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Survey research and the public understanding of science

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Public Understanding of Science – The Survey Research

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The term 'public understanding of science' has a dual meaning. Firstly, it covers a wide field of activities that aims at bringing science closer to the people and to promote public understanding of science in the tradition of a public rhetoric of science (see Fuller, 2001 for the idea, and OECD, 1997 and Miller et al., 2002 for attempted inventories of such initiatives). Secondly, it refers to social research that investigates with empirical methods what the public's understanding of science might be and how this might vary across time and context. This includes the conceptual analysis of the term 'understanding'.

I will concentrate on the latter and focus on the discussions raised by research using large-scale nationally and internationally representative sample surveys that ask people lists of prepared standard questions from a questionnaires instruments. Other forms of enquiries of PUS will be covered in different chapters [add cross-reference to other chapters]. I will review the changing research agenda by typifying three 'paradigms' of PUS research by the questions they raised, the interventions they supported and the criticisms they attracted. The chapter ends with a short outlook on the potentials for future research and a brief afterthought on the 'public deficit concept' and survey-based investigations. This review expands on previous reviews of the field (Pion & Lipsey, 1981; Wynne, 1995; Miller, 2004).

Survey research in public understanding of science

Table 1 lists the main surveys of public understanding of science among the adult populations since the 1970s, typically with nationally representative samples of 1000 interviews and more in any one context. The lists is not a comprehensive inventory, but it shows the best known surveys of scientific literacy, public interests and attitudes to science which are also partially comparable: the US National Science Foundation publishes an indicator series since 1979 (e.g. NSF, 2002), the Eurobarometer (DG Research) series since 1978 covering initially eight and recently 32 European countries, the national UK (ESRC, OST, Wellcome Trust) and the French series (CEVIPOV; see Boy 1989 and 1993) reaching back to mid 1980s and early 1970s respectively. The earliest survey of this kind seems to date from 1957, just before Sputnik shocked the Western world (Michigan: Withey, 1959). Later efforts came from Canada (MST), New Zealand (MST), Malaysia (STIC), India (NCAER), China (MST, CAST), Japan (NISTEP), Brazil (CNPq, FAPESP) and Latin America in general (RICYT).

Many relevant surveys that are related to specific and often controversial developments are not listed here. For example, over the years the International Social Survey (ISS) consortium, Eurobarometer, or national and international polling companies have conducted numerous attitude surveys on specific topics related to nuclear energy, computer and information technology, the environment, biotechnology and genetic engineering, and most recently nanotechnology. Also the 'busy industry' of risk analysis has collected numerous samples of data on 'risk perceptions' of this, that and the other under the sun. Then, there are many surveys of adolescents' understanding of science culminating in the global assessment of scientific literacy at school age by OECD-PISA in 2006. They are not included in this review.

However, the fact that a sizable corpus of nationally and internationally comparable survey data has accumulated over the past 40 years offers opportunities for secondary analysis, dynamic modelling and global comparisons that call for a renewed research effort. A complete inventory of relevant national and international surveys of specific topics of science and technology remains to be done.

Table 1: the main national surveys of public understanding of science

	UK	F	EU	Bulgaria	US	Canada	New Zealanc	Japan	India	China	Malaysia	Argentina	Brazil
1957					Michigan								
1970													
1971													
1972		CEVIPOV			Harvard								
1973													
1974													
1975													
1976													
1977	EB7	EB7	EB7										
1978	EB10a	EB10a	EB10a										
1979					NSF								
1980													
1981													
1982		CEVIPOV											
1983					NSF								
1984													
1985					NSF								
1986	MORI												
1987													CNPq
1988	ESRC	CEVIPOV			NSF								
1989	EB31	EB31	EB31			MST							
1990					NSF								
1991								NISTEP		MST			
1992	EB38.1	EB38.1	EB38.1	BAS-IS	NSF								
1993													
1994													
1995					NSF					CAST			
1996	OST/Well			BAS-IS									
1997					NSF		MST			CAST			
1998													
1999					NSF								
2000	OST/Well										STIC		
2001	EB55.2	EB55.2	EB55.2	EB				NISTEP		CAST			
2002													
2003										CAST		RICYT	FAPESP
2004	OST								NCAER				
2005	EB63.1	EB63.1	EB63.1	EB63.1									
2006					NSF-GSS								MST

