoveries are doing more harm than good.	❑	❑	❑	❑	❑
11.	Climate change should be given top priority.	❑	❑	❑	❑	❑
12.	What I learn in science lessons is useful for me.	❑	❑	❑	❑	❑
13.	I separate most of my waste for recycling.	❑	❑	❑	❑	❑
14.	It is annoying to see people do nothing for the climate change problems.	❑	❑	❑	❑	❑
15.	Scientists do not have enough time to spend with their families.	❑	❑	❑	❑	❑
16.	Science can help to make the world a better place in the future.	❑	❑	❑	❑	❑
17.	When I leave school, I would like to work with people who make discoveries in science.	❑	❑	❑	❑	❑
18.	Scientists are less friendly than other people.	❑	❑	❑	❑	❑

Please see the back of the page

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
19.	I prefer to use public transport or bicycle over car.	❑	❑	❑	❑	❑
20.	Science lessons are fun.	❑	❑	❑	❑	❑
21.	Scientists do not care about other persons.	❑	❑	❑	❑	❑
22.	I would like being a scientist after I leave school.	❑	❑	❑	❑	❑
23.	I always switch off the lights when I leave a room.	❑	❑	❑	❑	❑
24.	People worry too much about climate change.	❑	❑	❑	❑	❑
25.	Policy decisions should be more based on what scientists say.	❑	❑	❑	❑	❑
26.	A job as scientist would be interesting.	❑	❑	❑	❑	❑
27.	The seriousness of climate change has been exaggerated.	❑	❑	❑	❑	❑
28.	I always turn off the computer when I don’t use it.	❑	❑	❑	❑	❑
29.	Science is man’s worst enemy.	❑	❑	❑	❑	❑
30.	Science is one of the interesting school subjects.	❑	❑	❑	❑	❑
31.	Scientists are as fit and healthy as other people.	❑	❑	❑	❑	❑
32.	I try to save energy.	❑	❑	❑	❑	❑
33.	Science lessons bore me.	❑	❑	❑	❑	❑
34.	Science helps to make life better.	❑	❑	❑	❑	❑
35.	Climate change is a threat to the world.	❑	❑	❑	❑	❑
36.	I feel it’s important to take good care of the environment.	❑	❑	❑	❑	❑
37.	A career in science would be dull and boring.	❑	❑	❑	❑	❑
38.	Money spent on science is well worth spending.	❑	❑	❑	❑	❑
39.	Scientists do not have many friends.	❑	❑	❑	❑	❑

Please see the back of the page

Part C

For each of the following statements, please <u>TICK ONLY ONE BOX</u> whether this statement is true, false or you don't know. Please <u>ANSWER ALL QUESTIONS</u>.

		True	**False**	**Don't know**
1.	The most of the current Climate Change is due to greenhouse gases generated by human activity.	❑	❑	❑
2.	If my city will have a heat wave this summer, it means climate is changing.	❑	❑	❑
3.	Climate change is only defined as the rising of temperature of the earth's surface.	❑	❑	❑
4.	Climate change is a result of the ozone layer becoming thinner.	❑	❑	❑
5.	Climate Change is partly caused by the increase in the emission of heavy metals.	❑	❑	❑
6.	Rise in sea level and drought are some of the consequences of Climate Change.	❑	❑	❑
7.	There is a direct link between Climate Change and skin cancer.	❑	❑	❑
8.	The ocean can absorb CO_2 emitted by humans.	❑	❑	❑
9.	Because of Climate Change an oxygen deficiency can arise.	❑	❑	❑
10.	Because of climate change the water in seas and oceans will expand.	❑	❑	❑
11.	The acidification of forest is a result of Climate Change.	❑	❑	❑
12.	Because of climate change certain plants and animals may become extinct.	❑	❑	❑

Thank you for your cooperation!

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Appendix 3: Manual for Implementation of Questionnaires 2009-2010

CarboSchools

Manual for Implementation of Questionnaires 2009-2010

1. Self Evaluation Tool (SET)
2. Attitudes questionnaire (pre-test and post-test)

Prepared under WP4

September, 2009

Manual for Implementation of Questionnaires 2009-2010

Content

In this manual, you will find general information about the Carboschools (CS) Self Evaluation Tool (SET) and the Attitudes Questionnaires (AQ).

1 Aim of the Questionnaires

Carboschools' partners come from different backgrounds and perspectives and are managing their projects in different ways. The questionnaires therefore contain questions common to all, but the SET also contains open questions that can be different from a partner to another.

The aim of the SET is to give feedback to regional coordinators (RC), scientists and teachers about the project. Results of this evaluation do not give you a bad or good score. It only compares pupil's opinions of science, project organization, enjoyment and difficulty of the project, and project's impact on students with your own impression.

The aim of the Attitudes Questionnaires (AQ) is to measure the changing attitudes of pupils towards science, school science and climate change during the CS projects. The questionnaire is conducted before (AQ1) and after (AQ2) the project and the results will be compared by WP4. A knowledge test will also be part of the AQ.

The questionnaires may be implemented by RCs or by (science) teachers from schools in which pupils are involved in the project.

2 When which Questionnaire?

This school year (2009-2010) a distinction will be made between projects.

- Project type 1: projects that last at least 10 hours per pupil.
- Project type 2: all the other projects.

The SET will be implemented in projects of both types. The AQ will only be implemented in projects of type 1, because a considerable amount of time spent in the project is needed for *changing* attitudes.

An overview:

Before project	during project	after project (max 1 week)
AQ1---- (send to WP4)	Project type 1	AQ2-SET --- (send to WP4)
	Project type 2	SET ---- (send to WP4)

The pre-test of AQ is called AQ1. This questionnaire should be implemented before or right at the start of a project. The post-test of AQ will be combined with the SET, in the combined AQ2-SET questionnaire. In this way time and effort is saved for pupils and teachers/RCs to fill in one questionnaire in stead of two. It also enables WP4 to conduct more detailed analyses on individual level. The AQ2-SET or SET should be implemented at the end of the project (not later than a week after the project ended).

3 Structure of the SET

For the evaluation of the projects, we developed a questionnaire to be filled in by pupils it is composed of three parts: A, B and C.

In Part A, there are some background questions about pupils like gender and grade. Further, it is possible to investigate the influence of pupil background characteristics (age, gender, interest in science, grades for science subjects etc.) on their perceptions of the project. This section is from question A1 to A6.

Part B, consists of closed questions in four item Likert scale from strongly agree to strongly disagree. These are questions A7 to B14. Pupils tick their answer by choosing the alternative most appropriate to their view. In test methodology, it is common to ask opinions by posing some more or less similar questions. For this reason some of the questions seem to overlap.

As for third part of the questionnaire, *Part C*, there is no fixed set of precisely defined questions. Items in this part may include pupil's personal ideas on the project and you can have opportunity to ask opinions, specific for your projects. This section can require more time and thought than closed questions. That's why the number of question should be kept low. Regional coordinators can reorganize these questions according to their specific projects. The anwers are not analyzed by WP4.

4 Structure of the AQ1

The AQ1 consist of three parts.

In Part A, there are some background questions about pupils like gender, grade, parent's education level, and science lessons. It's more extensive than the background variables asked in the SET. This section is from question 1 to 12.

Part B consists of closed questions in five item Likert scale from strongly agree to strongly disagree. These are questions 1 to 39. This part of the questionnaire measures the attitude of pupils towards science, school science and climate change. Pupils tick their answer by choosing the alternative most appropriate to their view. In test methodology, it is common to ask opinions by posing some more or less similar questions. For this reason some of the questions seem to overlap.

Part C consists of a 12 items knowledge test about climate change. The statements could be answered "true", "false", or "don't know".

The total number of items in AQ1 is 63. It will take about 15 minutes to fill in this questionnaire.

5 Structure of the AQ2-SET

This combined questionnaire AQ2-SET consists of the Parts A, B and C from AQ1 and Parts B and C from the SET. Therefore *Part A, B, and C* will be the same as in the pre-test AQ1. Part B and C from the SET will be called *Part D and E* in this questionnaire. The total number of items is 83, and 4 open questions (part E). It will take about 20 minutes to fill in.

6 Translation

The questionnaires were developed in English, the working language of the project. The SET was translated into the partner's national language by regional coordinators. **The AQ1 and AQ2-SET should be translated very soon by RCs.**

Back translation is the most frequently used way to translate the source version of the test (generally English language) into the national languages, then translating them back to and comparing them with the source of language to identify possible discrepancies. But there is no time left for back translation. Projects will need the AQ1 very soon.

Instead of this, you are asked to take particular care translating the following items. In this section definitions were given of some important concepts that were necessary to understand the questionnaire more efficiently and would therefore be helpful in the translation.

For Part B

Science lessons: *This covers all physics, chemistry, biology, integrated science or combined science lessons in all kind of schools. In same countries geography classes are included (Germany).*

For example:

1. I learn interesting things in *science lessons*.

Scientist: *Any professional involved in science –technician, engineer, PhD student, senior scientist, ex- scientist, science communicators etc.*

For example:

7. *Scientists* work for the good of humanity.

In SET, *scientist(s)* refers to specific individuals; the pupils have met this scientist. In AQ *scientist(s)* refers to a wider image of scientists.

For other questions about translations, feel free to ask WP4 researcher Elma Dijkstra (e.m.dijkstra@rug.nl).

