NANOYOU - WP 1

REPORT ON THE ANALYSIS OF SURVEY RESPONSES

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PP = Restricted to other programme participants (including the EC services).
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Executive summary

The report at hand shows the entire work carried out within Work package 1 – survey and requirements analysis.

It is based firstly on an exemplary literature review in the fields of nanotechnology and science communication, under special consideration of science communication and education to young people. Secondly, it is based on empirical work carried out between June and November 2009 in several European countries and Israel. Empirical work included focus group discussions with young people in three age groups, expert interviews of different related fields, e.g. teachers and science communication experts, national context questionnaires – filled in by representatives of five countries, and a comprehensive online questionnaire, which was carried out in eight European languages and was filled in by 2.397 respondents of four age groups which were differently represented:

Obviously, the youngest group is very hard to reach. As nanotechnologies are not yet part of the regular school curricula, particularly interested teachers who carry the communication activities by themselves are needed. Those teachers have to be found and contacted. Without having those contacts in the participating countries, it is difficult to get to the youngest group. For the middle group, aged 14 to 18 years it seems easier to find interested teachers who are able and willing to integrate the subject in their classes. In this group the survey could gain the highest response rate. For the eldest group (19 – 25) it is also challenging, because communication channels are not as clearly available compared to schools. Because of the sample sizes of the age groups, analyses have been done finally within two groups, the youngest group and the two older groups together.
Respondents came from 25 countries, of which the countries with the highest respondent rates were Austria, Romania, Italy and Spain. However, the survey activities as a whole showed some interesting findings and tendencies about young people in Europe that were asked by the DoW.
For instance concerning sources of knowledge it can be stated that school, TV and radio, movies and the internet are the most important sources of information about NT for young people. But there is a strong wish for them to learn more at science centres and museums, at events and in seminars, courses and workshops, more than they do up to now.

In general, results show that there is a high interest for nanotechnologies among young people in these four countries and a wish for more profound knowledge in the future. However, the interest for NT is bigger than the knowledge, and young people would like to know more about it in the future.

NT is already part of future education and professional career considerations. Nevertheless young people are also very aware about risks and societal impact. Although they widely believe in positive developments in the future, they remain sceptical and critical against major issues such as privacy, consumer protections, environment and health.
In general, young people think that NT will improve our lives in future. They are mostly optimistic up to euphoric but at the same time believe in risks and are aware of negative impacts as well. For further developments and applications young people ask for independent regulation and control agencies.

Concerning gender there is a gap concerning interest and knowledge. But seemingly there are potentials. Girls show a strong interest for the future and would like to learn more, or they are still uncertain whether the topic could interest them later on.

Table of Contents

1 INTRODUCTION

Especially in communicating future technologies like nanotechnologies that are, as often stated, still in their infancy; especially young people are widely seen as *the* central public. As future generation they will be carriers of future developments. Nanotechnology is seen as enhancement technology with high expectations and promises. But at the same time they could lead to wide ranging societal changes. Nanotechnology developments and applications will pose further questions about future development but also seek for new future projections and visions that need new forms of orientation beyond traditional schemes. The discourse about nanotechnologies therefore leads to wider discussions about societal future in general that needs to involve societal participants as well. Young people as one segment of society are considered important target groups predominantly because of two main reasons. Firstly, they are seen as a critical public who accepts and adopts new technologies, and will be consumers of new products. And secondly, they are seen as future engineers and scientists in the various sectors and fields of nanotechnologies. Thus, also recruiting is a very important aspect of science communication to youth. So NT also has to be attractive for the scientific offspring.

Therefore communication activities are tending to cover both: the scientific understanding of technology and its socio-scientific assessment. As science and technology studies have already revealed, more information and a better understanding of a technology do not necessarily lead to an increased acceptance of a technology. It requires enhanced communication between science and society for a successful technology and its societal acceptance (Zöller 2008). Consequently new formats of public dialogues and public involvement were developed.

Many activities are already carried out across Europe, such as “nanotruck” or “nanocamp”, some formats are especially targeting at young people, as for instance “nanoreisen.de” or games like “nanoboy” or videos, songs etc. In Austria, the ‘nano initiative’ or the ‘generation innovation’ initiative are offering a range of formats for interested young people, like for instance the “nano-practica”, internships in nanolabs, “nanodays” or online communities like “fit-remixed”. Such activities reach out for highly interested young people in their “leisure time”. To meet young people in their “professional time”[2], which is at school, adequate trainings and materials have to be carried out. NANOYOU targets at both, undertaking outreach activities at school and via science centres and is working out appropriate formats and materials for that purpose.

As a core aim of this work package, an initial requirement analysis was carried out to present a state of the art in NT communication activities and to build up the basis for the materials worked out later on. The analysis contained a literature review, giving insight into actual experiences and considerations in the field of science communication, especially of emerging technologies like NT. Furthermore qualitative and quantitative survey activities took place in six European countries, including experts and young people themselves as the two main stakeholder groups. For the quantitative analysis a comprehensive online questionnaire was open for two months, available in eight different languages. Additionally, a national context survey” was carried out in order to contextualise findings of the survey according to countries.

[2] *Report from the Workshop: Communication Outreach in Nanotechnology: from recommendations to action*. (2008). Retrieved Jan 12, 2009, from ftp://ftp.cordis.europa.eu/pub/nanotechnology/docs/nanooutreach_action_final_mar_08.doc

The report at hand will describe all instruments implemented for the survey, show descriptive and analytical outcomes and gather conclusions and recommendations.

1.1 PURPOSE AND SCOPE OF THE TASK

The aim of the survey was to "explore and clarify young people's knowledge, attitudes, specific values, concerns and expectations concerning nanotechnology", especially in three subareas:

Medicine and health, information and communication technologies, energy and environment

As a basis this work package was meant to find out about the current situation in the participating European countries. The survey activities should reveal what young people know about nanotechnologies, if they have ever heard about NT, and if yes in which context? What do they associate with the term? Which expectations do they have, which considerations? What are their general attitudes concerning nanotechnologies? What are their interests? What are their future visions? Special attention was given to ethical, legal and social aspects (ELSA). The survey was intended to find out which of these aspects would come up while discussing nanotechnologies with young people and how they were going to deal with them. What are the most important aspects for young people?

The survey should also clarify which sources of knowledge are in use. It was intended to show which curricular and extracurricular activities exist. For the situation in schools the survey aimed at finding out if NT is already part of school curricula. If yes, which subjects are related and which teaching materials are in use? Is NT already part of initial or continuing professional development of teachers' education? Which extracurricular infrastructures are available for interested youth?

Furthermore, the survey looked at the national contexts in the participating countries. The question was if there were any public debates going on or any campaigns pro or contra NT and by whom? Which actors were taking responsibility for awareness rising in each country and how were discussions reflected in the media?

Finally the survey wanted to find out, what works in science communication. Which good practise examples do exist? What are the teaching experiences so far concerning the scientific understanding and discussing ELSA? And last but not least, which expected or observed gender differences could be gathered by experts?

1.2 RELATIONSHIP WITH OTHER TASKS

Tabular overview 1: NANOYOU participants:

Participant number	Name	Short name	country
1	ORT Israel (Coordinator)	ORT	Israel
2	EUN Partnership AISBL	EUN	Belgium
3	The Chancellor, Masters and Scholars of the University of Cambridge	UCAM-DENG	United Kingdom
4	Interdisciplinary Nanoscience Centre at the University of Aarhus	iNANO-AU	Denmark
5	Barcelona Science Park	PCB	Spain
6	The Centre for Social Innovation	ZSI	Austria
7	Centre de Culture Scientifique Technique et Industrielle de Grenoble.	CCSTI Grenoble	France
8	La cité des Sceicnes et de l'Industrie	CSI	France
9	Halevi Dweck & Co. ARTTIC Israel Company ltd	ART	Israel

Inputs by participants:

Participants 3 and 4 gave input concerning nanotechnology examples.

Participant 3 conducted 2 focus groups in UK

Participant 1 conducted an expert focus group in Israel.

Participant 3 conducted additional expert interviews in the UK.

Participants 3, 4, 5, 7 and 8 provided contact persons for expert interviews

Participants 2, 3, 4 and 5 provided translations and proof readings for the online-questionnaire.

Participant 2 supported announcement, promotion and contacts to pilot schools for the online-survey.

All participants supported announcement, promotion and contacts to teachers and schools for the online-survey in their countries.

Participants 1, 2, 3, 4, 5, 7/8 provided contacts to national representatives for the national context survey (including Romania).

1.3 STRUCTURE OF THE DOCUMENT

The report at hand is the description and analysis of the entire work carried out within WP 1 – Survey and requirement analysis. The implemented empirical work is based on a literature review in the fields of science communication, nanotechnology and communication and education activities with young people.

Chapter 2 will give an overview about the most relevant aspects in communication activities of nanotechnologies to youth.

In Chapter 3 the qualitative part of the survey will be described, including a short introduction of the different instruments and descriptions of the samples. Also included will be main decisions of analysis related to response rates and possibilities of significant results.

In Chapter 4 a description and analysis of the empirical work will be given. Each instrument will be analysed separately according to the main issues to be worked out with the survey:

- 4.1. Focus groups
- 4.2. Expert interviews
- 4.3. National context survey
- 4.4. Online survey

In Chapter 5 the main conclusions of all results will be gathered. Recommendations if possible will be summarised.

The annex contains the entire descriptive frequencies output of all questions of the online questionnaire.

1.4 ETHICAL ISSUES

The participation on focus groups was voluntary and anonymous; the collected data of participants cannot be tracked back. Group participants, teachers and parents got an information letter about the survey activities.
Within the focus group discussion we did not use any kind of products; we just showed pictures of nanotechnology applications.

1.5 IPR ISSUES

The report at hand has the status public and will be published on the NANOYOU web portal.

2 DESK RESEARCH

In order to carry out the work for the survey instruments, an extensive literature review had to be done. The material included journal articles, conference papers, books, policy papers and project reports. It also contained a research on NT related websites and searched for existing materials for teaching and communicating NT. The main related fields were nanosciences and technology, science and technology studies, technology assessment and pedagogy. Experiences of similar projects and theories were incorporated into the survey tools of NANOYOU. The following only gives an exemplary overview about basis and some ideas about relevant aspects of NT communication activities to youth and does not claim for completeness.

POLICIES

NT has been designated as a prioritized area in the national science and technology policies of many countries. At the same time, the potential health and environmental risks of nanotechnology or societal implications of nanotechnology are also concerned. The acceptance of nanotechnology is also an important issue in their national programs, e.g. in Japan (Takemura 2008). For Europe, the European Commission in 2004 published the Communication paper "Towards a European Strategy for Nanotechnology" (COM 2004). This paper sought to bring out a discussion on nanosciences and nanotechnology on a broad level and proposed an integrated and responsible strategy for Europe. It sought to maintain and strengthen European R& D in nanosciences and nanotechnologies, but it also considered issues that should ensure the creation and exploitation of the knowledge generated for the benefit of the society. It says: "The public trust and acceptance of nanotechnology will be crucial for its long-term development and allow us to profit from its potential benefits. It is evident that the scientific community will have to improve its communication skills! (COM 2004:20). So the science community was prompted to enhance its science communication activities. Furthermore, youth was integrated as potential target group for communication activities. Considered as an "essential ingredient" the strategy highlighted the importance of engaging the younger generation in discussions about science from an early age on, the "youth should be attracted to "nano" (COM 2004:14).

A year later, the action plan "Nanosciences and nanotechnologies: An action plan for Europe 2005-2009" was published. It continued the relevant topics of the previous communication paper, amongst which it also included the aim of pursuing a "true dialogue with stakeholders" and furthermore to encourage industry to take account of social, health and safety and environmental concerns. So both the dialogue and societal issues were addressed: "A better dialogue between researchers, public and private decision-makers, other stakeholders, and the public is beneficial for understanding possible concerns and tackling them from the standpoints of science and of governance, and to promote informed judgement and engagement" (COM243 2005:2). And later in the text: "An integrated strategy cannot be implemented in a linear fashion but it requires coherent and coordinated action. In addition, given the increasing interest of citizens in the implications of N&N, it is important that action at EU-level is given appropriate visibility and is effectively communicated" (COM243 2005:12). National country strategy plans, like, for instance, the UK ten years plan for science and innovation in 2004 adopted the issue to its targets. "The Government wants constructive, inclusive

and open public debate and dialogue (...) To do this, the Government will work to move the debate forward—beyond simplistic notions of the public being ignorant of science, or being either pro-science or anti-science; and beyond crude notions of a particular technology being either 'good' or 'bad'(Gavelin und Wilson 2007:4). It was followed by an outline Programme for Public Engagement on Nanotechnologies (OPPEN) 2005, which highlighted six main aspirations for public engagement on nanotechnologies, one of which was to "establish and maintain public confidence in the development of technologies by understanding the public's concerns and showing their impact on government regulation. In consequence of it, six huge engagement projects were carried out in the UK[3]. Many other similar projects took place in several European countries. So communication and public dialogue became key elements across Europe.

To break down the strategies to concrete levels the EU launched a process with several events (including web consultations for six months) for outreach consultations. One of it was the workshop Communication Outreach in nanotechnology: From recommendations to Action (Brussels, 24-25 October 2007) with various experts (some of which are part of the NANOYOU consortium now) in the fields of opinion-making, science communication, outreach, social engagement, design, arts and nanotechnology. The group worked out programmes to three main questions: To whom, what and how should we communicate? (Bonazzi und Palumbo 2008). The workshop team came up with a range of recommendations. One part of it was the emphasis on youth. Young people should be reached in their 'professional time' and in their 'leisure time'. Appropriate communication tools should be developed suitable for the different age groups. To find out about the knowledge and the communication needs of young people to build the basis for developing adequate materials and tools became main objective for the NANOYOU project.

DIALOGUE AND COMMUNICATION

One main challenge within communication of nanotechnologies as stated in many reports is the scarce knowledge of the target groups. So for instance the Risiko-Dialog study in Germany and Switzerland revealed that 70% of the respondents stated not to know anything about nanotechnologies. Only 15 % stated to know much about it, and another 15 % stated to know a little about it (Grobe 2007:16). Other studies confirmed similar numbers, whereas approximately 80% of American respondents and 60% of their European counterparts have never heard of nanotechnology, or are only vaguely aware of what it entails. (Hanssen, Walhout, und Est 2008). Or according to the citizens' panel 2008 in Birmingham, UK: "Participants initially knew very little about nanotechnologies on their arrival at the Panel, with most not even having heard the term before. They found it difficult to conceptualise the scale of nanotechnologies and some found that the scientific information (e.g. about constructing nanomaterials at the molecular level) was difficult to assimilate. Participants found it much easier to understand and think about nanotechnologies when they were given concrete examples of the ways in which they might be applied (Opinionleader 2007:9).

Therefore, many experts believe in the necessity of a preliminary input before carrying out science communication activities. The German youth dialogue (http://www.nano-jugend-dialog.de) for instance used written

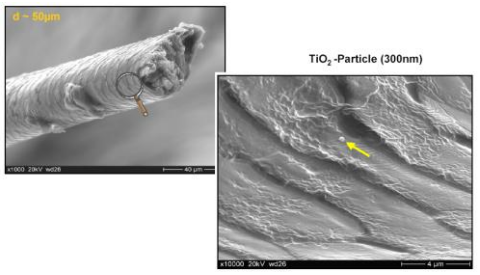
[3] Small Talk, Nanodialogues, The Nanotechnology Engagement Group (NEG), Democs, NanoJury UK, Global Dialogue for Nanotechnologies and the Poor (GNDP), Nanotechnologies, risk and sustainability, Nanologue, Institute of nanotechnology, Nanoforum

introduction documents and started their panels with briefing sessions. Often experts from the field of nanotechnologies are invited to give first inputs about certain subareas of nanotechnologies (Zöller 2008).

As nanotechnology represents not only one technology, but a broad range of different subjects, approaches, fields of applications and stages of development, communication about nanotechnologies is very complex. (Fleischer und Quendt 2007:1). So according to our project partners we agreed on the plural form nanotechnologies.

Starting point of communication activities often is a short definition about nanotechnologies to narrow down the subject. Especially for people who don't know about it, to find a definition that is precise and sound at one hand and encompasses different approaches and applications on the other hand is challenging. Based on communication experiences, participants would like to know a definition, that would make clear about what the term entails (Hanssen, Walhout et al. 2008:52). Still, there exist a variety of different definitions in use. Not only in different ways by officials, activists and social scientists , but also in the scientific community there exist a variety of different approaches and ideas of which similarities are not easy to describe and to structure. Often unclear in communication activities are different terms that are used interdependently, like nanoscience and nanotechnology, nanoparticles and nanomaterials. For the NANOYOU project we had to work on an appropriate definition. Based on the common definition of the British Royal society with our scientific project partners we have carried out a short definition for usage as preamble of the empirical survey. In order to keep it simple, we finally separated nanosciences and nanotechnology and skipped the passage about nanosciences. The following is the final short definition we have used for survey activities:

> "Nano as prefix has the simple meaning of billionth (10^{-9}). In the case of nanotechnology, the reference is to the nanometre (nm) which is one billionth of a metre (or one millionth of a millimetre). The nano-world is the world of atoms and molecules. To illustrate: a sugar molecule, which measures about one nanometre, is about as big in relation to an apple, as the apple is in relation to the earth. Look at the example with the hair to see how small that is.
> Due to the very small size structures can have new attributes, for example they change colour."
> -"Nanotechnologies are the design, characterization, production and application of structures, devices and systems at nanometre scale".



."

Illustration 1: Hair example

Illustration 2: sugar-apple-world example

In general, it is seen as being very difficult to explain and discuss the topic nanotechnologies with the public and with youth in particular. How to explain the very abstract and inconceivable topic is the main question. Explanations and analogies immediately reach the limits of common human experience. Therefore images and visions can take over and make the boundary between fact and fiction blurring (Gimzewski und Vesna 2003).

There are a range of further challenges for communicating NT, as for instance worked out by the NISE network about communication activities of science museums (Bringing Nano to the public Crone 2006), amongst which the vocabulary needed to explain the nanoworld (like atoms and molecules) are unfamiliar and poorly understood by the public.

Another important aspect of communicating nanotechnologies and discussing ELSA in particular are the methods and formats which are suitable especially for the target group youth. Across Europe, many projects, citizen panels, forums, and dialogues took place that cannot be shown here in detail[4]. None of them targeted in particular at youth, but it became obvious that the voice of young people should have been heard too. So one of the feedback statements of the Verbraucherkonferenz 2006 in Germany was: "Wünschenswert wäre auch noch ein Schüler gewesen…der jüngste war 20" (trans: it would have been desirable also to have a pupil...the youngest was 20" (Zimmer, Hertel, und Böl 2008:29). So two years later the "Jugendforum Nanomedizin" was carried out – a participatory series discussing nanomedicine and its societal impact with young people (Zöller 2008). The youth forum was held in three cities in Germany. 54 young people between 16 and 27 were involved in a programme which resulted in an opinion report carried out by the youths themselves. The structure of the programme was modular in two blocks and took place over a longer period of time. Both blocks of the youth forum programme were two and a half days. (Half days or full day workshops are used in many similar cases of deliberative forums). The programme started with a playful entrance with a nano-quiz. For (self-)evaluating purposes, a test in form of a quiz seems appropriate. We have integrated a short nano-quiz in the NANOYOU online questionnaire as well to stimulate interest towards finding out the correct solution, and to get insight to young people's knowledge about NT.

4 Some further examples of participatory projects on NT were: "Kleine Technologie - Grote Gevolgen" (2004), "Nano in Focus" (2006) by Rathenau-Institut (NL), "NanoJury" in UK (2005), "DEMOS" (UK): "The NanoDialogues" (2006), the EU projects Nanologue and NanoDialogue (2005/06), the TA-SWISS project "publifocus Nanotechnologie" (2006) in Switzerland, the "Verbraucherkonferenz Nanotechnologie" (2006) by BfR in Germany and the "Conférence de Citoyens sur Les Nanotechnologies (2007) by Conseil Régional d'Ile-de-France (F).
For further reading: Gavelin and Wilson in presenting the findings of the Nanotechnology Engagement Group (NEG) that document the learning from a series of projects and events that attempts to involve members of the public in discussions about the development and governance of nanotechnologies suggest a list of recommendations for public engagement. (Gavelin und Wilson 2007). Powell and Colin worked out 10 Recommendations to support citizen engagement in nanotechnology (Powell und Colin 2008).

The next step of the youth forum was an introductory lecture about NT by an expert with a discussion afterwards, in which young people could raise their questions.

At the end of the day the participants watched some examples of science fiction. Berne & Schummer have worked out educations aspects of science fiction (literature) for teaching nanotechnology, in their case to becoming nano-engineers. They suggest that "through science fiction, moral imagination can be elicited as a primary analytical tool, so that engineering students can engage and deliberate over moral judgments in light of emotion, attitudes, and preferences, through the creative and illuminative power of the human intuition" (Berne und Schummer 2005:462).

On the following day of the first block, the forum participants had an excursion to a nanolab where they could have a look on actual experiments. Furthermore they got another lecture on NT that also mentioned possible risks of NT and nanomedicine. On the next day the participants got another lecture about NT focuses on nanomedicine. Group works carried out different fields of applications afterwards. For ELSA the participants heard another lecture later on. Again within smaller working groups participants discussed main aspects and worked out questions.

Another element of the forum was a role play on nanomedicine. It was meant to work out different positions and rehearse argumentations for discussions and the expert hearing. In the US Jarmon and Keating also implemented role playing in their deliberative simulation activities aiming at participants could "experience transformative perspective-taking in a nanotechnology scenario to develop participants' deeper understanding of multiple stakeholders' views and critical thinking about nanotechnology decisions. The authors believe that "educational role-play scenarios with active participation of the public can serve as a dynamic method for civic engagement across a range of complex, interdisciplinary topics and new technological dilemmas" (Jarmon und Keating 2008:282). NANOYOU worked out dilemmas and role cards for role playing games as well. Interactive and creative elements were also positively evaluated in the Verbraucherkonferenz, but also working in smaller groups in nice and trustful atmosphere (Zimmer u. a. 2008)

Between the two blocks of the forum participants had to work out a so called "mini-expertise" about certain applications of nanomedicine and their ethical and social impact. For this task, participants got information materials which had been compiled by the organisers. This structure replicated the experiences of the previous Verbraucherkonferenz, which had provided participants enough time between the blocks for exchange, research and preparation.

Furthermore, the participants could decide on experts they would like to invite to a hearing that should relate on their worked out expertise.

After the hearing participants were invited to take part in a creative element. The so called "scenario" should work out images, poems, sketches for the year 2030 to show their assumptions and expectations in the field of nanomedicine.

Based on all previous work the young people gathered main topics and decided about key text elements which should be part of their final recommendation paper. The final paper, finalised by two selected participants was handed over to policy representations during the closure event.

One appreciated aspect of the youth forum was the rather narrow focus on nanomedicine. Especially in the wide field of NT, it is difficult to gain people's interest when the topic is not broken down to less abstract applications. To involve lay people in discussions about nanotechnology in general could be comparable to involve people in discussions about all things that are less than on meter tall or the like. From a pedagogical perspective, for a thoughtful discussion about emerging technologies like NT, in a nowadays world where science changes so quickly, the question is if school

curricular still can be organised around “basic stories” or rather on “topical stories”, related to socio-scientific encounters with exciting and societal relevant themes (Turner 2008:64 cited after Solomon 1999).
Another accompanying element of the German youth forum was the online discourse (www.nano-jugend-dialog.de). This forum was meant as discussion platform between experts and young people, but could not attract many participants over the whole period of time. In general, it seems discussion formats better work face to face. Discussions in groups seem to be appropriate. The format of focus groups seems to be appropriate and successful (Fleischer und Quendt 2007). The question is, if discussions in big groups like school classes.

ATTITUDES

The Eurobarometer survey of 2005 on Europeans, Science and Technology revealed that 80 % of the respondents stated being quite or very interested in new developments in science and technology. Far behind of the main fields of interest such as medicine, environment, ICT, economics and humanities, nanotechnology only gained the last place. Some studies in specific countries in Europe and the US also revealed, that the public is not very interested in NT but in general has a positive attitude (Cobb und Macoubrie 2004; Opinionleader 2007). However knowledge about nanotechnology among the public in general is very low as it was shown, for example, by the European Commission’s Eurobarometer 64.3 survey: "Europeans and Biotechnology in 2005: Six in ten adults had not heard of the term 'nanotechnology' (61%). A study of UK public engagement initiatives confirmed EC Eurobarometer surveys that public awareness of nanotechnologies is low and the concepts difficult to grasp. Engaging people in NT requires focusing on applications affecting people’s lives (nanoBio-RAISE o. J.). Besides singular events or certain regions, public debates do not widely exist and nanotechnologies are not yet part of school curricular in the most European countries. Overall, these results show that the interest of the general public in and the knowledge about nanotechnology are rather low and that there is a strong relation between the public perception of nanotechnology and other technologies. If known at all, „nanotechnology” is a fuzzy concept to laypersons and can probably best be described as „no specific attitudes” technology (Fleischer und Quendt 2007).