‘Paradigms’ of researching the publics of science

Over the last 20 years the public understanding of science has spawned a field of enquiry that engages, to a greater or lesser degree, sociology, psychology, history, communication studies, and science policy analysis. It remains somewhat marginal but vigorous in its output. Table 2 below gives a schematic overview of three ‘paradigms’ of research into public understanding of science. The table models the relationship between science and the public based on the attribution of deficits. Each paradigm has its prime time, and is characterised by a diagnosis of the problem that science faces in its relation to the public. A key feature of each paradigm is the **attribution of a deficit** either to the public or to science. Each paradigm pursues particular research questions through survey research and offers particular solutions to the diagnosed deficit problems.

Table 2: Paradigms, Problems and Solutions (source: Bauer et al, 2007)

Period	**Attribution** **Diagnosis**	**Strategy** **Research**
Science Literacy 1960s – 1985	Public deficit Knowledge	Measurement of literacy Education
Public Understanding 1985 – 1995	Public deficit Attitudes	Know x attitude Attitude change Education Public Relations
Science & Society 1995 - present	Trust deficit Expert deficit Notions of the public Crisis of confidence	Participation Deliberation 'Angels', mediators Impact evaluation

Scientific Literacy (1960s – mid 1980s)

Scientific literacy builds on two ideas. Firstly, science education is essentially part of the secular drive for basic literacy in reading, writing and numeracy. The second idea is that science literacy is a necessary part of civic competence. In a democracy people partake in political decisions in one way or the other, either directly through voting and indirectly via expressions of public opinion. However, the political animal is only effective if it is also familiar with the political process (Althaus, 1998). The assumption is that scientific as well as political ignorance breeds alienation and extremism, hence the quest for 'civic scientific literacy' (Miller, 1998). These ideas highlight the dangers of a cognitive deficit and call for more and better science education through the life cycle. However, it also plays to technocratic attitudes among elites: the public is de-facto ignorant and therefore disqualified from partaking in policy decisions.

An influential definition of 'science literacy' was proposed by Jon D Miller (1983 and 1992). It includes four elements: (a) knowledge of basic textbook **facts** of science, (b) an understanding of **methods** such as probability reasoning and experimental design, (c) an appreciation of the **positive outcomes** of science and technology for society, and (d) the **rejection of 'superstition'**. Miller developed these literacy indicators from earlier work (Withey, 1959; see also the review of Etzioni & Nunn, 1976) supported by the US National Science Foundation (NSF). Between 1979 and 2001 NSF undertook a bi-annual audit of the nation's scientific literacy with representative surveys of the adult population. Similar efforts, but less regular, came in Europe in the 1980s, and since also elsewhere (see table 1 above).

The research agenda

Knowledge is the key problem of this paradigm, and it is measured by quiz-like items (see famous examples in table 3). Respondents are asked to decide whether a statement of a scientific fact was true or false. Some of these items became notorious, travelled far and hit the news headlines, not least because of their scandal value.

Table 3: Examples of knowledge and attitude items in literacy research

Knowledge items

Item 1. 'Does the earth go around the sun or does the sun go around the earth? (**the earth goes around the sun**; the sun goes around the earth; dk).
Item 2. 'The centre of the earth is very hot' (**true**, false, dk)
Item 3. 'Electrons are smaller than atoms' (**true**, false, dk)
Item 4. 'Antibiotics kill viruses as well as bacteria' (true, **false**, dk)
Item 5: 'The earliest humans lived at the same time as the dinosaurs' (true, **false**, dk)

Attitude items (Likert scales)

Item 6: 'Science and technology are making our lives healthier, easier and more comfortable' **(agree = positive)**
Item 7: 'The benefits of science are greater than any harmful effects' **(agree = positive)**
Item 8: 'We depend too much on science and not enough on faith' **(disagree = positive)**

1 strongly agree;
2 agree to some extent;
3 neither/nor;
4 disagree to some extent;
5 strongly disagree;

9 don't know (DK).

