Project:
The Landscape and Isobars of European Values in Relation to Science and New Technology (ValueIsobars)

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Measuring Values

Work package 2

Authors:

George Gaskell, Stavroula Tsirogianni, Nicole Kronberger

Partner (institution):
LondonSchool of Economics and Political Science (LSE)
Methodology Institute

1. Introduction and overview

Different social groups call upon different knowledge bases and social values, consume media with different agendas and as a result construct different representations of science and technology. From the perspective of technology and society the idea of choice – adoption or resistance - is crucial. Choice in turn is based on conceptions of the good life; things current and for the future that are seen as desirable and worthy of effort, as against those things that constitute a challenge to the good life and future lives, and as such should be resisted. As societies are marked by a plurality of values, the challenge for the modern republic is not that of a conflict-free existence but finding ways to understand and manage competing visions of the good life. As a basis for governance, accessing and measuring values represents an important challenge. This report takes up this issue and addresses the measurement of values in the context of science and technology. During the *Value Isobars project* the following questions were addressed:

1. What value concepts inform empirical studies in the science and technology domain? What are the strengths and weaknesses of the respective approaches?
2. What is being published on the relationship between values and public perceptions of science and technology?
3. What data are available for analyses of the relationship between values and public perceptions of science and technology?

In the following, we first report on key insights resulting from analyses conducted on these questions. A review of value concepts and related value measurements was complemented by a review of what is being published on values in the science and technology domain. Furthermore, the field was scanned for the availability of data addressing values in the context of science and technology. The results were presented in detail in prior deliverables. In this report we summarize the main outcomes and formulate key challenges for future research. The four challenges addressed include:

- What to ask (conceptualisation)
- Who to ask (sampling)
- How to ask (formats and methodologies), and
- What to do with the data (data analysis)

For each of these challenges we formulate recommendations and identify future research needs.

2. Key insights resulting from the project's activities

2.1. Literature review

Measuring values is not a straight forward task. First, there a theoretical understanding of what values are is needed, and then decisions on how to measure values must be taken. In our first deliverable, we provided an overview on theoretical approaches that have influenced value measurement. This review resulted in the differentiation of eight approaches to understanding values in different theoretical traditions and disciplines. For each approach, we discussed the major strengths and weaknesses. The review shows that conceptualising and measuring values is a complex endeavour. There are many different understandings of the term value and the suggestions for measuring values vary widely.

The review suggests that the classic psychometric paradigm (values as attitudes held by individuals) seems to be given priority over the anthropological view when studying values. As a consequence, values are more likely to be conceptualised as individual rather than as social phenomena. This may be due, first, to the fact that it is easier to measure values at an individual level. Furthermore, the historical conditions in which the approaches developed may have played their role. We found that the social, economic, political developments between the two world wars and the periods that followed led scholars to prioritise a humanistic approach in their study of values. They saw values as means to world peace, democracy and solidarity. This coincided with psychologists' concerns to establish the scientific status of their discipline, which led to a strong concern with improving measurement techniques. Surveys and experiments were the dominant methodologies and analytical approaches prioritised questions about the universal validity and internal consistency of value systems.

In terms of value measurement, the most influential suggestions were made by Hofstede (1980, 1991), Inglehart (1977; Inglehart & Abramson, 1999), Rokeach (1967, 1973), Schwartz (1992; Schwartz et al., 2001) and Triandis (1995). None of these were developed in a context related to science and technology. If at all, the Inglehart index shows most affinity, mainly because of its consideration of environmental topics. The problem with this approach is that it addresses only one value dimension (materialism/ postmaterialism), which may be too narrow to capture all value-related concerns in the domain of science and technology. The same is true for Triandis who aimed at classifying cultures on the dimension of individualism versus collectivism. Hofstede's approach was developed within an organisational context, focusing on work values within a multinational company. Rokeach's and Schwartz's goal, finally, was to provide a comprehensive consideration of universally valid values. These latter approaches deliberately abstract values from any context or content; they aim at measuring values in a trans-situational way. Value measurement taking into account the specific characteristics and affordances of the science and technology context is rare. Dake (1991), for example, proposed a scale to measure cultural theory (Douglas & Wildavsky, 1982; Thompson & Wildavsky, 1990). However, the approach received relatively little empirical support.

In summary, the existing value scales either address single value dimensions (e.g. materialism versus postmaterialism, or individualism versus collectivism) and hence may be too specific for more general questions related to science and technology; focus on contexts other than science and technology (e.g. the context of work and organisation); or involve rather lengthy value batteries supposed to measure universal value systems. The latter

approach is time and cost-intensive and may be too broad for the purpose of informing science and technology governance.

2.2. ISI Web of Science Search: What is published on values?

In a second step, we focused our interest on whether and how the lines of thought identified in the literature review left their marks on empirical research on values in the context of science and technology issues. What has actually been published and which theoretical traditions provided the framework used?

We analysed all studies addressing values in the context of science and technology, published in high impact journals as indexed in the ISI-Web of science database (for details see deliverable 2). Our search in the SSCI data base consisted of a search for the key words *value*, *worldview*, *ethics*, *moral*, *culture* or *religion* and all their grammatical variations as they co-occur with *science* or *technology*. Out of 4,348 publications from 1956 to 2010, 3,359 were non-empirical papers and 989 were empirical occupying 23% of the overall body of literature. Both automatized analyses using the Alceste software (Reinert, 1990, 1998) and manual coding using the Atlas.ti software (www.atlasti.com) were conducted (for more details see deliverable 2 and the appendix). Since the focus of this report is on value measurement, we focus on the analysis of the empirical papers. In the following we summarize the most important results.

Values and related concepts. In the empirical papers, about a third (N = 346) referred to the concept of value. In contrast, more than half of the empirical papers dealt with questions on culture, while slightly more than a quarter of the papers employed the concept of ethics. Moral and religious aspects both were addressed in about 9% of the empirical papers. The worldview concept clearly is the least often used concept for guiding empirical analyses in the context of science and technology. It should be noted that some papers make use of more than one concept. Furthermore, the numbers refer to papers that include the terms in their title or abstract. Reference to the concept hence does not necessarily imply that the concept is of central importance to the paper. As a consequence, the numbers are more likely to over- rather than underestimate the true availability of empirical value studies. Taking into account that the data cover more than half a century, it must be concluded that empirical value studies in science and technology contexts are far from frequent.

Theoretical approaches. The heterogeneity and fragmentation reported for the literature review (section 2.1) were mirrored in the empirical articles published in SSCI journals. Early value theories were developed to address societal questions pertinent to intergroup conflict, prejudice and war. This is probably why these frameworks have not been widely used in studies on science and technology. In contrast, those theories that were developed after the 70s (i.e. Inglehart, Hofstede, Triandis, Schwartz) seem to have had a stronger impact on research in values, science and technology. However, some of these theories bear many similarities with their antecedents in terms of promoting an individualistic, universal and abstract understanding of values; others are rather narrow in focus as they address single value dimensions. In contrast, the affordances of governance in the field of science and technology demand for a contextualised understanding of values on

the one hand, and an inclusion of a wider range of values on the other hand. In our data base, the Hofstede approach is the most frequently cited. Given that a large proportion of empirical publications were found to concentrate on issues around work and management, it is not surprising that we find many references to this work, which originally stems from an organisational approach and focuses on work values. All of the other theoretical approaches identified in deliverable 1 do (infrequently) appear in empirical work on values in the context of science and technology but there is no standard approach to measuring values in this domain.

The contexts addressed by empirical value studies. As the Alceste analyses show (for more details see the appendix), three key areas have attracted particular empirical research interest: 1) Science education (including issues related to evolution, religion, science literacy and gender); 2) Diffusion of Information Technologies, business innovation and modernisation processes; and 3) Biomedical issues as they relate to clinical and medical research and to more general questions of health and illness. The concept of values was found to be more associated with the former, whereas ethics was more often embedded in the latter. Manual coding provides further support for this finding. Table 1 presents the relative frequency of contexts addressed by empirical studies employing the value concept; for comparison it also shows the corresponding numbers for studies relying on the concept of ethics. For the latter, medical issues and science education clearly are most important. For empirical value studies, in contrast, information technologies play a prominent role. Similarly, economic development and modernisation as well as management and organisational issues attract attention. The medical context, environmental and food issues, and science education also are of relevance to empirical value studies.

context	Relative frequency of contexts addressed by empirical studies	
	mentioning values[1] (n = 346)	mentioning ethics (n = 268)
Information technology	32%	16%
Medical context	28%	61%
Education/Learning	25%	32%
Environment/Food & Agriculture	25%	13%
Economic context/Modernisation	22%	3%
Management/ Organisational Issues	21%	12%
Biotechnology	7%	22%
Religion	5%	4%
Nuclear Power	2%	0.4%
Nanotechnology	1%	0%

Table 1. Contexts addressed by empirical 'value' and 'ethics' studies. Note that more than one context can be relevant to a publication; the percentages hence do not sum up to 100%.