However, there exist a range of surveys and studies to reveal public opinions on NT, like for instance the work by nanoforum (EU 5FP) that worked out an online survey with a total of 720 people (Nanoforum 2005) to work out main concerns of NT or nanologue (Nanologue 2006a).

The Eurobarometer 64.3. of 2005 compared to similar surveys in the US: When asked whether nanotechnology will improve our way of life, 50% of the US sample agreed against only 29% of Europeans. The authors suggest that “people in the US assimilate nanotechnology within a set of protechnology cultural values” and are thus more positive about science and technology generally. By contrast, in Europe there is “more concern about the impact of technology on the environment, less commitment to economic progress and less confidence in regulation” (Gaskell u. a. 2006:81)

Or the NEG report summarising the findings of the key UK activities is suggesting that there are three key areas which are consistently raised by lay publics deliberating nanotechnology: “First, public attitudes are formed not only in relation to particular technologies, but also to the policies and values that shape the direction of technological

development, and to the social and political conditions in which they emerge. Second, perceptions of risks are thus mediated by public perceptions of those institutions charged with oversight – their honesty, independence, competence and so on – all of which influenced people's reception of current claims. And, thirdly, there was a consistent demand for more open discussion and public involvement in policymaking relating to the management of nanotechnology policy, invoking the sense that such matters were too important to be left to 'experts' but needed instead to become part of public discourse and civic life" (Davies, M. Kearnes, und P. Macnaghten 2008:4).

The final reports of National Citizens' Technology Forum 2008 show common themes: the call for regulation, the need for a new and dedicated policy commission, concerns over access and equity, the need to prioritise remediation over enhancement, and the requirement for wise and judicious oversight (Davies u. a. 2008:6)

It has also been carried out that technology itself is often less the source of concern than is its indirect consequences for society (Macoubrie 2006:235).

The Main issues worked out by the UK deliberative citizen panel were: Participants were very excited about the potential that nanotechnologies offer, but wanted to balance the potential benefits against the potential risks. The range of applications should balance caution with innovation, safety, environmental issues, cost, power and ownership (Opinionleader 2007:11).

Davies et all see a remarkable consistency across different studies: we find optimism – particularly about the social benefits of new technology – mingled with concern, particularly around the motivations and trustworthiness of those driving the technology, and combined with a desire for increased openness, information, and public deliberation (Davies u. a. 2008:7).

Based on such findings Macoubrie suggests that nanoscientists could "take heart from the interest clearly present on the part of the public, evident in the finding that while concerns are expressed, benefits are still expected to exceed risk.(Macoubrie 2006:236).

What about youth and adolescent?

The recent Eurobarometer Flash Survey on Young people and science including nanotechnology, revealed young people's knowledge and expectations about nanotechnologies: Concerning knowledge: "One-third of young people (34%) were not aware of innovations related to nanotechnology. Among the respondents who had heard or read about innovations in this field, almost equal proportions were either interested (33%) or not interested (28%). (Eurobarometer Flash Survey 2009:28). And concerning attitudes: "Young EU citizens found it more difficult to assess the balance of risks and benefits in the case of innovations in the field of nanotechnology: a quarter (27%) gave a "don't know" response. Furthermore, while 44% of respondents thought there were more benefits than risks in such innovation, 19% thought that the benefits and risks would be equal and only 11% thought that the risks would overshadow the benefits. In other words, among the respondents who gave their opinion, the proportion of respondents who thought there would

be more benefits than risks was significantly larger than the proportion who thought the opposite. (Eurobarometer Flash Survey 2009:34).
Finally, concerning gender and interest, "Young men showed a higher level of interest in innovations in the fields of *computer and video surveillance techniques*, *nuclear energy* and *nanotechnology*. However, while young women were frequently not aware or aware but not interested, in innovations in these fields, (Eurobarometer Flash Survey 2009:33).
So, knowledge and interest, but also negative expectations are still on a low level.

It has now become very clear that even though awareness of nanotechnology is very low, awareness and understanding of the science and technology behind new technologies is relatively unimportant in public perception and opinion-forming. "What is of primary importance to the individual is the possible impact of a technology on their own life and on those of their close relatives and friends", so the findings of the Bioraise-team. "The tendency is to overemphasise risks when benefits are not clear, and underestimate or accept risks if the product is available on the market and significant personal benefit is experienced from its use. Otherwise their interest in science and technology is largely as spectacle, entertainment or controversy. (nanoBio-RAISE o. J.)

Bos et al. have studied the early involvement of adolescents in emerging technology discussions. They based their work on the psychological concept of the "first impression bias" – meaning that an opinion will be difficult to change, once it is built. According to that, first impressions of emerging technologies may be very strong in attitude formation. (Bos, Koolstra, und Willems 2009:244). Additionally, whereas adults may base attitudes on pre-existing knowledge and previous experiences, adolescents may be expected to have less well established frames of reference. In their study they wanted to find out about attitudes of young people before they got information of the new technology. Their findings suggest that adolescents are generally positive toward the technology "when confronted with it via 'unframed' and 'objective' information at least as judged by experts (Bos u. a. 2009:250f). Their findings are congruent with studies that showed that people who receive neutral information tend to be more optimistic and positive toward an emerging technology than the uninformed ones (Scheufele und Lewenstein 2005).

Seemingly, decisive for science assessments are predominantly cultural values. For instance in the US, recent articles in the educational literature have revealed that student positions on socio-scientific issues are determined by their ethical assumptions, not by their understanding of "methods of inquiry" or of the nature of science in general.(Turner 2008:64). (Macnaghten, Kearnes und Wynne 2005)

OUTLOOK

Since its first visionary outline by Eric Drexler in 1986, nanotechnologies are expected to radically change our world. With this emerging technologies we are creating solutions for a future which is no longer embedded in our present (minds) and cannot be judged by today's' moral principles and knowledge. Therefore Adam and Groves recommend scholars and practitioners "who have come to recognize the global effects of the elimination of embodied futures from the frame of reference"(Adam und Groves 2007:14) to shift perspective and focus. For them it is to "understand processes and events in the wider scheme of things, to recognise connections and implications, to appreciate things in their continuity and emergence". Therefore they call for historical perceptiveness and a trans-disciplinary approach.

This approach includes the public in the discourse and in decision making processes, but also looks at wider contexts in which developments could have an impact. The task is not about knowing the future and of course not pretending to do so, but "rather about aiding individual and social endeavours to choose wisely from a spectrum of options and preferences with their associated potential effects" (Adam und Groves 2007:34).

Another aspect of an expected future is an understanding of where our common future should lie or how it should look like. As for the case of nanotechnology there does not yet exist a "clearly articulated vision what nanotechnology can deliver (Nanologue 2006b:55), so a scientific and societal dialogue about it is outstanding. Such a dialogue "should address the central question of where the technology is heading and relate it to accepted and shared societal goals" Adams and Grove advise for understanding ourselves "not as objective observers and voyeurs" of an upcoming future, but "as implicated participants, inescapably responsible for that future in the making" (Adam und Groves 2007:15). This means not only to deal with expected results or technical solutions from which we might benefit, but to consider the wider societal impact in an anticipated future from a present point of view. Or as Berne and Schummer suggested, for education activities of future nanotechnologists, they "should enter an imaginative process to free them from the constraints of pure technical problem solving efforts and to allow for more reflection of the ethical dimensions of the emerging nanotechnology age" (Berne und Schummer 2005:67).

3 SURVEY

3.1 INSTRUMENTS

As described in Deliverable 1.1, four different sources of information contribute to the overall results:

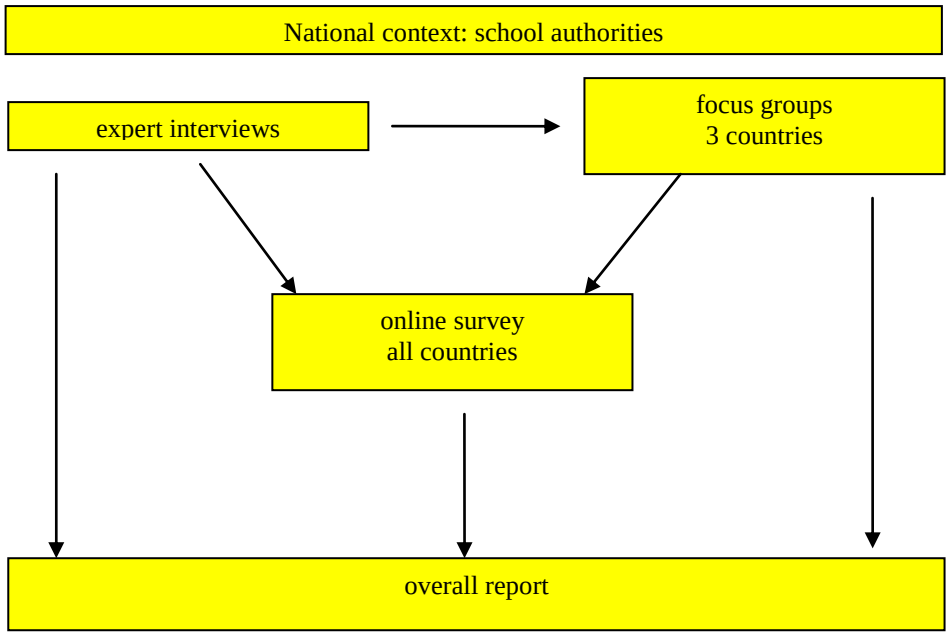


Figure 1: Research design

The national context report should give an overview if and how nanotechnology is part of school curricula. This information is necessary to frame young people's knowledge and interest in nanotechnology.

Expert interviews and focus groups provided qualitative information that was used to develop the questionnaire for the online survey but are results that stand for themselves, because they give information, that cannot be concluded from quantitative data, e.g. how young people discuss the matter of nanotechnology among themselves, what words they use, what emotions they show.

The online survey that was conducted in all countries shall give us information about young people's knowledge and attitudes. The online survey is not representative, therefore the quantitative information does not allow us to make conclusions about the population of young Europeans.

Although we set standards in developing the questionnaire (e.g. in translation) to make questions comparable between countries, comparison will not be possible due to different distribution strategies and therefore different sample structures.

3.2 DESCRIPTION OF SAMPLES

3.2.1 Focus groups

Tabular overview 2: Recruiting strategies

Focus group no.	Country	Recruiting strategy	Incentive	Location	Describe Participants
1	UK	Invitation sent by email to local School science teacher who responded yes. Teacher selected participants. Follow up phone calls.	No	Took place at School – Netherhall School, Cambridge.	13 year olds 2 males and 2 females. No particular interest in science.
2	UK	Invitation sent by email to local School science teacher who responded yes. Teacher selected participants. Follow up phone calls.	No	Took place at School – Bottisham Village College, just outside Cambridge.	15-16 year olds 2 males and 2 females. No particular interest in science.
3	Austria	School class came with their teacher to the fair, ten participated voluntarily	no	Exe 09 Wels[5]	Only males, between 17 and 20, students higher technical vocational college
4	Austria	School class came with their teacher to the fair, ten participated voluntarily	no	Exe 09 Wels	Only females, between 11 and 13
5	Austria	Invitation via mailing list of youths science club Vienna – participants answered by themselves	Movie-coupon	Invitation to ZSI office	4 females between 12 and 14
6	Austria	Invitation via mailing list of youths science club Vienna – participants answered by themselves	Movie-coupon	Invitation to ZSI office	4 males between 12 and 14
7	Austria	Personal contact[6]	no	Invitation to ZSI office	Male, 22 years
8	Austria	Personal contact	no	Invitation to ZSI office	Female, 20 years

Participants got some information material about nanotechnologies after the discussions for further studies.

In the run-up to the online survey six focus group sessions were held in order to explore the diversity of views and experiences that young people have about Nanotechnologies. Focus groups were conducted in Austria and the UK. Due to financial restrictions, the recruitment of participants was conducted in a **non-random** way. In total there were 6 focus group discussion held. 18 boys and 19 girls took part in the focus group discussions. All of them were receiving some sort of schooling. Besides the focus group discussion, two individual interviews were conducted with a 20 year old woman who studies Social Sciences at the University in Vienna and a 22 year old man who studies Architecture in Vienna. Due to summer break holidays it was not possible to find participants for a focus group discussion. This is the reason why we did these two individual interviews but the same guideline as in the focus group discussions was applied for the individual interviews.

[5] See attached invitation flyers in the appendix
[6] Invitation letters were sent to mailing list of student union of food and biotechnology Vienna university for applied life sciences science-center network list and via student union physic faculty university of Vienna- Due to summer holidays there was no response

The first two focus group discussions were held directly at a scientific event for pupils in Upper Austria, a province of Austria. The event, called '*experimentale* 09', was an interactive event where pupils from all over Austria had the possibility to present their scientific experiments and exchange knowledge (http://www.nawi4you.at/). The focus group participants (pupils) were recruited via flyer and with the support of their teachers. Teachers were asked whether their pupils have time and interest to participate a focus group. Finally, two focus group sessions were conducted at the '*experiment*ale 09'. The participants of the first focus group were all males between the ages of 17 and 20. All of them were attending the same school type and level, in other words they attended a HTL in Upper Austria, which is an Austrian school type with focus on technical education and engineering. In the second focus group discussion there were 11 girls joining. All of them were between 12 and 13 years old and they attended a secondary modern school in Upper Austria.

The third and fourth focus group discussion was conducted at the Centre for Social Innovation in Vienna. The participants were recruited via an invitation letter sent to the youth 'Science Club' in Vienna. All participants answered by themselves. The participants of the third focus group were all females between the age of 12 and 14 and all of them attending different grammar schools in Vienna. The fourth focus group discussion consisted of only male participants from 12 to 15 years. All of them were attending different grammar schools in Vienna.

The fifth and sixth focus group discussion was conducted in Cambridge, UK. Invitations sent by email to local school science teacher. Teachers from two different schools reacted to the invitation and selected participants for the discussion. One of the focus group discussions in the UK was conducted at Netherhall School in Cambridge with two boys and two girls, who all were 13 years old.

The other focus group discussion was at Bottisham Village College in Cambridge. Two male and two female teenagers between 15 and 16 years from this College participated.

An information fact sheet for parents of the participating children and teenagers was distributed to make the content and aims of the research project and the focus groups transparent, especially when it comes to participants younger than 18 years old. As you can see most of the 6 focus group were quite homogenous in terms of the age of the participants. Besides the same age group almost all focus groups consisted of either all male or all female participants, which were intended by the interviewers. Distinguishing the groups by gender seemed to be convenient in order to create a relaxed atmosphere. In retrospect it was a good choice, especially when thinking about the statement made by the girl in the second focus group discussion. She said that she would like to know more about NT but not in school because she fears that some male classmates would laugh if she did not understand something (FG female 12-13). The focus group discussions, as a tool of the qualitative research, were designed to examine the discourse of young people, to help to ask the right questions within the online survey started in the beginning of October 2009.

3.2.2 Expert interviews

For the qualitative survey (together with the UCAM team) we carried out 15 expert interviews in Austria, the UK, Spain, France, and Denmark.

Interviews with 15 experts were conducted, two thirds of which were men and one third of which were women. One of the female experts was doing her PhD on nanotechnologies at the time. Most other experts were teaching either Chemistry, Physics or both in secondary schools, one of them was also an employee of the "Netzwerk der

Naturwissenschaften“ (network of natural sciences) in Austria and head of the “Fachdidaktikzentrum der Naturwissenschaften“ (centre of technical didactics in natural sciences). One expert was a professor teaching the subject Nanotechnology at the university level and head of the Nano-Science Centre of this university. Another one of the experts was a state superintendent of schools in Austria in charge of the natural scientific subjects of all secondary schools in the area. Representatives of sciences centres in the UK, France, and Spain were interviewed as well. Last but not least a specialist in science communication to youth in Austria participated in an interview.

3.2.3 National context survey

To help framing the information and data that collected brief national context reports giving information about the position of nanotechnologies within the national school curricula a short questionnaire was sent to experts in school authorities (ministries etc.), who are responsible or have broad knowledge about the curricula. The questions were asked personally or by using a written questionnaire via email or doc. file.
Consortium partners on the spot helped to contact representatives in Austria, France, Romania, Spain, and the UK.

3.2.4 Online survey

Overview about development of the survey and time planning

- draft questionnaire ready for sending out to partners August 7th by ZSI
- feedback gathered from partners until: August 14th
- final questionnaire ready for translation: September 1st
- technical set up: September 10th, including a “pre-testing”
- Open online survey in eight languages: October 1st
- Consortium meeting Oct. 28th 2009: decision for extension of the online survey
- Survey closes at Nov. 30th

3.2.4.1 Development of the survey

Based upon results of focus groups, expert interviews and existing instruments for surveys dealing with nanotechnologies in this age group, a questionnaire for the online survey was developed.
As the Technology Readiness Index (Parasuraman, 2000) is an instrument designed for overall population it could not be simply adopted but served as source for some adapted items – to make them applicable for young people. Other important references were Eurobarometer (2005), Nanologue.net (2006) and the survey instrument developed for pupils’ attitudes toward technology PATT (deVries et al, 1988).
A first paper-and-pencil draft of the questionnaire was distributed among research partners for feedback and comments and then adapted. Discussion was very fruitful, especially because feedback was given by persons from different backgrounds and disciplines. Selection of “good” examples to illustrate nanotechnology applications proved to be most

difficult, but in the end research partners agreed on four examples that cover the relevant fields of energy & environment, medicine and ICT and at the same time fit in young people's everyday life.
It was decided to develop two questionnaires, a more simplified one for younger participants and a longer one that included more and more complicated questions for the older ones. As participants had to give information about their age group at the very beginning of the survey, they could be directed to the appropriate version of the questionnaire.
The questionnaire included the following parts:

- Interest in technologies (compared to other spheres)
- General attitudes towards technologies
- Knowledge about nanotechnologies
- Opinions on examples of products (jacket, sunglasses, lab-on-a-chip, socks)
- Opinions on nanotechnologies (only 15plus)
- Curiosity about nanotechnology (more information, possible educational or career goals)
- Background variables (as far as possible standardised, like ISCED classification of education etc.)

The questionnaire is included in this deliverable in the appendix.
Knowledge about nanotechnology was tested in kind of a quiz, solutions were given at the end of the questionnaire. Additionally participants could get some extra information about nanotechnology in the selected fields (energy and environment, medicine, ICT) during the survey.

After transferring the questionnaire into an online survey tool, "beta-testing" was organised in Austria and the UK in order to check time to fill in, comprehensibility, clarity and phrasing. Participants of the different age groups were asked to fill in the questionnaire online and give their feedback and comments afterwards.

3.2.4.2 Recruitment and Advertising, Distribution strategies and Time Planning

Sample structures depend on distribution strategies. Each country had different ideas and strategies how to make people participate in the survey. To understand differences between samples we need to know how information was distributed and how people were motivated to participate in the survey, country by country.
As described in Deliverable 1.1, we planned a broad distribution strategy, on the one hand, more or less structured by multipliers, namely via teachers & school networks, science centres and universities, and on the other hand unstructured via PR activities and websites, personal contacts and so on.

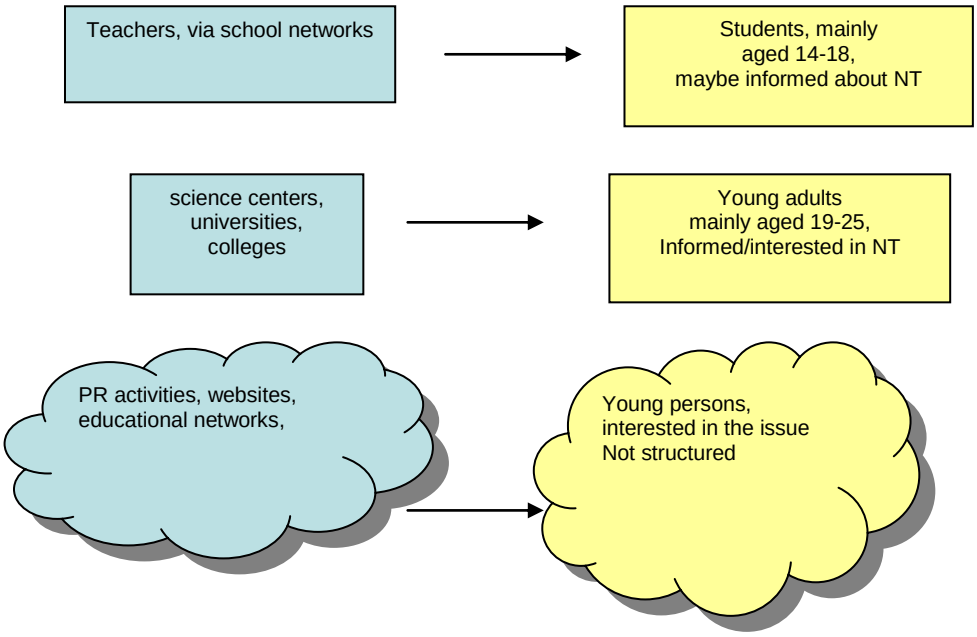


Figure 2: Distribution strategies

These strategies worked with different success in the different countries, on the whole, one can say that the main multipliers were interested teachers. We had problems addressing the youngest and the oldest age group.

The survey started on Oct 1st, 2009 and it was planned to keep it open for a month. Due to low participation rates, this time span was prolonged. Last participating schools finished the survey on Dec 4th, 2009. The prolongation was successful, as the total number was nearly doubled after Oct. 31st.

Reports from participants about advertising and distribution strategies

The questionnaire was open and not restricted to pre-defined participants. Therefore, basically, the promotion for the questionnaire happened via the NANOYOU portal and the distribution channels by EUN.
Because no extra budget was allocated to «specific advertisement activities», any announcement of the online questionnaire in the participating countries and beyond (for example Italy and Romania) was in the hands of the consortium partners.
For the countries that gained the most respondents the following activities were additionally undertaken (incomplete, exemplary):

Austria
School and education portals (www.eduhi.at), list servers of nano- or science communication initiatives (/www.science-center-net.at/index.htm), 2 press releases (www.e-teaching-austria.at), ZSI website and ZSI newsletter, SORA newsletter, (http://www.zsi.at/en/projekte/laufend/5206.html), contacting visits at youth and science communication/education events (Experimentale 09), conferences (Scicom09), online communities (facebook, www.fti-

remixed.at), direct mailing (school inspectors, teachers, head teachers), (natural science)teachers' networks (http://www.vcoe.or.at/), university departments (physics, chemistry, maths, applied life sciences), junior university, youth science club, youth organisations, e-twinning, ORF science, Ö1 children university, personal communication.

Spain

Participant 5 did mailings to their contacts which included 1072 people and they used their newsletter (which had around 30 subscribers by then as it was the first one) and highlighted the launch of the survey in the NANOYOU portal that has received the visits of 813 different visitors in September, 1832 in October and 1905 in November.

Italy

Participant 4 (who is Italian) had personal contacts to science teachers, the info was then passed on the word to some colleagues, just by mouth-to-mouth (and maybe emails).

Additionally:

Denmark

Participant 4 had put the info into iNANO Educational website, email sent by the outreach director of the faculty of science to the list of teachers the faculty has contact with ((1300 teachers, 16-19 years pupils) and middle school (200 teachers, 14-15 years pupils)with the description of the project (in Danish). Furthermore there was an email sent to the largest network of Danish teachers called SKOLEKOM (www.skolekom.emu.dk) with the description of the project (in Danish).

3.2.4.3 Sample structure before and after data cleaning

Coverage and sampling is challenging in self-administered surveys. The main problem of our online survey was that due to financial limitations we had to work without drawing a sample and could only publish the online survey and take efforts to make it known among young people in our target countries. The different distribution strategies described above are important because they make us understand what kind of participants we might expect in the survey.

Nevertheless, we have limited knowledge about what part of the population is represented, we can only describe some facts, e.g. distribution according to countries, gender, age groups, and according to the channel how participants were invited to join the survey.

It is common sense that surveys with low response rates represent those who are more interested in the issue (e.g. Dillman 2000, p.194ff). We will therefore assume that our sample is biased according to interest in nanotechnology, maybe even to knowledge on nanotechnology.

In this chapter we will describe the size and structure of the sample – we will use the term sample, although it is not a sample in a statistical meaning, but a group of participants, and make conclusions about what kind of results or knowledge can be supported by the data from the survey.