Source: e.g. Eurobarometer 31 of 1989.

Respondents score a point for every correct answer (as highlighted in table 3). It is a problem to find short and unambiguous statements that have one correct and authoritative answer, and to balance easy and difficult items and from different fields of science. The responses to these items, often between 10 or 20, must be correlated to form a reliable index of knowledge. Research involves the construction of such items and the testing of their scalar value; 'constructing' is the right word because finding and testing such items is a bit like brick laying, it has to stand up in the end. Recently item response theory is brought into the discussion for this purpose (Miller & Pardo, 2000). As indicators these items are only reliable in combination; any isolated single item has little significance. But, also in batteries the reliability of these scales is an issue (Pardo & Calvo, 2004). However, public speakers and the mass media repeatedly pick out stand-alone items as indicators of public ignorance and reasons for public alarm. For example, the item about the sun and the earth (item 1 above in table 2) has seen many citations out of context.[1]

What counts as scientific knowledge? Miller suggested two dimensions: facts and methods. This stimulated efforts to measure people's understanding of probability reasoning, experimental design, the importance of theory and hypothesis testing. Critics have argued that the essence of science is process and not facts (e.g. Collins & Pinch, 1993). Therefore topics like theory testing, probability and uncertainty, peer reviewing, scientific controversies, and the need to replicate experiments should be included in the assessment of literacy. Scales of methodological knowledge are more challenging to construct, and if employed still only based on very few items. An open question suggested by Withey (1959) proofed to be useful: *'Tell me in your own words, what does it mean to study something scientifically'*. Respondents' answers are coded for methodological and institutional awareness. However, the coding remains controversial: normative or descriptive (see Bauer & Schoon, 1993)? Process also includes awareness of scientific institutions and its procedures, what Prewitt (1983) called 'scientific savvy' and Wynne (1996) called the 'body language' of science. The latter dimension has received some attention in explorative studies but waits to be implemented in international surveys (see Bauer, Petkova & Boyadjjewa, 2000 and Sturgis and Allum 2004).

Researchers also looked at the 'don't know' (DK) responses to knowledge items and revealed ambiguity in self-attributed ignorance. Comparing incorrect responses and DK-responses suggests an index of confidence: women and some social milieus consistently prefer declaring ignorance rather than guessing as they are less confidence to opine on science (Bauer, 1996). Turner & Michael (1996) described four qualitative types of admitted ignorance: embarrassment 'I go and find a book in the library'; self-identity 'I am not very scientific'; division of labour 'I know somebody who knows'; smugness 'I couldn't care less'. Sudden changes in the rates of DK-responses over time might also indicate methodological issues: survey companies can alter their interviewer protocol, accept a DK as an answer or probe further. The latter reduces the rate of DK. Such changes might reflect a change of fieldwork contractor, like in the case of Eurobarometer, over the years.

Many countries have undertaken audits of *adult scientific literacy*. The US NSF has presented bi-annual 'horse race' type rankings of different countries on literacy to answer the question: where does the US stand? A key problem of such comparisons remains the fairness of the indicators. The existing set of knowledge items are biased with regards to the national science base. Countries tends to a historically specialised science base, or a corps of scientific heroes from one rather than the other discipline, and literacy scores are likely to reflect this particular science base (e.g. Shukla, 2005; Raza et al, 1996 and 2002). Raza and his colleagues' suggestions for culturally fair indication and analysis deserves more attention than it has received hitherto.

What is to be done?

The literacy paradigm is fixated on the cognitive deficit. Interventions are seen mainly in public **education**. Literacy is a matter for continued education, requires renewed attention in the schools' curricula and on the part of a publicly responsible mass media that is called to task (see e.g. Royal Society, 1985).

Critique

The critique of the literacy paradigm focuses on conceptual as well as empirical issues. Why should science knowledge qualify for special attention? What about historical, financial or legal literacy? The case for 'science literacy' needs to be made in competition to other types of literacy.