7 Implementation

The AQ1 questionnaire should be implemented before or at the start of the project. The AQ2-SET (project type 1) or the SET (project type 2) questionnaire should be implemented near the end of a project, no later than 1 week after the last activities. Sometimes it is preferable to administer questionnaires shortly before finishing the project. Implementation can be carried out by regional coordinators or by the teacher. If this process is carried out by regional coordinators, follow the instructions below. If this process is carried out by teachers, see the Questionnaire Implementation Manual for Teachers (Appendix D).This document needs to be translated by regional coordinators to the national language of the partner. On the cover page (Appendix A, B, or C), you are invited to write additional remarks, for instance about the situations which might have influenced pupils' answers on the questions.

7a Before implementation

Keep the form the same as in the English version in your translated version using Times New Roman, Font Size=11 with 1.5 space. Use one sheet, printed on both sides for parts A, B, C and D. Open-ended questions (Part E) should be added to the questionnaire. Part E should be on a separate sheet and will not be sent for analysis to Groningen (WP4). Write the project name and school name on the questionnaire before producing copies.

7b During Implementation

- Remind pupils about the importance of giving answers to all questions and not to skip any of them including open-ended questions.
- Be sure all pupils who participated in the project fill in the questionnaire. The missing data can affect our results.
- Implementation duration is *15 minutes* on average for AQ1, *20 minutes* for AQ2-SET. Do not give less than 15 of 20 minutes for pupils to complete the questionnaires. Some respondents will complete earlier.
- Please pack each class/group papers seperately.

7c After Implementation

Open ended questions of the questionnaires are to be used by regional coordinators. Part A – D of AQ and Part A and B of SET will be sent to Groningen (WP4) for further analysis. Cover Page for AQ1, AQ2-SET, or SET (See Appendix A, B, or C) goes along with the questionnaire to give some background information about the project. It focuses on *one project* that might involve different schools or groups. Please write the name of the project in Question 3. Then, fill in the table given in Question 4. You can see the table below as sample for this question.

				Number of Pupils	
	Name of the School	**Type of the School**	**Grade**	**Girls**	**Boys**
1.	**X**	General	9	23	20
2.	**Y**	Vocational	10	35	30
3.	**Z**	General	11	2	1

- Do not mix school/class/group data
- If there is more than one school, pack each school data separately and check if the school name has been completed in Question A4.
- Fill in Cover Page. There is no page limitation for this document. Please feel free to extend the number of pages, if the given space is not enough for your answer.
- Then, package all completed forms together and post as one package.
- Send all evaluation forms and cover pages to Groningen (WP4)
- If you have a small group with few participants, communicate with WP4 about the way data will be analyzed.
- Do not throw away the original forms, if you have sent the data to Groningen (WP4) electronically. All forms should be sent to Groningen (WP4).

8 Postal address

Elma Dijkstra, IDO, Faculty of Mathematics and Natural Sciences, PO Box 407, 9700 AK Groningen, the Netherlands

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Appendix 3A: Questionnaire Implementation Manual for Teachers

QUESTIONNAIRE IMPLEMENTATION MANUAL for TEACHERS

Dear Teacher,

This manual is prepared to help you to implement the questionnaire(s). If you have any questions, contact with the Carboschools regional coordinator.

- Write the project and school name on the questionnaire in indicated places before producing copies.
- Give at least 15 minutes (SET or AQ1) or 20 minutes (AQ2-SET) for your pupils to complete the questionnaire.
- Remind your pupils about the importance of giving answers to ALL questions and not skip any of them.
- Check that all pupils who participated in the project fill in the questionnaire.
- Please pack each class/group separately.
- Return all original papers to your regional coordinator.

Contact information for regional coordinators

Regional Coordinator
Name, Surname:
Address:
Telephone:
E-mail:

Appendix 4: Spring School Evaluation Report

CarboSchools Spring School
Jena (Germany) 10-16 April 2010

Evaluation Results

This evaluation concerns:

1) General Aspects
2) Workshops
3) Group Work
4) Teacher Sessions
5) Usefulness of Spring School

About the Spring School:

The Spring School has gathered small teams of students (aged 15 & more) & teachers from 7 countries to create a unique educational experience around:

- thematic workshops for students to learn and practice exciting science about global change topics, with in parallel open meetings between teachers to discuss project ideas & cooperation
- group work for students to jointly produce short presentations communicating their findings to a wider audience
- a cultural & event day to discover Jena in a creative and original way
- a one-day Global Change Science Festival where all participants have shared their experience & project outputs with external scientists & educators

The Spring School took place at Landschulheim "Stern", a guesthouse for schools & youth camps located in the forest above Jena on top of a limestone hill - 30 minutes by foot from the city center. Recently renovated and located in a beautiful natural environment, this place offered great facilities for creative group sessions as well as for socializing. The Science Festival took place in the main hall & auditorium of the Max Planck Institute for Biogeochemistry.

1 General Aspects

Some general aspects of the Spring School are evaluated separately. In table 1 the average appreciation scores of these general aspects are presented.

Table 1.
Average appreciation score (1 = very bad - 5 = very good) on general aspects

Aspect	Average score students (n = 44)	Average score teachers (n = 14)
Cultural & Event Day / Conference Day	4.4	3.8
Global Change Science Festival	3.9	4.2
Organization	4.0	4.1
Accommodation	4.2	4.0
Food	2.8	2.2
Meeting students / teachers from other countries	4.7	4.9
Speaking English	4.3	4.4
Overall opinion on Spring School	4.4	4.2

The evaluation of the Spring School is both for students and teachers very positive. The food was evaluated very negatively by the Italian students, but the other students were less negative. All teachers and students are very positive about meeting students and teachers from other countries. This also goes for speaking in English. Finally, the overall opinion on the Spring School is (very) positive with 4.4 for students and 4.2 for teachers.

2 Workshops

The thematic workshops took place from Sunday to Tuesday morning. The different topics are presented with the appreciation scores (only students) in table 2.

Table 2.
Average appreciation score (1 = very bad - 5 = very good) on thematic workshops (n = 44)

Workshop	N	Supervision during workshop	Overall opinion on workshop
Atmosphere	13	4.1	3.9
Oceans	11	4.7	4.4
Soils	12	3.9	3.8
Forests	9	4.3	3.6
Average score		4.2	3.9

It seems the students are very positive about the thematic workshops. In particular, the oceans workshop scores very well.

3 Group Work

The thematic workshops took place from Sunday to Tuesday afternoon. The different group works are presented with the appreciation scores (only students) in table 3.

Table 3.
Average appreciation score (1 = very bad - 5 = very good) on group works (n = 44)

Group work	N	Supervision during group work	Overall opinion on group work
Flash mob	7	4.6	4.3
Eco-cluedo	7	3.9	4.4
Climate-neutral art	4	4.3	4.8
Street Art	6	4.0	4.7
Monster PET	6	4.7	4.3
Dante e Virgilio	3	3.7	3.7
Documentary	6	4.2	4.0
Politics	5	4.8	4.8
Average score		4.3	4.4

It seems that the students are very positive about the group works as well. In particular, the politics group work scores very well, which also appears from the answers to usefulness question 1 (in the last paragraph).

4 Teacher sessions

The teacher sessions took place from Sunday to Tuesday morning. The different aspects are presented with the appreciation scores (only teachers) in table 4.

Table 4.
Average appreciation score (1 = very bad - 5 = very good) on teacher sessions (n = 14)

Aspect	Average score
Coaching during teacher sessions	4.1
Usefulness of teacher sessions	4.1
Overall opinion on teacher sessions	4.1
Reading first draft of CarboSchools booklet	3.9

Table 4 shows a positive score on all aspects of the teacher sessions. In particular, the e-twinning session was evaluated very positive, as will be shown in the next paragraph.

5 Usefulness of Spring School

1) Which session(s) was (were) the most useful to you and why?

STUDENTS
Most popular answer was the thematic workshop (16 students). Furthermore, the flash mob (8 students), the group works (7, in particular politics), and the poster session (4) were also useful to the students. 3 students answered “meeting everyone” as the most useful, and salsa was mentioned by 2 students.

TEACHERS
De e-twinning session was answered by 10 teachers as the most useful session, because they can use this tool later on. The poster session during the science festival was answered by 2 Italian teachers.

2) Which session(s) was (were) the least useful to you and why?

STUDENTS
Many students didn’t answer this question, or said that all sessions were useful. For the students that did answer this question, most popular answers were the group work (9 students, in particular eco-cluedo) and the thematic workshop (4 students).

TEACHERS
The most popular answer was the reviewing / correcting material (CS website, booklet). 1 teacher missed a discussion about the booklet. Further, the science festival was experienced as too long by 3 teachers.

3) Of all the things that you learned while at the Spring School, what would you like to learn more about?

ONLY FOR STUDENTS
The students gave many different answers on this question. Most popular answers were specific topics they’ve learned about in the thematic workshop; politics; actions to stop/reduce climate change problems; and some students would like to learn more about salsa.

3) Are you considering implementing anything particular in your classroom as a result of your participation?

ONLY FOR TEACHERS
Most popular answer is the use of experiments that were demonstrated during Spring School (7 teachers). 3 teachers answer the future use of e-twinning. 2 teachers will give presentations about the Spring School to their other students at home.