In total we had n=492 participants who joined the questionnaire for 11-14 year olds, as well as n= 1905 participants in the older age group but quite a number of participants dropped out after a few questions.

The decision to drop all participants that filled in 20 items or less was made in order to keep only participants with at least some answered questions in the data set. In other words: people with 20 valid answers or less were defined as "drop out" and were excluded from further analysis. When it comes to multiple response sets, we defined the whole response set as one missing or valid answer when computing the number of missing resp. valid answers.

Table 1: number of valid answers

	Participants in the survey for 11-14 year olds	Participants in the survey for 15-25 year olds
0 to 10 valid answers	111	245
11 to 20 valid answers	32	117
21 to 40 valid answers	60	286
41 and more valid answers	289	1.257
total	492	1.905

We observe rather high drop-outs after completing the quiz, but our threshold for missing values keeps participants that dropped out after the quiz as part of the sample. That is why we decide to keep all persons that completed the quiz in the sample, even if they had more than 20 missing values.

Table 2: Sample sizes before and after data cleaning

	Participants in the survey for 11-14 year olds	Participants in the survey for 15-25 year olds
Before data cleaning due to missing values	492	1.905
After data cleaning	371	1.604

Table 3: Sample sizes in age groups , after data cleaning

	total number
10 and younger	6
11-14	365
15-19	1.302
20-25	105
26 and older	197
total	1.975
after dropping n=6 aged 10 years and younger	1.969

The sample (after data cleaning) includes people outside the targeted age group. Within the cleared sample, we have 197 People aged 26 or older, and 6 people aged 10 or younger - these 6 persons were also dropped for the analysis.

It is evident that the survey covers the 20-25 year olds rather poorly. We will not be able to make separate analyses for 20-25 year olds, therefore we will merge this group with the 15-19 year olds.

As we do not want to lose the evidence gained from people aged 26 plus, we will keep them for the analysis but show results separately.

After dropping participants aged younger than 11 we have a data set with n=1.969 cases.

Table 4: Distribution according to countries and age group

country	11-14	15-19	20-25	26 and older	total
Austria	160	351	30	38	579
Belgium	4	3	0	1	8
Denmark	0	3	1	0	4
France	3	12	9	8	32
Great Britain	2	24	6	1	33
Israel	7	11	3	1	22
Spain	6	198	13	52	269
Bulgaria	1	1	0	0	2
Cyprus	6	1	1	1	9
Czech Republic	0	27	2	0	29
Estonia	1	0	0	0	1
Germany	13	20	5	5	43
Greece	3	20	0	1	24
Ireland	1	1	0	0	2
Italy	14	87	2	5	108
Latvia	2	5	0	1	8
Lithuania	1	8	0	1	10
Luxemburg	1	0	0	0	1
Malta	0	0	0	1	1
Netherlands	0	2	0	0	2
Poland	0	4	0	1	5
Portugal	4	5	0	0	9
Romania	39	123	1	4	167
Slovakia	1	5	0	0	6
Sweden	1	0	1	1	3
Other	10	51	3	4	68
not answered	85	340	28	71	524
total	365	1302	105	197	1969

The survey failed to cover all countries.

We will only analyse countries that have at least 100 cases, and within these countries age groups that cover at least 50 cases. 50 is a very small number for analysis, as confidence intervals become bigger and bigger with smaller samples (a maximum of plus/minus 9,8% for n=100), but as we have a non representative sample anyway, we have to use the results in an explorative context, just to gain ideas about the age group.

Sample sizes after data cleaning allow separate analyses for the following countries:

- Austria and Romania for both age groups (11-14, 15-25),
- Spain and Italy for the older age group only (15-25).

All other countries comprise the category "other countries" and will contributed to analyses of product examples, similarities and dissimilarities according to gender, education or other background variables.

Of course, the total number of completed interviews is crucial, but additionally it should be split via the channels, how participants were recruited for the survey to gain a better picture what kind of participants are represented in the sample (e.g.: Welker et al. 2005, p.250).

Table 5: Distribution according to channels

	total	% of valid answers
In class/a teacher directed me	1019	78
Friends	108	8
Link from another website	69	5
Science magazines	7	<1
Science or Kids' Museum	9	<1
Link from NANOYOU website	72	6
Don't know	30	2
total	1314	100
not answered	655	
	1969	

Teachers were the most important "distributors" of the survey. 78% of participants (who answered this question) participated in the survey because a teacher directed them doing so. The importance of teachers holds for gender, educational background and even age of participants.

8 percent got the information from friends, 11 percent came from a website (including the NANOYOU website).

We can conclude that participants highly represent pupils with teachers interested in the topic.

In terms of methods and data interpretation we have to consider that our sample is (at least partly) a clustered sample. Corrections for variances and other methodological difficulties can be more or less ignored in our case, as we will not treat the sample as a representative sample anyway.

Table 6: Distribution according to gender

	total	11-14	15-19	20-25	26 and older
female	696	148	431	47	70
male	756	132	536	32	56
Total valid	1452	280	967	79	126

There is nearly no gender gap in participation, but we will keep the gender aspect in mind during further analysis.

3.2.4.4 Summary – how can results be interpreted?

As the sample is not representative, we must not conclude from sample results to the population of young Europeans. But we can and will use results in an explorative sense:

We will get first ideas about some young people's knowledge and attitudes towards nanotechnologies, and the ones we are talking about, are the ones who are very likely to be the most interested, most informed ones or the ones who have the most interested and most informed teachers, friends or other reference persons who made them participate in the survey. This makes our participants kind of "pioneers" among the young Europeans. With some luck, they represent the opinion leaders or possible multiplicators for future nanotech-related information.

Our sample is not representative but can be used in an explorative sense!

Participation rates give us first conclusions for further work:

Teachers are our most important communicators.

It is rather difficult to reach the youngest target group.

4 RESULTS

The descriptions and analysis written in the following sections are based on the following empirical materials:

Tabular overview 3 : Empirical activities

Instrument	number	countries
Focus groups with young people	6 +2	Austria, UK
National context questionnaire	6	Austria, France, Romania, Spain, UK
Expert interviews	15	Austria, Denmark, France, Spain, UK
Expert focus group	1	Israel
Online survey	Oct 1 - Nov 30 2009 open to three age groups	In eight languages

4.1 FOCUS GROUPS

Content overview

- Knowledge about nanotechnologies
- Sources of knowledge (existing and desired)
  - School
- Associations, attitudes and opinions
- Interests and preferences
- ELSA (ethical, legal and social aspects)
  - Socks
  - GPS Jacket
  - Solar cell sunglasses
  - e-paper
  - Drug delivery

4.1.1 Knowledge about nanotechnologies

Before answering the question what young people know about Nanotechnology (NT), it is to point out that most of the young people are familiar with the term 'nanotechnologies'. However, the actual knowledge about NT is basically quite limited. Although a lot of the young people have a little idea about NT, they had difficulties to explain this complex issue. Some girls of the age group 11-14 never heard about the term NT before. None of the young people could give a definition of NT but most of them knew products made through NT. So, when discussing about the youth' knowledge about NT, it is actually a discussion about products which result from NT as the following quote shows: '*you do not actually talk about nanotechnologies but rather about products and their characteristics […] most people are not aware of that this is nanotechnology*' (FG male 17-20).

It must be emphasised that the focus group session with the oldest participants, the boys between 17-20 years old, knew the most products, especially products processed with the nano-sealing. Some of the participants said that the first time they heard about NT was in relation to nano-sealing and window panes (FG male 17-20). Nevertheless, participants from the younger age group (11-14 years) also knew some nano-products. Besides nano-sealing, which was mentioned often, they heard about clothes which were treated by NT, sun blockers, etc. However, it seems that the young people know, on the one hand, products, but one the other hand, it is difficult for them to understand the NT components of some products. Especially the youngest age group 11-14 could not understand what the NT components of specific products (e.g. socks with silver particles) were, independent from gender. This was also confirmed by other surveys, there is little knowledge about nanotechnologies, but at least some applications are known. So for instance young people know about self-cleaning surfaces, followed by medical and health applications according to a German/Swiss study the most. (Grobe 2007:16)

Although it seems that knowledge about NT is maybe related to the age of the young people or to their gender, it is a false conclusion. The social and school background or a general interest in technical issues of the young people is rather determining than the age or gender. A 20 year old participant, who studies social science, told us that she actually does not know anything about NT. In the focus group discussion we asked for school background of the participants but possible weaknesses of the online survey can be identified due to the fact that the school type was not inquired. Considering the social and educational background should not be neglected.

4.1.2 Sources of knowledge (existing and desired)

Generally, television, radio and internet are mostly used or would be used to get information about NT. Young people get information via television, radio, newspaper or a magazine because NT is occasionally a topic in the media. But it is a different situation with the internet. Young people do not come across NT issues in the internet coincidentally. The internet is used more consciously as a source of knowledge compared to the television, radio, newspapers, magazines, etc. One participant said that he prepared a presentation about NT in school and it was quite easy to get information on the internet, when targeted searching for (FG male 17-20). Another female participant remarked that the design of media (print and internet) is important to make young people curious about NT. The design should be more exciting to wake interest of the youth. Besides the desire for classical media as source of knowledge, exhibitions were stated also in order to get information about NT by some participants.

4.1.2.1 School:

Nanotechnology is mostly not an issue at school or rather any part in the curriculum. However, an integration of NT issues into the curriculum is explicitly demanded by the young participants. NT do not have to become an extra subject but the desire of the youngsters is to get at least some information on NT in any related subjects like Physics, Chemistry, etc. The reason why young people prefer to get information at school and from teachers is maybe due to the complexity of the NT issue. It prompts questions and ambiguities, which may be solved and cleared through discussion in school. In this context a female focus group participant, who was 12 years old, said that she would like to have more

information on NT but not in school because of the male classmates, who would laugh about her (FG female 12-13). Statements like this could contribute to a new discussion on co- and mono-education.
A 22 year old boy said that NT should be a topic in school in order to 'arouse interest'. He stated that if young people learn something about NT they have more options in future and may consider NT in their career choice (Int male 22).

4.1.3 Associations, attitudes and opinions

Connotations and associations to the term were, in some cases, on a general level and in some cases quite precise. The data gathered on connotations and associations about the term nanotechnologies showed different results according to the age group of the participants. The participants of the first focus group were pupils of a HTL in Austria, which is a school with focus on technical education. In this special case they were specialized in engineering. They were all between 17 and 20 years old. The data shows that they have a basic knowledge on nanotechnologies. The term 'nanotechnologies' was well known and they could associate spontaneously not only the mathematical formula 10-9 but also that it is about smallest particles, which is used in computer technology. And they knew products made with nanotechnologies, like coatings, etc. In contrast, a girl who is 20 years old and studies social science said that she has already heard the term NT but has no idea what it actually is. Most the female participants of the second focus group, who were between 12 and 13 years old, haven't ever heard of the term. Some could at least associate something with nanotechnologies. Two girls said that they think about *atoms* and *bacteria* when hear the term nanotechnologies. Some of them assumed that nanotechnologies have something to do with negative issues, like *diseases*, *mold* or *fungal infections*.

The girls from the third focus group were between 13 and 15 years and were all attendees of a grammar school. Their spontaneous connotation with the term nanotechnologies was that it must be something very small, has to do something with microchips and very small systems. The participants of the forth focus group were between 12 and 15 years old, all male and were all attending the grammar school and members of the science club in Vienna. Their connotation with nanotechnologies was more precise than general. They talked about *nano-motors*, the *CERN* in Geneva, *grid structures of atoms and molecules*, *chemistry*, etc. Another focus group session held in the UK showed that most of the male and female participants, who were between 13 and 15 years, had also very precise ideas connected to the term nanotechnologies, like '*the stuff that can solve cancer with the little robots…*' or '*…technology that might be able to do crazy things like control peoples' minds.*' (FG UK 13-15)

So, except of some young girls, who have never heard about the term nanotechnologies before, most of the young participants know the term and can allocate it to a '*world of small things*'.
None of the participants connoted the term with school, which confirms the statement made before that nanotechnologies are mostly no issue in school. When asking them what they associate with the term physics, they often mentioned school, teachers, etc. Nanotechnologies are mostly not communicated and discussed in school or neither a part of the curriculum, as young people said.

Young people's opinions and perceptions of development of NT are positive as well as negative. They assume that NTs have a great potential, especially in the medical branch and they think that the NT development basically steps in the right direction. They are even enthusiastic on the development of school curricula and think about an own NT subject in around 20 years. Besides these positive attitudes towards NT, they also mentioned some fears and threats. Limits should be set to guarantee that e.g. these technologies will not contribute to human cloning. Another doomsday scenario which young people often mentioned was that robots will get out of control and '*move and think independently like in the movie MATRIX*' (FG female 13-15). The fact that people become older and older because of medical improvements and development is critically assessed. Remarkable in this context is that the girls and young women mentioned more often concerns and fears than their male opposites. The fears were not only expressed towards environmental issues but also on health issues and on technical control over human beings. The boys and young men seem to have a more pragmatic approach. Instead of refer to the past and always cling to the past, people should be open-minded towards innovation and development. All things have negative and positive aspects and it is not possible to hinder technical development. Connected with the examples of the NT products, one boy said that '*...you just have to choose the positive things and do not get into the negative'* (Int male 22). In order to ensure development and minimise negative impacts and risks, young people think that more funds for research are very important and necessary.
Young people seem to reflect about the '*two sides'* of NT. They are critical minds but highlight also positive effects: '*Nanotechnology is a good thing, once all risks will be banned*' (FG male 12-15).

In terms of control authorities, young people mostly agree in their opinions. Control authorities and institutions were claimed. Their internationality and independence were emphasised by most of the young people. Governmental influence instead of private and economic interests behind control mechanism should be assured. Through the involvement of several control authorities young people want to guarantee misuse of power in order to achieve a non-hierarchical control mechanism. Besides control mechanism the aspect of labelling NT products was a topic. Young people want to have information about products which are manufactured by NT, especially in the medical sector where intervention in human bodies is performed and they want a voice and right to say where and how far developments on NT should go.
Although most of young people emphasised the importance of control mechanism there were a lot of concerns on its autonomy. Especially the boys and young men were very sceptical about the independence of control authorities and stated that the possibility on misuse and '*corruption*' (FG male 12-15) is high. Another male participant stated '*where power is, there's fraud*' (Int male 22).
However, few of the young people were against control due to the difficulties with independence. '*I think it is pointless, because first you need monitors, then you need monitors for the monitors, etc. and then it would just get ridiculous.*' (FG UK 13-15)

4.1.4 Interests and preferences

The young people took great interest in nanotechnology and its future development during the focus group sessions. In addition there is great interest in learning more about nanotechnologies. Even young people who have not heard anything or hardly anything about the term nanotechnologies showed interests in developments. Hence, it is to consider

raising young people's interests on nanotechnologies. As experienced during the focus group sessions, using practical examples fosters a discussion and helps the young people to connect the technology to their daily lives. A girl of a focus group brought in that it is important to foster girls in a certain way, because they are basically less encouraged in terms of technical issues than boys (FG female 13-15). This is a very crucial point. Strengthen young women's interest in technology and especially in nanotechnology may work by relating communication to their daily live issues. If there are gender specific interests you should be aware of it and try to find a way to integrate young women into the nanotechnology communication but avoiding to become gender stereotyped.

When asked the young people what they would invent if they were a nanotechnology scientist, a lot of them would invent products and devices in the field of medicine and ICT. Energy and environmental issues were also a topic, which a lot of the focus group participants stated their interest in. Especially clean and renewable energy like solar energy was mentioned often. In the field of ICT the wishes of the young participant were similar to the current development of technological devices in terms of their size – the smaller the better. Small nanotechnology devices, e.g. very small watches with calendar function, were often mentioned and assessed as very practical. But building very small devices is not always positive. '*...producing everything smaller does have advantages but especially for older people it is not always a positive development. For example the small mobile phones are not very functional anymore. It annoys you when everything becomes smaller and smaller until you are not able to read it anymore…*' (Int female 20).

For some young people nanotechnologies seem to fulfil the wish for every kind of product. Even nanotechnology inventions like '*to beam*' or '*a drug that can heal every disease*' were named by the participants. It seems that some young people set their hope in nanotechnologies, which may open infinite opportunities. However, young people are also sceptical as you can see in the next chapter about ethical, legal and social aspects (ELSA) of nanotechnology products.

4.1.5 ELSA (ethical, legal and social aspects)

We wanted to find out about their opinion on ethical, legal and social aspects by giving examples of several nanotechnology products. The description of some examples of NT products and applications should facilitate the young people's reflection about possible chances, risks, etc. It appeared as a successful part during the focus group sessions. The young people, independent from age and gender, had the ability to discuss ELSA by these product examples. Difficulties occurred especially at the targeted drug delivery example. The young people could mostly not understand the nanotechnology aspect behind. The example with the jacket with the GPS function was also not clear to everyone.

In the following you will find the results on each products concerning ELSA.

Socks

Given definition during the focus group discussion:
Silver nano-particles placed into socks eliminate the bacteria which cause smelly feet and fungal infections.

The attitudes towards the socks added with nano silver-particles are varying between positive and negative. A lot of the young people said it is a positive and useful product in general but have negative aspects in terms of (waste) disposal or not yet in sight long term damages. Many of the young people were sceptical and said that they would not want to wear them before long term testing declared their harmlessness. On this matter, a 14 year old boy said, he does not want to be abused as a '*human guinea pig*' before the producers can assure no harm (FG male 12-15). Another stated negative aspect of these socks was that these silver-particles may infiltrate into the human skin or the socks may get another character because of the treatment with silver particles (e.g. deflagrable).
Certainly the price is a crucial factor for young people. A 14 year old boy said that the additional charge of these socks, which he would expect, is not worth buying (FG male 12-15). Another one said that '*I would like to have them if they were cheap*' (FG UK 13-15).
Positive aspects stated by the young people were mostly concerning the useful aspects when for example doing sports. While some said that there might be environmental risks due to disposal, it was also stated that these socks have positive aspects for the environment because you do not need to wash them so often. That would reduce water consumption and have a positive impact on the environment.
It has to be pointed out that the fewest negative aspects were stated by the second focus group discussion with the girls between the age 12 and 13 and the third focus group with the girls between 13 and 15 years.
Another interesting statement was made by a two boys, who were 18 and 19 years old. Although they did not refuse to wear these socks totally, they said they would not want that their children would wear them.

GPS Jacket

Given definition during the focus group discussion:
A jacket that contains a global positioning system to enable locating people where they are.

In General, the opinion about the jacket is mostly negative. Topics like surveillance, total control, etc. are very important for young people. They do not want that other people constantly know where they are. One boy said that it seems that this jacket is '*one further step to a totally controlled society*' (FG male 17-20). These concerns were mentioned independent of the age and gender of the participants. Most of the young people said that they do not want to

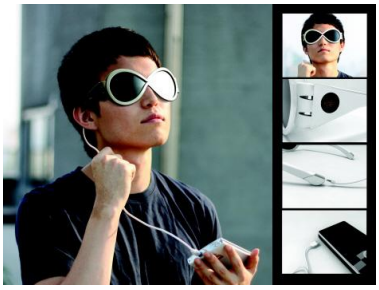
wear such a jacket and they would not even want that their children would wear such a jacket. So, negative aspects were mostly mentioned in the context of monitoring and control. Remarkable is that one young girl had concerns due to surveillance but not in terms of government control but rather that criminal people, e.g. '*a thief who pursuits you*', could locate her (FG female 12-13) and another girl said that the jacket would be helpful when '*you are kidnapped by terrorists in Egypt*' (FG female 13-15). This special fear may refer to the gender differences in the perception of public space. While the boys related their concerns to total surveillance of the government and police, these girls related their concerns to criminal behaviour.

The jacket was only assessed positively in terms of winter sports, hiking and extreme sports. A lot of the young people said that it is a useful product, when you do skiing or hiking. In case of avalanches or when you got lost, an easy detection through a jacket would be useful.

Another important fact is that some young people wish that it would be possible to '*turn off or on*' the GPS function of the jacket. They want to control the function of the jacket but if it is turned on all the time, they mostly dislike this product. One girl explicitly said that the jacket is '*actually a good thing and when you don't want to be detected you don't have to wear it*' (FG female 12-13).

Another remarkable aspect is that compared to the socks, the environmental aspect of the jacket does not seem to play that important a role.

Solar cell sunglasses



Given definition during focus group discussion:

The sunglass protects the eyes against UV-light. The lenses of the glasses have dye solar cells, collecting sun energy and convert it with a power jack at the back of the frame into power for small devices such as mobile and mp3 player.

The opinions about this product are very contrary. One the one hand the young people like this product and think it is a useful invention. Especially the environment factor was emphasised. This product can contribute to '*reduce electricity*' and '*saves the environment*' because you do '*not need batteries*' for your mp3 player anymore. Remarkable is that a lot of the young people said that this technology would be more useful when implementing on bigger surfaces like on a rucksack. Another issue was the UV protection. The attitude towards the sunglasses is quite positive as long as an UV protection is guaranteed.

The young people also expressed their concerns on possible radiation. They do not feel very comfortable when wearing such a product near the head or the eyes. Most of the girls from the second focus group said that they would not buy these even these would be affordable, because they fear possible health risks (FG female 12-13). In addition, the fear of burn was stated due to the fact that a device e.g. a charger could get quite hot. Another negative aspect which was mentioned was the cable which connects the glasses with the small device. It is considered as disturbing. This statement is quite interesting. It seems that such a new and innovative invention does not reconcile with an ordinary 'old fashioned' cable we know actually from walkman, mp3 player, etc. Less would probably say that the cable of earphones

of an mp3 player is disturbing but when thinking about the solar glasses it is disturbing. The expectations and demands towards new technologies and especially nanotechnologies seem to be very high.
Besides the possible health risks and functional demands, the design of the sunglasses is an important factor for young people. Some said that they maybe would buy it when the design would be more according to their taste. Finally the price is also an important factor for young people. If the sunglasses cost to much they won't buy these.

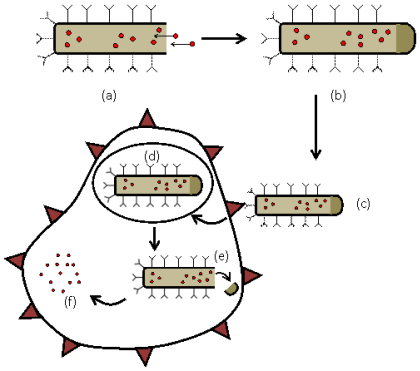
E-paper

Given definition during focus group discussion:
Displays that are light and thin and flexible allow reading from an electronic device like from paper.

Most of the young people have a positive attitude towards the e-paper. They emphasised the practical view which e-paper can have, e.g. space-saving because you do not need a lot of books anymore, no need for a huge amount of slip of papers, etc. The most often mentioned positive aspect was the environmental aspect of this product. Compared to LCD or Plasma screens the e-book is considered as less energy consuming. In addition the young people stated that the e-paper could contribute to the protection of the rainforest, because the paper production will decrease. A suggestion was to introduce it especially in schools in order to '*reduce paper waste*' (FG male 12-15) and to reduce the amount of school books. You won't need a book for every subject anymore. Another suggestion was to use the e-paper especially for daily newspapers, for private use as well as in coffee shops or restaurants, in order to reduce the huge amount of paper waste.
An important aspect, which should not be missing is the possibility of a search feature. Without a *search function* the e-paper wouldn't be so advantageous. Concerns were mentioned on possible health risks due to *radiation* of the screen or electricity, especially from the girl's side. The security vulnerability in terms of computer viruses was also a possible threat. In case of computer viruses the whole content on the e-paper would be '*destroyed within a couple of seconds*' (FG male 12-15), while it is not possible to destroy books in the same extent. The fact that you are not able to scribble notes on the e-paper like into ordinary books was stated as a disadvantageous aspect.

When asking the young people whether they would buy the e-paper, most said that it depends on the price. They actually would like to have it but thought that it is probably very expensive and they could not afford it.

Drug delivery



Given definition during focus group discussion:
A nano tube is stuffed with a drug that can be brought directly to the infected cell of the human body. The nano-tube enters the cell and delivers the drug.