When it comes to more specific technological developments, empirical value studies are scarce. For example, there are 25 studies on biotechnology that mention the term 'value' in their title or abstract; the corresponding numbers for nuclear power and nanotechnology are 6 and 3. Given that the data base spans more than half a century, one must conclude that for specific technologies, empirical evidence on the role of values is marginal. Another example may illustrate this observation. A journal that carries the term 'values' in its name is *Science, Technology and Human Values*, which was launched (under a

different name: 'Newsletter of the Program on Public Conceptions of Science') in the early 70s for the purpose of contributing to the development of research and teaching on the dynamics between culture, politics and science. In 1976 it was renamed to 'Newsletter on Science, Technology and Human Values' to reflect its emphasis on the ethical and value dimensions of science and the public views on these. Since its launch, the journal has produced 1,757 publications in total. However, a paradox emerges when looking at the number of publications dedicated to the research of values in science and technology. Since 1976, only 81 publications include the term 'values' in their title, keywords list or abstract, out of which 59 are articles. Furthermore, from these 59 articles, only 27 are empirical studies, out of which only ten introduce the public in their analysis of values.

The methods and samples used in empirical value studies. In terms of methods used, values are particularly likely to be addressed with the help of survey research (the ethics concept, in contrast, is more likely to be employed in qualitative research such as in interviews or focus groups). Often, the survey data are not based on representative samples and cross-national comparisons are rare. The Anglo-Saxon culture is the primary focus of research, followed by research from Northern Europe. Given that only English language publications were included in the analysis this may be of little surprise. However, the general trend in the social sciences to disseminate research in English (Gingras & Mosbah-Natanson, 2010) has implications in terms of who participates or not in the production of knowledge. For governance it means that evidence on value-related issues is not equally available for all countries and regions.

The example of Biotechnology. Since the Value Isobars project has chosen two applications – biometrics and dual use – we also checked whether and how often these issues come up in empirical value research. We did not find a single publication dealing with these issues. However, since the two applications often become relevant in the wider context of biologically sensitive issues, we picked out empirical research on biotechnology for the purpose of illustration. In our data base there are 89 publications presenting empirical research on biotechnology. Only 25 papers explicitly draw on the concept of values (in comparison, 63 papers draw on the concept of ethics). In terms of the relevant research topics, the biomedical/health context is the most researched topic (n= 12) followed by environmental and food related concerns (n= 7). About half of the value studies draw on survey research (n = 12); interviews and/or focus groups are used similarly often (n = 11). In terms of the samples used in these studies, there are three key groups. These are a) the public as a generic category, which is used in 6 studies and mainly in surveys (n=4), b) scientists and researchers (n= 6) and c) students (n=3). Other samples include different members of the public such as religious groups, employees, patients, environmentally active groups, or farmers. In terms of the countries studied, there is a focus on publics from the USA and Northern Europe. Moreover, cross-cultural or cross-country comparisons are rare. From a policy making perspective, such comparative investigations would reveal possible connections in the relations between citizens, state, science and the industry and between public value concerns and the design of institutional structures of governance in different countries.

2.3. Review of data availability

Bringing policies in line with the values of European citizens is an important task for governance. However, it is not only the speed of research innovations that poses challenges. As our analyses show, it is not easy to gain information on what role values play when it comes to the evaluation of science and technology. There clearly is a lack of cross-cultural research in the topic which could allow exploring similarities and differences in the values of publics in different countries. However, does this gap relate to the absence of research interest or is it a lack of data availability?

To address this question we searched for measurement instruments, and more precisely for survey data that is available in the public domain (for details see deliverable 1). In our search, three aspects were considered. First, data should have a European dimension, representing a number of European member states. Secondly, surveys should include questions addressing public perceptions of science and technologies. And thirdly, surveys should provide value indicators. Ideally, data should combine all three aspects (see Figure 1).

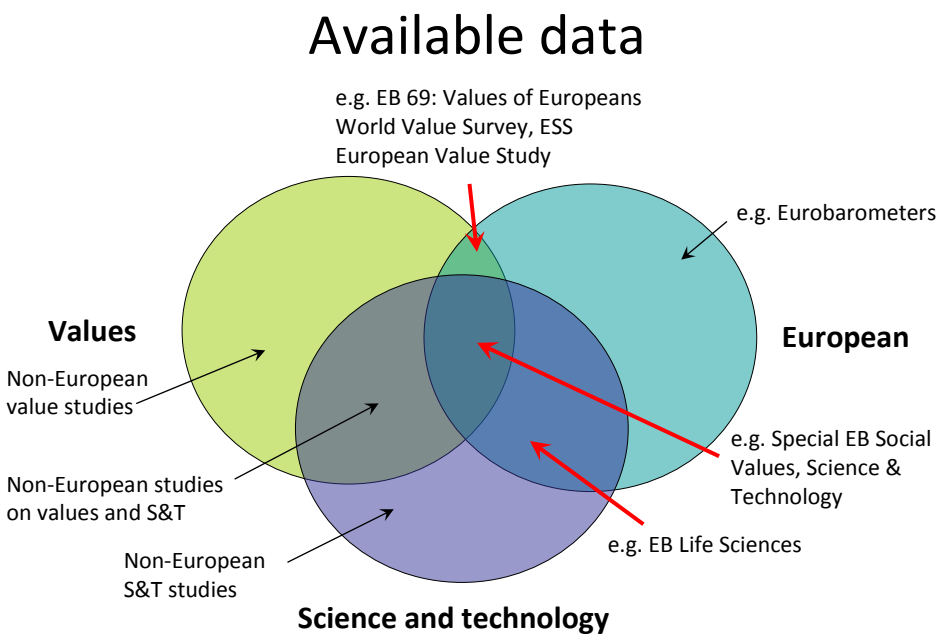

Figure 1. Available data.

Our search indicates that there is little data available satisfying all three criteria (see Table 2 for an overview). There are four important survey series focusing on values that, however, include very few items addressing public perceptions of science and technology. These are the World Values Survey (WVS), the European Social Survey (ESS), the European Values Study (EVS) and the Value Survey Module (VSM).

When it comes to surveys on public perceptions of science and technology in European countries, it is primarily the Eurobarometer (EB) surveys that provide a rich data base. There are many such Eurobarometer surveys on a wide variety of topics. Given the project's focus, surveys such as the 'Science and technology' Eurobarometer and the

'Europeans and Biotechnology' Eurobarometer (EB 73.1) are of particular interest. In these surveys, values are very little covered.

Finally, it is only one wave of Special Eurobarometers that combines all three criteria, explicitly addressing values in the context of science and technology (Special Eurobarometer on Europeans, Science and Technology & Special Eurobarometer on Social Values, Science and Technology, EB 63.1)[1]. The disadvantage of Special Eurobarometers is that they often are one-shot surveys. As a consequence, time-series data are not available, precluding insights on developments over time.

	Survey name	Year of fielding
Value Surveys	World Values Survey[2]	Every 5 years, since 1981
	European Values Study[3]	Every 9 years, since 1981
	European Social Survey[4]	Every 2 years, since 2002
	Value Survey Module[5]	Availability of country scores since 2001
Science & Technology Surveys	Science and technology (EB 73.1)[6]	2010
	Europeans and Biotechnology in 2010 (EB 73.1)[7]	2010
Surveys addressing both values and S&T	Special Eurobarometer on Europeans, Science and Technology (EB 63.1)[8]	2005
	Special Eurobarometer Social Values, Science & Technology (EB 63.1)[9]	2005

Table 2. *Availability of survey data for European countries on values, and/or perceptions of science and technology*

In summary, the search for data indicates that there is relatively little data available addressing values in a science and technology context, providing representative data for a number of (European) countries. However, it is not the case that no data is available at all. As our ISI-Web of Science search shows the data are very little used in high profile publications. We found that up to 2010 only four published studies were based on data from the World Values Survey and two drew on Eurobarometer data. It can be concluded that the lack of representative cross-national analyses that investigate values empirically in science and technology contexts is due to a combination of reasons. The available data may not be 'ideal', but there also is a lack of exploitation of available resources.

[1] http://ec.europa.eu/public_opinion/archives/ebs/ebs_224_report_en.pdf; http://ec.europa.eu/public_opinion/archives/ebs/ebs_225_report_en.pdf
[2] http://www.worldvaluessurvey.org/
[3] http://www.europeanvaluesstudy.eu/evs/about-evs/
[4] http://www.europeansocialsurvey.org/
[5] http://www.geerthofstede.nl/research--vsm.aspx
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[8] http://ec.europa.eu/public_opinion/archives/ebs/ebs_224_report_en.pdf
[9] http://ec.europa.eu/public_opinion/archives/ebs/ebs_225_report_en.pdf

Qualitative data (such as interview or focus group transcripts) traditionally are less accessible in the public domain. There are several reasons for the difficulty of sharing qualitative data, such as, for example, the fact that the interpretation of qualitative data demands for context knowledge and background information. Especially when it comes to research fielded in different countries and languages, problems abound. However, recent trends indicate increasing efforts to store qualitative data, making it accessible to the wider research community (see for example the Economic and Social Data Service[10]). To date, however, to our knowledge there is no nameable qualitative data base on values in the context of science and technology as held by European citizens.

Based on the reviews presented in the prior sections we now turn to the challenges for future research. As we will emphasize there is both a need for further data collection and a need for better exploitation of existing resources. Taking the perspective of governance in the field of science and technology, specific demands for data collection and data analysis come to the fore. We address these by discussing the questions 1) what to ask; 2) who to ask; 3) how to ask; and 4) what to do with the data.