Appendix 5: Overview projects 2008-2010

*

Year:	2008/2009 (1), 2009/2010 (2), 2009/2010 (3)
Topic:	Forests (F), Ocean (O), Atmosphere (A), Soils (S), River (R), Citizenship (C)
Group:	Whole class (W), Small group (S), Individual (I)
Type of activity:	Literature Research (LR), Computer Work (C), Frontal Lectures (F), Hands on experiments (H), Presentation by students (P), Site visit (S), Laboratory visit (L)
Relation project and curriculum:	Graded & compulsory (GO), Graded & Voluntary (GV), Non-graded & Compulsory (NO), Non-graded & Voluntary (NV)
Approach:	Inquiry based science education (I), Frontal lectures (F), Predefined problems and experiments (P)
Type of partnership:	1 = Teacher - Research Unit (via RC), 2 = "Half" Teacher - Scientist (via RC), 3 = Teacher - Scientist (no RC), 4 = Pupil - Scientist

Institute	Project name	AQ (pre / post) or SET	Year*	N	Girls	Boys	School	Time (h) spent	Average age of students	Topic *	Group*	Type of activity*	project & curriculum*	Approach*	Type of partnership*
INRA EPHYSE/ EPOC Bordeaux	1 Les flux de carbone (Jauffre Rudel)	AQ (34/26)	2	34	19	15	Lycee Jaufre Rudel	20	15.4	O, A, R	W	C, F, H, P, S, L	GO	I	2
	2 L'affaire Carbo	AQ (31/32)	2	31	19	12	Lycee Agro-viticole de Blanquefort	65	15.5	F, S, A	W	LR, C, F, H, P, S,	GO	I	1
	3 Cailloux fleuris	AQ (11/8)	2	11	5	6	Lycee de la Sauque	40	15.2	F, S, A	S	LR, C, F, H, P, S,	NV	I	1
	4 Carboschools at max linder	SET	1	45	26	19	Lycee Max Linder, Libourne	100	16.2	F, A, C	W	LR, C, F, H, P, S,	GV	I	1
		AQ (35/30)	2	35	17	18	Lycee Max Linder	90	15.2	F, A, C	W	LR, C, F, H, P, S,	GV	I	1
	8 Carboschools Saint Cricq	AQ (32/33)	2	32	11	21	Lycee Saint Cricq	40	15.3	F, S, A	W	LR, C, F, H, P, S,	GO	I	1
	9 The Greenhouse Effect and the Gironde Estuary	AQ (14/12)	2	14	12	2	College Paul Emile Victor, Branne	30	14.4	O, A, R	W	LR, C, F, H, S, L	NV	I	2
	10 Carboschools Graves 2009	AQ (19/19)	2	19	6	13	Lycee des Graves	50	15.1	A, O, F	S	LR, C, F, H, P, S,	GO	I	1
	11 Carboschools Ellul	AQ (10/9)	2	10	5	5	College Jacques Ellul	58	14.0	F, S, A, C	W	LR, C, F, H, P, S,	NV	I	2
	12 Personal project - the study of school tree cores to determine local past climates	AQ (3/0)	2	3	0	3	Lycee Max Linder	60	15.7	F	S	LR, C, H, P	GO	I	4
	13 Carboschools Condorcet 2009	AQ (28/21)	2	28	13	15	Lycee Condorcet	90	15.3	F, S, A	W	LR, C, F, H, S,	GO	I	1
	20 C4 AL Andernos-les-Bains	AQ (25/24)	2	25	10	15	College Andre laHaye	38	14.1	O, A, R	W	LR, C, F, H, P	GV	I	3
	21 ICBF Pau	AQ (66/65)	2	66	30	36	Lycee Immacule Conception	10	15.5	F, A, O	W	LR, F	GC	I	1
	22 Le changement Climatique - Pierre de Fermat	AQ (25/25)	2	25	13	12	Lycee Pierre de Fermat	50	15.3	F, S, A	W	LR, C, F, H, P, S,	GO	I	1
	44 Carboschools Berthelot	AQ (14/0)	2	14	6	8	College Berthelot	20	13.4	S, A, O	W	LR, F, H, P	GO	I	3
	41 Carboschools a Lycee Condorcet	SET	1	25	9	16	Lycee Condorcet, Bordeaux	100	16.1	F, S, A	W	LR, C, F, H, S, P	GO	I	1
	42 Graves affiche	SET	1	11	9	2	Lycee des Graves, Gradignan	100	15.8	F, A	W	LR, C, F, H, P, S	GO	I	1
	43 Etude des Particules presentes dans les eaux fluviales	SET	1	18	11	7	College Paul Emile Victor, Branne	40	14.9	O, A, R	W	LR, C, F, H, S, L	NV	I	2
CNR-IBIMET Firenze	5 Atmospheric CO2 –ITC in Poppi	AQ (40/11)	2	40	26	14	Istituto Tecnico Commerciale, High school for business, Poppi	20	15.3	A	W	F/H	NV	F	2
	6 Atmospheric CO2 –Liceo in Prato	AQ (15/24)	2	15	11	4	Liceo Scientifico Niccolo Copernico, Prato	25	16.1	A	S	H	NV	I	4
	7 Atmospheric CO2 - ITAS in Florence	AQ (18/2)	2	18	4	14	Istituto Tecnico Agrario, High vocational school for agricolture, Firenze	50	17.7	A	I	C	NV		4
	18 The soil does a breath	SET	1	14	5	9	Liceo Scientifico Niccolo Copernico, Prato	35	17.0	S	W	H	NV	I	4
		AQ (10/7)	2	10	5	5	Liceo Scientifico Niccolo Copernico, Prato	35	17.1	S	W	H	NV	I	4
	52 Bossoleto as natural laboratory for CO2	AQ (0/19)	2	19	9	10	S. Pertini Secondary School, Rapolano	15	13.3	A	W	S	NV		2
	31 Meteo at home	SET	1	2	0	2	Liceo Scientifico Niccolo Copernico, Prato	15	19.0	A	S	H	NV		3
	32 CO2 at school	SET	1	20	5	15	Liceo Scientifico Niccolo Copernico, Prato	10	17.0	A	W	H	NV	I	3
	33 Photosynthesis, I measure it	SET	1	11	5	6	Liceo Scientifico Niccolo Copernico, Prato	15	17.9	A	W	H	NV	I	2
	34 CO2 web	SET	1	20	3	17	Istituto Tecnico Agrario, High vocational school for agricolture, Firenze	5	17.4	A	I	C	NV		4
	35 Plants and Natural CO2 springs	SET	1	42	20	22	S. Pertini Secondary School, Rapolano	13	13.0	A	W	S	NV		2

