

# Knowledge, Attitudes and Opinions on Nanotechnology across European Youth

Results from a specific survey carried out  
in 25 EU countries

edited by  
the European Commission  
Directorate General RTD  
Directorate Industrial Technologies

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This summary report synthesizes the public "Report on the analysis of survey responses" (91 pages), developed under contract NMP4-SA-1009-233433, archived as NANOYOU\_D1.2\_ZSI\_final, authored by Josef Hochgerner, Ilse Marschalek, Petra Moser, Magdalena Strasser, Johanna Blum, Steve Schwarzer, Eva Zeglovits – ZSI/SORA. We are particularly grateful to all of them and to Yoel Rothschild, Coordinator of the NANOYOU project for providing valuable inputs and for fine tuning and correcting the text.

Τὰ πάντα ῥεῖ καὶ οὐδὲν μένει.

Everything flows, nothing stands still.

(Heraclitus)

## ***Foreword***

This study reflects a large undertaking about a hugely important nano-topic (forgive the sequence of puns), the topic of nanotechnology research. In particular, it surveys the views of thousands of young people from a large array of countries, regarding one of the most pervasive and most frequently touted as promising areas of research. For quite some time now, and after the revolution brought about in and by information and communication technologies (ICT) became apparent, nanotechnology and biotechnology have usually topped most lists of areas where the 'next-big-thing' would come from; areas which could emulate the impact and pervasiveness of ICT. And of the two, nanotechnology is almost by definition the more horizontally pervasive one, permeating potentially all of the aspects of our lives as *homo habilis*, using and manipulating matter, be it of the organic or the inorganic type.

This self-conscious attitude and search for the 'next-big-thing' in itself is an important phenomenon, based on, but also going beyond the premise of scientific and technological (S&T) developments per se. It is often said that the Renaissance was the first period in human development that was self-conscious enough to be aware of its own character, naming itself, instead of waiting for later historians to invent a *rubrique* for it. We may be living through the first period in S&T development that has taken self-consciousness to another level, by looking to brand and coronate its own successor.

Attitudes and views – especially of younger people, who will be called upon to use, finance, regulate, and adapt to future technological development and its impact – are increasingly important in self-conscious times. They drive expectation formation, choices about fields-of-study, use and financing of technologies, and they establish an interactive symbiotic relation with technological breakthroughs themselves. Unlike periods of lower awareness, where technological developments are dealt with only ex-post, in times like ours views matter. The present study breaks new ground in this sense and is a very welcome addition to our understanding of this symbiotic relationship.

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### *Note of the Author*

The European Commission has a clear strategy on communicating nanotechnology. The first, crucial steps that shaped the European Commission's whole approach go back to 2004, when the Communication "Towards a European Strategy for Nanotechnology"<sup>1</sup> was published, followed in 2005 by the "Nanosciences and Nanotechnologies: An Action Plan for Europe 2005-2009"<sup>2</sup>. A strategy for an integrated, safe and responsible nanotechnology was framed for Europe and the rest of the world. Clearly, "societal impacts need to be examined and taken into account. Dialogue with the public is essential to focus attention on issues of real concern rather than "science fiction" scenarios.

It was acknowledged that "nanotechnology is poorly understood. Since it is complex and concerns a scale that is invisible, nanotechnology may be a difficult concept for the public to grasp. While the potential applications of nanotechnology can improve our quality of life, there may be some risk associated with it, as with any new technology - this should be openly acknowledged and investigated. At the same time the public's perception of nanotechnology and its risks should be properly assessed and addressed".

So, developing and appropriate communication and dialogue on nanotechnology has become a need put forward by the EC, to align nanotechnology development with the people's expectations and concerns. Doing so, "the public trust and dialogue on nanotechnology will be crucial for its long-term development and allow us to profit from its potential benefits."

The emphasis on this could not have been clearer. The EC aimed to implement the Action Plan's mandate by encouraging "a better dialogue between researchers, public and private decision-makers, other stakeholders, and the public", and stressing how "beneficial" this would be "for understanding possible concerns and tackling them from the standpoints of science and of governance, and to promote informed judgement and engagement".

Several initiatives have been launched under the 6th and 7th Framework Programmes (FP6 and FP7) of the European Union relating to communication, outreach and societal dialogue which will last until 2013.