The assessment of the drug delivery method through NT is very ambivalent. On the one hand young people think that it is basically a good medical improvement in order to heal serious diseases. Especially the target oriented operation is identified as very positive. On the other hand young people are very sceptical and reserved. Many concerns and fears in terms of possible side effects and accidentally destruction of healthy cells were expressed. A 14 year old girl said that she would be afraid that the medicine destroyed the wrong cells and it would '*make you more ill instead of healthier*' (FG female 13-15). The wrong cell in this context would mean that there is a fear that it could destroy the healthy instead of the diseased cells. Some also mentioned that they were afraid of misuse of this special medical treatment. One boy even mentioned that it could '*become a biological weapon*' (FG male 17-20). Compared to the socks or the jacket, this NT product has '*much worse dimensions in case of any dysfunction*' (FG female 13-15).
Another important aspect was that a lot of young people thought that it wouldn't be affordable for most of the people all over world, which may leads to '*social conflicts*' (FG male 12-15). The inequitable allocation in this context is an important topic for young people, independently of age or gender as our focus group discussions showed. In order to solve this problem there was the idea of an independent group of scientist who are working on this product without the claim for a patent and provide it to all. As you can see the fair allocation on this matter is a really important issue for young people. A focus group participant from the UK said '*It would be so unfair if it wasn't available to everyone*' (FG UK 13-15). And a 20 year old girl said that she basically has a positive and affirmative attitude towards medical improvement, but raises the question whether it has only positive aspects if people become older and older (Int female 20). Besides possible negative social aspects of this medical treatment, there are also thoughts about possible ethical aspects.

However, the opinions are various and in some instances young people said that they actually are afraid of it but would like to get treated when there is no other possibility. A young participant stated: '*I think it's a bit weird having something injected into you but if it helped I wouldn't care. I mean it's better than dying*' (FG UK 13-15).

Besides the different opinions about the drug delivery example, there were difficulties occurring

4.2 EXPERT INTERVIEWS

Content overview:

- Knowledge
- Attitudes
- Sources of knowledge
  - School
  - University
  - Extracurricular:
- Educational system debate
- Communication to the target group - Assumptions and difficulties
- Teaching materials and good practice examples
- Good practise, recommendations, examples of materials
- Campaigns and public debates
- Gender!

4.2.1 Knowledge

Young people do not have a lot of information on the topic of nanotechnology. This is especially the case for the age groups of 11- to 14-year-olds and 15- to 19-year olds. There is disagreement among the experts whether 20- to 25-year-olds having more knowledge about nanotechnology than the younger groups or not, some of them believe that they do. Young people's knowledge mainly depends on whether a certain person is interested in science and specifically looks for information on nanotechnology, whether he or she has teachers who discuss the topic in different school subjects or whether that person studies a related subject at university. Therefore having a basic knowledge on the issue of nanotechnology seems to be more of a “coincidence” (Exp 2) and strongly depends on the people they interact with. An expert from Denmark states: "Yes, I don't think it's as much an age issue as it is an interest issue. I think that's what it comes to because you can find 12-year-old students who know more about nanotechnology than 25-year-olds. It's based on interest".

If young people do know something about nanotechnology it generally involves certain nanotechnology products that are advertised in different media. These products include sunscreen and sprays for shoes or windows. There is mostly no deeper knowledge of nanotechnology or even an understanding of what the word "nano" means. It is difficult for teachers to increase the students' knowledge because they hear the word "nanotechnology" but do not ask any questions.

Concerning gender differences some experts believe that boys and men are often more interested in natural sciences than girls or women. One expert from the UK (6) says: "I would say, I think the boys would be more interested, they tend to be geekier and more into science than the girls.” Some think there is no gender gap in knowledge and interests at all, others believe that there is but ultimately nobody argues that male pupils actually have a much greater knowledge concerning technology in general or nanotechnology in particular. One expert from Denmark (10) reflects on the issue and states: “It's more accepted that men are interested. I find that most of the time the girls are a little scared of it, they

are scared of math and science. That can really stop them. But then, when we start to talk about it, it normally shows that they know equally as much about it as their fellow students. But I think this is a bigger issue that's based on how the society sees things and not really how we teach things."

Experts in Israel emphasise the importance of basic knowledge about nanotechnology in order to understand this abstract topic. Most young people have little knowledge in sciences for such an abstract field.
The estimation on gender differences in Israel is quite similar. While some experts and teachers think that there are no differences and they would never make any differences, others think that boys are more interested. One teacher suggested that the unbalanced stated interests towards nanotechnology and technology in general might be a social thing. Another Israeli teacher said that the Israeli education is basically aimed more at boys when it comes up to science and technology subjects. However interest in technology and ability do not necessarily correlate like another teacher told.
In order to raise girls and young women's' interest in technology a teacher said that girls are more interested when separated from the boys within classes.

4.2.2 Attitudes

Many young people use products without knowing that nanotechnologies were used in their production. Since their knowledge on the topic is very little and they do not understand what the word "nano" means they cannot consider the impacts on health or the environment. An expert from France (12) believes that young people's uncritical attitude towards nanotechnology can be explained by their little knowledge on topics in the area of technology which have been controversially discussed in the past. Many young people are more concerned with a certain product's design than with its function. Teachers try to raise the pupils' awareness by explaining possible risks which often makes them concerned about continuing to use these products. In addition, an expert from the UK (9) mentioned that young people were especially critical about any products that served the purpose of surveillance when informed about them. Apart from teachers who seem to be the main source of knowledge about disadvantages of nanotechnologies, the media can also play an important role in educating pupils about the possibility of risks concerning nanotechnologies. They also seem to take this information given by the media very seriously. Gender differences might exist concerning the attitudes towards nanotechnology. One teacher (1) explains that, in his experience, boys are more likely to ignore the risks of certain products whereas girls are a lot more careful. He believes that boys should be told about the worst-case scenario to sensitize them to the possibility of risks regarding nanotechnologies and that less drastic explanations will have the same effect on girls.

From the answers given by experts in the conducted interviews it can be concluded that young people's seemingly uncritical attitude regarding nanotechnology is caused by a lack of information on possible risks. When youths are informed about those they do show a lot of concern.

4.2.3 Sources of Knowledge

4.2.3.1 School:

Nanotechnology is not part of any school curricula, at least not as a specific topic. It can be regarded as part of the education on new technologies. Due to this fact it strongly depends on teachers whether nanotechnology is part of young people's education. Some interested and dedicated teachers discuss it others might not even have any knowledge on the topic themselves. An expert from Denmark (10) states: "It also really depends on if you have a very passionate teacher because I can see the children who come to the classes and if the teacher is very passionate you can see it in their interest and that they have a great knowledge, they can actually grasp what an atom is and they have an idea of what DNA is and that molecules can assemble into larger structures. And then you can have 14-year-olds who don't even know what atoms are." According to some experts, if nanotechnology is taught in school it is often not discussed in depth: "Science at the moment in the UK is taught in a very broad way. It is termed as 'science literacy'. It is supposed to give students a wide knowledge but not at a particularly deep level, it is often jokingly referred to as 'pub quiz level'" (7).

School subjects that could include information on nanotechnology are Physics and Chemistry, or other subjects of the natural sciences, and also technical subjects, especially in technical and vocational schools that offer subjects, such as engineering and electronics. Ethical issues could also be discussed in social subjects. In Spain a new subject that includes education on nanotechnology ("Science for citizens") was introduced in the school curricula. As also results of the online survey (see chapter 4.4.) will show subjects for teaching nanotechnologies will rather be found in sixth grade than in lower grades. Many more students of upper levels participated at the online survey. Teachers have more difficulties to integrate nanotechnologies in the lower levels. Science communication programmes often only start at the age of 14. Their primary task is not to teach, but to raise interest; therefore they work with elder students who already know better their interests. They don't believe that younger children would already be interested in the subject nanotechnologies (Exp 14).

Many teachers are concerned with the lack of information available on nanotechnology, especially concerning the risks of nanotechnology products. They treat this problem in different ways. Some of them think it makes teaching nanotechnology very difficult because they do not know what to tell the students, others tell their students that information on disadvantages of nanotechnology is scarce and discuss possible risks with their students and some only teach about technical aspects of nanotechnology leaving out any ethical aspects.

Nanotechnology is not specifically part of school textbooks in any of the countries. That is because "School text books are very curriculum specific" (7). Therefore, teachers who want to teach their students about nanotechnology have to use their own materials. Some teachers in Austria use materials from different websites (www.schule.at, www.eduhi.at) or the "Nano-Koffer", a case that includes general information, instructions and materials for nanotechnology experiments. Some of the experts did not know which materials on nanotechnology existed or if there were any materials available which could be used to teach young people about the topic.

4.2.3.2 University:

According to some experts, it is much more likely for young people to come across the subject of nanotechnology while attending university than while they are in school. Others believe that this is only true for certain subjects, such as Physics, Chemistry or Engineering. However, there seem to be other ways as well (8): "I heard about nanotechnologies because I was doing Political Science related to information and communication technologies and then this areas sort of came up and I thought: that´s my chance of doing an interesting PhD".

Other experts expect some "zealots" to promote the topic more and more. For him, "academic enthusiasts spreading the word 'will help that' nanotechnology gets its feet into the curriculum" (3).
One expert (12) mentioned that it was quite popular to study subjects related to nanotechnology in France. The situation in the UK seems to be different (8): "I think the main thing that would come up, if anything comes up related to education, is that we need UK students or high school, college students to do more science degrees. " An expert from Austria (2) also mentions that more university students with a science degree would be needed.

So it can be expected that even within the group of 20- to 25-year-olds who are doing a degree at university only a small proportion knows about nanotechnology. That is because in many countries only a small number of students choose to do a degree in the natural sciences.

4.2.3.3 Extra-curricular sources and activities:

Only few experts know about institutions apart from the public school system that could add to young people's knowledge about nanotechnology. In the UK there is a nanoscience centre that aims at getting children to talk about nanotechnology and the issues of it. In addition, there are science festivals held in the UK at which information on nanotechnology is given. An expert working in the UK says: "I really believe that whatever comes up in these festivals sort of trickles down into the education system. It's because these events are fantastic for making people open their eyes up for science. "
A university in Austria offered courses about nanotechnology for gifted young people, one science centre is being built in Austria and there are also nano-camps and internships for interested young people.
Young people's sources of knowledge concerning nanotechnology also include media, such as broadcast media (radio or television), internet-based media (e.g. youtube) or print media (magazines).

4.2.4 Educational System Debate

Teacher education:

Information on nanotechnology is not (yet) part of the initial education for teachers in most countries with one exception (8): "I would be surprised if whatever the Swedish science board published on nanotechnologies wasn't also aiming teachers. I think it probably was. And we do have a very rigid education for teachers in sciences. So, it's very likely that anyone graduating now would know about nanotechnologies as well, it's very likely."

There is more disagreement in the case of teachers' continuing development. Some experts say that there are already many courses for teachers on nanotechnology in Austria, others from the same country believe that there is very little information on nanotechnology in further education in this area. The same disagreement is noticeable in the UK. One expert (6) states: "I haven't seen it offered. I think teachers wouldn't think it was relevant because it is such a tiny part of what we teach, no pun intended. I think until it is part of the curriculum there would be no justification to fund such development."

Taken all answers together, there are more possibilities to get information on nanotechnology within continuing development for teachers now than a few years ago but it seems that teachers have to take a special interest in nanotechnology to even find out about the courses offered. Briefings for teachers targeting at preparing them for upcoming discussions within wider public debates are not watched or expected so far (1).

Reforms:

There do not seem to be any ongoing or planned reforms of schools' curricula concerning the inclusion of topics related to nanotechnology in any of the countries. But according to an increasing awareness, an increasing number of events and initiatives, like for example the nano-initiative in Austria (www.nanoinitiative.at) or the nano-community (http://www.generationinnovation.at/nano) are seen as indicators and starting points for future changes and reforms.

4.2.5 Communication to the target group - Assumptions and difficulties

The main aspect in communicating nanotechnologies to youth is teaching. Not only for teachers but also for experts in science centres, learning about NT is prevailing. How to make young people understand this abstract topic or which analogies to use to make these complex things more understandable are core issues. Clearly, a deficit oriented science communication model is predominant. One reason for that is that nanotechnologies are considered as being very new. So people cannot have an idea about them. Before discussing, they have to be provided with information; at least they have to get some briefing beforehand to know what to talk about. All mentioned communication activities usually start with an information session. Although experts are certain that young people (beginning with the age of ten years) are already able to understand, they believe that "and instruction, guidance and explanation" (Exp 12) is needed. But to tell people (not only young people in particular) about nanotechnologies is not easy. Experts face many difficulties in explaining and "translating" (Exp 12) the topic to young people.

The first and main difficulty when communicating NT is to make them understand the size. Because NT materials and applications are not visible, they are seen as being too abstract to understand. To imagine something at nanoscale, young people "have no idea" (Exp 13). It is "fundamentally the scale" that causes the biggest difficulties (Exp 7). The youngsters might know that NT is the world of atoms and molecules, but that does not really help to understand what that means. If something is not visible, too small for us to contemplate people will become suspicious (Exp 7). For this expert, a physics teacher, a clear understanding is a must, because "when people fail to understand

something they fall back on myth, this can be dangerous" (Exp 7) he said.

Although the prefix nano is mostly known and even related with tininess it is still difficult to comprehend. The youngsters often know that nano means "very, very little" (Exp 11), but they cannot say how little that is in fact. "With the children it's basically to grasp the concept of something being that small. Normally if I have the younger children I use a lot of time trying to get them to get an idea of what a nanometer is and why we are actually interested in stuff that goes on in a length scale like this. It's very different depending on what they know in advance" (Exp 10). And many do not know much in advance. An explanation is that NT is not part of their daily life and not part of their knowledge (Exp 11). Maybe they would know that there is NT around them or part of technologies or products they are actually using, but they would not understand why they should know about it. They are using their mobile phones without knowing how it works, why should they care about it? Pilot works with smaller groups are under testing these days to see, if they would be "active about nanotechnologies to do something to try to get some photographs and to do communication. Aare they going to be interested in or are they going to remain not concerned" (Exp 11) would results of these testing. (See more details about knowledge about nanotechnologies of young people in chapter 4.2.1.)

So one main further difficulty in communication nanotechnology to young people is interest: How to win young people's interest for nanotechnologies, and furthermore: How to keep it? The main related question is how to present, teach, and communicate NT to young people that it could be interesting for them? How to get their attention? (Exp 8) There are many examples of NT products that are already used in science communication activities (for example NT exhibitions in CSI and CCSTI). (See more examples in chapter 4.2.6). They can show effects of NT very good, like for example a light, but robust tennis racket, or a hydrophobic coat, but the examples can hardly explain the used technology behind. "It's easy to see the application but the young people do not understand why and how it works" (Exp 12). Other technologies like DNA analysis for example can be explained and demonstrated in hands on activities very easy, the technology and its impact can be made clear. For example in the Barcelona science park a playful 'murder quest' was used that would finally lead to identify the 'murder' by extracting his DNA. But that doesn't work similarly for nanotechnologies.

As another important difficulty, experts therefore mentioned expensive and elaborate equipment that is needed to give good examples of nanotechnology. Readymade demonstrations are hard to afford, like for instance the Nanokit from MIT for constructing a simple form of a scanning tunnelling microscope model costs 6.000 € (Exp 13). But practical and tangible applications are needed to make things clearer. For instance, young people are invited to take part in the production of solar cells: "And then as we make the solar cells we also try and give them a theoretical feeling of what's actually going on when they make these cells and why do they have to do things in the way that we have told them (Exp 10). It is important to give the young people a "wider idea" (Exp 10), especially for the older groups who mostly have a knowledge base but cannot put it into a wider context.

Related to interest is the factor of the understanding of its importance. Among so many developments and technological innovations why should nanotechnology be of special interest? It is impossible to know about everything, so young people often refuse to get known to certain issues (Exp 12). How are nanotechnologies represented to make more clear about their relevance is one related question. Some applications seem to be more evident and thus relevant, like for instance applications in electronics. But other less evident applications like for instance in cosmetics are rarely known. Nano particles used in sunscreens are not highlighted as "nano-sunscreen" or the like, so how should consumers know that they are using a high-tech nanotechnology product and thus get an idea about its relevance? (Exp 11) With the slightly older it is mostly to get them to see why this could actually have this influence in their daily life. (Exp 9)

This also brings ethical, legal and social aspects in the discussion. Young people first have to get an idea about the impact to discuss possible consequences, is a prevailing assumption. Some teachers refuse to discuss ELSA because they do not feel enough competent to give sufficient information about consequences, especially about risks. In general, materials available about nanotechnologies lack ethical, legal and social aspects. To inform the teachers about the technological aspects is dominant. The main idea is to show how nanotechnologies function on a chemical or physical basis. But especially for their work with the pupils teachers would need more information about ELSA and the societal impact of nanotechnologies. Most examples about nanotechnologies focus on applications, but not on effects and impact. Without being more knowledgeable, some teachers do not feel comfortable discussing ELSA with their students. As long as they do not have enough knowledge or there is no existence of proofed knowledge, they refuse to discuss the topic. They do neither want to be too enthusiastic, nor to fearful. A teacher's role is not to stand in front of the class, saying "be careful with this" (Exp 1) an expert said. Another expert limits discussions on direct impacts: "Most of the time I only speak to them about the consequences that they can relate to because I find that mostly they just see it like this: if they gain something that's good but they can't always see the big picture so it can be really difficult" (Exp 10). Therefore teachers and science mediators often stick to simple cause and effect examples and avoid discussions about wider environmental and societal impacts.

Experts who are more experienced in nanotechnologies than teachers do not share the same considerations. As long as they feel more comfortable about their knowledge they would have more trust that also children and youths would be able to understand pros and cons as long as they would get balanced information, for example about nano particles: "And the question then is you say, well, on one side you have a potential problem where they might cause cancer or diseases and on the other hand they are being used for a positive purpose, usually in a new material. So where do you draw the line, how do you put the balance between positive and negative? And I think that's an interesting debate and something that children seem to understand as well. The way they think is incredibly interesting and given a sensible level of information, they can have very effective discussions" (Exp 9). Of course the danger lies in claiming in either one direction, "so if you are going to give them a long talk about the dangers of Nanotechnology and then give them one example of something useful, you set their minds and that's it. And the converse is true if just giving them just a long list of all the great things which will happen in their lives because of Nano and say by the way some of these things might cause a few minor problems" (Exp 9). A "sensible level of information" is needed for effective discussions (Exp 9).

In Israel experts estimate also that nanotechnology as an abstract topic is challenging to communicate to young people. It is hard to demonstrate the miniaturising to young people and dealing with small sizes on nanoscale level. In order to understand the abstract topic, young people need to get demonstrations but as mentioned, it is difficult to demonstrate and comprehend the size. To minimize the difficulties of communicating nanotechnology it is crucial to tell the young people and students how it will affect their future and in what content could it contribute to their future. They need to know how it could change their lives.

4.2.6 Teaching materials and good practice examples

The experts in the interviews were asked to give good practise examples of communication activities and materials targeted especially to young people who they had heard of or with which they had already made good experiences. Generally, they mentioned some basic requirements for communication activities with young people:

A new technology like nanotechnology should make use of information and communication technologies in the first place. As 'digital natives' young people are used to make extensive use of new media, especially the internet. According to the experts' statement that gaining young people's interest for the topic is the key, nice colourful and hip graphics on cool websites could be used. "Anything gadgetry, mobile phones or computer stuff" (Exp 6) might help, especially for visualisation. The usage of DVDs and videos were mentioned as good examples as well. Because understanding size and dimensions of the nanoscale is so difficult, any visual explanations should be used. One of those examples is the German site: www.nanoreisen.de, which offers three different zooming in journeys down to a scale of 10^{-14} with many pictures and explanations. Equipped with suitcase and travel guide the participants are guided on a "fascinating tour" (Exp 4) for detecting and exploring the mysterious nanoworld. Info and material can also be downloaded in PDF format.

One further supporting aspect to attract young people's interest is to relate the topic to their own life as much as possible. As they are building up their identity they are very much interested in communicate about their own personal life. They consider issues very concrete and start thinking about their relevance, if they can directly relate to it. "So if you connect nanotechnologies to their way of life and their preferences then you'll be fine" (Exp 8).

As long as examples and analogies are sincere and do not follow stereotypes, especially concerning gender. Young people would recognise any intensions that are not really truthful. They will also expect teachers, guides or moderators to listen to their questions and fears. Listening to them and not considering their questions as stupid is a must. And they will have many questions as the experiences of the experts have shown already. Science communication especially with youth will never be a one way direction, but has to be open in both directions, too. "So one of the challenges would be to find people who are sensitive enough to communicate with youth" (Exp 8). Persons have to be careful about cultural differences as well.

One key factor in communicating nanotechnologies at schools is time. Materials and examples have to be suitable to be integrated in the lessons. Videos for instance should be short and precise ("3 – 4 minute sequences" – Exp 2). Role plays and games are appreciated but very time consuming. Furthermore, any playful design is rather seen as "too time consuming" (Exp 2) and therefore difficult to implement during classes. Half day or full day workshops might be implemented, but these activities need earlier planning activities and cannot be integrated in everyday life at school.

Examples and showcases

As mentioned above, good examples of nanotechnology applications are essential in communication activities to youth. Among expert interviews, of course exhibition makers and science centres do have a lot of experience. Their lessons learned could be a profound basis for developments of further materials, which could be used at schools as well.

Some small examples and products are rather easy to get, like for instance, carbon nano tubes in ultra light tennis rackets, nano-suncream, deodorants, identification chips or hydrophobic surfaces with which the lotus effect can be

shown. Silver nano particles in socks are also very easy to understand. This was confirmed by the experts out of their experiences, and with our results of focus group discussions and of the online questionnaire. (We have tested examples of nanotechnology products and used some of them for the online questionnaire. Please see detailed results in chapter 4.4.). One expert had the idea of using fine dust related with smoking to sensitise the youngsters and give an ideas about size and properties of nanoparticles.

More difficult to discuss are medicine and health related examples. Especially for the younger group, it is very difficult to grasp. The example of the lab on the chip offers several good discussions points, but still is extremely difficult to understand which nanotechnology lies behind. "And then you can talk to them about, well, what does that mean? How would you feel, if, you know, your, one of your little machines at home said that you were ill or said that something was not quite right or not normal. How would you respond to that? Do you think it is a good thing? You can ask children would they be happy for their medical health state to be constantly monitored, externally. And if you came to a job and somebody can look at their record, what their health has been like over the last ten years on an almost daily basis, how much alcohol they drink, whether they took drugs, how comfortable children would be with that? And it is quite interesting if you ask children that because most of them don't like it. So I think there is a lot of interesting debate about that" (Exp 9).

Heated gold nanoparticles in cancer treatments were mentioned as rather useful example by expert 10 (it will be tested during the role play dilemmas as well, see activities of WP 3), "but I don't really have a super example because there isn't that many examples of what's working".

Whereas the example of nano gold particles, already used in the Roman Empire to colour glass into red is mentioned frequently as being practicable.

The younger the target groups, the less they described examples seem to be suitable. The described examples "you can use from 15-18 years and up. I think it's quite difficult to have a pro/con discussion with the younger children. I can't think of a really good example" (Exp 10).

According to experts in Israel medical products are good examples to demonstrate the use of nanotechnologies. For example medical devices with cameras could be demonstrated to young people. As an Israeli expert said they need to know it can be used in the medical field. Communication products like cell phones are also good examples to demonstrate nanotechnology and draw young peoples' attention to it. Nevertheless there is a shortage of tools for demonstration as an expert in Israel stated.

Materials for use at school

In Austria experts mentioned a very good practice example, the "Nanokoffer", (nano-case). It was developed by the Tyrolean science teachers network (Initiative Imst). It is seen as fully equipped, so that is ready for use without any additional purchasing. It also contains a comprehensive script and a DVD which offers "very, very good explanations" (Exp 4, A). With some of its examples it is also critical against nanotechnologies, but predominantly it is meant to inform about the technology, not about impacts or risks. But still, it is rarely used at schools and not very well known. Initiatives like that often depend on the personal engagement and efforts of teachers. For lack of resources, good examples are often not maintained.

For the federal inspector of Upper Austria, any supporting material for teachers should not be distributed solely, but in combination with a vocational training for teachers. Those who attend the training should get the material afterwards for the use in their lessons. Otherwise such materials would be not handled properly and if the experiments don't work, the teacher would put it away and forget it again. A similar example, the so called "sex-suitcase" in Austria was distributed to all schools for sex education, but it was forgotten after a while and not used any more. There are several platforms on the internet, where materials are available for download, in Austria for example: www.schule.at or http://www.eduhi.at. But teachers have to look for materials by themselves.

Nanotechnology as a singular topic is not covered by textbooks so far (in UK and A), at least the teachers don't know about it. But often the topic is covered in, although it is not necessarily an individual book. (Exp 9, UK). Materials used are found by the teachers themselves via internet or they got them as accompanying scripts to courses and experimental kits, but materials are not available in form of conventional school books. This is seen as the reason why most of the teachers do not discuss the topic in their class. As long as the topic NT is not part of the books, it only depends on the teacher's interest, what the pupils will learn about the topic. As one expert puts it: Teachers would need "a nice simple explanation so you don't have to spend hours on the internet trying to find out about it. Some good resources and interesting facts and examples of applications the kids would be interested in .That would be really useful." (Exp 6, teacher).