	36 Sustainable agriculture vs greenhouse effect	SET	1	46	11	35	IIS Alberti IPAA Vetrone	20-100	18.3	S	W	H	NV		1
UIB-BCCR Bergen	14 Carboschools Bergen	SET	1	62	29	33	Bergen Kathedralskole Bjorgvin Videregaende Skole Danielsen Videregande Skole	30-65	18.6	O	W	H, F, C, LR, S	GO	P	3
		AQ (0/55)	2	55	27	28	Bergen Kathedralskole Bjorgvin Videregaende Skole Danielsen Videregande Skole	30-45	17.3	O	W	H, F, C, LR, S	GO	P	3
	50 Bergen project 3 biology kathedralskole IB (spring 2010)	AQ (15/13)	2	15	8	7	Bergen Kathedralskole	18	16.7	O	W	H, F, C, LR, S	GO	P	3
	53 Bergen Danielsen (fall 2010)	AQ (4/4)	3	4	1	3	Danielsen Videregande Skole	20	17.8	O	W	H, F, C, LR, S	GO	P	3
	54 Bergen Bjorgvin (fall 2010)	AQ (11/8)	3	11	9	2	Bjorgvin Videregaende Skole	16	18.1	O	W	H, F, C, S, L	GO	P	3
	55 Bergen Katedralskole technology & research (fall 2010)	AQ (16/12)	3	16	0	16	Bergen Kathedralskole	16	17.4	O	W	H, F, C, S, L	NO	P	3
	56 Bergen Danielsen Science & Technology (spring 2010)	AQ (12/0)	2	12	2	10	Danielsen Videregande Skole	9	17.2	O	W	H,S,F	GO	P	3
	57 Bergen Katedralskole biology (fall 2010)	AQ (35/34)	3	35	27	8	Bergen Kathedralskole	20	16.7	O	W	H, F, C, S	GO	P	3
LSCE-IPSL Paris	15 Ocean acidification	AQ (17/9)	2	17	7	10	Lycee professional Jean Moulin	50	16.9	O	W	LR, C, H, P, S	NO	P	1
	16 Les scientifiques, peuvent-ils prevoir l'avenir?	AQ (36/32)	2	36	27	9	Lycee Corot	50	15.2	A	W	C, H, LR	GV	I	1
	17 Carbon cycle	AQ (18/10)	2	18	10	8	Lycee Rene Descartes	15	15.2	A	W	LR, C, H, P	GV	I	1
	29 Regulation of atmospheric CO2	SET	2	14	5	9	Lycee Camille Claudel	18	15.5	A, O, F	W	C, H	GV	I	1
			1	18	12	6	Lycee Rene Descartes	18	15.9	A	W	LR, C, H, P	GV	I	1
	30 Objectif CO2	SET	1	291	193	98	Lycee Rene Cassin Lycee la bruyere Lycee Talma Lycee Leonard de vinci Lycee Fragonard Lycee Monod Lycee Charles Baudelaire Lycee Paul Lapie Lycee Gustave Monod Lycee Galilee ycee Robert Doisneau Lycee Alfred Kastler Lycee Emmanuel Mounier	20	16.1	F, S, A, O	W	C, H, P	GV	I	1
RUG Groningen	19 Stage CIO + NLT meten en interpreteren	AQ (3/3)	2	3	3	0	Unic Utrecht	22	16	A	S	H, P, L	GO	p	4
	46 Lessenserie CO2	AQ (19/20)	2	19	14	5	Maartenscollege	7	16.7	A	W	C, F, H	GO	FP	3
	47 Opdracht technasium Zernike CO2web	AQ (2/0)	2	2	0	2	Zernike Technasium	?	17.5	A	S	LR, C	GO	I	1
	49 NLT Meten en Interpreteren	AQ (14/13)	2	14	6	8	Christelijk Lyceum Delft	40	17.4	A	W	C, F,	GO	FP	2
	28 Profielwerkstuk	SET	1	2	2	0	Maartenscollege	?	18.5	A	S	LR, C, H, P, L	GO	I	4
	45 DoMUS in Scienceweek	SET	2	5	1	4	Willem Lodewijk Gymnasium	2,5	16.2	A, C	S	L	?	I	4
	48 Girlsday 22 april	SET	2	4	4	0	Werkman	8	14.0	A	S	L	NV	I	4
PC B-	23 Gradient Mar-Muntanya (2009)	AQ (0/8)	1	8	5	3	Sant Gervasi	24	16.3						
	58 Gradient Mar-Muntanya (2010)	AQ (15/0)	2	15	9	6	Sant Gervasi	?	16.1						
	24 Carboschools Sant Gervasi 4 ESO	AQ (21/0)	2	21	13	8	Sant Gervasi	?	15.3						
MPI-BGC Jena	25 Treibhaus Erde	SET	1	7	4	3	Ernst Abbe Gymnasium	5	15.6	A	W	H	NV	P	4
							Otto-Schott Gymnasium			A	W	H	NV	P	4
	26 Baum & Klima	SET	1	10	2	8	Carl Zeiss Gymnasium	1	13.1	A, F	W	H	NV	P	4
	27 Ich sehe was, was du nicht siehst - forschen mit Satellitenbildern (Fernerkendung)	SET	1	6	6	0	Jenaplan Schule	5	17.7	F	I	C	NV	P	4
			1	15	4	11	Elisabeth Gymnasium	6	15.9	F	I	C	NV	P	4
	39 Bodenprojekt	SET	1	15	7	8	Elisabeth Gymnasium	6	15.5	F	W	H	NV	P	4
	40 Forstprojekt	SET	1	16	11	5	Elisabeth Gymnasium	6	15.7	F	I	H	NV	P	4
	51 CO2 projekt	SET	2	17	8	9	Carl Zeiss Gymnasium	5	15.5	A	W	H	GO	I	4
							Prof. Franz Huth Possneck						GO	I	4
							Roman-Herzog-Gymnasium Schmoell						NV	I	4
							Martin Andersen Nexoe Gymnasium Dresden						NV	I	4
	59 Girls Day 2010 Treibhaus Erde/Boden	SET	2	5	5	0	Landesschule Pforta	3	16.0	A, S	W	H	NV	P	4
							Diesterweg Gymnasium Plauen						NV	P	4
							Pestalozi Gymnasium						NV	P	4

	60 Girls Day 2010 Ich sehe was, was du nicht siehst - forschen mit Satellitenbildern (Fernerkendung)	SET	2	2	2	0	Anger Gymnasium	3	13.5	F	I	C	NV	P	4
IFM-GEOMAR Kiel	37 Carbon Cycle, Climate Change and Impact on the Ocean	SET	1	13	7	6	Gymnasium Wellingdorf	70	19.8	O	W	LR, P	GO	P	1
	38 Researching about the Climate Problem through Experiments and Technology	SET	1	15	1	14	Gymnasium Wellingdorf	25	17.3	O	W	F,H,S.L,P	GO	PI	3
	The Ocean and CO2 (younger students)	SET young students	1	10	3	7	Gymnasium Wellingdorf	40	11.9	O	W	H,P,L	NV	PI	4
	Measuring CO2 in the Classroom (younger students)	SET young students	1	21	9	12	Gymnasium Wellingdorf	?	11.5	O	W	H,P	NV	I	4

Appendix 6: Correlation matrix part D of the SET

Table 4: Correlation matrix (** correlation is significant at .01 level 2 tailed, * correlation is significant at .05 level 2 tailed)

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20
D1 My interest in science topics is low	1,000	-,307**		-,447**	,315**	,264**		-,162**	-,116**	,231**			-,199**	-,160**	-,123**	-,120**	-,120**	-,072**		-,312**
D2 My grades for science subjects are high	-,307**	1,000	,214**	,422**	-,104**	-,080**	,103**	,186**	,161**		,128**	,087**	,201**	,210**	,175**	,211**	,247**	,198**	,077**	,269**
D3 We do a lot of science at school		,214**	1,000	,085**	,113**		,086**	,094**	,147**	,078**	,132**			,062*	,115**	,179**	,097**	,137**	,104**	,071*
D4 I like science lessons more than other lessons at school	-,447**	,422**	,085**	1,000	-,178**	-,180**	,060*	,135**	,130**	-,058*		,067*	,179**	,205**	,122**	,142**	,118**	,135**		,430**
D5 It is difficult to understand scientists	,315**	-,104**	,113**	-,178**	1,000	,428**		-,060*	-,038	,292**			-,164**	-,113**	-,070*		-,090**			-,174**
D6 Most scientists are boring	,264**	-,080**	,032	-,180**	,428**	1,000	-,165**	-,239**	-,187**	,298**	-,137**	-,122**	-,263**	-,235**	-,170**	-,211**	-,097**	-,172**	-,112**	-,259**
D7 This project was well organized	-,025	,103**	,086**	,060*		-,165**	1,000	,551**	,440**	-,135**	,435**	,254**	,274**	,335**	,375**	,489**	,123**	,358**	,254**	,218**
D8 I enjoyed this project very much	-,162**	,186**	,094**	,135**	-,060*	-,239**	,551**	1,000	,575**	-,196**	,377**	,327**	,536**	,518**	,394**	,591**	,124**	,417**	,307**	,325**
D9 I learned many new things from this project	-,116**	,161**	,147**	,130**		-,187**	,440**	,575**	1,000	-,114**	,345**	,364**	,359**	,414**	,420**	,505**	,090**	,490**	,291**	,262**
D10 This project was too difficult	,231**		,078**	-,058*	,292**	,298**	-,135**	-,196**	-,114**	1,000	-,112**		-,204**	-,183**	-,108**	-,139**	-,139**	-,077**	,060*	-,087**
D11 The instructions for the project were clear		,128**	,132**			-,137**	,435**	,377**	,345**	-,112**	1,000	,256**	,253**	,335**	,366**	,452**	,187**	,359**	,280**	,170**
D12 This project made me understand climate change studies are very important for human future		,087**		,067*		-,122**	,254**	,327**	,364**		,256**	1,000	,263**	,285**	,284**	,345**	,130**	,352**	,499**	,235**
D13 I would like to work on projects like this more often	-,199**	,201**		,179**	-,164**	-,263**	,274**	,536**	,359**	-,204**	,253**	,263**	1,000	,614**	,288**	,462**	,115**	,337**	,220**	,386**
D14 I like learning science in this way	-,160**	,210**	,062*	,205**	-,113**	-,235**	,335**	,518**	,414**	-,183**	,335**	,285**	,614**	1,000	,380**	,518**	,197**	,413**	,226**	,332**
D15 The supervisor's explanations helped me to understand this project	-,123**	,175**	,115**	,122**	-,070*	-,170**	,375**	,394**	,420**	-,108**	,366**	,284**	,288**	,380**	1,000	,465**	,191**	,461**	,312**	,229**
D16 My overall opinion on this project is good	-,120**	,211**	,179**	,142**		-,211**	,489**	,591**	,505**	-,139**	,452**	,345**	,462**	,518**	,465**	1,000	,249**	,494**	,372**	,326**
D17 My knowledge was sufficient to understand this project	-,120**	,247**	,097**	,118**	-,090**	-,097**	,123**	,124**	,090**	-,139**	,187**	,130**	,115**	,197**	,191**	,249**	1,000	,195**	,183**	,139**
D18 I learned very much from the scientist(s) in this project	-,072**	,198**	,137**	,135**		-,172**	,358**	,417**	,490**	-,077**	,359**	,352**	,337**	,413**	,461**	,494**	,195**	1,000	,343**	,324**
D19 This project made me realize that people can affect climate change		,077**	,104**			-,112**	,254**	,307**	,291**	,060*	,280**	,499**	,220**	,226**	,312**	,372**	,183**	,343**	1,000	,224**
D20 This project makes me more interested in choosing a scientific career	-,312**	,269**	,071*	,430**	-,174**	-,259**	,218**	,325**	,262**	-,087**	,170**	,235**	,386**	,332**	,229**	,326**	,139**	,324**	,224**	1,000