In this line, a Communication Roadmap on nanotechnology has been very recently published ("*Communicating nanotechnology – an action-packed roadmap to a brand new dialogue*", published in April 2010), building on knowledge and awareness of nanotechnology: this comes forward with a whole system of organised mechanisms designed to prepare the ground to a very effective feedback and exchange with society. This sets out an ambitious scheme of implementation measures that tests the communications model's efficacy to deliver its messages to millions of citizens effectively. This communication exercise should, indirectly, have two major, desirable effects: increasing the consensus between stakeholders, society and policy-makers on EC decision-making about nanotechnology; and strengthen the image of the EC as an impartial, transparent and trustworthy communicator on nanotechnology.

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<sup>1</sup> European Commission (2004): *Towards a European Strategy for Nanotechnology*, COM(2004)338; EC, Brussels, 2004, at: <http://cordis.europa.eu.int/nanotechnology/actionplan.htm>

<sup>2</sup> European Commission (2005): *Nanosciences and nanotechnologies: An action plan for Europe 2005-2009*, COM (2005) 243, EC, 2005, Brussels, at: <http://cordis.europa.eu.int/nanotechnology/actionplan.htm>

This publication has demonstrated how important is knowing more on the key audiences: in this respect, a crucial input is provided by surveys and web consultations, which enabled us to collect thousands of comments from the lay public and stakeholders, allowing for a wide variety of views, opinions, expectations and concerns from a very broad and multifaceted audience.

Finally, as reaching the right audiences with the appropriate message and means is pivotal, all these dialogue efforts will culminate into the "***European Platform on Nano Outreach and Dialogue (NODE)***". This will deal with a specific system of mechanisms to enliven and coordinate the continuous and open dialogue on nanotechnology within the whole EU society, empowering both EC and Member States with a very challenging tool for delivering technical democracy on nanotechnology. As a consequence, different sets of communication activities and products will converge into a robust and integrated framework enabling to increase both confidence and trust in the EC as a truly transparent and trustworthy nanotechnology communicator.

In this light, this report is a true "first": I do hope this work contributes well enough to fulfil all the challenges it entails, so to inspire others.

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*Gloriae amore vitae*



## ***Executive Summary***

*This survey was carried out from June to November 2009 under NANOYOU project, receiving inputs from 2.000 respondents in 25 European Member and Associated States. Four methodologies were used (i.e. focus groups, expert interviews, national survey, online survey including a knowledge quiz) to study the knowledge, interest, attitudes, opinions, concerns and expectations on nanotechnology in various age segments of lay people, i.e. younger teens, youngsters, young adults. Results show that:*

- Interest is far exceeding the present state of knowledge: nanotechnology is already part of future education and professional career considerations;*
- Television, radio and press are the main sources of information, while the internet is used for purposeful in depth search. School is also a key source for youngsters, while science centres and special events are more important for younger teens.*
- Health, ICT, sustainability, the main considered application areas, match the interest of young people.*
- Balanced information is crucial. When properly informed, adults and young people also show a lot of concern on the potential risks and societal impacts on privacy, consumer protection, environment and health.*
- Gender difference is apparent. In general, boys still know more about nanotechnology. By trend females are more interested in health applications, albeit showing more concerns for safety, while males favour ICT applications.*
- Finally, young people clearly ask for setting up independent regulation and control agencies.*

## Table of contents

<i>Foreword</i> .....	5
<i>Note of the Author</i> .....	6
<i>Executive Summary</i> .....	9
THE SCENARIO: EC COMMUNICATING NANOTECHNOLOGY .....	11
1. SETTING THE SCENE.....	15
2. SCOPE .....	16
3. MATERIALS & METHODS.....	16
4. RESULTS.....	18
4.1 Knowledge .....	18
4.2 Attitudes and opinions.....	18
4.3 Interest and curiosity .....	19
4.4 Values and concerns.....	19
5. CONCLUSIONS.....	23
7. ACKNOWLEDGMENTS.....	24

## THE SCENARIO: EC COMMUNICATING NANOTECHNOLOGY

This report summarises and presents the results from a survey carried out by NANOYOU project. This survey has been addressing several age segments of young people, young adults and a reference group of adults (10%), targeting a representative audience in EU Member and Associated States, with a specific focus on young people. About 2.4 thousands participants provided valuable inputs, though about 2.400 responses were considered appropriate for statistical analysis.