[10] http://www.esds.ac.uk/

3. Challenge 1: What to ask

Major challenges

- There is no standard instrument to measure values in the context of science and technology
- In order to be useful for governance, values need to be addressed in combination with beliefs
- The issue of value conflict needs particular attention; thereby different levels of aggregation need to be taken into account (e.g., individual, social groups, regions, countries)

Value content. As detailed in the prior sections, there is no value concept that could be routinely used in the context of science and technology studies. Accordingly, there is no standard measurement instrument that can be relied upon. There still is a need for pilot studies to address the question what values or value systems are of importance to controversies over science and technologies. For such explorative purposes, qualitative research may be particularly useful. Furthermore, reviews and meta-analyses can contribute to synthesizing the fragmented literature. When it comes to surveys, a problem with existing value scales is that often they are rather lengthy. Taking into account the costs of fielding representative surveys in a number of countries, there is a need for developing shorter scales that nevertheless cover the most important value issues related to science and technology.

Values in context – the role of beliefs. A particular challenge to studying values is that the proliferation of different constellations of social contexts necessitates the existence of hybrid and heterogeneous value systems. There is growing evidence that demonstrates that individuals as reflective agents are able to hold multiple identities and values. Hence, people mix and switch between them rather than being guided by universal canons. In light of this, measurements that go beyond unitary and universal accounts of values are necessary, which will explore the different situational underpinnings of attitudes towards different technological and scientific developments in conjunction with different cultures, milieus, regions, socio-demographic groups etc.

Furthermore, an important research need concerns the question on how values operate on abstract versus contextualised levels. For example, many people agree that ‘human dignity must prevail’; there is less consensus, however, on what counts as ‘human’ and whether human dignity applies to human embryos or not. A consequence for the measurement of values is that instruments need to address values in combination with related beliefs. Only the combination of the subjective importance of a value and the judgment on whether the value is relevant to a particular context will give the full picture.

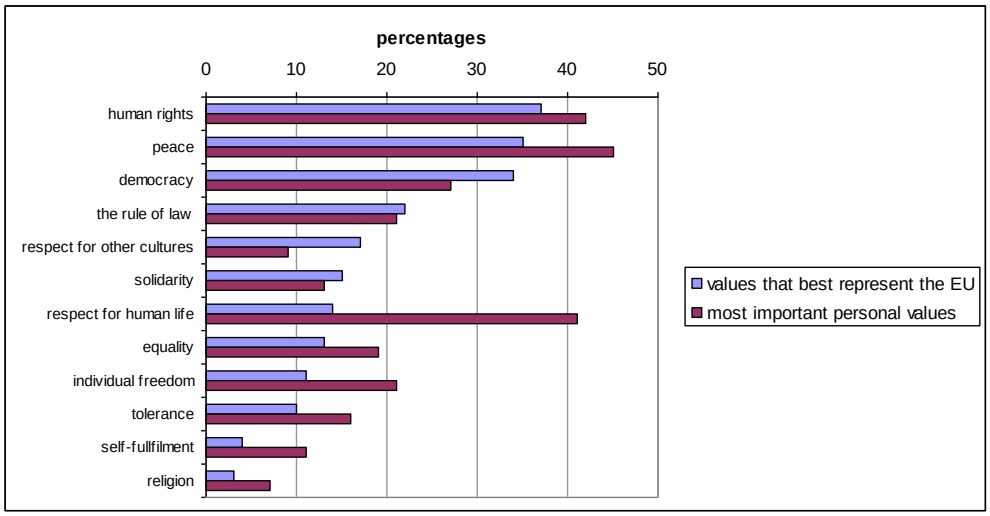


Figure 2. Personal and EU values (based on data from Eurobarometer 69 'Values of Europeans').

Consider another example. In the 2008 Eurobarometer 'Values of Europeans' [11], respondents were presented a list of values and asked to choose three values that represent best (a) their personal values, and (b) the values promoted by the European Union. Figure 2 represents the results across the 27 European member states. One value attracts particular attention, namely 'respect for human life'. While it is one of the most important values when it comes to personal importance, it is as less important to the European Union. Of course, questions arise about the meaning of the divergence. It is easily thinkable that the value touches upon technology issues (e.g. in the context of human embryonic stem cell research). However, without further items that address different contexts for which the values might be important, no conclusions can be drawn. For purposes of governance, the abstract value alone does not provide sufficient information. Hence, it is important to study values as they pertain to beliefs about specific technological contexts, applications, goals, or key players pursuing these goals rather than as abstracted from them.

As the review on data availability showed, there are not many data sets available that address both beliefs and values. Value surveys such as the World Values Survey (WVS), the European Social Survey (ESS), the European Values Study (EVS) and the Value Survey Module (VSM) do include items on a variety of contexts such as work, education, religion, politics, the environment or economy. Hence, future modules could add the science and technology context. Similary, Eurobarometers related to science and technology topics could be enriched by a well-developed values battery. Another issue is the availability of time-series data in these surveys, which would allow for tracing the European value trajectories as they relate to science and technology. Again, there is a lack of data in this domain.

As the review of published work on values in a science and technology context showed, there are some contexts for which values have been addressed quite extensively (mostly in medical contexts, science education and consumer contexts). For specific technologies such as biotechnology, nanotechnology or nuclear energy, however, publications are rare and there is a need for further research.

A challenge for governance: managing value diversity and value conflict. As for governance issues of diversity and conflict are of particular importance, there is a need for information on the degree of consensus on value importance, and divergence respectively.

[11] http://ec.europa.eu/public_opinion/archives/eb/eb69/eb69_values_en.pdf

Thereby, different levels - such as European (vs other parts of the world), national, or regional – are to be addressed. Similarly, within society variation and the value concerns of different social groups need to be investigated. Research needs to attempt to explain and interpret value diversity, ambiguity and complexity that is relevant to policy making. For doing so, data is necessary that can be aggregated and broken down in different ways. Individual-level data that is collected in a number of nation states provides the most flexible data. Our review of published work shows that value conflict and diversity in the context of science and technology is very rarely addressed by empirical studies.

4. Challenge 2: Who to ask

Major challenges:

- Research agendas should reflect the diversity of needs and problems within and across societies.
- Qualitative research needs to complement survey research. While the former is better suited to capture the range of value-related concerns, the latter allows estimating the degree to which such concerns are shared or contested.

It increasingly is taken for granted that 'the public' represents a critical passage point for measures of science policy. Thereby, the public is a construct or shortcut to name a variety of diverse groups. Figure 3 illustrates the variety of such publics. The different groups may be more or less organized (e.g. in civil society groups or nongovernmental organizations). Networks of citizens frequently are formed in order to represent moral, ethical or ideological concerns and hence often voice value-related concerns. However, not all individuals participate in such networks and decision-makers may wonder to what degree concerns voiced by interest groups are shared by individual citizens. It is the (potential) conflicts that often are of particular interest.

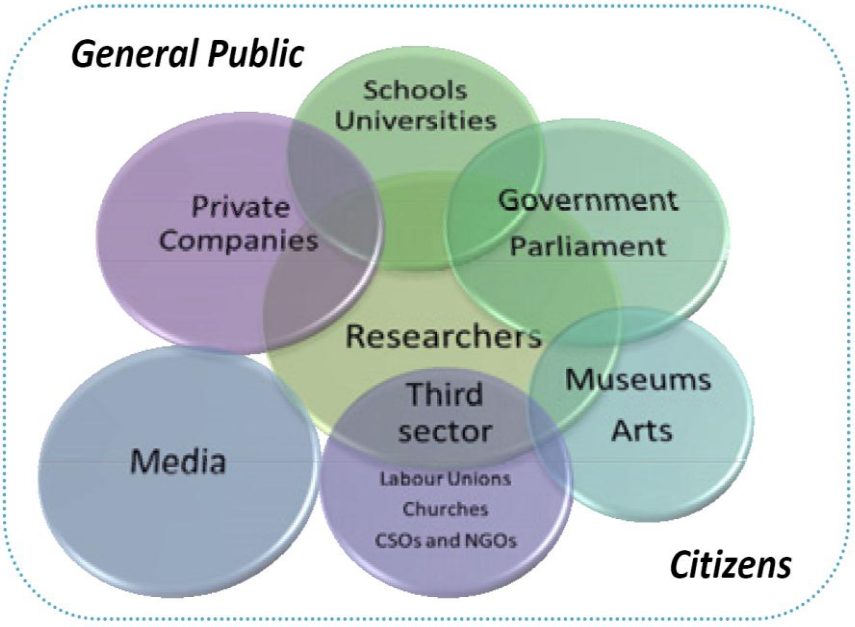


Figure 3. The 'public' as composed by a variety of groups (MASIS Expert Group, 2009, p.21)

For value measurement the question results who should be interviewed about values in relation to science and technology. While qualitative research traditionally has addressed the concerns of a limited number of specific groups, survey research has focused on concerns of the general public. Research on values in the context of science and technology will profit from including both perspectives. While qualitative research will be more suitable to address the question on what is the range of value concerns within a society (phenomenon representativeness), survey research will be more apt to address the question

to what degree such concerns are shared within and across countries (population representativeness).