Appendix 7: Table 2.7 about students' opinions per institute

Table 2.7: Students' opinions on the regional project per institute (n=1370)

		D7 This project was well organized		*D8 I enjoyed this project very much*		*D9 I learned many new things from this project*		*D16 My overall opinion on this project is good*		*D17 My knowledge was sufficient to understand this project*		*D18 I learned very much from the scientist(s) in this project*		*D19 This project made me realize that people can affect climate change*		*D20 This project makes me more interested in choosing a scientific career*	
		Count	Column Valid N %	Count	Column Valid N %	Count	Column Valid N %	Count	Column Valid N %	Count	Column Valid N %	Count	Column Valid N %	Count	Column Valid N %	Count	Column Valid N %
Inra Bordeaux	strongly disagree	25	6%	25	6%	21	5%	10	3%	26	7%	13	3%	12	3%	82	21%
	disagree	36	9%	35	9%	41	10%	28	7%	57	14%	29	7%	25	6%	90	23%
	agree	134	34%	163	41%	147	37%	125	32%	134	34%	164	42%	112	29%	147	37%
	strongly agree	202	51%	175	44%	188	47%	233	59%	178	45%	189	48%	242	62%	75	19%
CNR-IBIMET Firenze	strongly disagree	5	2%	6	3%	4	2%	7	3%	10	5%	5	2%	8	4%	31	14%
	disagree	38	17%	28	13%	31	14%	16	7%	54	24%	32	14%	30	14%	92	42%
	agree	131	59%	126	57%	133	61%	155	70%	131	59%	143	65%	109	50%	65	29%
	strongly agree	47	21%	62	28%	51	23%	43	19%	26	12%	41	19%	73	33%	33	15%
Bergen	strongly disagree	8	4%	6	3%	5	3%	3	2%	13	7%	5	3%	15	8%	42	24%
	disagree	42	23%	56	31%	47	26%	37	20%	61	34%	62	35%	55	30%	81	46%
	agree	109	60%	95	52%	103	57%	110	61%	83	47%	91	51%	86	47%	42	24%
	strongly agree	23	13%	24	13%	26	14%	31	17%	21	12%	20	11%	26	14%	11	6%
LSCE Paris	strongly disagree	5	1%	10	3%	6	2%	3	1%	7	2%	6	2%	4	1%	57	15%
	disagree	22	6%	47	12%	48	13%	23	6%	90	24%	72	19%	43	11%	147	39%
	agree	215	57%	248	66%	214	57%	241	64%	212	56%	226	60%	202	54%	132	35%
	strongly agree	136	36%	72	19%	108	29%	108	29%	68	18%	71	19%	128	34%	42	11%
RUG Groningen	strongly disagree	8	17%	6	13%	2	4%	4	9%	1	2%	5	11%	3	7%	14	31%
	disagree	15	33%	17	37%	24	53%	13	30%	8	17%	23	50%	19	43%	21	47%
	agree	18	39%	21	46%	14	31%	24	55%	30	65%	15	33%	20	45%	8	18%
	strongly agree	5	11%	2	4%	5	11%	3	7%	7	15%	3	7%	2	5%	2	4%
Barcelona	strongly disagree	0	0%	1	12%	0	0%	0	0%	0	0%	0	0%	0	0%	1	12%
	disagree	1	12%	0	0%	0	0%	1	12%	2	25%	0	0%	1	12%	1	12%
	agree	5	62%	4	50%	6	75%	4	50%	5	62%	5	62%	6	75%	5	62%
	strongly agree	2	25%	3	38%	2	25%	3	38%	1	12%	3	38%	1	12%	1	12%
Jena	strongly disagree	1	1%	4	4%	0	0%	1	1%	1	1%	1	1%	2	2%	9	10%
	disagree	7	8%	5	5%	6	6%	5	5%	14	15%	6	6%	18	19%	35	38%
	agree	51	55%	47	51%	50	54%	41	44%	47	51%	61	66%	44	47%	33	35%
	strongly agree	34	37%	37	40%	37	40%	46	49%	30	33%	25	27%	29	31%	16	17%
Kiel	strongly disagree	1	4%	0	0%	2	7%	0	0%	1	4%	2	7%	3	11%	4	14%
	disagree	8	31%	9	33%	3	11%	9	32%	4	14%	7	25%	6	21%	17	61%
	agree	17	65%	18	67%	14	52%	18	64%	17	61%	12	43%	13	46%	7	25%
	strongly agree	0	0%	0	0%	8	30%	1	4%	6	21%	7	25%	6	21%	0	0%

Appendix 8: Tables 1.4, 1.5, and 1.6 including Z-values/rs-values and significances

Table 1.4: Z-values/rs-values and significances for differences in students' opinions compared for student characteristics (n=1370)

		Gender	*Age*	*Relation with Curriculum*
	Question	Girls (n=716)	Older students	Voluntary (n=813)
	Organization			
7	This project was well organized.		- (rs=-.192, p=.000)	+ (Z=-5.316, p=.00)
11	The instructions for the project were clear.		- (rs=-.216, p=.000)	
15	The supervisor's explanations helped me to understand this project.		- (rs=-.148, p=.000)	+ (Z=-1.962, p=.050)
16	My overall opinion on this project is good.	+ (Z=-2.296, p=.022)	- (rs=-.211, p=.000)	+ (Z=-2.474, p=.013)
	Enjoyment			
8	I enjoyed this project very much.	+ (Z=-2.028, p=.043)	- (rs= -.194, p=.000)	+ (Z=-5.047, p=.00)
13	I would like to work on projects like this more often.		- (rs=-.125, p=.000)	+ (Z=-4.012, p=.00)
14	I like learning science in this way.		- (rs=-.148, p=.000)	
	Difficulty			
10	This project was too difficult.	+ (Z=-3.595, p=.00)		- (Z=-4.234, p=.00)
17	My knowledge was sufficient to understand this project.	- (Z=-2.436, p=.015)	- (rs=-.145, p=.000)	- (Z=-2.413, p=.016)
	Impact			
9	I learned many new things from this project.	+ (Z=-2.248, p=.025)	- (rs=-.172, p=.000)	+ (Z=-4.654, p=.00)
12	This project made me understand that climate change studies are very important for human future.	+ (Z=-2.739, p=.006)	- (rs=-.221, p=.000)	+ (-7.867, p=.00)
18	I learned very much from the scientist(s) in this project.		- (rs=-.246, p=.000)	
19	This project made me realize that people can affect climate change.		- (rs=-.173, p=.000)	+ (Z=-3.351, p=.001)
20	This project makes me more interested in choosing a scientific career.		- (rs=-.106, p=.000)	+ (Z=-3.230, p=.001)

+ = difference in positive direction
- = difference in negative direction

Table 1.5: Z-values and significances for differences in students' opinions compared for project activities characteristics (n=1370)

		Literature Search	*Computer Work*	*Frontal Lectures*	*Hands on Experiments*	*Presentation by students*	*Site visit*	*Lab Visit*
	Question	601	960	559	1145	665	581	103
	Organization							
7	This project was well organized.	+ (Z=-2.039, p=.041)	+ (Z=-2.509, p=.012)		+ (Z-2.707=, p=.007)	+ (Z=-6.244, p=.000)		
11	The instructions for the project were clear.	+ (Z=-3,887, p=.000)				+ (Z=-2.278, p=.023)		
15	The supervisor's explanations helped me to understand this project.	+ (Z=-3.836, p=.000)				+ (Z=-4.177, p=.000)		
16	My overall opinion on this project is good.	+ (Z=-6.075, p=.000)	+ (Z=-2.632, p=.008)	+ (Z=-2.282, p=.022)	+ (Z=-2.806, p=.005)	+ (Z=-3.912, p=.000)		
	Enjoyment							
8	I enjoyed this project very much.	+ (Z=-3.229, p=.001)				+ (Z=-2.361, p=.018)		
13	I would like to work on projects like this more often.		- (Z=-4.962, p=.000)					- (Z=-3.824, p=.000)
14	I like learning science in this way.	+ (Z=-2.074, p=.038)	- (Z=-2.084, p=.037)					
	Difficulty							
10	This project was too difficult.	+ (Z=-6.386, p=.000)	+ (Z=-3.994, p=.000)			+ (Z=-2.266, p=.023)		
17	My knowledge was sufficient to understand this project.	+ (Z=-4.900, p=.000)						
	Impact							
9	I learned many new things from this project.	+ (Z=-3.462, p=.001)			+ (Z=-2.873, p=.004)	+ (Z=-4.951, p=.000)		
12	This project made me understand that climate change studies are very important for human future.	+ (Z=-3.153, p=.002)		- (Z=-3.486, p=.000)		+ (Z=-6.391, p=.000)		
18	I learned very much from the scientist(s) in this project.	+ (Z=-6.105, p=.000)		+ (Z=-3.149, p=.002)		+ (Z=-3.581, p=.000)	+ (Z=-3.271, p=.001)	+ (Z=-2.113, p=.035)
19	This project made me realize that people can affect climate change.	+ (Z=-6.994, p=.000)				+ (Z=-5.888, p=.000)		
20	This project makes me more interested in choosing a scientific career.		- (Z=-2.825, p=.005)	- (Z=-2.173, p=.030)			- (Z=-2.855, p=.004)	- (Z=-3.410, p=.001)