This is not an isolated exercise, as it is an important step along the strategic roadmap the EC has been developing since six years on communicating nanotechnology. Good governance depends on it, as the EC had already acknowledged robustly. The DG RTD, Directorate Industrial Technologies, is firmly set to push this bold principle towards building a broad consensus to support the EC's policy on integrated, safe and responsible nanotechnology. So appropriate communication comes first, and a sound and clever method is needed here, identifying whom you are reaching out to, since audiences are many, envisaging the impact to make people feel personally involved and eager to know more. Additionally, it is crucial to anticipate how to meet the communication needs of the so called "stakeholders" who have a specific interest in nanotechnology, of young people who might not be quite aware of it yet, and of the general public whom the EC wants to keep fully informed about the research developments as they come along.

This strategy started in May 2004, when the European Commission (EC) adopted the Communication "Towards a European Strategy for Nanotechnology"<sup>3</sup> and in June 2005, the EC published "Nanosciences and nanotechnologies: An Action Plan for Europe 2005-2009"<sup>4</sup>. More recently in 2008, the "Commission's Recommendation on a code of conduct for responsible nanosciences and nanotechnologies research"<sup>5</sup> was published stating that "*good governance of nanotechnology and nanoscience (i.e. N&N) research should take into account the need and desire of all stakeholders to be aware of the specific challenges and opportunities raised by N&N. A general culture of responsibility should be created ...*"

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<sup>3</sup> European Commission (2004): *Towards a European Strategy for Nanotechnology*, COM(2004)338; EC, Brussels, 2004, at: <http://cordis.europa.eu.int/nanotechnology/actionplan.htm>

<sup>4</sup> European Commission (2005): *Nanosciences and nanotechnologies: An action plan for Europe 2005-2009*, COM (2005) 243, EC, 2005, Brussels, at: <http://cordis.europa.eu.int/nanotechnology/actionplan.htm>

<sup>5</sup> European Commission (2008): *Commission Recommendation on a code of conduct for responsible nanosciences and nanotechnologies research*, C(2008) 424 final, Brussels, 07/02/2008, at: [http://ec.europa.eu/nanotechnology/pdf/nanocode-rec\\_pe0894c\\_en.pdf](http://ec.europa.eu/nanotechnology/pdf/nanocode-rec_pe0894c_en.pdf)



**Preparing for appropriate communication and dialogue on nanotechnology impel the EC to develop foresight-thinking, strategies and policies**

Most schools' curricula do not cover nanotechnology well, and this may partly depend on the large unawareness and lack of engagement in nanotechnology shown by EU population. Although "nano" words appear frequently in the media, nanotechnology is poorly understood; some think of nano as a form of "magic"<sup>6</sup>, others fear mainly the risks. Unfortunately, these misunderstandings and misperceptions about science are not isolated phenomena<sup>7</sup>. Some of the problems of communicating nanotechnology depend on its invisible nature, its novelty and revolutionary approach. However, the experience of communicating other new technologies shows that the public needs to be introduced to them in a clear and simple way, taking into account common needs and interests, preferably from the very beginning their development.

The EC has already looked further into changing a conventional science and technology communication approach called the "deficit model", according to which the public must understand science in order to accept it. This model is no longer working well<sup>8</sup>, as it seems completely obsolete<sup>9</sup>: this change can be summed up by saying that for communicating science and technology the "*scientific understanding of public*" has now become more important than the "*public understanding of science*"<sup>10</sup>. Consequently, it is possible to see how European institutions such as the European Commission have moved from top-down to bottom-up communication approach on nanotechnology, promoting a "dialogue" model<sup>11</sup> based on science communication as a multi-way exchange of information between specialists

<sup>6</sup> European Commission (2001): "Europeans, Science and Technology" in *Eurobarometer* 55.2, Brussels, December 2001;

<sup>7</sup> European Commission (2006): "Europeans and Biotechnology in 2005: Patterns and Trends", in *Eurobarometer*, Brussels, July 2006.