Qualitative research. Governance needs to understand how different social groups use and share values to resolve and frame conflicts as they relate to different technologies. Qualitative methods can help understand how individuals and groups navigate through value dilemmas and the resources they draw on to resolve these in relation to a particular technology. Qualitative methods allow engaging with a plurality of perspectives, examining different dimensions of complex phenomena, and providing insights into how specific groups use values to resolve dilemmas and make sense of technologies. Stakeholders' values can be studied through the collection and analysis of available documents such as policy documents, reports, opinion pieces and parliamentary debates. Expert interviews are regularly used as foresight tools, to identify new controversial technologies. Public engagement exercises, apart from being seen as tools of deliberative democracy, could be also used as sources of data on the value dimensions of technologies, to be further scrutinised and interpreted. Of course in this case, researchers need to be mindful of the limitations that the contexts in which these exercises take place (who structures these, for what purposes, how) may bear on the nature and quality of the data. Specialist discussion forums and new social media can also become useful vehicles for data collection regarding social groups with specific interests, allowing easy and fast access to diverse samples. These types of data can be particularly useful for understanding public reactions and ways of making sense of new technological developments as they enter the public sphere and raise controversies.

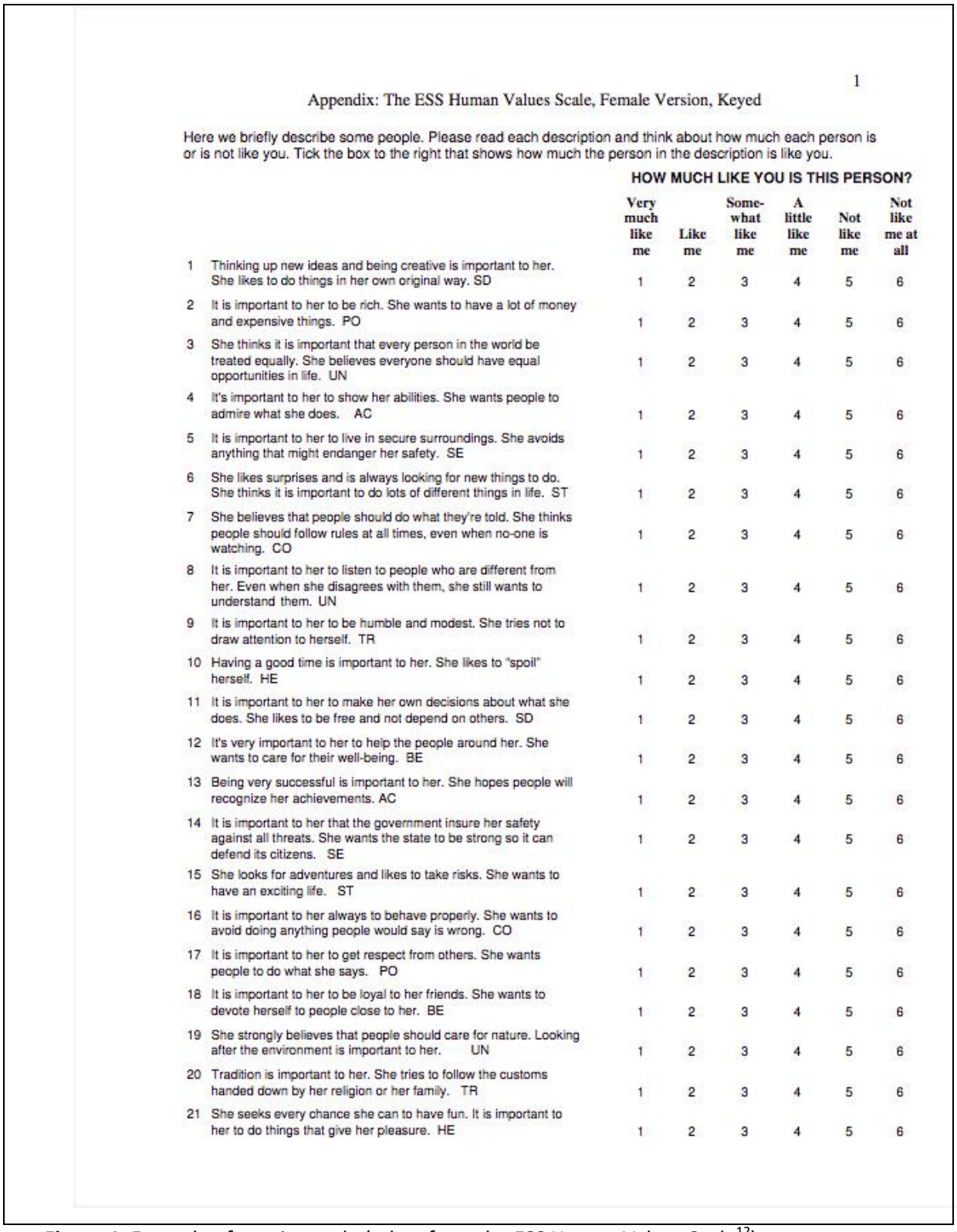
Surveys. As already mentioned, the strength of surveys is to provide insights on the degree to which concerns are shared within and across countries and other social units; the representativeness of results certainly is of great importance to decision-makers. However, value surveys could be improved by taking the following aspects into account. Individuals' value concerns tend to vary depending on the life domain to which they pertain; identities, social roles and values are closely intertwined. Technologies represent different risks and possibilities for different social groups. We thus see the need for surveys to unearth the differences in value sets between individuals acting as various types of stakeholders (e.g. farmers, activists, NGO members, scientific community etc.) or those not affiliated with an organized stakeholder group. In order to address the more specific value concerns in a representative way, in future value surveys modules could be included that contain detailed questions on people's involvement in interest groups and on their perceptions of these groups. These value surveys should also allow for insights on how individuals' value priorities change or not depending on the role they take in different life domains. Moreover, our review of published literature showed that publics from some cultures, especially from less technologically advanced countries, are underrepresented in the research body. Instruments such as the surveys discussed in section 2.3 provide the opportunity to address the concerns of citizens in a wide range of countries. Future research should address the full range of concerns within and across societies.

5. Challenge 3: How to ask

Major challenges:
- Values are truistic by nature, which makes rating scales prone to framing effects
- Forced choice or ranking formats activate 'upon reflection' judgments
- Vignettes and scenarios can be used for stimulating deliberation on values
- Piloting of value questions and formats is crucial

Related to the opposition of qualitative versus quantitative research methods is the question on the degree of structure involved. Structured formats provide the respondent with a series of response options, which can make responding easier, and help the researcher to accumulate and summarize responses more efficiently. But, they can also constrain the respondent and limit the researcher's ability to understand what the respondent really means. There are many different response formats, each with their own strengths and weaknesses. In the following we review the most commonly used formats in value measurement.

Rating. Many value surveys measure what people cherish or what constitutes *ideals, goals, and guiding principles* in their lives. In terms of methods, people typically are confronted with lists of values and asked to indicate how important these are to them. Such rating scales are a widely used measurement method. The Portrait Value Questionnaire (Schwartz et al, 2001), for example, employs such rating. While the original version included 40 items, this was shortened to make it suitable for large scale surveys, such as the European Social Survey (see Figure 4). The advantages of rating include that scores can be used for most statistical analyses and that it is suitable for lengthy scales. Moreover, rating provides information on the latitude of acceptance of a specific item. From the respondents' perspective rating is a comparatively easy task. In the context of measuring values, however, the problem with rating scales is that there is a tendency of acquiescence. Values, by definition, are things that are considered good. If asked to rate the importance of values, people will tend to consider most values important and as a consequence, the responses will be skewed towards the agreement pole. This is the so-called ‘values as truisms’ problem (Maio & Olson, 1998); values are cultural truisms that are widely shared and rarely questioned. Hence, attention is needed when formulating value items for such scales because the manifestation of the desirable (as this is inherent in the concept of values) in the item could push ratings to extremes.



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Appendix: The ESS Human Values Scale, Female Version, Keyed

Here we briefly describe some people. Please read each description and think about how much each person is or is not like you. Tick the box to the right that shows how much the person in the description is like you.