Secondly, is literacy a continuum or a threshold measure? Miller originally envisaged a threshold measure. To qualify as a member of the 'attentive public for science' one needs to command 'some minimal level' of literacy, be interested and feel informed about science and technology, appreciate some positive outcomes, and renounce superstitions. However, the definition of this 'minimal level of literacy' changed from audit to audit, and it is unclear whether the reported changes, or for that matter the lack of changes (Miller, 2004), reflects changes in definition or in substance (see Beveridge & Rudell, 1998).

Thirdly, critics argued that indicators of 'textbook knowledge' are irrelevant and empirical artefacts. Of real importance is knowledge-in-context that emerges from local controversies and people concerns (Ziman, 1991; Irvin & Wynne, 1996). However, what accounts for the consistent correlations between measures of literacy, attitudes and socio-demographic variables? We must recognise a certain intellectual failure to engage with these robust results.

Fourthly, there is the question of 'superstitions'. Does belief in astrology disqualify a member of the public from being scientifically literate, as Miller (1983) suggested? The co-existence of superstition and scientific literacy is an empirical matter. Astrology and scientific practice serve different functions in life. To make the 'rejection of astrology' a criterion of literacy bars us from understanding the tolerance or intolerance between science and astrology in everyday life, which is a cultural variable (see Boy & Michelat, 1986; Bauer & Durant, 1997).

Knowledge items can be controversial in substance. So for example physicists might point out that whether 'electrons are smaller than atoms' cannot be determined in general but depends on circumstances. Thus the authoritative answer to this questions is more shaky than one would like to admit. But one will be able to life with a generally correct textbook answer. However, more problematic is the statement 'The earliest humans lived at the same time as the dinosaurs', which according to biology textbooks is 'false' to be correct. This item captures, in particular in the US, a debate over evolutionary theory which, but by now means globally, clashes with fundamentalist religious culture (see Miller et al, 2006). It is thus not entirely clear whether this item is to be treated as an indicator of science literacy or of cultural values; this will depend on the context.

Finally, it is suggested that the concern with literacy is correlated with the crisis of legitimacy of 'big science'. To overcome this crisis by literacy assumes a fundamental gap in the operations of literate scientists and an illiterate public, for which there is little evidence beyond elitist prejudice. Furthermore, if Roger Bacon's notion of 'knowledge = power' holds, any attempt to share knowledge without simultaneous public empowerment will create alienation rather than rapprochement between science and the public. Literacy is therefore the wrong answer to what many see as a crisis of legitimacy and trust (Roqueplo, 1974; Fuller, 2000).

Public Understanding of Science (1985 – mid 1990s)

New concerns emerge under the title public understanding of science (PUS).[2] In the UK this is marked by an internationally influential report of the Royal Society of London with that very title (Royal Society, 1985). PUS inherits the notion of a **public deficit,** however, now it is the attitudinal deficit that is fore-grounded (Bodmer, 1987). The public is not sufficiently positive about science and technology, too sceptical or even outright anti-science. This must be of major concern to scientific institutions like the Royal Society. Old and new good reasons for the public appreciation of science are put forward: it is important for making informed consumer choices; it enhances the competitiveness of industry and commerce; and it is part of national tradition and culture (see Thomas & Durant, 1987; Gregory & Miller 1998; Felt, 2000). The Royal Society of London famously assumed that more public knowledge will ‘cause’ more positive attitudes. Hence, the **axiom** of PUS became: ‘the more they know, the more they love it’.

Research agenda

The evaluative appreciation of science is mostly measured by Likert-type attitude scales. Respondents agree or disagree to evaluative statements and thereby express their positive or negative attitude towards science (see table 3 for some famous examples). Some statements, in order to assess a positive attitude, require the respondent to disagree, others to agree, depending on the formulation. This mixed tactic avoids the acquiescence response bias, i.e. the general tendency to agree to such questions in the artificial context of survey interviews. Another related issue is how to deal with ‘neither/nor’ and DK options. Not offering a ‘neither/nor’ may increase the variance in the data, but forces people into positions which they do not hold. This would leave no space to express real ambivalence, genuinely motivated abstention of judgement, or the absence of opinion. There must be space for the ‘idiot’, i.e. in ancient Greece the one that does not have an opinion in public (on the recent revaluation of the ‘idiot’ see Lezaun & Soneryd, 2006) .