<sup>8</sup> European Commission (2004): *Nanotechnology: views of the general public* (2004), EC, Brussels

<sup>9</sup> Bonazzi, M.(ed.), (2007A): *Working paper resulting from the workshop on: Strategy for communication outreach in nanotechnology*, EC, Brussels, 6<sup>th</sup> February 2007,

[http://cordis.europa.eu/nanotechnology/src/publication\\_events.htm](http://cordis.europa.eu/nanotechnology/src/publication_events.htm)

<sup>10</sup> Bonazzi, M. and Palumbo, J. (eds.), (2007): *Report from the workshop - Communication Outreach in Nanotechnology: from recommendation to action*, EC, Brussels, 24-25<sup>th</sup> October 2007,

[http://cordis.europa.eu/nanotechnology/src/publication\\_events.htm](http://cordis.europa.eu/nanotechnology/src/publication_events.htm)




<sup>11</sup> Bonazzi, M.(ed.), (2007B): *Working Paper resulting from: Open web consultation on a Strategy for communication outreach in nanotechnology*, EC, Brussels, March-October 2007,

[http://cordis.europa.eu/nanotechnology/src/publication\\_events.htm](http://cordis.europa.eu/nanotechnology/src/publication_events.htm)

and non-specialists<sup>12</sup>, rather than a one-way communication<sup>13</sup>. It describes a process that enables each party to share, listen and be listened to in full respect of the other's points of view. This dialogue model of communicating nanotechnology is founded on an interactive approach seeking to involve many audiences in the discussion and to provide the most complete range of viewpoints and perspectives<sup>14</sup>.

Additionally, a clear message has been sent to communicate and dialogue with selected audiences about nanotechnology. Among these, a very important segment consists of youngsters, pre-adolescents, adolescents (or "teens") and young adults. If they were appropriately informed about nanotechnology in a balanced way, which means on both its exciting prospects and potential risks, they may become well informed and engaged on this subject and contribute to the public debate and decision-making on nanotechnology<sup>15</sup> in the future. These age groups are exactly the focus of the present survey.

The importance of this study is reinforced by the results coming from two separate workshops, with an open web-based consultation on nanotechnology communication outreach launched in the past years. The first workshop (organized on 6<sup>th</sup> February 2007) focused on the main issues to frame a strategy<sup>16</sup>; whose results were presented in an open web consultation (from May to October 2007)<sup>17</sup> to gather comments and questions to be addressed in a second workshop (organized the 25-26<sup>th</sup> October 2007). All these exercises identified a set of potential actions to be developed by the EC<sup>18</sup>. These initiatives, involving the participation of 48 international experts<sup>19</sup>, identified young people as a key audience to reach via multipliers like school and communication media, using visual and "hands-on" techniques such as games, contests or competitions.<sup>20</sup>

<p>Report from the Workshop: Communication Outreach in Nanotechnology: from recommendations to action (Brussels, 24-25 October, 2007)</p>	<p>Working Paper Resulting from the Workshop on: Strategy for Communication Outreach in Nanotechnology (Brussels, 6th February 2007)</p>	<p>Working Paper Resulting from the Workshop on Open Consultation on a Strategy for Communication Outreach in Nanotechnology (Brussels, 6th February 2007)</p>
<p><small>Interested citizens and stakeholders are invited to express comments, opinions and suggestions by end June 2007 to <a href="mailto:matteo.bonazzi@ec.europa.eu">matteo.bonazzi@ec.europa.eu</a>. A final document will be then published.</small></p>		
		
<p><small>Editors: Matteo Bonazzi and Jennifer Palumbo European Commission Unit "Nano- and Converging Sciences and Technologies" Date of publication: January 2008 This publication can be downloaded from: <a href="http://cordis.europa.eu/nanotechnology">http://cordis.europa.eu/nanotechnology</a></small></p>	<p><small>Editor: Dr. Matteo Bonazzi European Commission Unit "Nano- and Converging Sciences and Technologies" Date of publication: 20 April 2007 This publication can be downloaded from: <a href="http://cordis.europa.eu/nanotechnology">http://cordis.europa.eu/nanotechnology</a></small></p>	<p><small>Editor: Dr. Matteo Bonazzi European Commission Unit "Nano- and Converging Sciences and Technologies" Date of publication: 20 April 2007 This publication can be downloaded from: <a href="http://cordis.europa.eu/nanotechnology">http://cordis.europa.eu/nanotechnology</a></small></p>

<sup>12</sup> Cobb, M.D. Macoubrie, J.(2004): *J.Nanoparticle Res.*, 2004, 6, 395-405;

<sup>13</sup> Cobb, M.D. (2002): *J.Nanoparticle Res.* 2002, 4 , 561-570

<sup>14</sup> BMRB international (2007), *Public perceptions about nanotechnology: risks, benefits and trust*, London, in [www.nanotech.org.uk](http://www.nanotech.org.uk) ;

<sup>15</sup> Bonazzi, M. and Palumbo, J. (eds.), (2007): *quoted paper*.