+ = difference in positive direction

- = difference in negative direction

Table 1.6: Z-values/rs-values and significances for differences in students' opinions compared for project general characteristics (n=1370)

		Duration of the project	*Approach*	*Group size*
	Question	Longer projects	IBSE (n=871)	Small groups (n=59)
	Organization			
7	This project was well organized.		+ (Z=-.6.706, p=.00)	
11	The instructions for the project were clear.		+ (Z=-3.773, p=.00)	
15	The supervisor's explanations helped me to understand this project.	+ (rs=.064, p=.020)	+ (Z=-4.436, p=.00)	
16	My overall opinion on this project is good.	+ (rs=.100, p=.000)	+ (Z=-4.916, p=.00)	
	Enjoyment			
8	I enjoyed this project very much.	+ (rs=.069, p=.012)	+ (Z=-4.117, p=.00)	
13	I would like to work on projects like this more often.		+ (Z=-2.594, p=.009)	+ (Z=-2.044, p=.041)
14	I like learning science in this way.		+ (Z=-3.682, p=.00)	
	Difficulty			
10	This project was too difficult.	+ (rs=.055, p=.044)	+ (Z=-2.952, p=.003)	
17	My knowledge was sufficient to understand this project.		+ (Z=-4.107, p=.00)	
	Impact			
9	I learned many new things from this project.	+ (rs=.109, p=.000)	+ (Z=-3.402, p=.001)	
12	This project made me understand that climate change studies are very important for human future.	+ (rs=.084, p=.002)	+ (Z=-9.541, p=.00)	
18	I learned very much from the scientist(s) in this project.	+ (rs=.096, p=.000)	+ (Z=-5.123, p=.00)	
19	This project made me realize that people can affect climate change.	+ (rs= .154, p=.000)	+ (Z=-8.844, p=.00)	
20	This project makes me more interested in choosing a scientific career.		+ (Z=-4.347, p=.00)	

+ = difference in positive direction

- = difference in negative direction

Appendix 9: List of interviewees

Interviewee(s)	*Position*	*Region*	*Date interview*
Marc Jamous	RC	Paris	15-09-2009
Ingunn Skjelvan	RC	Bergen	08-10-2009
Francesca Ugolini	RC	Florence	11-04-2010
Dominique Pasquerault Caroline Briand	Teachers	Paris	11-04-2010
Mariana Pirillo	Teacher	Florence	11-04-2010
Joachim Dengg	RC	Kiel	12-04-2010
Elisabeth Engum	Teacher	Bergen	12-04-2010
Stephanie Hayes	RC	Bordeaux	13-04-2010
Mauricette Mesguich	Teacher	Bordeaux	13-04-2010
Aicha Elouzeri Chloe Dupuis Pauline Jacquet Adelaide Ragot	Students	Bordeaux	15-04-2010
Helene Overaa Eide	Student	Bergen	15-04-2010
Leatitia Goldberg	Student	Paris	15-04-2010
Guiseppe di Giulio Francesca Conte	Students	Florence	15-04-2010

Appendix 9A:Summary interviews with teachers

Region	*Paris*	*Florence*	*Bergen*	*Bordeaux*
Number of teachers interviewed	2	1	1	1
1What was the project about?	Acidification of oceans, scientific investigation.	Environmental education & CO2.	Day cruise on a research vessel. Students got 2 questions: how are the ocean currents in the fjord and is it a source or sink for CO2?	One scientific approach: measuring CO2. Second change of ecological footprint. How can we reduce or CO2 emissions?
2What was the role of students?	Students started with reading of newspaper article, and investigating it. Check the information in the article. Then making a film. Create a DVD, fiction. And release to a wider public. Create a poster, which is linked to this project, it's about environmental issues.	Experiments to know CO2, a week of science with an exhibition. This year 4 projects: interview, role play, data analysed with gas analyzer, analysed data with meteo station.	Health security issues, so it was more like how to do fieldwork when you are on a boat? Equipment on the boat. Communication with the people on board. In the lessons I told them about data analysis, filtration of data etc. I gave them some questions to guide them. After that they had to write a scientific report. Second cruise in March. Changes in measurement etc.	It is voluntary. They begin in the first year. The class was called Carboschool. Different subjects, all the year. Integrated, but in all lessons in a different way. In my class: CO2 data analysis; organizing an event; organic mail; invented a game.
3What was the role of the scientist?	The scientists were like counselors, they helped to understand the questioning and the issues. They started the project and imagined the topic. They brought up some questions during the conference. And helped with the experiments, and went with the students on a trip to do experiments.	Important role. For the methods, for the guiding of students, and even for the idea that peoples have about future and studying science. They are in a school for science.	They introduced the project, and then came back with more theory about the carbon cycle. Taught students about Excel. They added toxic liquid and brought it to the university. Last year I took the students to the institute, but this is better for chemistry. I am a researcher myself, otherwise I had used the scientists more.	Conference in the beginning of the year about climate change and the greenhouse effect. Another one on the field, to the lab. Next year they can carry out a new project with a researcher. The researcher helps them. So I have one class with 1 scientists, and several smaller groups with a scientist each.
4What was your role in it?	There were many teachers involved. Many points of view, political, science etc. Each helped with own subject.	Supervision. I think the scientist like to work with the best students. I am a teacher and I make sure to work with all.		Coordinating role, for the other teachers. And own lessons.
5What was the location of the project (school or research institute)?	Two locations mainly, first the school, and the south of France, there are the labs, and took the samples.	The school.		One time on the experimental site, afterwards we do our own measure in the school. They showed us an experiment.
7Did the scientist visit the school? Was that useful? How many visits?	Two scientists came to school. One had done a mission in the nor pole, she told us about that. Marc accompanied the students all the way during the project, he came many times. Very useful, because the topic is very actual. The scientist is very up to date. And the students can meet scientists.	Almost 5 visits, in a year. The last year we won an important premium for this activity. The first in Italy, because we have a cooperation with the scientist.		Never the same scientists.
8What was the aim of the project, from your perspective?	Different aims. They want their students to work on a real project. They need some knowledge to understand an article in a newspaper.	To increase cultural, global, not only knowledge, but personality, point of view.	In my curriculum students should do a research project within geoscience. Main aim research and theory. We don't know the answers all the time, it's good they experience that.	Many goals. To make them interested in science. And to make the right choice for further study.
9What do you think is the impact of this project on the students?	It is a bit early to say. 4 students decided to go to Jena, which was a surprise. Vocational school, science is not in the curriculum.	It is really important, I think it is important to do experiments. It is not common to do experiments in Italy.	My group of students, very mixed. Some are interested. They got more interested I think. But because of project or subject?	We evaluate it every year. They like working differently.
10Do you think this project has increased the social skills of students?	Yes, they worked in teams. They had to raise money, worked in a workshop. For the experiments they worked in pairs and had to keep appointments etc.	Yes, very much. There is groupwork.	It is not really teamwork. Not all students did the tasks in the first cruise, so in the second cruise they didn't trust each other. But some students are really not motivated.	Yes, they have to work in groups all the time.
11Is the motivation of students in science classes increased after the project?	Yes, science is not that scientific anymore for the students.	Yes, students are not liking only read and repeat.		Yes, it is interdisciplinary, they like it. They can make links. After this year, they don't see the different topics as different as before.
12Do you think this project increased the attractiveness of school science?		Not in my experience, because I have a class that choose science in a scientific school. So they are already interested in science.	Yes (geoscience). The collaboration with university, fieldwork, that makes a difference. I bring my students to the university, and they like it.	
13Do you think this project increased the attractiveness of your school for both students and parents?	It might have, but just for students in our high schools.	Perhaps. Now we have the number of the first classes of next year. They increased. I think because the premium. So Carboschools is responsible.	I guess it would when I was better in promoting. To write the reports afterwards etc., I don't like it.	Parents ask the headmaster whether their children can be in this class, it is original. It is an impact.
14Was the project part of a school lesson?	Many teachers involved. It was linked to the curriculum	Yes. Science	Geoscience.	Many school lessons.
15Was the subject matter in the project new to the students?	Yes, they only knew from the news in the newspaper. Only one knew about it, because he is interested in it.	Excel was new. It's very difficult for me and for the students. Only for one student CO2 was new. Few students knew databases.	Some things they knew. Carbon cycle everybody has had about it. New was CO2 in oceans and doing mathematical calculations on this.	All was new.
16Where there obstacles in realizing the project within the school?	One is motivation of the pupils. The school is in the inner city, absents, violence etc. Other obstacle is getting the money. Little support from administration in school. "Too ambitious". Time schedules of students were difficult too.	Yes, the principal obstacle is the time. In Italy the lessons are very organized. If I want to make an experiment, I must ask a teacher for his time, it's not easy	No. Not with the administration, because it benefits the students and the school. The only problem is the other classes, so my teachers are not so happy. I have a very supportive principal and department leader.	Yes. Sometimes my colleagues. They see my pupils as selected pupils. My headmaster supports me a lot, but not all my colleagues.
17Did you collaborate with the scientist in this project? In what way?	They communicated by mail or they met. The partnerships were very efficient, quick answers etc.	We prepared the program together. She works with a group once a time, and I with the rest of the class, for the other aspects, theoretical way. She is not only doing experiments, but even with Excel,	You get so many emails with invitations for a lot of things. I haven't asked a lot of help from Eva and Ingunn, because I am a researcher myself.	Before the lecture we work a lot. The scientists made a lecture for teachers in the beginning. The scientist helps us to design the project. We meet 4 or 5 times before the project start. It is difficult to see him more often, he is busy.