		HOW MUCH LIKE YOU IS THIS PERSON?					
		Very much like me	Like me	Some-what like me	A little like me	Not like me	Not like me at all
1	Thinking up new ideas and being creative is important to her. She likes to do things in her own original way. SD	1	2	3	4	5	6
2	It is important to her to be rich. She wants to have a lot of money and expensive things. PO	1	2	3	4	5	6
3	She thinks it is important that every person in the world be treated equally. She believes everyone should have equal opportunities in life. UN	1	2	3	4	5	6
4	It's important to her to show her abilities. She wants people to admire what she does. AC	1	2	3	4	5	6
5	It is important to her to live in secure surroundings. She avoids anything that might endanger her safety. SE	1	2	3	4	5	6
6	She likes surprises and is always looking for new things to do. She thinks it is important to do lots of different things in life. ST	1	2	3	4	5	6
7	She believes that people should do what they're told. She thinks people should follow rules at all times, even when no-one is watching. CO	1	2	3	4	5	6
8	It is important to her to listen to people who are different from her. Even when she disagrees with them, she still wants to understand them. UN	1	2	3	4	5	6
9	It is important to her to be humble and modest. She tries not to draw attention to herself. TR	1	2	3	4	5	6
10	Having a good time is important to her. She likes to "spoil" herself. HE	1	2	3	4	5	6
11	It is important to her to make her own decisions about what she does. She likes to be free and not depend on others. SD	1	2	3	4	5	6
12	It's very important to her to help the people around her. She wants to care for their well-being. BE	1	2	3	4	5	6
13	Being very successful is important to her. She hopes people will recognize her achievements. AC	1	2	3	4	5	6
14	It is important to her that the government insure her safety against all threats. She wants the state to be strong so it can defend its citizens. SE	1	2	3	4	5	6
15	She looks for adventures and likes to take risks. She wants to have an exciting life. ST	1	2	3	4	5	6
16	It is important to her always to behave properly. She wants to avoid doing anything people would say is wrong. CO	1	2	3	4	5	6
17	It is important to her to get respect from others. She wants people to do what she says. PO	1	2	3	4	5	6
18	It is important to her to be loyal to her friends. She wants to devote herself to people close to her. BE	1	2	3	4	5	6
19	She strongly believes that people should care for nature. Looking after the environment is important to her. UN	1	2	3	4	5	6
20	Tradition is important to her. She tries to follow the customs handed down by her religion or her family. TR	1	2	3	4	5	6
21	She seeks every chance she can to have fun. It is important to her to do things that give her pleasure. HE	1	2	3	4	5	6

Figure 4. Example of a rating scale (taken from the ESS Human Values Scale[12]).

[12] http://datadatabase.files.wordpress.com/2011/03/schwartz-value-inventory1.jpg

Consider the following example. In the 2008 'Values of Europeans' Eurobarometer[13], half of the respondents was asked to indicate their agreement (agree, disagree, don't know) to the item 'Economic growth must be a priority for (our country), even if it affects the environment', while the other half of respondents indicated their agreement on the item 'Protecting the environment should be a priority for (our country), even if it affects the economic growth'. As Figure 5 shows, agreement to the two items differed considerably. While in the former formulation, 53% opted for the environmental option, in the latter it was 74%. Although in both cases a majority opted for the environmental response, the difference is considerable, pointing to the importance of question formulation.

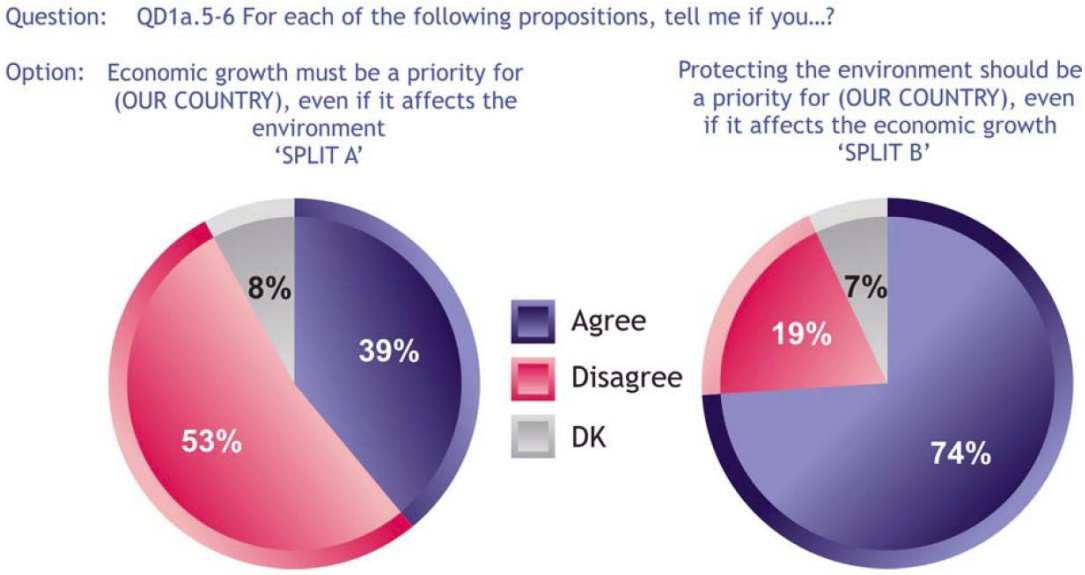

Figure 5. An example of question framing (Eurobarometer 69, Values of Europeans[14], p.57)

The methodological solution of formulating the item differently for the two halves of respondents (that is, introducing a so-called split ballot) is but one possibility of addressing the truism problem. In the Eurobarometer 73.1 'Europeans and Biotechnology in 2010'[15] a similar question was asked by making use of a different format. In this survey, respondents were offered two possible ways of dealing with climate change and asked to indicate which was closest to their opinion

- To halt climate change, we have to rethink ways of living even if it means lower economic growth
- Technology will stop climate change and global warming so we can maintain our way of life and economic growth

Ten per cent of respondents said that they don't know (the corresponding numbers in the split ballot are 8% and 7% respectively). In this format, however, there was less temptation to simply agree to whatever value was emphasised: 64% chose the first option, while 26% preferred the second option. The numbers lie in between the two percentages of the split ballot and hence seem to provide a more accurate measure.

[13] http://ec.europa.eu/public_opinion/archives/eb/eb69/eb69_values_en.pdf
[14] http://ec.europa.eu/public_opinion/archives/eb/eb69/eb69_values_en.pdf
[15] http://ec.europa.eu/public_opinion/archives/ebs/ebs_341_winds_en.pdf

Forced choice and ranking. The just mentioned format is an example of forced choice; respondents are presented two or more options and choose the one that most closely corresponds to their view. A further example is the so-called Inglehart index, one of the very few value measurements developed in a context broadly related to science and technology (see Figure 6). The Inglehart-index is based on four items, which have been used in the Eurobarometer-series and in the World Values Survey (WVS). Respondents are asked to choose the most important option first and the second important one second.

There is a lot of talk these days about what this country's goals should be in the next ten or fifteen years. Would you please say which one of them you yourself consider most important in the long-run:
a) Maintaining the order of nation;
b) Giving the people more say in important government decisions
c) Fighting rising process; or
d) Protecting freedom of speech.

Figure 6. Inglehart index[16]

Forced choice involves ranking (for another example see Figure 7). Rather than addressing what is valued these formats investigate what is valued *more* than something else. Ranking forces either/or positions, which makes it a more difficult and time-consuming process for respondents as trading in values often is experienced as aversive and unpleasant. However, the procedure forces respondents to think about values, which can yield more reliable results and allow for important insights concerning the relative importance of different values.

Rokeach Value Survey

Each value is accompanied by a short description and a blank space. Your goal is to rank each value in its order of importance to you for each of the two lists. Study each list and think of how much each value may act as a guiding principle in your life.
To begin, select the value that is of most importance to you. Write the number 1 in the blank space next to that value. Next, choose the value is of second in importance to you and write the number 2 in the blank next to it. Work your way through the list until you have ranked all 18 values on this page. ….

A Comfortable Life (terminal) _____
A prosperous life

Equality (terminal) _____
brotherhood and equal opportunity for all

Ambitious (instrumental) _____
hardworking and aspiring

Broad-minded (instrumental) _____
open-minded

etc.

Figure 7. Examples of terminal and instrumental values in Rokeach's Value Survey

[16] http://www.worldvaluessurvey.org/index_surveys

Moreover, respondents sometimes are asked how much gains in one value are needed to give up another value (e.g. how many lives need to be saved in order to allow human embryos being used for research). This allows for insights with regard to tradeoff resistance and the degree to values being 'protected', 'sacred' or 'taboo' (Baron & Spranca, 1997; Fiske & Tetlock, 1997). A weakness of approaches considering value combinations, clashes or conflicts, is that in order to be systematic long lists of value comparisons are to be made. This may be difficult and tiresome for respondents and costly in terms of survey administration. It often is not possible to ask that many questions. So the challenge is to identify value sets that are relevant in a specific context. A meta-analysis of empirical research on values and science and technology could help identify such value sets for future studies.

Scenarios and vignettes. Scenarios and vignettes can be used both in qualitative and quantitative methods to explore values in context, as they relate to different points of view. They can be complemented with scales that measure respondents' range of acceptance, rejection or non-commitment. Figure 8 presents an example. Scenarios and vignettes are often employed in qualitative studies as a stimulus for individual interviews or group discussions. They are less suitable for large representative surveys as they tend to be lengthy and complex to process. However, short vignettes can be used to tackle complex issues pertinent to value dilemmas, as they relate to alternative points of view about a particular topic. Furthermore, they can help exploring values in relation to beliefs. Potentially, respondents can also be asked to state the extent to which they agree or disagree with each option and then choose the one that comes closer to their view. This is a method commonly used in social judgment (Sherif & Hovland, 1961). A scenario can be found acceptable or not depending on whether it falls on the respondent's range of acceptance, rejection and non-commitment. This would enable us to identify how respondents negotiate dilemmas and how they proceed into compromises.

Length of Life – Man/Nature Relationship

Three men were talking about whether people themselves can do anything to make the lives of men and women longer. Here is what they said:

B (Mastery): One said: it is already true that people like doctors and others are finding the way to add many years to the lives of most men by discovering (finding) new medicines, by studying foods and doing other such things as vaccinations. If people will pay attention to all these new things they will almost always live longer.