<sup>16</sup> Bonazzi, M. (ed.), (2007A), *quoted paper*.

<sup>17</sup> Bonazzi, M. (ed.), (2007B), *quoted paper*.

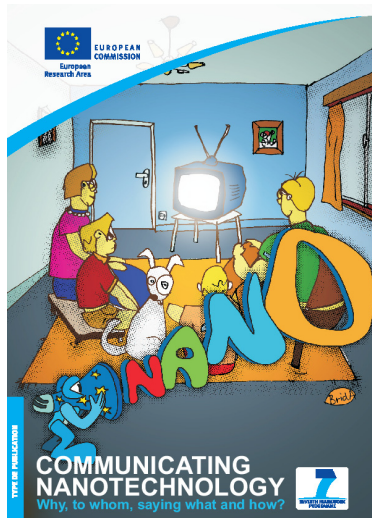
<sup>18</sup> Bonazzi, M. and Palumbo, J. (eds.), (2007), *quoted paper*.

<sup>19</sup> Bonazzi, M. (2008): "Communicating nanotechnology through art", in *Art and Science - creative fusion*, EC, Brussels, December 2008, ISBN 978-92-79-10879-2, pages 13-14, EC, DG RTD, re-printed in 2009.

<sup>20</sup> Bonazzi, M. (2009A), *quoted paper*.

## **Developing initiatives for communication and dialogue on nanotechnology requires innovative approaches**

In this line, a Communication Roadmap on nanotechnology has been published in April 2010 ("*Communicating nanotechnology – An action-packed roadmap to a brand new dialogue*"<sup>21</sup>) to provide a whole system of organised mechanisms designed to communicate nanotechnology to civil society, reaching millions of citizens. This roadmap demonstrated the crucial role of knowing in depth the key audiences. So, surveys dedicated to young people are identified as key tools enabling to collect comments in an organised way, thus providing a broad variety of views framing the opinions, expectations and concerns of young lay public.



All the recommendations coming from these studies have been considered by the present survey. In the same line, an online open consultation open for contributions from December 2009 to February 2010 was launched to support the preparation of a new action plan for nanotechnologies for Europe for 2010 to 2015. It was designed to collect the views of experts active in the field and by the public at large on the benefits, risks, concerns and awareness that nanotechnologies represent. It further sought to receive their opinion on future directions for governance and all relevant policies for an integrated, safe and responsible development and commercialisation of nanotechnologies and nanotechnology-enabled processes and products. The instrument used for the public consultation was a questionnaire jointly designed and worded by the Inter-service Group on nanotechnologies. About 700 responses were received from the general public, individual researchers, research organisations, industry, public authorities and NGOs.

As reaching the right audiences with the appropriate message and means is pivotal, all these dialogue efforts will culminate in the near future into the "**European Platform on Nano Outreach and Dialogue (NODE)**". This will deal with a specific system of mechanisms to enliven and coordinate the continuous and open dialogue on nanotechnology within the whole

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<sup>21</sup>Bonazzi, M., (2010): *Communicating nanotechnology: Why, to whom, saying what and how? – An action-packed roadmap to a brand new dialogue*, EC, Brussels  
[http://cordis.europa.eu/nanotechnology/src/publication\\_events.htm](http://cordis.europa.eu/nanotechnology/src/publication_events.htm)

EU society, empowering both EC and Member States with a very challenging tool for delivering technical democracy on nanotechnology. This should match communication and continuous dialogue activities with the development of nanotechnology, to consider lay people and stakeholder's expectations and concerns. It will to establish a science-technology-social media-based platform for nanotechnology outreach to support a transparent and continuous dialogue in Europe to continuously monitor and understand consumers' and citizens' opinion on nanotechnologies, with a specific emphasis on life-long education. For doing this, the platform aims to use online media to upgrade outreach and bring out the differences in attitudes and opinions across Europe, giving the pulse of the state of the debate considering both cultural and societal specificities. So, it will be a modular platform enabling stakeholders to identify opinions, expectations and concerns related to nanotechnology, describing their historical traceability; and understand cause-effect relationships on a comparative basis. The whole of society (e.g. educators, students, NGOs, media, consumers, industry, researchers, citizens) will benefit from it monitor what people really think, with a special focus to citizens' and consumers' attitudes, behaviors, trends and prospects. Particular attention will be paid to national specificities and needs, helping to prepare options for framing policy responses in the light of public opinion, and promoting multi-stakeholder partnerships.