		how to analyse the data.		
18How did you experience the collaboration with the scientist (obstacles, pleasant surprises)?	Very good as it is now.	Pleasant. I think it is the character of Francesca. She is very flexible. Because it is not simple to understand the school reality.	Good, but I knew them. In Norway the distance between scientists and other people there is not a big distance. There is no authority gap as in most other countries. That affects their contacts. You don't feel below the scientists.	It is a friend of mine, but the others are not, 5 different scientists. Very valuable with the students, but we cannot see them more. The contact is easy, want to show their work, and show it is interesting. For me the problem is that they are very busy.
19What actions would improve this collaboration between teacher and scientist?		Only the attention, I pay attention to the whole class. I think Francesca is most able for the little groups.		More visits from the scientist to the school.
20Are you still in touch with the scientist?	Yes.	Yes.		Yes
21Would you like this contact to be permanent? Why?	We hope it will continue.	I hope so, because I think the Italian style of teaching is too much theoretical.		It think it is important to keep in touch, maybe for other projects.
22Do you like to work on projects like this more often?	Yes, it is very important for the students. But we just lack time.	Yes.	Yes, I would like. I need to plan for longer periods of time. Project work is a lot of work planning by forehand.	Yes
23What did you learn from this project for your work as teacher?	It is better that students make their own experiment.	More actual and more practical.		It was the first time I worked with all my colleagues. And the contact with the students is different, very positive.
24What did you learn from this project for future projects?	To get students getting more and more involved in research practices.	I think I can be more organizing the time.		
25What should be the role of teachers and scientists in future projects? Same as in CarboSchools?	It would stay the same.	I think the same. I am positive about the project.	The way I had the collaboration was very good.	Scientists more times in school, and direct contact between scientists and students.
Comments?	The goal is to show students they are important. It is very rewarding, proud, big achievement.	How much is the budget? For so few students, I think it is a lot. But I think it is positive.	I had a lot of freedom in CarboSchools. But it could have been more prescribed about the topic etc Now I could connect it to my curricula. Otherwise I wouldn't have done it. One thing I missed, we didn't look at the social studies part, politics, economics, law. That would have made the project more interesting, but it would have demanded more collaboration between teachers.	The project had an evolution. The pupils asked for eco school. Their initiative. Two pupils are involved in this project. It is parallel the curriculum. They do what they want.

Appendix 9B: Summary interviews with RC's

RC	*Paris*	*Bergen*	*Florence*	*Kiel*	*Bordeaux*
1 What type of projects do you conduct?	Two projects about carbon cycle. Objectif CO2 biggest project (18 schools): analyzing temperature change & manipulations of CO2 (photosynthesis). Regulation of atmospheric CO2 (1 school): experiments with photosynthesis.	One experiment on marine science, with different focus for different classes (school subjects). One day cruises to the fjords: collect water samples. After that analysis in lab, writing reports.	I work for three, four schools. I suggest my activities in the beginning of the year. All different. Some ask for seminars, to research projects, to experiments, and data elaboration.	Short, playful projects for younger students (age 10-12), on basic concepts of oceanic carbon cycle. Second, group work for students aged 12-16, every week double lesson, some students do more. Other project in final year, it was compulsory but students didn't need the grade for the exams. So they were not really motivated. Final type are individual projects, personal contact.	Our topics are on forests. But also lakes. Two different topics.
2 What is your role in the projects?	Before project, meeting with teacher: how to conduct the project. RC starts the project in the class. RC is at the end of project for the presentation and corrects some slides. Answering mail and come back if teacher want.	RC has contact with schools/teachers, give lectures, and participate in experiments.	I am between the scientist and the school. I am the researcher. I guide the students step by step.	Matchmaking between teachers and scientists. Sally is more executive, writing manuals for experiments etc., and she is the role of scientist.	Coordinate the projects in the region. Start projects, find the partners, put the project together with them. Organizing site visits, lectures etc. I'm not a scientist. I don't often do activities. I do some English lesson. I always accompany the scientist. Make sure things are okay.
3 What is the role of the students?	Inventing experiments, collecting data, presentation of results.	At the ship experiments in groups, after analysis in laboratory, then write a report.	It depends. In the seminars the students are very passive, just listen. But in other projects they really run measurements.	Involved as actively as possible. Realizing science can be interesting. How do scientists work. In Germany school labs where experiments always have results. So we learn students it's not always like this. And third they have to find out if they are suited for science.	First getting background information. Frontal lecture. Some preliminary experiments. Then site visits, really depends on teachers what they do. Then they have to get up with a protocol. Do experiments, write the results, present results and again at final conference.
4 What is the role of the teachers?	To guide pupils.	Integrating the stuff in the curriculum (sometimes difficult). Teachers go along at the ship and sometimes at research institute for guidance.	I have some teachers that coordinate the groups. I usually work with the whole class. In some activities they are the supervisor. I am just supporting. But in for examples data elaboration the students follow me and the teacher supports.	Different levels of involvement. For example teachers help defining the topic and checking how everything is going. With younger students teachers are involved but never show up. The least we expect from the teacher it they support us with proposal writing. The institute should also profit from it. So we demand they support us in our public outreach. Contributing to open days of the institute.	Some teachers are well prepared and organize it well with me, but they also may be tourists. Just want their students to have a good time
5 What is the role of the scientist?	RC is the scientist. The other scientists visit the final student presentation and give feedback. And receive schools visiting the lab (just 1 school).	But the scientists runs the project, joins the cruise, do the talk before and after, correct the data, does a lot of things. Is involved in the whole process.	Antonio gives frontal lessons.	Depends on the kind of project. Scientist really works with students in the lab. Other end of spectrum: just give a presentation in a school or lab. But we want to do more than that. Try to involve scientists more deeply.	Most of the project don't have a real relationship between the scientists and school. This is in most projects, first a lecture and then a site visit.. I do have a few projects with a closer partnership between scientists and teacher.
6 What is the location of the projects (school or research institute)?	School; and amphitheater for final presentation.	One day on the ship; one to three times at the research institute. And schools for talks.	School. No space at institute. And in the field.	School and institute. Ideally institute. Younger students is mostly in schools. And space problem in institute. Older students at institute, sometimes even without scientist.	School, in the forest, or rivers, also laboratory visits. But INRA does not have a laboratory to show. Sometimes they go to factories.
7 Who invents the projects?	Objectif CO2: RC & 2 inspectors Regulation of atmospheric CO2: RC & 1 teacher	The scientists, with some involvement of teachers.	Me. And this year the students were very enthusiastic and they invented a game themselves.	Usually scientists, teacher and me. We sit together. Coordinator is needed because of experience.	Sometimes the teacher and I, I will give them the possibilities. When the scientists is more willing to engage with the teacher, then he discuss things with teacher.
8 How do the teachers and scientists collaborate?	RC conducted training for teachers in June 2008: how to work with the data file and experiments. But RC collaborates more with inspectors, they communicate back to teachers.	So there is always some contact, but of course the highest activity is around the experiments.	With Maddalena I share the tasks. In school time there is not much time for these activities. They run measurements in the field. With other teachers, it is not a proper collaboration, it's just supporting role for them.		We have identified 4 types of partnerships. Most common is teacher and lots of scientists. Indirect collaboration, via me. Then we have 1 real partnership, when really teacher and scientists have developed their project together. They were friends before. Then one half partnership, scientist collaborates more, he plans a little. Then we had scientists-pupils.
9 What is your opinion on the collaboration of teachers and scientists (obstacles, pleasant surprises)?	I think we need a person between teacher and scientist. Because scientists don't take time to prepare long term activities and collaboration.	It works well… we have to find the time. But I must say that I am very satisfied with the teachers we have contact with, it's very positive and helpful.	Nice relationship. Obstacles are related to the kind of activities. Like data analysis which is hard for teachers.	Depends on personalities. It's not really like Teacher Scientist Partnership. Mostly we use Phd students, because the others are busy. There are some partnerships growing strong, mainly because they knew each other already.	There is no real relationship and different scientists go to one school. But on the other hand, kids get to know different scientists, teachers are happy about that. I would love more direct, real partnerships.
10 What actions would improve this collaboration between teachers and scientists?	Teachers and students meeting the scientists. But I think it's very rare. A lot of teachers organize visit of laboratory, but they don't speak before of what they will show. It's just a conference the scientists give, but not more.	Without doubt, a situation where the coordinator was employed in a position more than 20%. This would give more time to facilitate meetings between teachers and scientists. Also, ideally, some of the scientists should have as a part of their job to collaborate with teachers/schools.	Several subject teachers should be involved in the project.	Improving by workshops, bring teachers and scientists together. Then the best ideas show up. But they are not always keen to get to know each other. Sometimes the student brings the scientist and the teacher together.	Scientists were chosen by the boss, so scientists were not motivated and not often available. And we have to ask unqualified people. Reduce number of schools, go for quality and not quantity, one scientist and one school. Workload now is too much.
11 Are the scientists still in touch with the teachers? In	Just for the final presentations. Yes, I think it should be permanent. I regret that	No, not necessary. I assume that the contact between teacher and scientist results in	It depends by my contract. But I think the next person will do this.	We make sure the next project follows. It is an illusion they stay in contact. But exceptions: some are friends.	Depends, some are friends. But the others, no.