Research on science attitudes is concerned with ‘acquiescence response bias’, the construction of reliable scales, the multi-dimensional structure of attitudes (e.g. Pardo & Calvo, 2002), the relationship between general attitudes and specific attitudes (Daamen & vanderLans, 1995), context effects of previous questions (e.g. Gaskell, Wright & O’Muircheartaigh, 1993), the comparative effects of web-based or telephone interviewing on the response variance (Fricker et al. 2005), and most importantly the relationship between knowledge and attitudes. The concern for literacy carried over into PUS, as knowledge measures are needed to test the expectation ‘the more they know, the more they love it’. However, the emphasis shifts from a threshold measure to that of a continuum of knowledge. One is either literate or not, but more or less knowledgeable (Durant, Evans & Thomas, 1989).

A potential gender gap in attitudes to science attracts attention and concerns. Breakwell and Robertson (2001) found that British girls are less inclined towards science than boys and this gap is unchanged between 1987 and 1998. Sturgis and Allum (2001) highlight the importance of a knowledge gap between men and women in explaining this attitude gap, when controlling for other factors. Eqaully, Crettaz (2004) shows for Switzerland of 2000 that gender does not explain attitudinal differences between men and women; it is science literacy and general education that makes all the difference.

The second PUS paradigm extended the range of concepts, methods and data. Mass media monitoring, in particular of newspapers, is cost effective and easily extended backward in time and updated into the present. The changing salience and the framing of science in the mass media offer alterative indicators of science in public (see Bauer, 2000; Bauer et al, 1995). Such analyses reveal long-term cycles and trends, such as the return to the medicalisation of science news, over the last 100 years (Bauer et al. 2006; Bucchi & Mazzolini, 2003; Bauer, 1998a; LaFollette, 1990).

What is to be done?

The practical interventions of the PUS paradigm might be divided into a rationalist and a realist agenda. Both agree with the diagnosis of an attitudinal deficit, the public is insufficiently infatuated with science and technology, but they disagree on what to do about it.

For the **rationalist,** public attitudes are a product of information processing with a cognitive-rational core. Hence, negative attitudes towards science - or unreasonable risk perceptions as is the fashionable concept of the 1990s – are caused by insufficient information, or they are based on heuristics, such as availability or small sample evidence, that bias the public's judgement of science and technology. It is the assumption that, had people all the information and operated without these heuristics, they would display more positive judgements of scientific developments. Thus, they would agree with experts, who do not succumb to these biases as easily as the public does. People need more information and training on how to avoid faulty information processing. The battle for the public is thus a battle for rational minds with the weapons of information and training in probability and statistics.

For the **realist,** attitudes express emotional relations with the world. Realists work the emotions and appeal to people's desires and gut reactions, and thus follow the logic of advertising and propaganda. In what is seen as the battle for the hearts of the public, the key question is: how can we make science 'sexy'? The '**consumer'** public is to be seduced rather than rationally persuaded. According to this logic, there is little difference between science and washing powder (see critically Michael, 1998). This agenda includes research on market segmentation, consumer profiling, and targeted campaigning in different segments of the public. British science consumers are divided into six groups with different demographic profiles (OST, 2000): confident believers, technophiles, supporters, concerned, the 'not sure', and the 'not for me'. A similar segmentation was developed in a recent Portuguese study (Costa, Avila & Mateus, 2002).

Critique

Attitudes need to be understood on a background of representations. Representations become visible when everyday common sense is challenged by novelty; they familiarises the unfamiliar (Farr, 1993; Wagner, 2007). This outlook shifts the research from rank ordering people by attitudes to characterising their representations of science in function of different life contexts (e.g. Boy, 1989; Bauer & Schoon, 1992; Durant, Evans & Thomas, 1992). Studying representations of science opens the door widely to other data streams, in particular qualitative enquiries (Jovchelovitch, 1996; Bauer & Gaskell, 1999; Wagner & Hayes, 2005).