For more convenient use, the Austrian agency science communication has recently released a compilation of teaching materials. The booklet (also available as PDF from http://www.generationinnovation.at/aktivitaeten/praktika/die-nanocommunity/nano-unterrichtsmaterialien.html) was reviewed by experts and offers a range of different materials, including description, availability and costs.

Playing "Decide" was also mentioned by experts as good examples, especially of those who are engaged in science communication activities. The game can be adopted for any topic. Expert 13 and the team are also updating and extending the sets of cards in their work with the youngsters. Especially ELSA will come up very soon during playing, and young people can often be attracted quite easily. Decide can be found among other good examples at the nanoyou portal.

In UK for instance, teachers can help make NT part of their subject by going on a so called "secondment scheme". (Exp 7). Teachers can get funded from organisations like the Institute of Physics or the Gatsby to have one day a week where they investigate a subject and put together work sheets and teaching materials for other teachers. It is also possible to have a scheme to get researchers into schools, a researcher in residence. St John's College at Cambridge run this scheme for example.

Other experts as well highlighted the possibility of lab visits with their students.

Teachers have already much experience in visiting genetic engineering labs and bio labs at universities. Compared to that it has to be considered that from universities, like for example the technical university of Vienna, classes with students without prior knowledge on the topic is very difficult to handle (Exp 15).

4.2.7 Campaign and public debates

Debates and campaigns in general

Asked for ongoing national technical debates in their country, experts often mention recent experiences with the GMO debate or even the nuclear energy debate. The debates vary in intensity and subject areas according to regional peculiarities and prominent events. For instance Prince Charles enhanced the debate about nanotechnology in the UK when he warned about the Grey Goo a few years ago. In Austria, a leading country for organic agriculture, the sensitivity about GMOs in agriculture is still active and as in other countries, too, the awareness concerning technological innovations and food is very high.

About nanotechnology there still does not exist a wide spread public debate and it is mostly ongoing among experts or with a specific interested public. Critics are often described by the experts as only being smaller groups and not being representative for the public opinion. For them, the question always is, how big are the groups and the public who are against NT or criticise it? On the other hand, experts share the opinion, that it would need a few critics to start with a public debate, and therefore they would expect more debate in the near future. Some would even hope for it, that like in former GMO or similar debates, some eco forerunners would contribute to initiate a wider debate: "..dass ich eigentlich davon ausgehe, dass gerade in diesem Grün- Biobereich oder irgendwo die Leute sich damit befassen anfangen müssten und dass ich da eigentlich hoffe, dass das passiert, weil ich glaub das ist eigentlich die Richtung, wo du davon ausgehen kannst dass einmal kritische Stimmen kommen“ – trans: I assume that in the green and organic realm people should start to get engaged, I rather hope that that would happen, because I think that is the direction, where critics should come from (Exp 4).

Or put in other words from an expert from UK: “There will be people who will be thinking about this and deciding what will happen. What tends to happen is that you get zealots in certain areas” (Exp 3).

For one expert (8) the debate is linked to the level of trust towards science and academia. A country like for instance Finland which seems to be very pro in innovation, considers a trustworthy academia and politics.

Congruently, experts would not see actual campaigns ongoing in their country. There are some initiatives, often private ones, but they would not call those campaigns. For instance the initiative “nano and me” in the UK which is run by a dedicated lady to bring technological knowledge to British housewives, was mentioned.

The situation in the UK

In the UK there are several public engagement exercises going on, like for example the nano dialogues, but a really wider debate, “no I would say not. I think some people would have an idea but there is no NT debate going on, no. I haven't heard of a discourse that joins NT with Education or science. It’s still not that well known, most people have no idea about it” (Exp 6). Or: “You do not hear that much about it” (Exp 7).

Among experts and other opinion leaders, for example research councils or government departments the debate is seen as being significant, although in the public realm the debate is not very strong. There were some significant studies done

into new technologies in the UK, often "that look for opportunities but also look for uncertainties. So it is not just a purely technical view, but a broader, a societal, ethical, environmental view, which is often thought" (Exp 9). Also the media covered nano related issues, but again, rather in technology minded papers or specific journals. But "unless so in the more popular newspapers because their relevance to the average person in the street is less" (Exp 9).
As already said before, a lot was reflected in the media, when Prince Charles, in 2004 warned about the grey goo, but later on the benefits were reported occasionally.

Nevertheless, more attention is paid on nanotechnology than on other technology, although there may not yet exist wide spread debates. There is "probably more public debate about that then a number of other new technologies" (Exp 9), so more sensitization seems to have taken place already. Also for policy makers: "Nano has such a precedence in the way the government look at Nano in an early stage and looked to those broader aspect" (Exp 9).

Public awareness and information predominantly happen related to consumer products. Some popular products are already known, at least people do have an idea about them through promotion activities in media. Within the topic, consumer products and medicine application receive a lot of attention. The closer it gets to the body the more people would be concerned, some experts think. "It concerns everyone" (Exp 8), therefore people are interested in it.
"The one that is most obvious and there is most press coverage about, is toxicity of free Nano particles. And I think people understand that actually. And you explained to people there are particles, which are so small you can't see them, they could be anywhere, could be in the air, could be on a surface that you touch, could be in a liquid that you drink, could be in food. And they might be beneficial but they might also be harmful and because they are so small, first of all they are difficult to find, and actually very difficult to understand how they interact with the body" (Exp 9).
Also politicians would be more concerned with nanotechnology. The topic would come more often, because it is seen related to two main aspects: One is the recurrently stated lack of students doing science and the second is the promissory character of the topic itself: "nanotechnology is a beautiful word if you could say it, you know, you've scored a point. So, but I don't know if it's gone any deeper in reflection" (Exp 8).

The situation in Austria:
Similar to the UK, "real" campaigns are not realised, although for teachers there are several new offers, including teacher's training and teaching materials. Concerted campaigns are expected to come. Or maybe those offers could already be parts of upcoming campaigns experts are wondering.

Like in the UK, the technology debate is often seen related with lack of offspring in technical and natural sciences. Given for example the situation in upper Austria, a traditional industrialised federal country, it suffers from scarcity of technicians and engineers. So science and policy tend to extend the topic to the public realm. They want to find out the reasons why less and less young people are interest in technology. Therefore they enhance the public technical debate (Exp 8).

But the wider public debate is only expected to be coming. Still the topic is "too far" (Exp 2) for the wider public. Furthermore there is not "enough hysteria" or to less "self named experts" that would act against it (Exp 2). As soon the

campaigns will start, they would be carried via the media and experts are afraid that then everything could be condemned, also the positive things, or those products "wo überhaupt nichts dagegen einzuwenden ist" (trans: where there won't be any objections to) (Exp 4).

These days existing products do have a good marketing, nano products are special, and "you should go for absolutely!" (Exp 4). Good marketing strategies support those attitudes. When talking about nano certain products would pop up, fascinating ones with new properties which are very attractive especially for young people. Only mentioning that something is new, or offers new possibilities would provoke wishes to have it.
But nano products offer indeed advantages which are seen very positive. Many customers get excited by coated self cleaning windows or robust surfaces. This is the reason why one expert believes that acceptance of nanotechnology would be introduced through consumer products (Exp 5). For consumers, experts fear that they cannot do otherwise than accept it on the long run. In general, information activities tend to be more pro, because of product information and advertisement for it.
Similar to the UK, the public is widely affected via products and not by a deeper discussion.
Among professional circles there is a discourse, also a rather critical one, but not in the public sphere.
To apply for grants seems to be more promising when relating the research to nanotechnology.

The situation in Spain:
In Spain there seem to be no public discussion about nanotechnologies at all. Other debates like abortion and euthanasia seem to be more relevant recently. As we already heard from other countries, there are small groups acting against it, but they are not taken very seriously so far.
In general there rather seems to be an undertone, "like nanotechnology is like electricity – no one should refuse it" (Exp 13).

The situation in France:
To speak about France in general seems to be impossible, because the case of Grenoble is a very different one. There is a controversial discussion ongoing with strong arguments from different groups. "In Grenoble you have a big centre of investigation about nanotechnology and there are a lot of discussions with the different protagonists with the politics and with the people" (Exp 12).
For the rest of France the debate seems to be not very loud, only a few articles with not much impact (Exp 11) on the wider public. For more specific public, like for instance industry workers who might be exposed to some dangers in production or other directly affected groups.
To follow such discussions, one has to have a certain interest and also watch certain media.
For a wider public the discussion is not held very deeply, in general the public would tend to agree on new technologies and its applications (Exp 12).
Mostly new technologies are related with information and communication technologies.
But there are also groups in France that are against technological innovations, like for instance computers at schools.

Experts do not really see a general tendencies, but different groups with different interests, but the public awareness is not very strong, just the opposite “it's very, very weak, very little” (Exp 11).
But also in France, experts believe that nanotechnologies could become a national debate as it was with GMO very soon.

The situation in Denmark:
Concerning the technical debate in general, there were some strong discussions some years ago about medical engineering and genetic modification, and lots of people feared that the same could happen with nanotechnologies, “a lot of people got really scared of it but it hasn't been that bad actually” (Exp 10) But there is a discussion ongoing, whereas not very controversially. Like in other countries, what most people know about nanotechnologies “is basically something you spray on your windows or you have socks that don't get dirty and so on” (Exp 10), not more. Those people or small groups who are afraid are considered as don’t know enough about it.
But things will change, because the government has planned “to put a lot of money into nanotechnology and they want that to be the next leading thing” (Exp 10). They put a lot of money in research, but also in education, science and infrastructure. Politics talk a lot about it on the news. “They really try to push Denmark as a country that should build a knowledge-based society”. So there is a discussion going on, not only related to nanotechnologies, but to new technologies in general.
The impact of it is not yet quite clear: “I think many people actually do science themselves a little detached from the whole thing because it can get very difficult to communicate it in a nice way. But there is a general discussion, yeah” (Exp 10).

The situation in Israel:
The estimations of Israeli experts concerning public debate differ. Some said that there is a public debate especially on medical and industry topics. One expert even said that there is a consensus in the medical field of nanotechnologies. Besides the medical field, which seems to be an important one in Israeli public, there is a public discussion on solar energy and on genetics. While some experts perceive a very positive debate on nanotechnologies others do not perceive any public debate on nanotechnologies. ‘Even after the recent Nobel Prize there was no discussion’ (Exp Israel).

According to another expert in Israel there is a wide discussion, with emphasis on creativity and education and training on nanotechnologies. The Israeli president is leading this discussion on public investments on this matter.

4.2.8 Gender

Concerning gender experts’ opinions are twofold: The ones who plead not to make any gender differences in communicating nanotechnologies, and others who suggest considering different interests related to gender.

As previously mentioned, tending to attract young people’s interest for nanotechnologies, experts suggest different

examples and topics that might interest rather girls or others that might rather interest boys. “Gender differences, well, I think with the interests, because girls and boys don't necessarily have the same interests, so, if you’re communicating nanotechnologies to a sports-fanatic kid, whatever gender, you might start off with a tennis ball or a tennis racket, right” (Exp 8). So some would suggest cosmetics for instance for females and car paints for boys. To find the line between good attractive showcases and enhancing existing stereotypes is surely not easy. Furthermore, young people would recognise too stereotyped approaches and would stop their collaboration immediately (Exp 8). But of course, differences in interest also occur in the same gender group.

Some of the experts also say that boys would have a different tolerance level. Their sensitization should start at different points. While girls seemingly tend to be more cautious, for boys the more “shocking scenarios” (Exp 1) would work, because of their higher tolerance level. Some experts confirm that boys would be more open to risks and more likely to agree on something new. They rather tend to try something new and have a look what is happening to them whereas girls would be careful to avoid any harm to their body (Exp 1).

Especially, interested girls are often seen “kind of nerdy” (Exp 10), because they do not really fit in typical pictures. Still, interest in science and technology is more related to males than to females. “I think that's related to the natural sciences in general. We do have an overweight of men. I just think that's society based. It's more accepted that men are interested. I find that most of the time the girls are a little scared of it, they are scared of math and science. That can really stop them. But then when we start to talk about it, it normally shows that they know equally as much about it as their fellow students but I think this is a bigger issue that's based in how the society sees things and not really how we teach things” (Exp 10). Often, girls are not aware that the topic could be of interest for them. A game like “nanoboy” (http://www.nanoboy.net/) featuring a male “hero to save the microcosmos” might not help to attract girls as well. Offers that also match female interests “would be a welcomed outcome of NANOYOU, but “it will definitely be a challenge especially if you catch girls who are not particularly interested in it. But I would really like to see that an effort were made in that perspective” (Exp 10).

Concerning gender, nanotechnology is seen almost in line with other technologies with of interested boys overweighing. Surveys of previous exhibitions and events about new technology show a gender gap in interest, and the NANOYOU online survey with a decreasing number of girls participating in the survey with increasing age seems to confirm it (see more details in chapter 4.4.).

To steer against such developments, some experts suggest to definitely ignoring any gender differences. They strictly reject the idea of assuming or expecting any gender differences that might occur while communicating to them. They want to start without any “prejudices” (Exp 2), and work with a very consciousness approach of equal treatment. For example in Austria, an expert believe that different treatments of girls and boys would start to early and enforce the different interests at an early stage, therefore he pleads for not making any differences (Exp 2).

Nevertheless, it is “reasonable to be aware. But I am not assuming there will be one, to set out assuming there could be is very different to setting out expecting one” (Exp 7). Other experts would prefer to prepare more detailed for gender gaps and offer special settings. (Girls of the youngest age group confirmed it during a focus group discussion). Joint events sometimes intimidate girls and prevent them from participating in the discussion. “Exactly, it’s a bit tricky because it would make the girls feel stupid and too scared to talk right. So, I think, if you’ve got a mediator, at least one mediator, a lot of weight is going to fall on that mediator’s shoulders in order to make everyone talk so it takes a degree of sensitivity to be able to address the right kind of questions everywhere” (Exp 8).

4.3 NATIONAL CONTEXT SURVEY

In order to investigate in a range of countries how the school/education system deals with the issue nanotechnologies in school curricula, the national context survey was conducted. It helped to consider differences as well as similarities between European countries.

In **Austria** nanotechnologies are not explicitly part in any curriculum but there is the possibility for interested teachers to include the issue into physics at last level of school. Nanotechnology relevant topics can also be involved into Chemistry and Biology subjects in senior classes. Threats and risks assessment of nanotechnology can also be a part of geography and economics. As described before there is an initiative called 'Nano-Koffer' which offers the possibility to work and experiment in the field of nanotechnologies in a very descriptive way to interest the teachers together with their pupils. However, it is not predefined in the curricula and is up to the teachers. Nanotechnology is not covered in pre-service/initial teacher education in Austria. Moreover, it is not covered through in-service/continuing professional development education.

The situation in **Spain** seems to be different because nanotechnologies are explicitly part of curricula. They are included into the subjects of science and technologies. For example the subject 'science for the contemporary world' which is about recognition of the contribution of new materials in the creation of new technology fields, deals with the issue of nanotechnology. In addition nanotechnologies (especially nanotubes) are included into Chemistry in high school or senior classes. Teachers have also the possibility to involve this issue into their subject even it is not a specific content of their subject. However, nanotechnologies are not covered through pre-service/initial teacher education in Spain. They are also not specifically part of in-service/continuing professional development education in Spain but there are specific measures (conferences, training sessions, etc.) in relation to this matter. External institutions have encouraged some spreading of action in Spain in co-operation with the education administration but there are no estimates of current changes in curriculum for fostering nanotechnologies as a topic in school.

The issue nanotechnology is only to a small part integrated into the curriculum in **France**. While it is no issue in elementary school, it is part of curriculum for pupils from 15 to 18 years. In Biology nanotechnologies can be a topic on the study of genetically modified organisms. In technical school nanotechnologies are mentioned little in the study micro-mechanisms. In physics and chemistry the words 'nanoscience' or 'nanotechnology' were not mentioned but the subjects could easily allow a connection to the nanoworld (e.g. atoms, molecules, etc.). At university M level nanoscience or nanotechnology can be studied within Physics (electronics and optics), Chemistry and Life Sciences.
The situation on pre-service and initial teacher education in France is differs. Every University has its own curriculum. Nanosciences and nanotechnology may be studied or not until the level L3.
Concerning teachers' in-service and continuing professional development education the different subjects covered by continuing education are chosen locally. Nanotechnologies may be tackled or not.

In France there is a debate about nanotechnologies and education nascent. Since 1995, the French Académie des Sciences has of the dealt with nanoscience. In the year 2000 and 2001 there were daily lectures about Science broadcasted on radio (e.g. manipulating atoms).

The situation on nanotechnologies in the school curriculum in **Romania** seems to be similar to the situation in Austria. Nanotechnologies are not explicitly part of the curriculum but there an individual possibility for teachers who would like to integrate them into school subjects. In Romania there are optional courses which can be decided by teachers. If a teacher chooses the optional course 'nanotechnology' the pupils can also decide whether they would like to attend. Depending on the student's grade, the optional courses are 1-2 hours per week at 5-8 grade or 3-4 hours per week in high school. Moreover, the Physics Faculty in Bucharest University has been integrating nanotechnologies during the master's degree.
Nanotechnologies are not covered through in-service/continuing professional development education in Romania and there are no training programmes or courses to qualify teachers in the area of nanotechnologies.

In the **United Kingdom** nanotechnology is not specifically referenced in the national curriculum programmes of study but it is referenced in the indicative content of the GCSE (General Certificate of Secondary Education) science criteria from which awarding bodies develop their specifications. It is up to these awarding bodies how much emphasis they place within their specifications. School in the UK must cover the national curriculum, but have the flexibility to include relevant and engaging contexts. Nanotechnologies could therefore be addressed. As the pre-service and initial teacher education in the UK is referenced in the GCSE science criteria, there may be some coverage of nanotechnologies but there are no training programmes or courses qualifying teachers in this area. Education policy on nanotechnology education could currently not be perceived.

In **Israel** the issue nanotechnology is basically not present at the educational/school system. There are some subjects on high school level e.g. biotechnology, chemistry or physics, where nanotechnology is sometimes an issue but it is not part of the curricula. It depends on the engagement, interest and commitment of the teachers whether they mention this topic in their subjects. However, nanotechnology is part of curricula on university level (e.g. Technion – Israel Institute of Technology)
In Israel nanotechnologies are not covered in pre- and initial teacher education and basically not covered through service/continuing professional development education. An expectation on continuing education services for teachers is the Weizmann Institute of Science.

4.4 ONLINE SURVEY

Results for four countries that covered more than a hundred participants will be shown country by country. Some questions (e.g. the products that illustrate nanotechnology applications) will be analysed for all countries together.

A complete set of tables is to be found in the appendix!

4.4.1 Austria

4.4.1.1 Who participated in the survey

In Austria, 160 young people aged 11 to 14 years and 381 15 to 25 year olds participated in the NANOYOU online survey. The findings of both age groups are separately described since differences with regard to age are expected.

The younger age group comprises of 45% 13 year olds, one third 14 year olds and 18% 12 year olds. The age group of the 15 to 25 year olds mainly are between 15 and 18 years old (87%). There are 54% of girls and 46% of boys in the sample of the 11 to 14 year olds. In the older age group however, the share of the young women is considerably lower (39%). The Austrian young people were mainly reached in class or by teachers. In the younger age group, almost all girls are reached in class or by teachers (96%) whereas only 79% of female participants aged 15 to 25 years were reached at schools. 85% of the boys were informed in class or by a teacher in each age group.

As a consequence of the recruitment strategies the sample predominantly comprises pupils and students who are mainly living with their parents. 91% of the 15 to 25 year olds are attending a school, 6% are studying at a university and 2% are working or unemployed.

40% of 11 to 14 year old respondents expect to reach a postgraduate level of education and a ninth wants to finish undergraduate or vocational training. 16% expect to achieve upper secondary education. The fact that one quarter of all participants between 11 and 14 years think that they will not obtain a higher than a lower secondary education suggests that they might not have developed career and educational prospects yet. About a half of the older survey participants from 15 to 25 years expect to achieve a postgraduate degree. One quarter wants to obtain a undergraduate or vocational training and 14% like to finish upper secondary education. Two out of five 11 to 14 year old Austrian respondents and one out of two of the older age group have at least one parent with an academic degree.

Table 7: Austrian subsample

	11-14	15-25
sex		
Girls	54	39
Boys	46	61
expected level of education		
Postgraduate	40	53
Undergraduate/vocational training	11	24
Upper secondary	16	14
Lower secondary	26	3
I do not expect to complete lower secondary	1	-
Don't know	7	6
channel to the NANOYOU survey		
In class/a teacher directed me	91	83
Friends	7	5
Link from another website	1	5
Science magazines	1	1
Science or Kids' Museum	1	1
Link from NANOYOU website	2	4
Don't know	3	3

Source: NANOYOU Online Survey 2009, in percent

Almost on half of the respondents of the younger age group live in rural areas. 17% live in small cities or towns and 36% in big cities or in the outskirts of big cities. The distribution of older interviewees differs as 64% live in urban areas (big cities or their outskirts). 12% live in small cities or towns and 24% in country villages.

4.4.1.2 Knowledge and interest - Quiz results & future expectations

More than one half of the 11 to 14 year old respondents have already heard about nanotechnologies. 26% had not learned of nanotechnologies before participating in the NANOYOU survey. The older respondents have heard of nanotechnologies more often (72%) than the younger. Yet, a fifth has not heard about nanotechnologies. About one half of the respondents in both age groups want to learn more about nanotechnologies. Compared to the other countries, a rather high share of the Austrian young people does not want more information: 39% of the 11 to 14 year olds and 38% of the 14 to 25 year olds.

There is a considerable gender gap in each age group. Girls have not heard about nanotechnologies as often as boys of the same age. Additionally, they do not wish to know more about nanotechnologies as often - though the difference in the older age group is not as pronounced as among the younger respondents. Girls are more frequently uncertain whether they want to learn more or not than boys. This suggests that there is some potential to arouse interest among girls.

Table 8**: Information about nanotechnologies**

	11 to 14 years*			15 to 25 years°		
Heard of nanotechnologies?	**yes**	**no**	**don't know**	**yes**	**no**	**don't know**
Girls	43	33	24	58	33	9
Boys	69	16	15	82	11	7
Learn more about nanotechnologies?	**yes**	**no**	**don't know**	**yes**	**no**	**don't know**
Girls	36	41	23	47	38	15
Boys	60	37	3	54	40	8

Source: NANOYOU Online Survey 2009, in percent, *n=160, °n=381

The most frequent source of information about nanotechnologies is education in school and at university. Moreover, the young respondents have often heard in television, movies and broadcasting about nanotechnologies. The internet is another important source for information in the age group between 15 to 25 years.

The NANOYOU survey participants prefer to learn more in the educational system, in TV, radio and movies as well as in the internet. In comparing the current channels of information and the ways the respondents want to acquire more knowledge some relevant differences occur: Considerably more respondents of both age groups wish to learn more at science centres and museums, at events and in seminars, courses and workshops than who have already heard there about nanotechnologies. They also want to get information in newspapers and magazines, even though the difference to current ways of information is less distinctive.

Table 9: **Sources of information**

	11-14 years		**15-25 years**	
	heard of*	**learn more****	**heard of°**	**learn more°°**
At school, university etc.	**74**	**73**	**63**	**75**
TV, movies, radio	**64**	**59**	**67**	**67**
Internet	37	**53**	**64**	**62**
Novels, fiction	15	14	27	18
Journals and non-fiction books	16	23	35	38
Newspapers, magazines	33	**44**	44	**53**
From parents or other adults	20	18	20	13
From brothers and sisters, peers	15	11	21	14
At science centres, museums, etc	22	**36**	34	**39**
Events	9	**33**	15	**29**
Seminars, courses, workshops	-	**27**	-	**36**
Don't know	7	6	3	6

Source: NANOYOU Online Survey 2009, in percent, *n= 86, **n=73, °n=275, °°n=194

The general interest in science and technology is high among the 15 to 25 year old respondents. Technology and science on average rank before all other fields of interest, like sports, arts and music etc. The 11 to 14 year old respondents are more moderately interested in technology, sports, arts and music and environment score higher on average. They are even less interested in science that ranks below society as well.

The interest in technology and science significantly varies with regard to gender. This finding points out the gender gap that pervades the results for the Austrian subsample that is already shaped early.[7] Significant differences in interest in technology and science are found among the 11 to 14 year old girls and boys. Among the 15 to 25 year olds, gender differences emerge in all fields expect politics.