what way? Should this contact be permanent? Why?	they do not meet about the long term consequences. I think they keep contact, but for punctual events. It should be in a different way.	increased knowledge and new ideas, which might be used without a scientist involved next time. I think the contact could be on and off.			
12 Is collaboration with schools policy of your research institute? Is this collaboration stimulated thanks to the Carboschools project?	It's more an obligation. Scientists were surprised at final presentation about degree reached by teachers and scientist. Policy is not changed, but scientists' view of teachers and pupils has changed.	It's not policy, but it is important. Between the lines.	Yes, several activities started I think 10 years ago. A group of scientists do this. They work on other kind of projects, not hands-on, but they do activities.	Some policy, but more student practica. Now outreach combined with students projects. Very successful, major projects. University, CarboSchools. It is not one of our goals, but now it is so structured.	Not usually secondary schools. More with last year of engineering school, or university students.
13 How many students/projects per year are conducted by your institute?	Not projects but just presentations. 5 to 10 percent of scientist. Once a month (guess).	Some activity: written fact sheets.	4 or 5 projects. Seminars some years much more than other years.	Individual theses: between 6 and 10. The group work 20-40 students in a year. Whole classes or Sally's work: 5 teachers 4 weeks to 6 months. One day events: 100 or 1000 of students in a year.	In CarboSchools, the first year 30 students Max Linder. The next year 160 pupils. And the year after that at least 300.
14 What are the objectives of the projects?	To give information about climate change. To inform pupils about climate change.	To promote knowledge on climate change in general, and to give the students and teachers a taste of scientific life.	Let them know what we really do in the office and in the field. Bring the science to the students. Knowledge of students second goal. We suffer in Italy from little science students in university.	Carboschools was different because it had an agenda. Other projects just getting students interested in science. The citizenship aspect is difficult, it is entering environmentalism. You try to influence opinions. Scientists do not like that. The topic of greenhouse effect is oversaturated.	To get pupils thinking about climate change, to understand them the carbon cycle and greenhouse effect. The objective of the unit is also to attract pupils to science. Recruitment to his unit, or INRA.
15 Is it easy/difficult to establish contacts with schools/students? What is your policy in this?	Not difficult. Teachers like it and asking for it. No special policy, just classical network..	4 schools are involved, but 1000 people got an email. So very few were interested, but for this purpose enough.	The schools were already contacted. We organized an event to catch up with schools. They were really keen to do this, so it is very easy. A good reputation for this kind of activities.	Waiting list for schools to join us. But initially mistrust. Both teachers and scientists. Now a very stable 10 partner schools.	Yes, we had no problems. French teachers like external projects in schools. The school inspector collaborates sent out a call and selected schools. Now even more schools. And guy from regional council from Educational Department got us financing for the little conference. He is very positive, CarboSchools is going to continue. So in our region it has really taken off.
16 Which factors stimulate or hamper the conductance of student projects in your institute? Money/time etc.?	For scientists: time For schools: money (for visiting lab) & contact (in the beginning they don't know who to contact)	Stimulating: At one point all EU projects had to include an outreach part, which stimulated to all kind of contact with non-scientists. I think this is not required anymore.	My time. With more money we could buy some stuff, but we can deal with this money. The weather can hamper the project. And collaboration with teachers, we need more teachers that could use data analysis (maths, ict.).	Stimulating is money. First pay someone to work. Second is the project status, you have to do and deliver. Hampering: overwork the scientists.	Hampering: time and motivation of scientists. phd students are more enthusiastic. Another factor: it is not the job of the unit to do this.. As RC you are lonely. Stimulating: it is expected they do some outreach.
17 Is your role in school projects an official task?	Yes for me it's an official task.	It's not a part of my paid time. In the Norwegian project we have a 20 percent position as a coordinator. But the project is so much more than 20 percent work.. And I do at least 20 percent work, but my salary comes from other sources.	Yes, part of my job is research and part is coordinating.		
18 What should be the role of scientists in cooperation with schools for future projects? Same as in CarboSchools?	I think it should be more or less the same. I like to implicate more the scientist, but I don't know how.	The same. But new project will be with teacher education etc. Then it must be in more cooperation with didactic people. Because it's very important to have these people involved, because they know how to present such new topics.	Much more collaboration with the scientists. One person is not enough.	The scientist does not have to contribute to outreach activities, because this is a different project. EU separated this (science and outreach). You have to stay and keep a close connection to the scientists. If scientists see their outreach people in the same meeting, they see it is the same thing.	The real partnership between scientist and teacher is fantastic, but it is not possible. I think that would be really great.
19 Do you like to work on projects like this more often?	Yes.	Yes, as long as it is a part of my regular job and not on top of everything else.	Yes I like to run measurements with the pupils. And also my Phd.	I do this for 100 % of my time. We have some new project applications running.	Yes and no. Why not: the fact you're not working in a team. And finding scientists is hard. Also because it is quite idealistic. That teachers and scientists want this. It requires a lot of extra time. But when it works, it is very satisfying. I like the part most the contact with the pupils. My work conditions were hard. But working with different countries is great.
20 What did you learn from this project for future projects?	To conduct experiments, which are appropriate for students. The project is too long; students want to change topics. Students don't remember everything what have been told a week ago.	It has been stimulating working and communicating with teenagers. We have to improve facilitating the projects, though.	The organization, the management of the activities. To be strict with the students, rules, practical worksheets.	International component is really nice, it adds something. We try this more. Three years is too short, in Pistoia teachers were thinking how to collaborate. It was too late. EU money is nice, but a lot of reporting. I think the relationships build up in Carboschools is very important.	More support should be given to RC, a tighter network of RC. Someone coordinating them. When writing proposal, you have to be realistic. Reduce number of schools. More quality. Workshops for teachers.
21 Comments?			CarboSchools very useful for students/teachers because they get some devices they normally do not get.	Try to avoid bring agendas (environmentalism) in the school by scientists. But for project funding you always need something new, but we have to deliver.	We need a team leader. Working half time is not enough. Address work situation some time.

Appendix 9C:Summary interview with students

Region	*Bergen*	*Florence*	*Paris*	*Bordeaux*
Number of students interviewed	1	2	1	4
1What did you do in the project?	Ocean, flux. Learn how the scientists work.	I made a game about the environment.	Experiments with sea water. Measurements of CO2 in the (sea) water. We went to the south of French, we visited the laboratory. And scuba diving. The scientists told us about the acidification of oceans. We did interviews with scientists. So different things.	Different things: conference, exhibition, visit of forests, measurements, recycling waste, trees, weather station for CO2 and wind direction, light, rain, Excel. Film about food, organization for EcoSchools. This year about food. We changed the food in the canteen.
2Was the project difficult?	No, very interesting.	Only making the characters.	More or less. It was not difficult for science, but we are vocational school and have normally no science.	Not very difficult, because it was very interesting and we liked to do it. Ecology is not boring, but interesting.
3What did you like about the project and why?	The time we were traveling with the boat.	I liked very much to stay with the people, play with them, and learn about the environment.	Scuba diving.	I liked working in group, and realize our own project. And working with scientists, and see how they work. It is a different way of working; it is very interesting, a new way.
4What did you dislike about the project?	I think I liked everything. But writing the report was boring.	Some parts are a little boring, but it is okay.	I liked it all, it was very interesting.	I think it is very interesting.
5What did you learn from this project?	Effect of pollution on the ocean, and how important it is to know more about it.	Knowledge about the environment.	The measurements of CO2 in the atmosphere, forests, and oceans.	We have learned a lot about the environment, the carbon cycle, greenhouse effect, photosynthesis, forests, different captures.
6Was the project part of a school lesson?	Yes, science.	No, we made it after the lessons.		
7Did you have to work in teams?	Yes. 5 persons in my class. I liked that.	Yes, I liked that.	Yes, twenty pupils in the class. I liked to work in groups.	
8How many times have you visited the research institute?	One time university, and one time on the boat. I like it to go out.	Not any time.	Research institute is in Monaco, so the researcher came to us.	Yes, three times. It was just to visit the laboratory, and the researcher explained us how they work. It was different from the typical work in the class.
9Did the scientist visit the school?	Yes, a few times, told us how to do the mathematics etc.	Yes, she went at our school many times.	Yes. It was very interesting.	
10Did you recognize the subject matter from your previous science in school?	Yes, we have learned something about the pollution before.	I already knew something about the environment, but now I've learned more.	Yes, the plankton, CO2. It was all new for me.	Yes, a little, in science we knew a little. Most was new. And we hade some stereotypes.
11Do you like to work on projects like this more often?	Yes, I think it's fun.	Yes.	Yes of course.	Yes, and we continue with the Ecoschools project, different project but the same way of working.
12Do you want a career in science? Why? Thanks to this project?	I want to be a scientist. I want to study geology in the ocean. I was already interested in this, not because of CarboSchools.	And maybe I want a career in science. Not thanks to the projects, already interested in science.	I learn commerce, it is very interesting but not for me.	We are in scientific class. Most want a scientific career. And we are more interested in science thanks to this project.