The critique of **deficit models** correctly highlighted the pitfalls of reifying 'knowledge' in the knowledge survey – scientific knowledge is what survey measure – and insisted on knowledge-in-context (Ziman, 1991) and on analysing how experts relate to the public (Irvin & Wynne, 1996). Wynne (1993) used the term 'institutional neuroticism' to point at prejudices of scientific actors towards the public that create a self-fulfilling prophecy and a vicious circle: the public, cognitively and emotionally deficient, cannot be trusted. However, this mistrust by scientific actors will be paid back in kind by public mistrust. Negative public attitudes then confirm the assumptions of scientists: the public is not to be trusted. This circularity of the 'institutional unconscious' calls for 'soul searching', i.e. reflexivity among scientific actors, and even endorsement of a post-modern epistemology of a plurality of knowledge centres.

The empirical critique of the paradigm focuses on the relation of interest, attitudes and knowledge. The correlation between knowledge and attitudes becomes a focus of research (Evans & Durant, 1989; Einsiedel, 1994; Durant et al, 2000). The results remain inconclusive until recently (see Allum et al, 2008): overall, large scale surveys show a small positive correlation of knowledge and positive attitudes, but they also show larger variance among the knowledgeable, and this correlation is variable. However, on controversial science topics, the correlation approaches zero. Thus not all informed citizens are also enthusiastic about all science and technology; for some developments, in particular controversial ones, 'familiarity can breed contempt'. In hindsight, it is surprising that anybody ever expected this to be different.

The concept and measurement of attitudes is the traditional remit of social psychology (e.g. Eagly & Cheiken, 1993). In classical theory cognitive elaboration is not a factor of positive attitudes but an indicator of their quality: knowledge fortifies the attitude to resist influence and makes it more predictive of behaviour whatever its direction (Pomerantz et al., 1995). What emerges, though, is that knowledge and information matter but not in the way common sense assumes. It is not normal that better informed citizens have more positive attitudes, or that poorly and well informed citizens equally stick to their views.

Many PUS surveys also measure the people's interest in science. Eurobarometer surveys suggest that self-reported interest is falling over time, while knowledge is increasing (Miller et al., 2002). This trend, if verified, would show that "familiarity breeds disinterest", thus touching another naïve assumption of the Literacy and PUS paradigms: the 'more we know, the more we are interested'.

Science in-and-of Society (mid 1990s to present)

The polemical critique of the 'public deficit models' ushered in a reversal of the attribution. The public deficit of trust is mirrored by a deficit on the part of science and technology and its representatives. The focus of attention shifts to the **deficit of the scientific expert**: their prejudices of the public.

Diagnosis

Evidence of negative attitudes from large scale surveys is contextualised with focus group research and in quasi-ethnographic observations and re-interpreted as a '**crisis of confidence'** (House of Lords, 2000; Miller, 2001). Science and technology operate *in* society and therefore stand relative to other sectors of society. The views of the public held by scientific experts come under scrutiny. Prejudices of the public operate in policy making and guide communication efforts, and these alienate the public. The **decline in trust** of the public vis-à-vis science also indicates the revival of an enlightenment notion of a sceptical but informed public opinion (Bensaude-Vincent, 2001).

What is to be done?

Writings on the new governance of science admonish more public involvement and a new deal between science and society (e.g. Fuller, 2000; Jasanoff, 2005). For the 'Science and Society' paradigm the distinction between research and intervention blurs. Many are committed to action researcher who reject the separation of analysis and intervention. This agenda, academically grounded as it may be, often ends in political consultancy with a very pragmatic outlook. Explicit and implicit notions of the public, public opinion and public sphere, are reported back as 'theories espoused' and 'theories-in-action' (Argyris & Schon, 1978) to stimulate reflective change of mind among these scientific actors. Thus, the bulk of activity under science and society fuses research and consultancy, and most of the evidence remains grey literature and informal conversation.