[7] non-parametric test of means of two independent samples (Mann-Withney test)

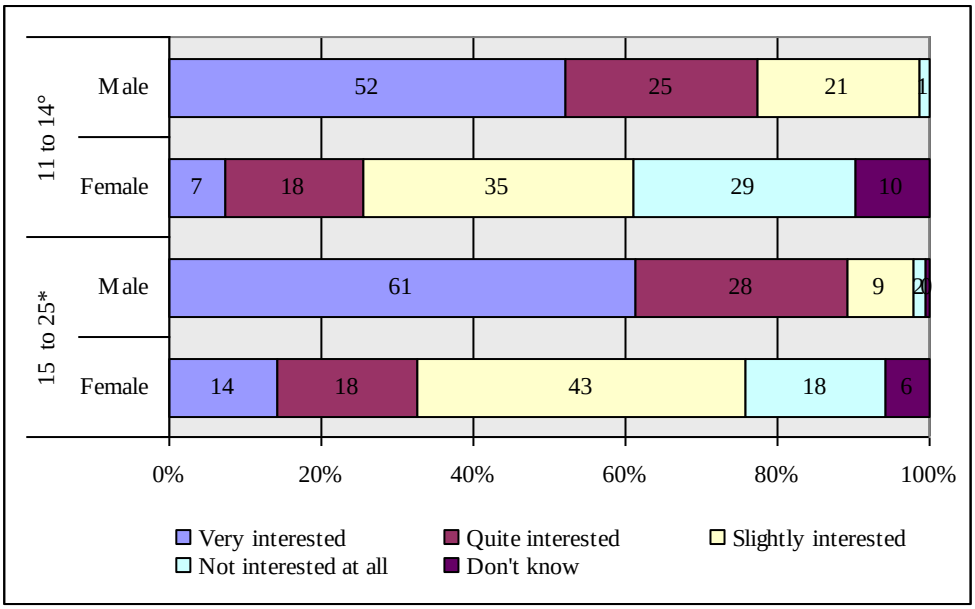


Figure 3: Interest in Technology

Source: NANOYOU Online Survey, in percent, *n=153, °n=371

Young people should be addressed to nanotechnologies differently because the fields of interests vary according to age and gender. Young girls and boys are likely to be interested in energy and environment issues. Girls of both age groups take an interest in medicine examples of nanotechnologies more often than boys. By contrast, boys appeal to information about ICT and especially boys at the age of 15 to 25 years could be reached by that topic. 15 to 25 year olds could be addressed with general information covering the fields of energy, medicine and ICT.

Table 10: Interesting fields of nanotechnologies

	11-14 years*		**15-25 years°**	
	female	**male**	**female**	**male**
Energy and environment	**28**	**23**	14	14
Medicine	**29**	13	**25**	7
Information and communication technologies (ICT)	13	**20**	9	**32**
All three fields	24	29	**40**	**37**
None of them	7	16	13	11

Source: NANOYOU Online Survey 2009, in percent, *n=128, °n=350

Interestingly there are not that big differences between boys and girls concerning educational and career goals as expected. About 70% of 11 to 14 year old boys and girls think that nanotechnologies are very complicated and too hard to study. Even if about one half of the 15 to 25 year olds still thinks that nanotechnologies are complicated to study about 35% of them are interested in studying nanotechnologies.

Internships in a laboratory are appreciated by both age groups similarly. Especially 11 to 14 year olds could be reached by summer camps during holidays. After all, boys are still more often interested in working in nanotechnologies than girls.

Knowledge

In the quiz the 11 to 14 year old respondents have an average score of 3.6 out of 7 correct answers. The 15 to 25 year olds were asked nine queries: They score 6.0 correct replies on average.

Boys of each age group know more about nanotechnologies than girls and score higher in the quiz.[8] 11- to 14 year old boys correctly answered on average 3.9 questions while girls of the same age positively reply 3.2 questions only. According to that, 11 to 14 year old girls more often do not know the answer and reply incorrectly in quiz. The data show a similar tendency among 15 to 25 year old girls (5.6 correct replies) and boys (6.1 correct replies) but the older girls do not give incorrect answers more frequently than boys; they more often respond "don't know".

The family background does not impact on the knowledge of the young people, who participated in the survey.

Table 11: Knowledge about nanotechnologies

	11-14 years*		**15-25 years°**	
number of true answers	**female**	**male**	**female**	**male**
0	3	-	2	1
1	8	4	-	-
2	27	12	7	4
3	27	32	7	4
4	14	16	13	8
5	11	14	14	17
6	8	18	20	25
7	3	4	19	24
8	-	-	14	14
9	-	-	5	3

Source: NANOYOU Online Survey 2009, in percent, *n=87, °n=276

4.4.1.3 Attitudes towards nanotechnologies

All in all, the respondents think of science and nanotechnologies as something good. The 15 to 25 year old girls and boys have more approving attitudes towards technology. They more frequently think that science and technology have brought about more benefits than disadvantages think than 11 to 14 year olds. They also more often suppose that science and technology should help solving problems of society.

Also, the young people of both age groups, who took part in the survey, predominantly think of nanotechnologies as something positive and progressive. 79% of the older age group supports the statement that nanotechnologies will improve our lives. The attitude towards nanotechnologies differs with regard to gender. In particular the rejection of nanotechnologies is rather high among girls at an age of 11 to 14 years (16%).

[8] Independent sample t-test

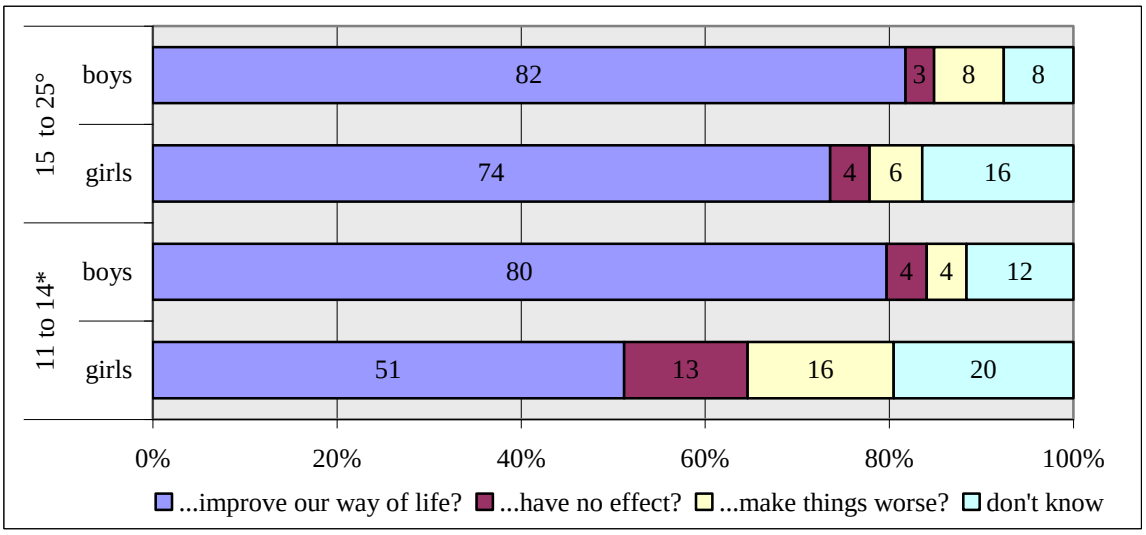


Figure 4: Will nanotechnologies…
Source: NANOYOU Online Survey 2009, *n=151, °n=365

The attitudes of the Austrian respondents towards science and technology are somewhat contradictory: Even though they overwhelmingly think that science and technology have brought more benefits than risks and that technology is safer than critics say they do not want society to depend too heavily on it. The older age group is optimistic about nanotechnologies and think that they are capable to solve resource scarcity and find new medical treatment of illnesses. Nevertheless 54% of the 15 to 25 year old respondents expect nanotechnologies to cause new health and environmental problems.

Yet more critique is expressed about privacy and wealth issues by the respondents. Three thirds of the 15 to 25 year olds are concerned that nanotechnologies might affect their privacy negatively. 65% think that only wealthy countries will benefit from progress of nanotechnology. The 15 to 25 year olds prefer strategic customer protection to handle insecurities regarding nanotechnologies.

4.4.2 Romania

4.4.2.1 Who participated in the survey

In Romania, 39 young people aged 11 to 14 and 124 young people aged between 15 and 25 years participated in the NANOYOU online survey. As the number of young respondents is small the explanatory power of the data is restricted, nevertheless results are discussed for each age group separately.

Girls and boys are equally represented in the age group of 11 to 14 year olds. The participation of 15 to 25 year old girls is considerably lower than that of male peers (32% female respondents). The majority of respondents were recruited at schools and by teachers in Romania. As a consequence 92% of the respondents of each age group are attending a school. 5% of the older age group (15 to 25 years) are studying at university and 2% are employed already. They respondents predominantly live with their parents (95%)

Among the 11 to 14 year olds 57% expect to achieve a postgraduate degree. 36% of the older age group wants to obtain a postgraduate level of education and 12% aspire to an undergraduate level. 41% expects to finish upper secondary education. Their parents' education is on a high level: At least one of the parents of two thirds of the 11 to 14 year olds

has got a university degree. The share among the older age group is similarly high (70%). It can be assumed that the sample is biased in favour of the well educated.

Table 12: Romanian subsample

	11-14	**15-25**
sex		
Girls	51	69
Boys	49	31
expected level of education		
Postgraduate	57	36
Undergraduate/vocational training	11	12
Upper secondary	9	41
Lower secondary	14	-
I do not expect to complete lower secondary	-	1
Don't know	9	11
channel to the NANOYOU survey		
In class/a teacher directed me	90	94
Friends	3	2
Link from another website	-	-
Science magazines	-	-
Science or Kids' Museum	3	-
Link from NANOYOU website	5	4
Don't know	-	-

Source: NANOYOU Online Survey 2009, in percent

Participants of the younger age group live mainly in small cities and towns (62%). 29% of this age group live in big cities and outskirts. The older respondents more frequently live in big cities and their outskirts (39%) and less often in small towns (33%). Another 29% of the 15 to 25 year olds live in rural areas.

4.4.2.2 Knowledge and interest - Quiz results & future expectations

About one half of 11 to 14 year old and 62% of the 15 to 25 year old respondents have already heard of nanotechnologies. Gender considerably influences the information about nanotechnologies: Boys of each age group have heard of nanotechnologies more often than girls. Only 53% of the 15 to 25 year old girls but 82% of boys at that age have heard of nanotechnologies yet. In contrast, the girls are as interested to learn more about nanotechnologies as boys are. In the older age group, three quarters of the girls want to know more about nanotechnologies. This pattern of highly interested girls pervades the Romanian data.

Table 13: Information about nanotechnologies

	11 to 14 years*			**15 to 25 years°**		
Heard of nanotechnologies?	**yes**	**no**	**don't know**	**yes**	**no**	**don't know**
Girls	30	65	5	53	35	12
Boys	74	21	5	82	5	13
Learn more about nanotechnologies?	**yes**	**no**	**don't know**	**yes**	**no**	**don't know**
Girls	85	10	5	75	14	11
Boys	84	11	5	67	28	5

Source: NANOYOU Online Survey 2009, in percent, *n=39, °n=124

Especially the internet plays a big role in raising the awareness among the respondents in Romania as the internet is the main sources of information about nanotechnologies. Apart from that broadcasting and movies and the educational system (e.g. school, university) provides information about nanotechnologies. 61% of the 15 to 25 year old were informed at school or university. Newspapers and magazines are another important source in this age group.

The important channels of information cover the preferred ways. The 15 to 25 year old participants want to be informed by internet (78%), at school and university (71%), by TV, movies and radio (64%). Moreover they like to gain information in newspapers and magazines and notably more of them want to learn about nanotechnologies in science centres, museums, events and courses than up to now.

Table 14: Sources of information

	11-14 years		**15-25 years**	
	heard of*	**learn more****	**heard of°**	**learn more°°**
At school, university etc.	**37**	**56**	**61**	**71**
TV, movies, radio	**53**	**50**	**65**	**64**
Internet	**68**	**53**	**74**	**78**
Novels, fiction	5	6	8	8
Journals and non-fiction books	-	3	3	13
Newspapers, magazines	26	**19**	**33**	**56**
From parents or other adults	26	9	13	11
From brothers and sisters, peers	16	19	16	13
At science centres, museums, etc	11	**38**	9	**41**
Events	16	22	15	**35**
Seminars, courses, workshops	-	22	-	**30**
Don't know	-	13	-	1

Source: NANOYOU Online Survey 2009, in percent, *n=20, **n=33, °n=76, °°n=88

All in all the young people who participated in the NANOYOU survey are moderately interested in technology and science issues. 60% of the 11 to 14 year olds and 66% of the 15 to 25 year olds are very or quite interested in technology. In each age group they care more about arts and music and sports and environment. For example politics is yet less interesting than technology and science. The general interest in technology is structured by gender, especially among the 15 to 25 year old respondents: One out of five girls is very interested and one out of three is quite interested in technology. By contrast 35% of boys of the same age are very interested and another 56% is quite interested in technology issues. The interest in science of boys and girls do not differ as distinctly.

The 15 to 25 year old respondents are especially interested in all three fields of information about nanotechnologies: energy and environment, medicine and information and communication technologies (ICT). Apart from that they appreciate medicine examples of nanotechnologies. Boys are more frequently interested in ICT than girls. According to the analysis the target groups should be addressed independently. Separate topics for boys and girls in each age group are recommended.

Table 15: Interesting fields of nanotechnologies

	11-14 years*		**15-25 years°**	
	female	**male**	**female**	**male**
Energy and environment	11	35	12	11
Medicine	17	12	**27**	**25**
Information and communication technologies (ICT)	22	29	13	**25**
All three fields	39	18	**46**	**36**
None of them	11	6	3	3

Source: NANOYOU Online Survey 2009, in percent, *n=35, °n=114

About two fifths of the Romanian respondents think of nanotechnologies as very difficult and hard to study. The survey participants like to take part in internships in nanotechnology laboratories and summer camps. Especially the young respondents are eager to practice in the field of nanotechnologies though the agreement is high in both age groups. Interestingly more 15 to 25 year old girls want to study and work in nanotechnologies than boys. 53% of the girls agree with the statement that they think about studying a related subject and, by contrast, 39% of the boys think about studying nanotechnologies. 77% of the girls review working in nanotechnologies as interesting and almost as much boys (75%).

Summing up the Romanian young people, who took part in the NANOYOU survey, are very interested and include nanotechnologies in their life plans. Girls of each age group show more enthusiasm about nanotechnologies than boys even though they are not as often informed.

Knowledge

In the quiz the 11 to 14 year old respondents on average score at 3.8 out of 7 true answers. The quiz contains 9 questions for the age group of the 15 to 25 year olds; on average they correctly answer 4.8 questions. In the older age group there is no difference according to gender, boys and girls know as much.

Table 16: Knowledge about nanotechnologies

	11-14 years*		**15-25 years°**	
number of true answers	**female**	**male**	**female**	**male**
0	-	-	-	-
1	17	-	-	-
2	17	7	9	3
3	33	21	13	19
4	17	29	27	25
5	-	43	20	19
6	17	-	9	22
7	-	-	13	9
8	-	-	4	3
9	-	-	4	-

Source: NANOYOU Online Survey 2009, in percent, *n=20, °n=77

4.4.2.3 Attitudes towards nanotechnologies

The young Romanian respondents' attitudes are positive towards science and technology. By contrast to the Austrian findings, the young Romanians are more enthusiastic about positive impacts; however, they do not want society to rely on science and technology. The older ones at an age of 15 to 25 years are more moderate yet positive. They still agree that science and technology are more beneficial than risky.

Each age group evaluates nanotechnologies positively: 89% of the 11 to 14 year olds and 78% of the 15 to 25 year old think that nanotechnologies will improve our way of life.

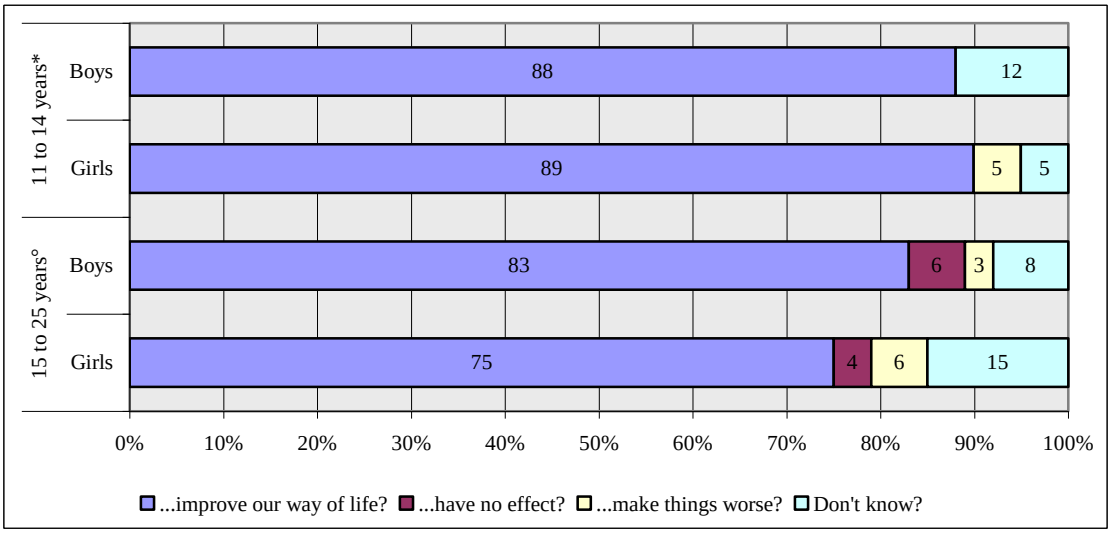


Figure 5: Will nanotechnologies…
Source: NANOYOU Online Survey 2009, *n=36, °n=117

The older respondents do not expect bad impacts as often as benefits and think that nanotechnologies are progressive and innovative. More than 80% say that nanotechnologies will improve resource exploitation and support new developments in medicine while not more than 52% think that nanotechnologies might cause new health or environmental problems. They are more concerned about privacy issues (68%) than other possible risks. Almost 90% of the 15 to 25 year old boys and girls support consumer protection with for nanotechnologies products.

4.4.3 Spain

4.4.3.1 Who participated in the survey

In Spain, 6 young people aged 11 to 14 years and 211 15 to 25 year olds participated in the NANOYOU online survey. Therefore the age group of the 11 to 14 year old boys and girls is not analysed for Spain. The findings presented below only refer to the respondents aged from 15 to 25 years.

The respondents of the older age group are predominantly 16 and 17 years old (74%). There are 47% of girls and 53% of boys in the sample. In Spain they were mainly reached in class or by teachers (86%). As a consequence 91% of the respondents are attending a school, 3% of them are studying at university and 4% are employed already. They respondents predominantly live with their parents (94%).

Among the 15 to 25 year olds expect 53% to achieve a postgraduate degree. 25% aspire to an undergraduate education and 16% expects to finish upper secondary education. Their parents' education is on a high level: At least one of the parents of 54% has achieved a university degree.

Table 17: Spanish subsample

	15-25
sex	
Girls	47
Boys	53
expected level of education	
Postgraduate	53
Undergraduate/vocational training	25
Upper secondary	16
Lower secondary	2
I do not expect to complete lower secondary	-
Don't know	5
channel to the NANOYOU survey	
In class/a teacher directed me	86
Friends	7
Link from another website	3
Science magazines	1
Science or Kids' Museum	-
Link from NANOYOU website	3
Don't know	1

Source: NANOYOU Online Survey 2009, in percent

The Spanish participants of the NANOYOU survey overwhelmingly live in urban areas: 60% live in big cities or in their outskirts of a big city and 32% in small cities and towns. Only 9% live rural areas.

4.4.3.2 Knowledge and interest - Quiz results & future expectations

The awareness of and the interest in nanotechnologies among the Spanish respondents is high. The majority of the 15 to 25 year olds have heard of nanotechnologies: 71% of the girls and 88% of the boys. 14% had not known nanotechnologies before participating in the NANOYOU survey. Additionally 71% want to learn more about nanotechnologies and about one fifth does not want more information.

There is a slight gender gap among the 15 to 25 year olds because girls have not heard about nanotechnologies as often than boys.

Table 18: Information about nanotechnologies

	15 to 25 years*		
Heard of nanotechnologies?	**yes**	**no**	**don't know**
Girls	71	19	10
Boys	88	10	2
Learn more about nanotechnologies?	**yes**	**no**	**don't know**
Girls	68	23	9
Boys	74	21	5

Source: NANOYOU Online Survey 2009, in percent, *n=211

The most frequent source of information about nanotechnologies is the educational system (e.g. in school and at university). Moreover, the young respondents have often heard about nanotechnologies in television, movies and radio. The internet is another important source for information in the age group between 15 to 25 years.

In comparing the current and the preferred channels of knowledge some differences stand out: More respondents want to learn more about nanotechnologies in school than up to now do. Considerably more respondents wish to learn more at science centres and museums, at events and in seminars, courses and workshops than who have already heard there about it. They also want to get information in newspapers and magazines. The kind of preferred channels show that they wish to gain reliable and thorough knowledge about nanotechnologies.

Table 19: Sources of information

	15-25 years	
	heard of*	**learn more****
At school, university etc.	**71**	**81**
TV, movies, radio	**70**	**55**
Internet	**56**	**51**
Novels, fiction	21	12
Journals and non-fiction books	12	19
Newspapers, magazines	36	**45**
From parents or other adults	15	13
From brothers and sisters, peers	21	14
At science centres, museums, etc	35	**48**
Events	10	**29**
Seminars, courses, workshops	-	**33**
Don't know	1	5

Source: NANOYOU Online Survey 2009, in percent, *n= 160 **n=150

The general interest in science and technology is high. The interest in technology varies with regard to gender significantly whereas the interest in science does not differ.[9] Differences according to gender are found in the fields of technology (boys), society (girls) and sports (boys) among the 15 to 25 year olds and reflect typical gender structures.

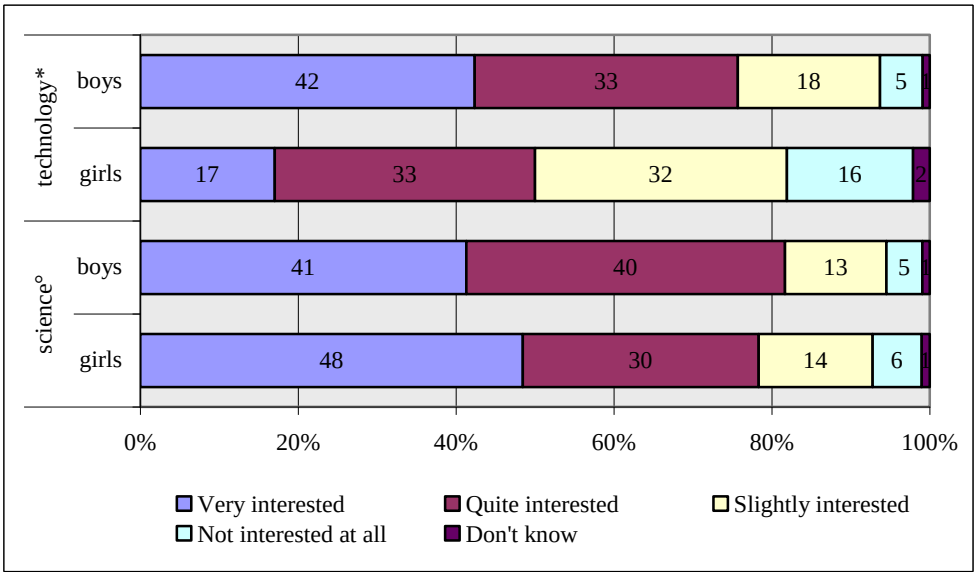


Figure 6: Interest in technology and science
Source: NANOYOU Online Survey, in percent, *n=205, °=206

[9] non-parametric test of means of two independent samples (Mann-Withney test)

Young people are interested in different fields of nanotechnologies and should be addressed differently. The interests vary according to gender: Girls from 15 to 25 years take an interest in medicine examples of nanotechnologies more often than boys. In comparison, boys appeal to comprehensive information about all fields of nanotechnologies.

Table 20: Interesting fields of nanotechnologies

	15-25 years*	
	girls	**boys**
Energy and environment	10	12
Medicine	**42**	19
Information and communication technologies (ICT)	15	19
All three fields	**30**	**44**
None of them	4	6

Source: NANOYOU Online Survey 2009, in percent, *n=202

However the differences in topics, educational and career goals towards nanotechnologies are not structured by gender among the Spanish survey participants. 82% of all respondents are interested in an internship in a nano-laboratory and 55% in participating in a summer school. Both activities are appreciated by boys and girls similarly.
About one half of the 15 to 25 year olds think that nanotechnologies are very complicated to study (56%). Nevertheless 59% are thinking of studying a subject related to nanotechnologies and even three quarters think that working in nanotechnologies would be interesting. All in all, the findings point out that Spanish respondents especially prefer practical experience to (theoretically) studying nanotechnologies. As a consequence, the interest in nanotechnologies of Spanish young people could be raised with exercises and practical tasks.