A (Submission): the second one said: I really do not believe that there is much human beings themselves can do to make the lives of men and women longer. It is my belief that every person has a set time to live, and when that time comes it just comes.

C (Harmony) The third one said: I believe that there is a plan to life which works to keep all living things moving together and if a man will learn to live his whole life in accord with that plan, he will live longer than other men.

Which of these three said mostly nearly what you would think is right?
Which of the other two ways is more right?
Which of the three would most other persons in…… say was most right?

Figure 8. Example of a scenario from the Values Orientation Method (VOM) questionnaire that focuses on the man-nature relationship problem (Kluckhohn & Strodtbeck, 1961)

Piloting. When it comes to cross-cultural survey development, piloting in all participating countries is important to test the impact of different modes of data collection (e.g. face to face interviewing, telephone, postal, internet surveys) and of different formats (rating, forced choice, ranking, vignettes) on response rates and biases, and evaluate the cultural, practical and theoretical base of the use of different measures. Moreover, issues of translation need to be given consideration. Although piloting is a labour intensive, extensive and complex stage in the research process, it is crucial and needs to be given the proper attention.

6. Challenge 4: Data analysis

Major challenges:

- Often more time and money is spent on data collection than on data analysis
- Existing data could be better exploited
- Data analysis should go beyond single-item interpretations
- There are powerful statistical methods that can help improve measurement quality, the reconstruction of latent values, and the identification of natural groupings
- There is a need for synthesis and integration of results by means of reviews and meta analyses

A final challenge concerns data analysis. As our various reviews show, the challenge is finding ways of addressing values in context, taking into account the limited amount of data that is available. Of course it would be helpful to fund data collection. For example, existing value surveys could be enriched by the inclusion of a technology-related item set; similarly, technology-related Eurobarometer surveys could be improved by the inclusion of a well-developed value battery. However, in times of austerity we also see the need of acknowledging and capitalising on the value of existing data on the subject through new types of analyses. As our reviews showed, many data sets remain under-analysed. This is unfortunate because data do not speak for themselves. To provide useful insights for science and technology policies, they must be carefully analysed and interpreted.

Secondary data analysis. Publicly accessible data sets such as the Eurobarometer surveys, the European Social Survey or the World Values Survey are rarely used in publications on values in science and technology contexts. In-depth exploration of such sets of data constitutes a clear opportunity. Open access to this type of data also creates the possibility for multiple analyses thus entailing the chance for fruitful scientific discussion. As pointed out earlier, the problem with these data sets is that they rarely address both values and science and technology issues in detail. The challenge hence is finding creative ways of linking datasets in order to explore values not as abstracted from their context but as they relate to beliefs about technologies. So, what are the possible inquiries? If a survey provides information both on values and on technology perception, *individual level analyses* can be conducted, but the data can also be aggregated for groups, countries and other units of interest. If surveys do not provide information on both values and technology evaluation, these surveys – providing information on one of the two aspects – nevertheless may provide useful information. However, the use is not as flexible as with individual level data as only aggregate data can be combined (*country level analyses*); often such aggregation leads to rather rough measures. For example, some surveys classify nations on the basis of values; these aggregate data can be used as value indicators in analyses relating this information to indicators stemming from other surveys (e.g. surveys focusing on technology perception). Although both types of analyses may be informative, it must be kept in mind that the meaning of the two types of analysis is different. Individual-level correlations produce dimensions of personality; country-level correlations produce dimensions of national culture. While individual level data can be aggregated to form higher level social units (social groups, regions, countries, etc.), the opposite move is not possible. Individual level data that combines values with items related to science and technology hence is more flexible and allows for a wider range of research questions.

Can people tell what they value? Fischhoff (1991) pointed out that researchers hardly agree on the empirical possibilities of accessing respondents' values. While some hold that people – if asked clear and meaningful questions – can very well provide meaningful answers, others are convinced that people actually lack clear and articulated values for many life domains. For the analyst this latter view implies that values cannot be asked about directly but need to be reconstructed on the basis of a number of a respondent's choices. Finally, there is an intermediate option, which states that people in general are not that badly informed about their own values that they need to start from scratch each time, but neither are all possible values necessarily well articulated. Whatever philosophy one adheres to, there are consequences for value measurement. We take the stance that contrasting different approaches will provide the most interesting insights. As a consequence, in addition to directly asking respondents about the values they hold ('expressed values'), research should address 'revealed' or 'basic' values. Such values may be accessed by the inspection of bundles of attitudes. On a more societal level, values may also materialise in group- or state-level indicators (such as economic development, state religion, democratic development, gender relationships, etc.). Such values address the issue of value climates or materialised value expressions that characterize larger social units or societies as a whole. The advantage of this approach is that it allows for insights into aspects that are of such importance to societies or groups that they materialize in laws and/or specific action. Such aspects may represent an important frame for individual thinking and perception; they may determine the limits of what is thinkable in a society and what is not. Importantly, members of a society need not necessarily be aware of this influence. A weakness of the approach certainly is that it will give a rather rough measure of values, and furthermore, within societal variation is hard to address. In terms of analysis the challenge is combining data in original ways.

Exploiting the potential of innovative statistical methods. The transformation of raw data into useful and actionable information for the purposes of understanding society and informing policy making needs careful attention. Unfortunately, analyses often do not go beyond the presentation of descriptive statistics such as average scores or percentages. While this may be adequate for some purposes, higher quality information with greater societal significance and functional use can be achieved. By employing innovative statistical analyses better quality information can be retrieved from survey data. Furthermore, such methods allow for the integration of different data and for critically probing interpretations.

Valid and reliable measurement. Responses to individual survey items are determined not only by the content of the question, but - as highlighted above - also by response tendencies (such as the acquiescence tendency to value items), question wording or the available response formats. Furthermore, respondents in different countries may bring different cultural understandings to the item content. It is hardly possible to address questions of data quality exclusively at the design stage. Thus, further quality control needs to take place during the analysis phase. In order to construct valid and reliable measurements of values, information from many items needs to be combined (it is important to move beyond single-item interpretations). Using statistical methods such as latent variable models (e.g. Skrondal & Rabe-Hesketh, 2004), it can be examined how different items function in the survey. Thereby, it is possible to analyse whether the items tap into the same construct, or whether there are response effects that might distort the information in the data. Once identified and modelled, biases can be accounted for and

separated from the value dimension, so that the overall accuracy of the scale is improved. Furthermore, in the context of cross-national comparison, it is important to examine whether the survey questions operate comparably across different countries and cultures. While survey designers often use detailed translation procedures to check the meaning of items across countries, the issue of non-equivalence of measurement also needs to be addressed during analysis. The mentioned statistical methods allow addressing the issue. Ultimately, they can also contribute to determining which items should be revised or deleted in future surveys.

Revealed values: values as latent constructs. As mentioned above, people may – at least in part – be unable to report on their 'true' value preferences. As a consequence, researchers may develop item scales that address values in more indirect ways; in combination the items are supposed to tap into the latent concept. Statistical latent variable models are used to represent concepts by multiple questions and analyse the relations among the concepts. The most widely used latent variable models are linear factor analysis models and their extensions. However, these are not always satisfactory because they treat the items as continuous variables. As we have shown, it is often more useful to measure values with the help of ranking or forced choice formats. Such items allow for only a limited number of response options, and thus produce categorical variables which have a fixed set of two or more possible values. For the analysis of such data, latent class or latent trait models will be the method of choice.

Exploration and the identification of natural groups. Latent variable analyses (e.g. latent class models) also resonate with an exploratory approach to the data that does not classify groups a-priori but rather aims at uncovering groups as they naturally occur in the data (Stares, 2008). It is typical in survey analysis to assume that country samples should be viewed as separate units, sometimes that the gender divide should be taken into consideration, or perhaps other stratifications such as levels of education, family status or income. But it might be both more meaningful and more efficient to divide Europeans into other groups. For example, one can divide the European public into different groups based on their answers to questions on scientific citizenship to produce 'modes of engagement' with science (Gaskell *et al.,* 2005). Uncovering natural groupings in the data set will contribute to identifying relevant classifications that can be used for further analyses. Latent class models provide the tools for the identification of natural groupings in a data set. With this analysis we can discover, using statistical indicators of model fit, how many classes are needed to adequately represent the variation in the data.

Furthermore, natural groupings need not necessarily be identified at the individual level but such groupings can be explored at country levels as well. Often, data are presented either at the European level or at the national level. But falling between these levels of aggregation is the possibility of clustering a number of countries according to similar profiles. Such clustering gives a systematic assessment of the Member States that fall into particular groups according to similarities in levels of support for new technologies or in terms of value preferences. Methods like cluster analysis and latent variable modelling help to assess and map out such similarities and differences.

Multi-level modelling furthermore helps address the question how value preferences are affected by multi-level systems in which they occur (at the national level, socio-economic characteristics, or history). For example, respondents can be understood as citizens of a specific country. There will be both individual variation and national-level variation; citizens in a country may share their concern for some values as they share the same context. Ignoring such clustering leads to errors in model estimation (Goldstein, 2003). Multi-level

models can be used to avoid such errors, to ensure that the comparisons made between groups are accurate. For example, multi-level modelling can allow assessing the ways in which value preferences depend upon national contexts – different levels of socio-economic progress, shared experience and culture, or different policy configurations.