Advise proliferates on how to rebuild **public trust** by addressing its paradoxes: trust is relational; once it is on the cards, trust is already lost; trust cannot be engineered, it is granted to who deserves it (see Luhmann, 1979). Public participation is the Prince's way to **rebuild public trust**: the House of Lords Report (2000) lists many forms of deliberative activities such as citizen juries, deliberative opinion polling, consensus conferencing, national debates, hearings etc. Essay writings order and describe the virtues, the experience and the know-how of these exercises of public deliberations (e.g. Gregory et al, 2007; Abels & Bora, 2004; Joss & Belluci, 2002; Einsiedel, Jelsoe & Breck, 2001; Seargent & Steel, 1998).

Critique

Deliberative activities are time consuming, require know-how, and they are thus increasingly outsourced to a newly forming private sector of professional 'angels'. Angels are age-old mediators; in this context not between Heaven and Earth, but between a disenchanted public and the institutions of science, industry and policy making. For the utilitarian spirit of politics the democratic ethos is not sufficient. Does the deliberation process pay off? is a pertinent question. Also the private sector of outsourced professional 'angels' makes claims and offers 'deliberation services', often with spurious product differentiations, which requires some kind of critical 'consumer' testing.

The answer to the audit problem requires process and impact measures. Researchers therefore advocate quasi-experimental evaluations of deliberative events and suggest process and outcome indicators (see Rowe & Frewer, 2004; Butschi & Nentwich, 2002) including indicators such as changing public literacy and attitudes.

This call for indicators of the public, and for media monitoring of the events, runs the risk of reinventing the wheel, albeit this time for a different car: to evaluate the 'angels' and their services. The re-entry of concerns for PUS by the backdoor of impact evaluation research of public deliberation is ironic but unavoidable. The analysis of costs and benefits needs a metric.[3] It may be that changes in media reportage, public knowledge, interests and attitudes offer that metric to audit the moderators of public audits. After all, we live in an 'audit society' (see Power, 1999).

An brief afterthought on an 'urban myth': public deficits and survey research

PUS survey research has at times been hampered by a polemic association of the 'deficit concept' with survey research. This polemic is reminiscent of an older one, namely Lazarsfeld's (1941) debate with Adorno over 'administrative' and 'Critical' research, but with a curious methodological fixation.[4] As the polemic has it: the PUS survey researcher is a 'positivist' who constructs the 'public deficit' of knowledge, attitude and trust to please her sponsors in government, business or learned societies. Thus, surveys serve existing powers to control their anxieties over public opinion. By contrast the 'Critical-constructivist' researcher will recognise this ideological entanglement and will use exclusively qualitative data. The achieved reflexivity will open his sponsors to a change of mind. 'Critical' qualitative research emancipates the public from the grip of elite prejudice. Where doxa reigns, there shall be logos. Be that as it may; so or similar goes the story. Problematic in all this is not the differentiation of knowledge interests, nor the move from prejudice to enlightenment, but the exclusive identification of knowledge interest and method protocol:

Survey research = positivist = anxious, de-contextual prejudice
Qualitative research = Critical-constructivist = contextual insight.

These implicit equations are of unclear origin like any urban myth, but probably arose from the influential British research programme on PUS of the late 1980s. In his handbook review of PUS research, Brian Wynne associated survey research and anxious elite prejudice and contrasted both to the alternative 'constructivists research':

> *'large-scale social surveys of public attitudes toward and understanding of science inevitably build in certain normative assumptions about the public, about what is meant by science and scientific knowledge, and about understanding. They may often therefore reinforce the syndrome [anxiety among social elites about maintaining social control, p361], in which the public, and not science or scientific culture and institutions are problematised…. The survey methods by its nature decontextualises knowledge and understanding and imposes assumptions* .. (Wynne, 1995, p370).