## 1. SETTING THE SCENE

It has been very clearly demonstrated that even though the degree of awareness on nanotechnology is very low, deeper understanding of science and technology behind it does not play a prominent role in shaping public perception and opinion. On the other hand, the possible impact of nanotechnology on daily life is of paramount importance for citizens<sup>22</sup>.

Generally speaking, 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 the interest of lay people in science and technology is largely considered as spectacle, entertainment or controversy<sup>23</sup>. So, the way consumer products are presented in the market and which information is provided, by/to whom and how is a key driver in shaping public perception, opinion and behaviours on nanotechnology. So, appropriate communication and dialogue on nanotechnology are crucial, and many activities have been therefore set up across Europe to dot that: at EU level the EC funded projects NANODIALOGUE and NANOLOGUE, NANOCAP, MACOSPOL, NANOPLAT, FRAMINGNANO to address outreach methodologies, and at the national level *nanotruck*, *nanocamp*, *nanoreisen.de*, and games like *nanoboy* or videos, songs etc. In some Member states, various nano initiatives are offering different formats for young people, eg. *nano-practica*, internships in nanolabs, *nanodays* or online communities like *fti-remixed*. Such activities reach out for highly interested young people in their **leisure** time. At EU level, various other activities have been carried out by the EC to meet young people in their **professional time**<sup>24</sup>, which is at school, heading to developing appropriate trainings and materials. Only few EC funded running projects target both professional and leisure time (i.e. NANOYOU, NANOTOTOUCH, TIMEFORNANO), undertaking outreach activities at

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<sup>22</sup> nanoBio-RAISE. o. J. *Public Perceptions and Communication about Nanobiotechnology*. <http://files.nanobio-raise.org/Downloads/NanoPublicFINAL.pdf>.

<sup>23</sup> Ibidem

<sup>24</sup> Bonazzi., M. (Ed.), 2008, *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](ftp://ftp.cordis.europa.eu/pub/nanotechnology/docs/nanooutreach_action_final_mar_08.doc)

school and via science centres and is working out appropriate formats and materials for that purpose.

In this light, a specific survey on nanotechnology targeting mainly young people has been identified as a priority, carried out by NANOYOU project to cross-fertilise the other mentioned running projects and shape future research activities on dialogue and engagement for nano-debate. Several age segments of young people have been addressed, including a segment of young adults. So, the survey targeted young people in EU Member and Associated States. About 2.400 participants provided valuable inputs, although 2.000 responses were considered for deep statistical analysis after data cleaning.

## **2. SCOPE**

The aim of the survey was to explore and clarify young people's (i) interest, (i) knowledge, (iii) attitudes, (iv) opinions, (v) specific values, (vi) concerns and expectations, (vii) curiosity concerning nanotechnologies, especially focussing on application areas such as (a) medicine and health, (b) information and communication technologies, (c) energy and environment

This analysis has been detailed in addressing the following questions:

- what do people and especially young people know about nanotechnologies, if they have ever heard about it, and if yes in which context
- what do they associate with the term "nanotechnologies"
- which concerns and expectations do they have on it and which considerations they frame
- what are their general attitudes concerning nanotechnologies
- what are their interests and curiosity
- what are their future visions
- which values drive their behaviour
- what degree of attention they give to ethical, legal and social aspects (ELSA).
- which drivers of ELSA would come up while discussing nanotechnologies with people and especially young people and how would they deal with them
- which sources of knowledge are in use
- which curricular and extracurricular activities exist on nanotechnology as already part of school curricula: if so, which subjects are related and which teaching materials are in use
- to what extent nanotechnology is already part of initial or continuing professional development of teacher's education
- which extracurricular infrastructures are available for interested youth
- at the national contexts in the participating countries, if there were any national public debates going on or any campaigns pro or contra nanotechnology and, if so, by whom
- which actors were taking responsibility for awareness rising in each country
- how were discussions reflected in the media
- what degree of use and credibility have media on nanotechnology
- what type of science communication would be most appropriate
- which good practice examples exist; especially focussing on what are the teaching experiences so far concerning the scientific understanding and discussing ELSA
- which expected or observed gender specificities could be discerned.

## **3. MATERIALS & METHODS**

This work 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 research included focus group discussions with young people in three age groups, expert interviews in 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 available in eight European languages and was filled in by 2.397 respondents of four age groups which were differently represented, before data cleaning.