A need for synthesizing results. In addition to detailed empirical analyses, reviews and meta analyses should synthesize what is known on the role of values for public perceptions of technologies. For example, a careful review of the existing qualitative studies may enable the identification of similarities and differences of issues arising across a number of technologies. Similarly, reviews and meta-analyses on quantitative analyses should provide better knowledge on the types and strengths of effects reported. Furthermore, analyses could focus on some of the following issues and questions.

i) What are the relations between specific values or value sets and specific technologies or families of technologies? Typologies or clusters of technologies should be identified that are similar in terms of underlying value conflicts and controversies. Conversely, frequent constellations of value conflict could be identified that affect clusters of technologies. In order to be useful to governance the challenge is to abstract from specific technological applications on the one hand but to be detailed enough to capture important differences on the other hand. For example, security and fairness have been found to be central in the evaluation of technologies like biometrics, biotechnology and nanotechnology. However, they may take different meanings and importance when it comes to these different technologies and their applications.

ii) When does a technological development become an issue for the public? Not all technologies pose value dilemmas or result in public controversy. Are specific values or value sets particularly likely to be related to conflict over technologies? When are they likely to be evoked? What developments and changes over time are observed?

iii) What are the values promoted by different groups and what is known on value 'coalitions'? For example, with the recent example of Greenpeace bringing to the German courts the case of stem cell patenting, the question arises as to whether environmental and green values emerge as a new set of values likely to play a role in the future of stem cell debate, a field traditionally dominated by religious concerns.

iv) What core goals are involved in different technologies (e.g. progress, innovation)? And how do these change in the context of different implementations (e.g. regulation, applications) for different groups?

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Appendix

ALCESTE, performing a correspondence analysis, classifies words used about a topic, thus identifying different ways of talking about that topic (Reinert, 1990; 1998). ALCESTE looks firstly for words that are frequently mentioned and secondly for words that co-occur. According to these criteria it distinguishes word classes that represent different forms of structures and discourse about the topic of interest (Kronberger& Wagner, 2000).

1. In a first step, we analysed the key contexts that are likely to elicit **both theoretical and empirical** research on the field. Our Alceste analysis distinguished 6 classes which were: Science Education; Socio-economic Development and Sustainability; Technological Diffusion and Markets; Medical Ethics; Religion and Science; and Bioethics and Law.

2. In a second step, we examined how **empirical** studies tackle questions on science and technology and whether they are any differences in the topics that are taken on for empirical analysis. Using the 989 empirical papers as our corpus Alceste distinguished 8 classes. These share many similarities with the classes derived from the analysis of all publications (theoretical and empirical). However, the current analysis identified further nuances in terms of the topics that are studied as well as in terms the association between methodologies and concepts used some of those classes. Specifically, empirical research on the topic of 'medical ethics' is divided into research on the health care system (class 6) and on the role of ethics in research and clinical practices (class 1). Another difference arises in the 'Technological Diffusion & Markets' class, which is further divided into those studies that take on issues of trust and risk around Information Technologies and Nuclear Power (class 2) and those studies that focus on the business and industrial implementation of information communication technology systems, dealing with management and organisational issues and comparing western (USA) and eastern cultures (Japan, China, Korea) (class 4). When 'science education' is empirically studied, research prioritises questions on the intersection between religion and education (class 14%) and scientific literacy in relation to gender (8%). Hence, the initial class of 'religion and science' takes a more narrow focus in empirical research to emphasise their relevance to science education. The metaphysical aspects of the relationship between science and religion appear to be a topic of theoretical discussion not taken on for empirical investigation. Finally, 'modernisation and sustainability' in empirical research focuses more on the latter emphasising the management of ecosystems and environmental resources (class 7).

3. In a third step, and as the emphasis of the current project is on **values**, we chose to examine in more depth those studies that focus explicitly on values. Alceste derived four classes, which focus on similar issues while also leaving out some other.

Table 2 summarizes the three Alceste analyses. The table is followed by further information on analysis II and III.

	Analysis I	**Analysis II**	**Analysis III**
	Theoretical and Empirical Papers Alceste Analysis I	**Empirical Papers Alceste Analysis II**	**Empirical papers on Values Alceste Analysis III**
Class 1	Science Education 21%	Research/Biomedical ethics 13%	Research/Biomedical ethics 36%
Class 2	Modernisation and sustainability 20%	Commercial Applications, Technological Diffusion and Nuclear Power 19%	Commercial Applications, Technological Diffusion, Nuclear Power & Modernisation 30%
Class 3	Technological Diffusion & Markets 19%	Bioethics 11%	Regulation and management of ecosystems and biodiversity & Information Technology Systems 24%
Class 4	Medical Ethics 18%	Information Technology and Management 16%	Gender and Scientific Literacy 10%
Class 5	Religion and Science 16 %	Science Education and Religion 14%	
Class 6	Bioethics and Law 7%	Health Care & Medicine 11%	
Class 7		Regulation and management of ecosystems and biodiversity/ Sustainability 8%	
Class 8		Gender and Scientific Literacy 8%	

Table 2. Classes derived from the three Alceste Analyses

Alceste Analysis II – Empirical papers

Number of words in corpus	191,635
Number of different unique words identified	11,807
Total number of words used in analysis	1,357
Number of ICU's	989
Number of ECU's	5,558
Average number of significant words per ECU	17.02
Number of lexical classes	8
Degree of stable classification	72%

Table 1: *Summary of Alceste Analysis II using empirical studies (n=989).*

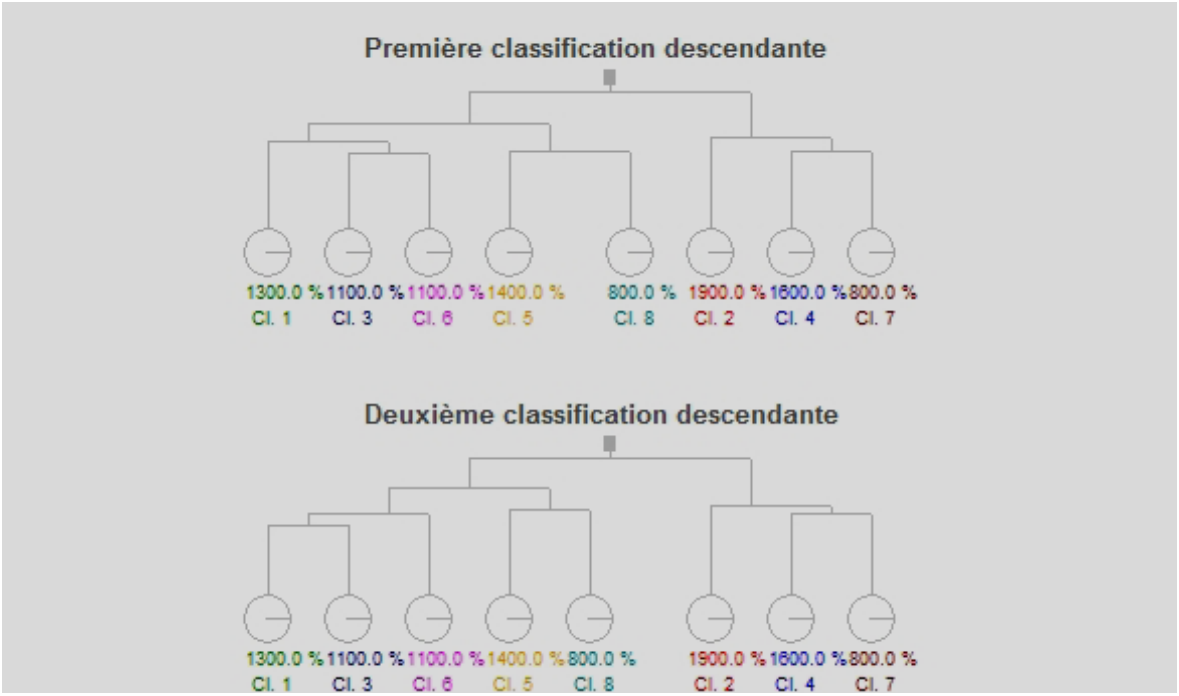

Figure 1: Analysis II- Dendrogram solutions illustrating the stability of class intersections.