Knowledge

In the quiz the 15 to 25 year old respondents have an average score of 4.8 out of 9 true answers.
The knowledge of boys and girls do not differ significantly. Moreover, the education as family background does not impact on the knowledge of the young people, who participated in the survey.

Table 21: Knowledge about nanotechnologies

	15-25 years*	
number of true answers	**girls**	**boys**
0	-	-
1	1	3
2	7	2
3	13	17
4	24	16
5	26	29
6	17	16
7	7	11
8	4	3
9	-	2

Source: NANOYOU Online Survey 2009, in percent, *n=169

4.4.3.3 Attitudes towards nanotechnologies

The Spanish young people who participated in the NANOYOU survey overwhelmingly think about science and technology positively. Almost all think that science and technology is beneficial for society (93%). Moreover 69% think

that science and technology is usually safer than critics say. However, some ambivalence is revealed by the data since three quarters do not want society to rely on science and technology too heavily. The girls' attitudes are more moderate yet positive.[10]

As well, the Spanish respondents evaluate nanotechnologies very positively: 88% of the 15 to 25 year olds think that nanotechnologies will improve our way of life. Only 2% think that nanotechnologies will have negative impacts on our lives.

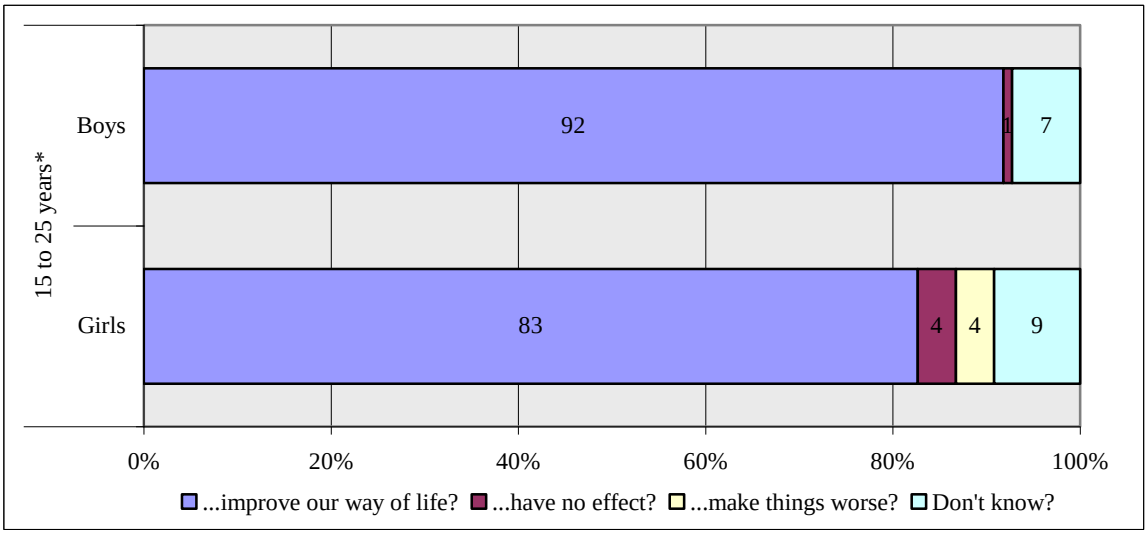


Figure 7: Will nanotechnologies…
Source: NANOYOU Online Survey 2009, *n=208

The 15 to 25 year old girls and boys are very optimistic that nanotechnologies will support developments in resource exploitation and medicine. Nonetheless they express the concern that only wealthy countries will benefit from nanotechnologies. Also, they agree by the majority that new problems related to health, environment and privacy will occur with progress of nanotechnology. They support consumer protection and prefer labels and independent institutions to inform consumers about nanotechnology products. Although attitudes towards nanotechnologies are not structured by gender as strongly as general attitudes towards science and technology girls are slightly more concerned about negative impacts.

4.4.4 Italy

4.4.4.1 Who participated in the survey

In Italy 14 young people aged 11 to 14 years and 89 15 to 25 year olds participated in the NANOYOU online survey. Therefore the age group of the 11 to 14 year old boys and girls is not analysed for Italy. The findings presented below only refer to the respondents aged from 15 to 25 years.

The respondents of the older age group are predominantly 15 years old (44%). One quarter is 16 years old and 23% is 17 years old. No one in the sample is older than 22. In the Italian subsample the boys are overrepresented: They

[10] non-parametric test of means of two independent samples (Mann-Withney test)

constitute 82% (n=73) of the sample and only 18% girls (n=16) are included. Subsequently findings for female respondents are based on a very small number of interviewees. In Italy, like in the other countries, they were mainly reached in class or by teachers (90%). As a consequence of the recruitment the NANOYOU survey participants are mainly pupils. 91% of the respondents are attending a school and only 3% of them are studying at university. They respondents predominantly live with their parents (93%).

Of the 15 to 25 year olds, 48% expect to achieve a postgraduate degree. 9% aspire to an undergraduate education and 31% expects to finish upper secondary education. Compared to Romania and Spain, their parents' education is on a lower level: At least one of the parents of 41% has achieved a university degree. ^

Table 22: Italian subsample

	15-25
sex	
Girls	82
Boys	18
expected level of education	
Postgraduate	48
Undergraduate/vocational training	9
Upper secondary	31
Lower secondary	5
I do not expect to complete lower secondary	1
Don't know	6
channel to the NANOYOU survey	
In class/a teacher directed me	90
Friends	-
Link from another website	2
Science magazines	-
Science or Kids' Museum	-
Link from NANOYOU website	6
Don't know	1

Source: NANOYOU Online Survey 2009, in percent

The Italian NANOYOU survey participants live in towns and rural areas: 46% live in a small city or towns and 42% in country villages or farm houses. Only a small share lives in big cities or in their outskirts (12%).

4.4.4.2 Knowledge and interest - Quiz results & future expectations

The awareness of and the interest in nanotechnologies is high among the Italian respondents. The vast majority of the 15 to 25 year olds have heard of nanotechnologies: 88% of the girls and 90% of the boys. 6% had not known nanotechnologies before participating in the NANOYOU survey. The participants are also eager to know more about nanotechnologies since 89% want to learn more. About 5% of the Italian girls and boys do not want more information.

Table 23: Information about nanotechnologies

	15 to 25 years*		
Heard of nanotechnologies?	**yes**	**no**	**don't know**
Girls	88	6	6
Boys	90	6	4
Learn more about nanotechnologies?	**yes**	**no**	**don't know**
Girls	82	13	6
Boys	90	8	1

Source: NANOYOU Online Survey 2009, in percent, *n=89

The most frequent source of information about nanotechnologies is, like in Austria and Spain, the educational system (e.g. in school and at university). Moreover, the young respondents have often heard about nanotechnologies in television, movies and radio. The internet is another important source for information in the age group between 15 to 25 years.

The preferred channels of information suit to the current ways. In comparison of the current and the preferred channels of information, some differences are found in the data: Considerably more respondents wish to learn at science centres and museums, at events and in seminars, courses and workshops than those who have already heard there of nanotechnologies. Approximately one third wants to get information in newspapers and magazines. The preferred channels of information show that they wish to gain reliable and thorough knowledge about nanotechnologies.

Table 24: Sources of information

	15-25 years	
	heard of*	**learn more****
Heard of: At school, university etc.	**84**	**82**
Heard of: TV, movies, radio	**55**	**60**
Heard of: Internet	**55**	**49**
Heard of: Novels, fiction	9	3
Heard of: Journals and non-fiction books	18	25
Heard of: Newspapers, magazines	40	32
Heard of: From parents or other adults	13	6
Heard of: From brothers and sisters, peers	15	8
Heard of: At science centres, museums, etc	30	**41**
Heard of: Events	14	**28**
Heard of: Seminars, courses, workshops	-	**27**
Heard of: Don't know	1	3

Source: NANOYOU Online Survey 2009, in percent, *n= 80, **n=79

The general interest in science and technology is high among the Italian young people that took part in the survey. Almost all are interested in technology (94%) and four out of five are interested in science. Compared to other fields of interest, only sports score higher on average.

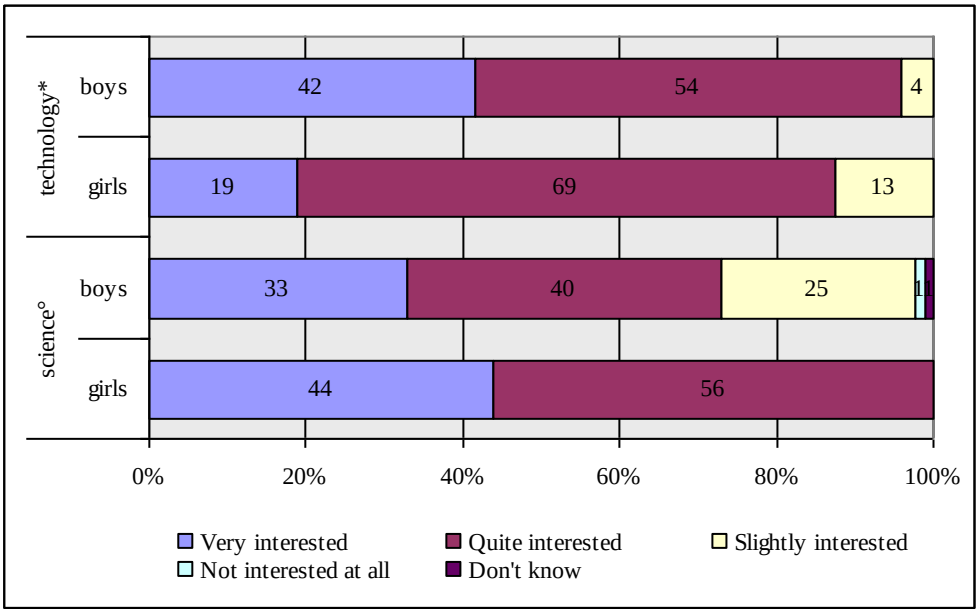


Figure 8: Interest in technology and science
Source: NANOYOU Online Survey, in percent, *n=88, °=89

Young people in Italy are interested in all different fields of nanotechnologies – energy and environment, medicine, information and communication technologies – and should be addressed with information covering that three fields.

Table 25: Interesting fields of nanotechnologies

	15-25 years*	
	girls	**boys**
Energy and environment	7	9
Medicine	14	13
Information and communication technologies (ICT)	7	22
All three fields	**64**	**53**
None of them	7	3

Source: NANOYOU Online Survey 2009, in percent, *n=78

The Italian respondents are keen to experience nanotechnologies as 84% of the 15 to 25 year old respondents are interested in an internship in a nano-laboratory and 88% think that working in nanotechnologies would be interesting. About two fifths of the 15 to 25 year olds think of nanotechnologies as too complicated to study (44%). About one half is thinking of studying a subject related to nanotechnologies and would like to take part in a summer school. All in all, the findings point out, that Italian respondents would like to acquire knowledge on nanotechnologies by practical experience.

Knowledge

In the quiz the 15 to 25 year old respondents truly answered 5.4 out of 9 questions.

Table 26 : Knowledge about nanotechnologies

	15-25 years*	
true answers	**girls**	**boys**
0	-	-
1	-	2
2	7	2
3	-	5
4	-	21
5	21	21
6	57	30
7	-	14
8	14	6
9	-	-

Source: NANOYOU Online Survey 2009, in percent, *n=80

4.4.4.3 Attitudes towards nanotechnologies

The Italian young people, who participated in the NANOYOU survey, are overwhelmingly optimistic about science and technology. Nine out of ten think that science and technology offer more benefits than risks for society and three out of five say that they are among the first in their circle of friends to know about a new technology when it appears.
Moreover, 61% think that science and technology is usually safer than critics say. Nevertheless one half of the respondents do not want society to rely on science and technology too heavily.

As well, the Italian respondents positively evaluate nanotechnologies: 93% of the 15 to 25 year olds think that nanotechnologies will improve our way of life. Only 3% think that nanotechnologies will have negative impacts.

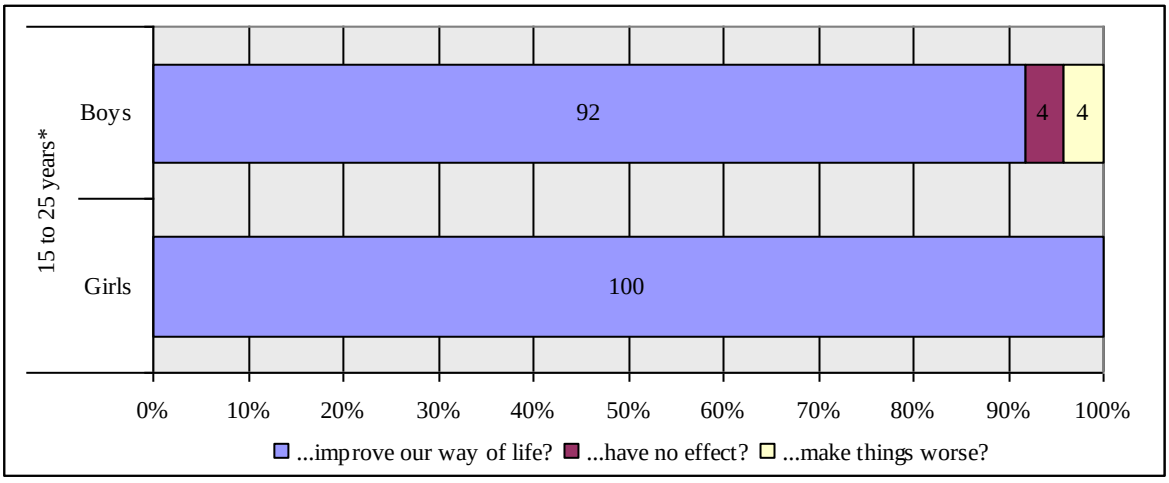


Figure 9: Will nanotechnologies…
Source: NANOYOU Online Survey 2009, *n=89

The 15 to 25 year old young people are very optimistic that nanotechnologies will enhance solutions for resource scarcity and medical treatment. Nonetheless three quarters of them express the concern that only wealthy countries will benefit from nanotechnologies. Also, they agree by the majority that new problems related to health, environment and

privacy will occur with nanotechnology progress. They support product labels and independent institutions that inform consumers about possible risks of nanotechnology products. The attitudes are already very positive but the findings point out that information of young people in should address possible risks and problems that nanotechnologies bear.

4.4.5 Overall Gender Gap?

As shown in the country results, a significant gender gap can be observed in the selected countries, for example according to interest in technology. As the gender gap seems to be of special relevance when it comes to developing further material and activities, there will be some extra analysis for the gender gap for all countries that shall provide information how the gender gap might be reduced in future.

Table 27 : Ever heard of nanotechnology? all countries

	female	male	female	male
	11 to 14	11 to 14	15 to 25	15 to 25
Yes	46%	68%	62%	84%
No	38%	21%	26%	10%
Don't know	16%	11%	11%	6%
	100%	100%	100%	100%

Source: NANOYOU Online Survey 2009
Differences between females and males statistically significant in both age groups, chi-square test, alpha=0,05

More males than females declare that they have ever heard of nanotechnology. The difference occurs in both age groups, even among the youngest, the gender gap is already visible.

The quiz results show a clear picture, too: Girls and young women know less about nanotechnology than boys and young men.

Table 28: Quiz results by gender and age group – all participants that have ever heard of nanotechnology

	female	male	female	male
Number of correct answers	11 to 14	11 to 14	15 to 25	15 to 25
0	3%		1%	
1	9%	2%	2%	1%
2	19%	9%	7%	3%
3	27%	27%	10%	8%
4	18%	23%	20%	13%
5	12%	18%	18%	21%
6	9%	13%	20%	23%
7	4%	8%	13%	19%
8			8%	10%
9			2%	3%
	100%	100%	100%	100%
n	68	90	298	479

Source: NANOYOU Online Survey 2009
Differences between females and males are statistically significant in both age groups, T-test for unpaired samples, assumption of non equal variances, alpha = 0,05

Among 11 to 14year olds, 31% of girls have only up to two correct answer whereas this percentage is much lower among boys (11%). 25% of girls have 5 or more correct answers, whereas 39% of boys reach these top scores. Same picture holds for the older group.

The difference in correct answers cannot completely be transferred to incorrect answers, because females have significantly more "don't know" answered. One could assume, that males that did not know the answer just made a guess that sometimes resulted in a correct answer. But even if this assumption holds, it explains only a small part of the differences between females and males. It is a fact: Boys and young men simply know more about nanotechnology.

But the following table gives some hints how these differences are to be reduced: One has to find the context that makes girls interested in nanotechnologies:

Table 29: Curiosity according to fields of application– would you like some examples in … ?

	female	male	female	male
	11 to 14	11 to 14	15 to 25	15 to 25
Energy and environment	20%	21%	13%	12%
Medicine	29%	13%	28%	13%
Information and communication technologies (ICT)	12%	25%	10%	25%
All three fields	30%	29%	42%	40%
None of them	10%	12%	8%	9%
	100%	100%	100%	100%

Source: NANOYOU Online Survey 2009
Differences between females and males statistically significant in both age groups, chi-square test, alpha=0,05

Females are more interested in medical applications of nanotechnology whereas males are more interested in ICT applications. Interest for energy and environment or all three fields is similar. This pattern holds for both age groups, but at different levels: in the older age group single interest for energy and environment draws back in favour of interest in all three fields.

4.4.6 Examples of nanotechnology products

The survey covered four examples of existing or possible products that contain nanotechnology applications and gave the following explanations of these products:

1. Jacket: A jacket that contains a global positioning system that is integrated in the fabric and cannot be switched off to make it possible to locate people wherever they are. The global positioning system device is powered by a nanomaterial that is inside the jacket and also harvests the energy for it.
2. Sunglasses: These sunglasses protect the eyes from UV-light. The lenses of the glasses have dye-sensitised solar cells, which are made of nanomaterials, collecting solar energy and converting it into electricity for small devices such as mobile phones and mp3 players.
3. Lab-on-a-chip: A lab-on-a-chip is smaller than a credit card, but can perform a blood test. Instead of taking samples to the lab, doctors will be able to use them in their consulting-room. In the device there are hundreds of nano-sized detection sites that can recognize diseases.
4. Socks: Silver nanoparticles woven into socks eliminate the bacteria that cause smelly feet and fungal infections.

After these explanations participants had to answer some questions on possible advantages and disadvantages of these products and finally could give their overall opinions on the products (good thing-bad thing, more risks-more benefits, want to have it – do not want to have it, useful-useless).
These statements and opinions were derived from our focus group results.

The examples in our survey were included for the following purposes:
Firstly, they shall help to give information about possibilities, chances and risks of applications of nanotechnology. The assumption is that examples of applications or products are easier to understand than the technology itself.
Secondly, examples will play a crucial role in the information material and activities to be developed during the Nanoyou project. Therefore we need survey results to understand, which examples work in a twofold sense:
(a) Which examples are easy to understand?
(b) What kind of effects do the examples have, what kind of opinions are supported by the examples?
We decided to analyze the examples across countries as firstly the newly given information should not depend so much on a countries' given frame as knowledge on nanotechnology and secondly we do not concentrate on descriptions so much, but on patterns in the answers.
Correlations or associations between answers can be interpreted even if population is not representative. We can find patters in the answers that might be transferrable to more young people than the ones who participated in the survey.

4.4.6.1 Opinions on nanotechnology applications and products

Table 30: Opinions on benefits and risks of nanotechnology applications and products

	n	Strongly agree	Agree	Disagree	Strongly disagree	Don't know	total
Jacket: good thing for outdoor sports or similar activities	1571	40	42	9	5	4	100
Jacket: I don't always want other people to know where I am	1536	33	35	18	8	6	100
Jacket: I would prefer a small portable device with that function	1537	37	36	14	8	6	100
Jacket: the nanomaterial might wash out and become bad for the environment	1514	25	31	16	10	19	100
Sunglasses: could help to save the environment	1499	45	39	8	2	5	100
Sunglasses: I would not want to wear something producing electricity onto my body.	1480	12	27	34	20	7	100
Sunglasses: This technology should be used not just on sunglasses	1487	45	38	8	2	7	100
Sunglasses: the nanomaterial might be bad for the environment	1449	19	35	17	8	20	100
Lab-on-a-chip: This technology could help to save lives.	1413	54	33	4	2	6	100
Lab-on-a-chip: This lab-on-a-chip is a good thing as long as only doctors use it	1431	39	39	11	5	6	100
Socks: Because these socks have to be washed less often, it could help to save the environment.	1411	34	35	18	7	6	100
Socks: I don't want to wear something on my skin that eliminates bacteria.	1400	11	18	37	26	7	100
Socks: This technology should be used for other clothes too	1396	36	37	15	5	7	100
Socks: the nanomaterial might be bad for the environment.	1370	19	30	18	11	23	100

Young people participating in the survey are open for both advantages and disadvantages of the jacket. Although an overwhelming majority agrees, that the jacket is useful for outdoor activities, they also sensible to privacy aspects (they do not want that their position should be known all the time) as well as usefulness (they also agree that the function of the positioning system is not necessarily to be integrated in the jacket but could be applied in some extra device). The environmental aspect is the one that is hardest to understand, nearly 20% cannot give an opinion whether particles might wash out and become dangerous for the environment.

The technology used for the sunglasses is very convincing for the participants. They agree very much, that the solar energy produced by the sunglasses might help save the environment and suggest that the technology might be applied on other products, too. This result fits very much to the focus groups where participants argued that the technology should be used on much bigger objects in order to get more energy. The fear for the user's health is rather low, only a minority does not want to wear something that produces electricity on their bodies. Again, the opinion, that

nanomaterials might be dangerous for the environment, is hardest to give. Nearly every fifth participant does not know how to answer this question.

Lab-on-a-chip is seen as a great chance to save lives. Although participants are quite careful about the privacy aspect and agree very strongly that only doctors should be allowed to use it.

The silver nanoparticles in the socks are seen as a good thing to protect the environment because you do not have to Wash them so often, and again, participants agree very much that this technology should be used more broadly. But on the other hand, nearly every third participant says, he or she does not want to wear something that eliminates bacteria on his or her skin. As for the other products, the argument referring to environment cannot be answered by nearly a fourth of the participants.

Generally speaking, most items were rather easy to understand. High levels of "don't know" answers occurred in three cases, marked in the tables above. All three items are the ones that were included in order to make possible environmental risks easier to understand. But, the environmental aspect still seems hard to understand
The high levels of agreement to advantages as well as disadvantages is a hint that young people are still very open to every kind of information given on nanotechnology and its applications.

Opinions on products were asked on a 0 to 100 points scale – we rescaled this to a more simple scale in order to reduce complexity in the report: We reduced it to 3 ranges: positive opinion, negative opinion or neither more benefits nor more risks.

Table 31: Opinions on products

	n	positive	neither nor	negative	Total
Jacket: good thing - bad thing	1687	41	44	15	100
Jacket: more benefits - more risks	1689	33	51	15	100
Jacket: want it - do not want it	1687	24	40	36	100
Jacket: useful - useless	1689	42	45	14	100
Sunglasses: good thing - bad thing	1625	53	40	8	100
Sunglasses: more benefits - more risks	1625	44	46	9	100
Sunglasses: want it - do not want it	1624	41	41	19	100
Sunglasses: useful - useless	1624	47	42	11	100
Lab-on-a-chip: good thing - bad thing	1574	52	41	7	100
Lab-on-a-chip: more benefits - more risks	1573	44	48	9	100
Lab-on-a-chip: want it - do not want it	1574	23	50	27	100
Lab-on-a-chip: useful - useless	1573	51	42	6	100
Socks: good thing - bad thing	1538	46	45	9	100
Socks: more benefits - more risks	1540	41	47	12	100
Socks: want it - do not want it	1539	37	43	20	100
Socks: useful - useless	1538	43	45	11	100

All four products are seen as good things by a majority of participants, and best results are given for the sunglasses and the lab-on-a-chip. Additionally, for all four products there are more young people that see more benefits than they see more risks. The jacket gets most sceptic marks here, the privacy aspects seem to influence this result somewhat. And, all four products are rated more often as useful than as useless. Interestingly, although opinions on the products are rather positive, a relative majority of young people does not want to have the jacket and the lab-on-a-chip.

4.4.6.2 Which examples contribute to strengthening or forming opinions?:

For further information activities the selection of examples should contribute to make nanotechnology easier to understand but also can be chosen in order to strengthen certain opinions. It will make a difference what arguments and explanations will be given for the examples.

In order to get an idea which example and which items giving partial information for each example contributes to certain opinions towards nanotechnologies, a simple measure of association shall be given. Du to scales and distributions, Pearson correlations were chosen for this purpose.