A description and analysis of the empirical work is given. Each instrument was analysed separately according to the main issues worked out with the survey:

- Focus groups
- Expert interviews
- National context survey
- Online survey and quiz

### **Number of valid answers across 25 EU Member and selected Associated States**

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
<b>total</b>	<b>492</b>		<b>1.905</b>

### **After data cleaning**

<b>MS or AS</b>	<b>11-14</b>	<b>15-19</b>	<b>20-25</b>	<b>26 and older</b>	<b>total</b>
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
<b>total</b>	<b>365</b>	<b>1302</b>	<b>105</b>	<b>197</b>	<b>1969</b>

Obviously, the youngest group is very hard to reach. As nanotechnologies are not yet part of the regular school curricula, identifying interested teachers who carry the communication activities by themselves are needed. 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 gained the highest response rate.

The eldest group (19 – 25) is also challenging, as communication channels are not as clearly available compared to schools. Because of the sample sizes of the age groups, analyses have been carried out within two groups, i.e. 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.

## 4. RESULTS

Main results in terms of (i) knowledge, (ii) attitudes and opinions, (iii) interest and curiosity and (iv) values and concerns on nanotechnology have been presented.

### 4.1 Knowledge

#### ***Nano: I do not know much, but I am interested in it...***

Interest in nanotechnology exceeds the current degree of knowledge on it. Young people could have heard about nano, but they do not have a deep understanding, as their knowledge is mostly related to specific nano consumer-products.

Key sources of knowledge are school, TV and radio, newspaper, magazines, movies as nano is occasionally a topic in the media. The internet is used for in depth research. School is a key source of information for all young people, but of course its performance depends strongly on the degree of engagement of teachers.

Overall, design of media (print and internet) is of paramount importance to compete for young people's attention. Adolescents wish to learn more at science centres, exhibitions and events. The degree of outreaching is related to interest.

### 4.2 Attitudes and opinions

#### ***Girls prefer health applications, boys favour ICT***

Young people's opinions and perceptions of development of nano are positive as well as negative: nano has a great potential, especially for health applications where the development steps in the right direction. Remarkable is that the girls and young women expressed interest in health application and male on ICT. Besides positive attitudes, some fears and threats emerged, and limits should be set to guarantee (e.g. these technologies will not contribute to human cloning or robots will get out of control). The younger group showed more interest in

sustainability aspects, whereas the elder group favoured broader interests. The fact that EU population is growing older than ever before thanks to medical progress is critically assessed.

#### **4.3 Interest and curiosity**

##### **Back to school: nano is "cool"**

Nano is already part of future education and professional career considerations of young people, as they are keen on developing school curricula by incorporating modules on nanotechnology.

#### **4.4 Values and concerns**

##### **Pick the good, drop the bad**

Although widely optimistic, believing that nano will improve our lives in the future in health, ICT and environmental applications, young people remain sceptical and critical against major risks and societal impacts (ELSA) such as privacy, consumer protections, environment and health. They clearly ask for independent regulation and control agencies. The young people, independent from age and gender, had the ability to discuss ELSA of selected consumer products, although some difficulties occurred especially on drug delivery. Remarkable is that the girls and young women mentioned more often concerns and fears than their male opposites, on health, environmental safety and enhancements.



*Anti-bacterial socks: positive and negative attitudes*

The attitudes towards antibacterial socks nano-enabled with silver nanoparticles are varying between positive and negative. A lot of the young people recognise it is a positive and useful product, albeit they could negatively impact the environment, both polluting during washing or waste disposal. Apparently, these issues require attention, and many of the young people were sceptical, so they declared they would not wear them before long term tests guarantee their harmlessness. Still, some declared they did not want to be abused as "human guinea pigs" before the product is honestly tested. Human toxicity is recognised as another important drawback, as silver-particles might infiltrate into the human skin. The price is also a crucial factor for young people. A better and cleaner performance doing sports was recognised as an advantage. Finally, although some more "nano-confident" young people would not refuse to wear these socks, they would not want their children wearing them.



### *GPS jacket: mostly negative*

The opinion about the jacket is mostly negative. In fact, topics like surveillance and total control are very sensitive for young people: they dislike other people constantly know where they are, and this attitude is independent of age and gender. Most of the young do not want to wear such a jacket and they would not even want their children wear it. So, abuse of monitoring and control is the main drawback. While boys related their concerns to total surveillance carried out by government and police, girls were more concerned by criminal misuse.