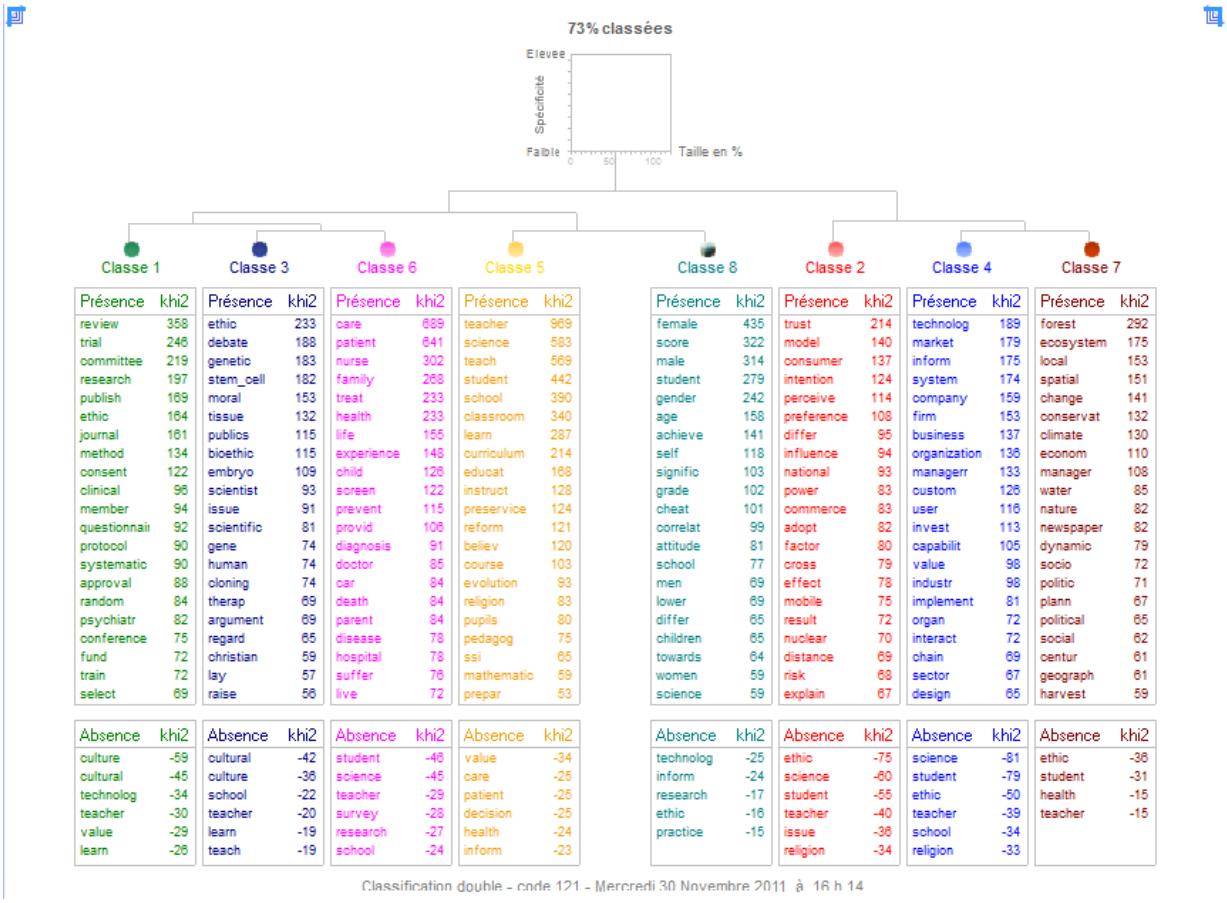

Figure 2: Analysis II-Most characteristic words contained in each lexical class ranked by their chi2 value.

Alceste Analysis III- Empirical Papers focusing on 'Values'

Number of words in corpus	40,855
Number of different unique words identified	5,690
Total number of words used in analysis	1,237
Number of UCI's	204
Number of UCE's	1,233
Average number of significant words per UCE	17.27
Number of lexical classes	4
Degree of stable classification	62%

Table 2: *Summary of Alceste Analysis III using empirical studies focusing on values (n=204).*

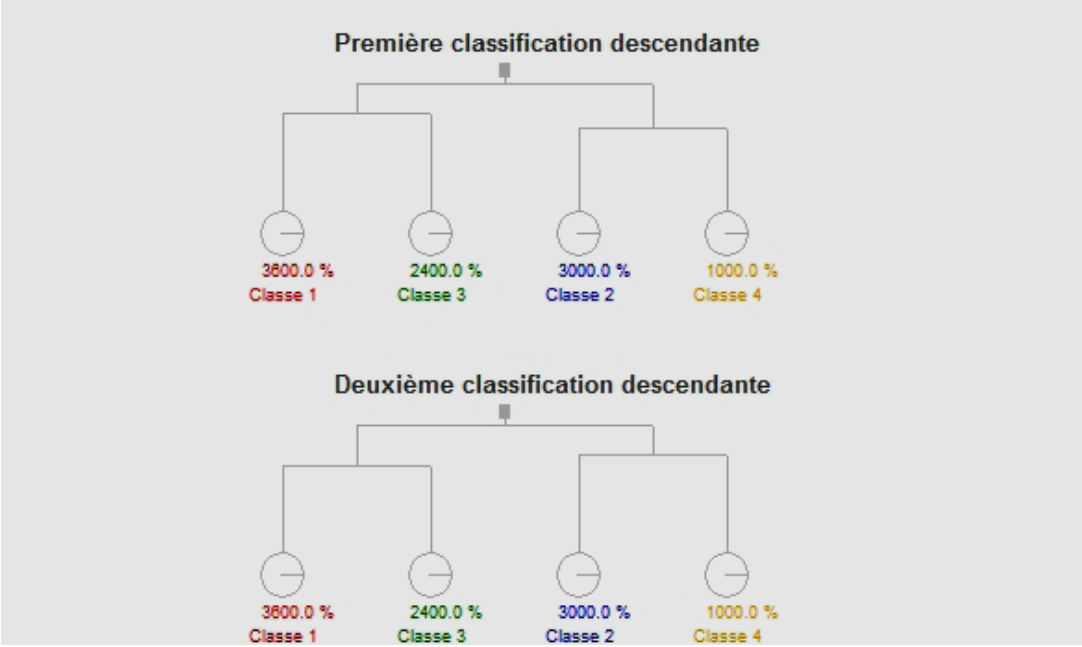

Figure 3: Analysis III- Dendrogram solutions illustrating the stability of class intersections.

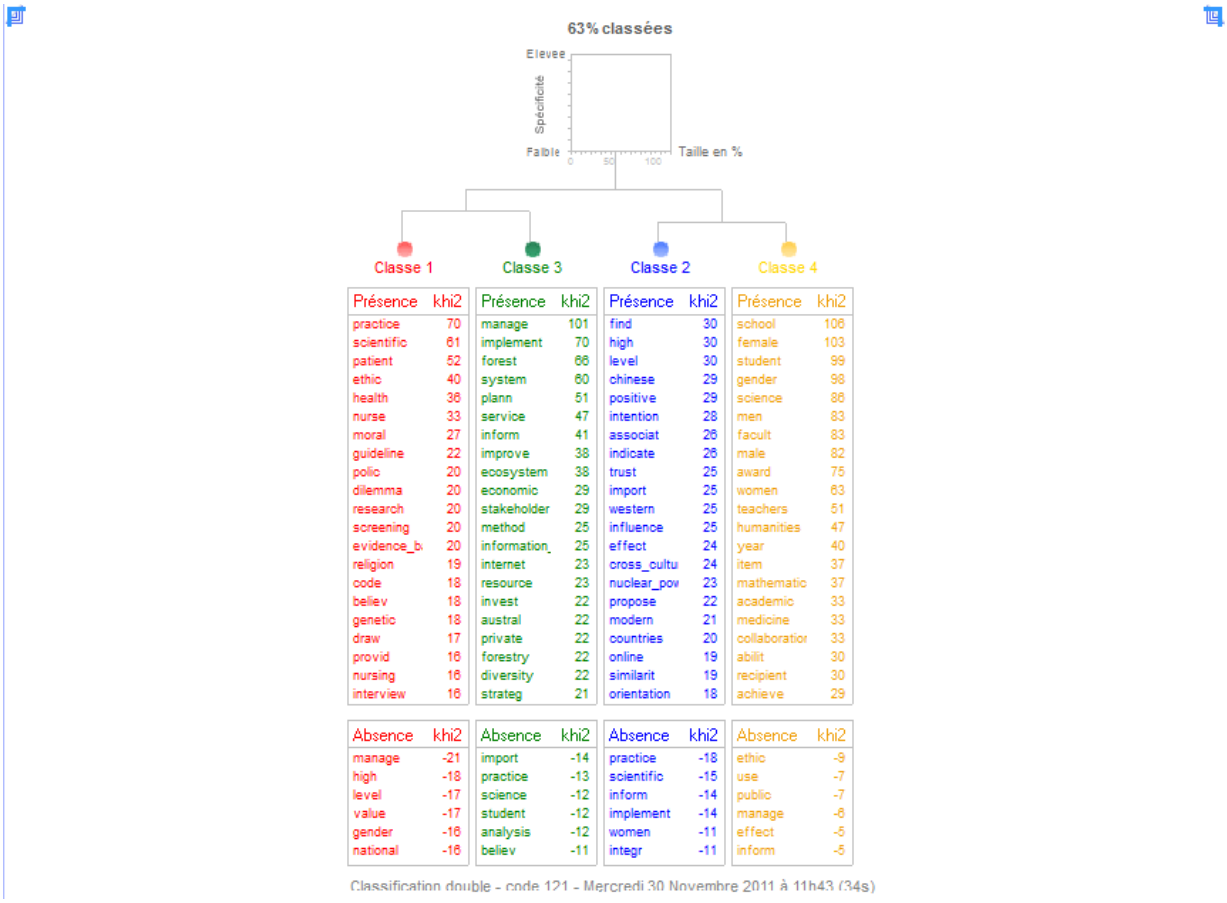

Figure 4: Analysis III- Most characteristic words contained in each lexical class ranked by their chi2 value.