Table 32: Pearson Correlations between items on products and items in attitudes towards nanotechnology, only 15-25year olds

	Nanotechnologies will help to use fewer resources, e.g. water or energy.	Nanomaterials might cause new health or environmental problems.	Nanotechnologies will improve the detection and medical treatment of illnesses.	Nanomaterials will make it too easy to spy on people.	Only wealthy countries will benefit from nanotechnologies.	Information about nanomaterials should be placed on products to help consumers decide.	An independent institution should declare if nanotechnology products are safe	Strong regulations for nanotechnology products make it difficult to develop new products.
Jacket: good thing for outdoor sports or similar activities	,262**	-,014	,164**	,013	,039	,087**	,139**	,106**
Jacket: I don't always want other people to know where I am	-,022	,132**	-,016	,300**	,227**	,148**	,184**	,062
Jacket: I would prefer a small portable device with that function	,067*	,099**	,050	,115**	,059	,124**	,144**	,039
Jacket: the nanomaterial might wash out and become bad for the environment	-,032	,390**	-,043	,196**	,167**	,133**	,184**	,141**
Sunglasses: could help to save the environment	,341**	,001	,202**	,045	,066*	,049	,067*	,088*
Sunglasses: I would not want to wear something producing electricity onto my body.	-,118**	,226**	-,141**	,097**	,019	,011	,020	,046
Sunglasses: This technology should be used not just on sunglasses	,242**	-,096**	,287**	,080*	,055	,150**	,170**	,108**
Sunglasses: the nanomaterial might be bad for the environment	-,050	,415**	,009	,235**	,212**	,205**	,235**	,135**
Lab-on-a-chip: This technology could help to save lives.	,335**	-,038	,403**	,096**	,065	,141**	,178**	,118**
Lab-on-a-chip: This lab-on-a-chip is a good thing as long as only doctors use it	,108**	,201**	,092**	,171**	,236**	,221**	,240**	,106**
Socks: Because these socks have to be washed less often, it could help to save the environment.	,361**	-,017	,187**	,024	,074*	,016	,022	,195**
Socks: I don't want to wear something on my skin that eliminates bacteria.	-,106**	,302**	-,176**	,132**	,088**	-,013	,019	,025
Socks: This technology should be used for other clothes too	,347**	-,125**	,368**	,045	,043	,122**	,050	,237**
Socks: the nanomaterial might be bad for the environment.	-,017	,509**	,017	,228**	,238**	,201**	,229**	,170**

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

In order to address the chances of nanotechnology when it comes to saving energy or resources, the sunglasses and socks help very much to give easy to understand examples. The table also shows a correlation with the item, that lab-on-a-chip might help to save lives, this correlation seems very unlikely to represent a causal order.

The risks of nanotechnology are best addressed by the items that say that nanoparticles might be bad for the environment, but, as we have seen above, these are the items that are most difficult to understand, therefore one had rather use the argument given for the socks, that one might feel uncomfortable about wearing something that eliminates bacteria.

Privacy aspects are most easily addressed by the jacket.
Other aspects as distribution aspects or consumer information aspects are not supported easily by the products selected. There are some statistically significant correlations, but the strength of this correlation is rather low therefore these correlations can be seen as not relevant.

4.4.6.3 Conclusions: The use of examples in further work:

Generally speaking, all four products were rather easy to understand. All four of them help to transport some benefits and risks of nanotechnology applications.

Most challenging for further material and activities is the matter of nanotechnology and its possible risks for environment and health, as the items used were too difficult for about a fifth of the participating people.

Additionally there must be some extra example that makes social dilemmas more clear; none of the products chosen is very helpful in explaining possible distributional aspects.

5 CONCLUSIONS AND RECOMMENDATIONS

To summarise, it has to be considered that the open structure of the survey obviously attracted students via interested teachers. According to the size of the middle group and their education level, it is also obvious that our sample predominantly consists of students of senior classes. Furthermore, the sample is very much characterized by Austrian respondents who build the biggest part of the analysis. Nevertheless, the following generalised results were cross checked with focus groups results and expert opinions.

5.1.1 Knowledge

In general, young people at least have heard about "nano", but mostly they do not have a deeper understanding.

Their knowledge about NT is predominantly related to specific NT products. They can name different products and applications, but cannot give explanations of the technology behind.

In answering the quiz they gained average results, they could answer half of the questions correctly.

However, the interest for NT is bigger than the knowledge, and young people would like to know more about it in the future.

Reaching out for young people with the topic of NT is related to interest, either by teachers or youths themselves.

On basis of the data at hand - although the sample sizes are not very big – no tendencies can be seen, that the area of living is decisive for knowledge about NT.

5.1.2 Sources of knowledge:

School, TV and radio, movies and internet are the most important sources for information about NT for young people.

The internet as source of knowledge is very attractive, because it allows for appealing designs. But as it is a pull rather than a push medium, information about NT doesn't happen coincidentally like in TV. Thus, youth have to be led to information about nanotechnology topic on the internet. In general, the elder group was more attracted by the internet.

Young people wish to learn more at science centres and museums, at events and in seminars, courses and workshops, more than they do up to now. Seemingly, they want to gain more thorough information about NT.

School and teachers

Again, it must be stated, that the majority of our sample was reached via school.

Nevertheless, school is a key source of information, but of course there are engaged teachers and less engaged teachers. Relating to their interests and engagement, the engagement of their students will be stronger or less strong. Teaching NT not necessarily implies discussing ELSA. Teachers sometimes do not feel enough trained for discussing ELSA.
Subjects in school related to NT are natural sciences, predominantly chemistry and physics. Therefore teachers of these subjects are those who take part in further continuing teachers training.
For teachers there exists information and teaching material about nanotechnologies, predominantly at the internet, but still it highly depends on the interest and engagement of each teacher to look for it and use it in the class. There also exists advanced training offers for teachers, but to look for them also strongly relies on the interest of the teachers.
In teachers' initial trainings NT is not yet part

To attract interest of students, preliminary teachers' interest has to be attracted.
For the future, students still name school as an important source of knowledge about NT.

5.1.3 Interests

In general, young people of our sample showed a medium to high interest in science and technology. In any case their interest is higher than in other topics like for instance the field of politics which is consistently on the last position.
Attracting and keeping the interest of the youth is a key factor. The interest is predominantly connected to products and their opportunities and development. Examples should be related to their daily life. The design is decisive. Furthermore interest relate to gender and age in terms of products and examples. Any practical information is preferred to theoretically. Answers in the questionnaire relating to the practical examples give a hint that young people are still very open to every kind of information given on NT and its applications.
Environment, ICT and health as the three main topics of NANOYOU project match the interest of the young people.
For the different fields of NT, the elder groups show a tendency to be interested in (all three) realms, whereas the younger group have preferences. Information should be given to the different groups accordingly. Especially the younger has to be informed rather specifically than on a general level.
For education and professional career goals NT is already part of their future considerations, at least partly.

5.1.4 Attitudes and expectations

In general, young people think that NT will improve our lives in future. They are mostly optimistic up to euphoric, but at the same time believe in risks and are aware of negative impact as well.
For some of them nanotechnology products open infinite opportunities and future possibilities. Youths are aware of its big potential, but they do also have considerations and ask for information and control.
The findings point out that information of young people in NT should also address possible risks and problems.

Young people see technology development, which mirrors also the development of nanotechnology, irresistible and therefore emphasized the positive aspects of it. The development of technology is seen like a „law of progress".

Technological progress is almost considered as a natural law, which you have to accept and handle it. It seems that young people anticipate its importance in the future.

Young people's seemingly uncritical attitude regarding nanotechnology is caused by a lack of information on possible risks. When youths are informed about those they do show a lot of concern.
The most important aspects demanded by the youth are transparency and information. They want to know whether NT is used in products. They want to have a say on development and applications especially when it comes up to privacy and surveillance. As consumers they want to be informed and be able to make their own decisions. Privacy, consumer protection, environment and health were constantly important, whereas distributional aspects (only wealthy people or countries) were not.
For further developments and applications young people ask for independent regulation and control agencies.
For consumer products young people seem to be very demanding and critical. Future applications should bring a distinct enhancement for them, otherwise they would refuse it. Interest and positive assessment is not equitable with the wish to use it or own it.
All four products used for the questionnaire were seen as good things by a majority of participants, and best results are given for the sunglasses and the lab-on-a-chip. Interestingly, although opinions on the products are rather positive, a relative majority of young people does not want to have the jacket and the lab-on-a-chip.

There is no tendency that the elder group is more critical than the younger group.

For discussing ELSA with young people, concrete examples of NT applications appeared as successful approach, whereas finding an appropriate medicine example is still challenging.

5.1.5 Public debates

Basically there is no broader public discussion on NT despite of specific examples like Grenoble or Prince Charles statement about grey goo in the UK.
Public debates in the countries are not wide spread. Innovation and technology debates are often discussed together with a lack of offspring in technical and natural sciences.

National debates have not yet really started, despite some concrete cases or regions (e.g. Grenoble). Wider media do not yet really cover the issue, more specific media. Teachers are not very aware of any debate, but involved researchers already are. They are also more informed about political strategies and aims concerning NT.

The topic seems not really be interesting for a wider public yet, but it is expected to be coming soon.

Initiatives to start with discussions would be smaller groups. The ones to promote it – here industry and companies play an important role to promote NT via consumer products which are often very attractive for young. The others would be initiatives starting being against it looking out for a wider public.

In general awareness of NT is increasing and also an increasing number of events and initiatives take place in Europe.

5.1.6 Communication

In communication activities there seem to be three different kinds of approaches:

- Knowledge transfer (informing and teaching about the technology)
- Dialogue and participation (discussing ELSA)
- Recruiting (attracting interest for future natural scientists and engineers)

How can these three approaches be communicated to the youth?

Knowledge transfer:
To provide basic information about nanotechnologies school could be an appropriate source of knowledge. Information has to be well balanced. These days the relevant subjects are chemistry and physics. The remaining question is what else could be related school subjects, who are the teachers and how to train them?

Dialog/ELSA
For ELSA and participatory dialogue special formats have to be developed. This could either take place at schools or within extra curricula activities. The question is how schools can offer the framework and which are the subjects where such discussions could take place?

Recruiting
Providing general information in school does not lead to more interest towards science and technology in general. Specific interests have to be discussed and provided in depth in additional formats.

The question is which aspects can be best communicated
For further information activities the selection of examples should contribute to make nanotechnology easier to understand but also can be chosen in order to strengthen certain opinions. It will make a difference what arguments and explanations will be given for the examples.

Generally speaking, all four used products were rather easy to understand. All four of them help to transport some benefits and risks of nanotechnology applications. Obviously, with certain examples, certain ELSA can be addressed.

Most challenging for further material and activities is the matter of nanotechnology and its possible risks for environment and health, as the items used were too difficult for about a fifth of the participating people although they were seen as fascinating.

Additionally there must be some extra example that makes social dilemmas more clear; none of the products chosen is very helpful in explaining possible distributional aspects.

5.1.7 Gender

In general, there is a gender gap concerning interest and knowledge in each age group.

Concerning nanotechnologies the gender aspects are seemingly similar to other technologies. Accordingly girls do not feel as much interested in nanotechnologies as their male peers. But seemingly there are potentials. Either girls show a strong interest for the future and would like to learn more, or they are still uncertain whether the topic could interest them later on. Especially girls in Rumania show much enthusiasm in NT even though they are not as often informed. More 15 to 25 year old girls want to study and work in nanotechnologies than boys.
To consider these differences some experts suggest not expecting and dealing with any gender differences whereas others are highlighting the importance of dealing with different interests and needs by gender.

According to group discussions it seems that educational aspects with basic information about nanotechnology could be better achieved during classes than dialogue and participatory aspects. For interactive formats, the difference tolerance levels and fields of interests by gender should be considered.

Raising young people's interest in nanotechnologies should be accompanied with the relevance for their future. This is a crucial point especially when considering the less social or educational encouragement of females. Strengthen young women's interest in technology and especially in nanotechnology could work by relating the communication on nanotechnologies to their daily lives and interests.

6 BIBLIOGRAPHY

Adam, B., und C. Groves. 2007. *Future Matters. Action, Knowledge, Ethics*. Leiden: Brill.

Arnall, Alexander, und Parr, Douglass. 2005. "Moving the nanoscience and technology (NST) debate forwards: short-term impacts, long-term uncertainty and the social constitution." *Technology in Society* 27:23–38.

Bell, L. 2008. "Engaging the Public in Technology Policy: A New Role for science Museums." *Science Communication* 29:386–398.

Berne, R.W., und J. Schummer. 2005. "Teaching Societal and Ethical Implications of Nanotechnology to Engineering Students Through Science Fiction." *Bulletin of Science, Technology & Society* 25:459–468.

Bonazzi, Matteo, und Jennifer Palumbo, hrsg. 2008. *Report from the Workshop: Communication Outreach in Nanotechnology: from recommendations to action*. Brussels ftp://ftp.cordis.europa.eu/pub/nanotechnology/docs/nanooutreach_action_final_mar_08.doc.

Bos, Mark J.W., Koolstra, Cees M.und Jaap T.J.M. Willems. 2009. "Adolescent responses toward a new technology: first associations, information seeking and affective responses to ecogenomics – Bos et al. 18 (2): 243 – Public Understanding of Science." https://univpn.univie.ac.at/+CSCO+0h756767633A2F2F6368662E666E747263686F2E70627A++/cgi/reprint/18/2/243.

Brice, L. 2007. *Engaging the public in nanotechnology? Three visions of public engagement*. http://www.csi.ensmp.fr/Items/WorkingPapers/Download/DLWP.php?wp=WP_CSI_011.pdf.

Brown, Nik, Arie Rip, und Van Lente. 2003. *Background paper version 14May03.pdf (application/pdf-Objekt)*. http://www.york.ac.uk/res/satsu/expectations/Utrecht%202003/Background%20paper%20version%2014May03.pdf.

Cobb, M. D., und J. Macoubrie. 2004. "Public perceptions about nanotechnology: Risks, benefits and trust." *Journal of Nanoparticle Research* 6:395–405.

COM. 2004. *Towards a European strategy for nanotechnology*. Brussels: EC.

COM243. 2005. "Nanosciences and nanotechnologies: An action plan for Europe 2005-2009.".

Crone, W.C. 2006. "Bringing Nano to the public." http://www.nisenet.org/catalog/tools-guides/bringing-nano-public.

Davies, S., M. Kearnes, und P. Macnaghten. 2008. *Nanotechnology and public engagement: a new kind of (social) science?* javascript:__doPostBack('dnn$ctr3070$Document$grdDocuments$_ctl4$lnkDownload','').

Deblonde, Marian, Michiel Van Oudheusden, Johan Evers, und Lieve Goorden. 2008. "Co-creating Nano-imaginaries: Report of a Delphi-Exercise." *Bulletin of Science, Technology & Society* 28:372-389.

deVries, Marc et al (1988): Pupils' attitudes toward technology PATT, Survey instrument, developed by Vorginia Tech and Eindhoven University, http://www.iteaconnect.org/Conference/PATT/PATTSI/PATTSurveyInstrument.pdf

Dillman, Don A. (2000). "Mail and Internet Surveys. The Tailored Design Method." Second edition. New York. Wiley.

Doubleday, R., M. Eames, N. Pigeon, und R. Wilson. 2005. *The Nanotechnology Engagement Group*.

Ebbesen, Mette, Svend Andersen, und Flemming Besenbacher. 2006. "Ethics in Nanotechnology: Starting from Scratch?." *Bulletin of Science, Technology & Society* 26:451-462.

Eurobarometer (2005): Europeans, Science and Technology. Special Eurobarometer 224, Wave 63.1 – TNS Opinion&Social, http://ec.europa.eu/public_opinion/archives/ebs/ebs_224_report_en.pdf

Eurobarometer. 2008. *Qualitative Study on the Image of Science and the Research Policy of the European Union*. European Commission.

Eurobarometer Flash Survey. 2009. *Young people and science. Eurobarometer Flash Survey 239*. http://ec.europa.eu/public_opinion/archives/flash_arch_en.htm#239.

Fiedeler, U., A. Gazsó, M. Simkó, und M. Nentwich. 2008. "Zur Definition von Nanotechnologie." *Nano-trust dossiers* 001:1–4.

Fisher, E., C. Selin, und J. M. Wetmore, hrsg. 2008. *The Yearbook of Nanotechnology in Society, Volume I: Presenting Futures*.

Fleischer, T., und C. Quendt. 2007. *"Unsichtbar und unendlich" - Bürgerperspektiven auf Nanopartikel. Ergebnisse zweier Fokusgruppen-Veranstaltungen in Karlsruhe*. http://www.itas.fzk.de/deu/lit/2007/flqu07a.pdf.

Gaskell, George, Allansdottir, Allum, Corchero, und Fischler. 2006. "Eurobarometer 64.3: Europeans and Biotechnology in 2005 report to the European Commission's Directorate-General for Research." http://www.ec.europa.eu/research/press/2006/pdf/pr1906_eb_64_3_final_report-may2006_en.pdf.

Gavelin, K., und R. Wilson. 2007. *Democratic technologies? The final report of the Nanotechnology Engagement Group (NEG)*. London.

Gimzewski, Jim, und Victoria Vesna. 2003. "The Nanomeme Syndrome: Blurring of fact and fiction in the constructin of a new science, Technoetic Arts." Technoetic Arts 1 (1): 1-17.." *Technoetic Arts* 1:1-17.

Grobe, A. 2007. "Die Zukunft der Nanotechnologie - Erwartungen von Konsumenten und Experten." *Apunto* 12/1 2007/08Dr Antje Grobe, Leiterin Nanotechnologie, Stiftung Risiko-Dialog:16–17.

Grove-White, R., P. Macnaghten, und B. Wynne. 2000. *Wising Up The Public and New Technologies*. Lancaster University.

Grunwald, Armin. 2005. "Nanotechnology - A New Field of Ethical Inquiry?." *Science & Engineering Ethics* 11(2). https://univpn.univie.ac.at/+CSCO+d0756767633A2F2F6A726F2E726F667062756266672E70627A++/ehost/pdf?vid=4&hid=8&sid=6e085883-b2c5-4857-8e41-c4f0f81a3165%40sessionmgr13.

Hanssen, L., B. Walhout, und R. van Est. 2008. *Ten lessons for a nanodialogue*. http://www.rathenau.nl/downloadfile.asp?ID=1486

Jarmon, L., und E. Keating. 2008. "NANO SCENARIO: Role-playing to appreciate the societal effects of nanotechnology." *Simulation & Gaming* 39:282–301.

Kahan, D. M., P. Slovic, D. Braman, J. Gastil, und G. L. Cohen. 2007. "Affect, values, and nanotechnology risk perceptions: An experimental investigation." *GWU Legal Studies Research Paper No. 261*.

Kaiser, Mario, Monika Kurath, Sabine Maasen, und Christoph Rehmann-Sutter, hrsg. 2009. *Governing Future Technologies. Nanotechnology and the Rise of an Assessment Regime*. Springer.

Kaufmann, Alain, Claude Joseph, Catherine El-Bez, und Marc Audétat. 2009. "Why Enrol Citizens in the Governance of Nanotechnology?." S. 201–215 in *Governing Future Technologies. Nanotechnology and the Rise of an Assessment Regime*. Springer.

Kearnes, Matthew, und Phil Macnaghten. 2006. "Introduction: (Re)Imagining Nanotechnology." *Science as Culture* 15 (4):279–290.

Kennedy, Joseph. 2008. "Chapter 1 Nanotechnology: The Future is Coming Sooner than You Think." S. 2–21 in *The*

Yearbook of Nanotechnology in Society, Volume I: Presenting Futures. Springer.

Lee, Chul-Joo, Dietram A. Scheufele, und Bruce V. Lewenstein. 2005. "Public Attitudes toward Emerging Technologies: Examining the Interactive Effects of Cognitions and Affect on Public Attitudes toward Nanotechnology." *Science Communication* 27:240–267.

Lösch, Andreas. 2008. "Chapter 9 Anticipating the Futures of Nanotechnology: Visionary Images as Means of Communication." S. 123–141 in *The Yearbook of Nanotechnology in Society, Volume I: Presenting Futures*. Springer.

Macnaghten, P., M. Kearnes, und B. Wynne. 2005. "Nanotechnology, Governance, and Public Deliberation: What role for the Social Sciences?." *Science Communication* 27:268–291.

Macoubrie, J. 2006. "Nanotechnology: public concerns, reasoning and trust in government." *Public Understanding of Science* 15:221–239.

Miller, J. D. 2004. "Public understanding of, and attitudes toward, scientific research: What we know and what we need to know." *Public Understanding of Science* 13:273.

nanoBio-RAISE. o. J. *Public Perceptions and Communication about Nanobiotechnology*. http://files.nanobio-raise.org/Downloads/NanoPublicFINAL.pdf.

Nanoforum. 2005. *Report from the Nanoforum online survey on the European Strategy for Nanotechnology published today*. http://nanoforum.org/dateien/download.php?userid=15454275&dateinr=369&dateiorig=000369.upl&dateiname=Nanoforum+press+release+Nano+Survey+report.pdf&zeitcode=17042009145945.

Nanologue. 2006a. *Nanologue Opinions on the Ethical, legal and Social Aspects of Nanotechnologies*. - Results from a Consultation with Representatives from Research, Business and Civil Society. http://www.nanologue.net/custom/user/Downloads/NanologueWP34FinalPublic.pdf

Nanologue. 2006b. *The future of nanotechnology. We need to talk.* http://nanologue.net/custom/user/Downloads/Nanologue_we-need-to-talk.pdf.

Opinionleader. 2007. *Which? Report on the Citizen's Panel examininig nanotechnologies.* http://files.nanobio-raise.org/Downloads/WhichNanotechnologyCitizensPanel_OpinionLeader_ReportAutumn2007.pdf.

Parasuraman, A. (2000): Technology Readiness Index (Tri): A Multiple-Item Scale to Measure Readiness to Embrace New Technologies. Journal of Service Research Volume 2; No. 4, May 2000, 307-320

Powell, M.C., und M. Colin. 2008. "Meaningful Citizen Engagement in Science and Technology. What Would it Really Take?." *Science Communication* 30:126–136.

Renn, O., und M. Roco. 2006. *White paper on Nanotechnology Risk governance*. http://www.irgc.org/IMG/pdf/IRGC_white_paper_2_PDF_final_version-2.pdf.

Scheufele, DA, und BV Lewenstein. 2005. "The public and nanotechnology: How citizens make sense of emerging technologies." *Journal of Nanoparticle Research* 7:659-667.

Shew, Ashley. 2008. "Nanotechnology's Future: Considerations for the Professional." S. 127–146 in *Nanotechnology & Society. Current and Emergin gEthical Issues*, herausgegeben von Fritz Allhoff und Patrick Lin. Springer.

Selin, Cynthia. 2007. "Expectations and the Emergence of Nanotechnology." *Science, Technology & Human Values* 32:196–220.

Siegrist, M., M.-E. Cousin, H. Kastenholz, und A. Wiek. 2007. "Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust." *Appetite* 49:459–466.

Takemura, M. 2008. "Activities on Social Acceptance of Nanotechnology." *Quarterly Review* 28:75–87.

Turner, Steven. 2008. "School science and its controversies; or, whatever happened to scientific literacy? – Turner 17 (1): 55 – Public Understanding of Science." https://univpn.univie.ac.at/+CSCO+1h756767633A2F2F6368662E666E747263686F2E70627A++/cgi/reprint/17/1/55.

Vierboom, C. u. a. 2008. *Wahrnehmung der Nanotechnologie in der Bevölkerung*. Berlin: Bundesinstitut für Risikobewertung.

Welker, M., Werner, A. and Scholz, J. (2005) „Online Research: Markt- und Sozialforschung mit dem Internet" Heidelberg. dpunkt.verlag

Zimmer, R. et al. 2007. "Nanotechnologien im öffentlichen Diskurs. Deutsche Verbraucherkonferenz mit Votum." *Technikfolgenabschätzung - Theorie und Praxis* Nr. 3, 16. Jahrgang:98–101.

Zimmer, René, Rolf Hertel, und Gaby-Fleur Böl, hrsg. 2008. *BfR-Verbraucherkonferenz Nanotechnologie. Modellprojekt zur Erfassung der Risikowahrnehmung b ei Verbrauchern*. Berlin: Bundesinstitut für Risikobewertung

Zöller, Katharina. 2008. *Jugendforen Nanomedizin. Chancen und Risiken, ethische und soziale Fragen der Nanomedizin aus der Sicht junger Erwachsener*.

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APPENDIX 1 : QUESTIONNAIRE TABLES

APPENDIX 2 : DOCUMENTATION MATERIAL

Appendixes are attached as a separate file.