The early detection was recognised as positive feature only in winter and extreme sport to prevent fatalities in case of avalanches or similar dangers. However, some young people wish to have the option to turn it off or on, as they want to control the GPS function of the jacket: if not, they mostly dislike this product. The environmental impact of this jacket is not seen prominent as in the case of antibacterial socks.



### *Sun-glasses: very controversial*

The opinions about this product are very ambivalent. Some young people like this product, thinking it is useful, especially when implementing this technology on bigger surfaces as a rucksack.. The most efficient UV protection was seen as an advantage.

On the other side, some other young people expressed their concerns on possible radiation, as they would do not feel very comfortable while wearing this product near their head or their eyes. Most girls would not buy them, due to health concerns. Additionally, the cable connecting the glasses with the charger was considered quite disturbing. Finally, design and price could also influence young people's choice.

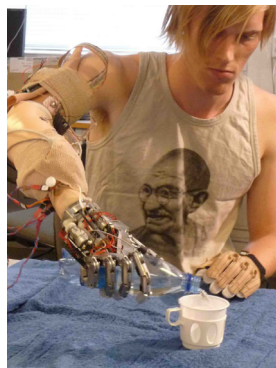
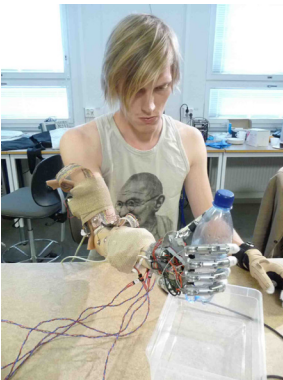


*e-paper: mostly positive*

*e-maps and e-books: fairly positive*

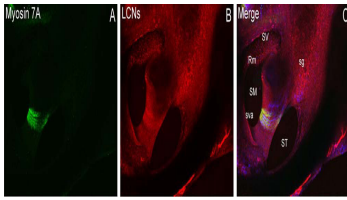
Most of the young people have a positive attitude towards the e-paper, being considered practical as space-saving. Environmental benefit in terms of paper and power saving was also considered as very positive, also compared to LCD or Plasma screens.

It was also suggested to use the e-paper especially for daily newspapers, for private use as well as in coffee shops or restaurants, allowing to reduce the huge amount of paper waste. The "word searching" function was recognised as another important advantage, although the difficulty to scribble notes on the e-paper was considered a drawback. Some concerns were mentioned on possible health risks due to screen radiation or parasite electricity, especially by the girls. The vulnerability in terms of computer viruses was also identified as a possible drawback. Finally, price was considered as a driver too.



*Health: positive but concerned*

Young people thought nanomedicine should be affordable for most people all over world: if not, social conflicts might arise. The inequitable allocation is a very sensitive topic for young people, independently of their age or gender. So, setting up an independent body was recognised as a possible solution to cope with nano-divide in health care. Additionally, possible ethical aspects and impacts on ageing population were addressed, rising both positive and concerned attitudes. Finally, although most young people recognised they actually are afraid of being nano-treated, they would accept it in case no other possibility would be available.



*Drug delivery: very controversial*

The assessment of nano-enabled drug delivery is very ambivalent as well. On the one hand, young people think it could be a good medical improvement to heal serious diseases, especially personalised medicine or targeted surgical operations. On the other hand, young people are very sceptical, showing many concerns and fears on the possible side effects and accidents damaging healthy tissues.

## 5. CONCLUSIONS

This survey was carried out from June to November 2009 under four methodologies, i.e. focus groups, expert interviews, national survey, online survey and knowledge quiz. The open accessible online survey was filled in 25 European Member and Associated States, and finally received useful 2.000 respondents after data cleaning. It addressed people's and especially young people's interest, knowledge, attitudes, opinions, specific values, concerns and expectations, curiosity on nanotechnology. Areas of special interest were medicine and health, ICT and sustainability, where positive impacts for our lives are expected.

Generally speaking, interest is bigger than knowledge, and the main source for information are television, radio, press, schools (for young people), and the internet for in depth search, while, science centres and dedicated events are important for younger people. Female prioritise health while male ICT applications.

However, people and especially young people remain sceptical and critical against major risks and societal impacts such as privacy, consumer protection, environment and health. They clearly ask for independent regulation and control agencies.

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