Such formulations, together with the book that came to summarise the British research effort of the late 1980s (Irwin & Wynne, 1996), framed an unhelpful polemic, and without intentions to that effect.[5] But, whereas Lazarsfeld invited convergence with Adorno, here the survey method is stigmatised by methodological boundary work (see Giryn, 1999). The intrinsic association of sample surveys and elite anxieties and the control of public opinion is a logical fallacy, historically unfounded, and unduly restrictive of social research (see Kallerud & Ramberg, 2002; Bauer, Gaskell & Allum, 2000). The abuse of survey data is clearly possible and documented by the polemic, which is an achievement to be appreciated. But the misuse of an instrument does not exhaust its potential. The intrinsic identification of data protocol and knowledge interest ignores the functional autonomy of motives, and the 'interpretive flexibility' of instruments. Generally, motive and behaviour stream are flexibly linked, and this goes for knowledge interest and method protocols, and also for survey research. Ironically, 'Critical' qualitative research is increasingly adopted by powerful sponsors, which absorbs much of the critical edge. After all, it is difficult to see why qualitative research should be immune to this type of incorporation. Nevertheless, we need to break with the stigma of survey research among PUS researchers and sponsors to liberate and expand the agenda for future research.

Where to go from here?

Progress in PUS research is modest as it seems: few new questions, but much new discourses. None of the new discourses made the previous ones obsolete. PUS preserves the relevance of literacy measurement and adds the attitudes. Science and Society, whilst rejecting the public deficit models, cannot, once consolidated, avoid the thorny problem of auditing, and ironically reinvents the old measures of the public. However, the focus is no longer the public's deficit, but the performance of the mediating 'angels' who spend public money to resolve the crisis of public confidence in science and technology.

Equally promising it the OECD assessment cycles of educational achievements (PISA), which in 2006 focused on 'scientific literacy' and will do again in 2015, albeit for children in schooling age. These results create large and detailed databases across many countries even beyond the OECD, and might also re-launch the discussions over adult literacy in these contexts.

In tracing the recent history of PUS research I both appreciated and deplored the 'deficit concept' in PUS research. In order to capitalise on the opportunities that arise from a global corpus of survey data that has accumulated over the past 40 years, we need to reopen the research agenda. We need to ignore a misguided stigma of survey research as a ride on public deficiency, and take it for what it really is: a powerful and 'movable immobile' representation of public opinion. Achieving this, I am confident that this field of research will enter its most fertile period, yet. Public understanding of science is an historical process. One-off point observations, i.e. the occasional survey or focus group, might have news and scandal value, but it is not a valid analysis of the historical dynamic. Now it is time to be ambitious again (see Bauer at al., 2007): let researchers come together with new efforts

- To integrate the different national and international surveys as far as possible into a global database, maybe under EU, WORLD BANK, UNESCO, OECD or UN flag and in collaboration with existing social science data archive;
- To encourage sophisticated secondary analysis and the continued documentation of this growing database;
- To construct dynamic models of public understanding of science over time, including cohort analytic and quasi-panel models, and test these in different contexts;
- To work towards global indicators of a 'culture of science' based on these surveys;
- To seriously commit to and develop alternative data streams such as mass media monitoring and longitudinal qualitative research efforts.

May the funding agencies and ambitious young researchers see the light at the horizon!

Resources

<u>Some national institutions that have sponsored or conducted PUS surveys</u>

BAS-IS	Bulgarian Academy of Science, Institute of Sociology, Sofia
CNPq	Brazilian National Research Foundation

CEVIPOV	Centre for the Study of Political Life, SciencePo, Paris
EB, Eurobarometer	DG-12, later DG Research, Brussels
ESRC	Economic and Social Research Council, UK
FAPESP	Research Foundation of the State of Sao Paulo, Brazil
ISS	International Social Survey consortium
MORI	British public opinion research company
NSF	US National Science Foundation, Washington, Science Indicators
NISTEP	National Institute of Science and Technology Policy, Japan
NISTED	National Institute of Science, Technology and Development, India
NCAER	National Centre for Applied Economic Research, Delhi, India
MST	Ministry of Science and Technology (Canada, China, Brazil)
Wellcome Trust	Research Foundation interested in PUS, London
RICYT	Latin American Network for Science Indicators [cpolino@ricyt.edu.ar]
CAST	China Academy of Sciences and Technology
OST	Office of Science and Technology, London
PISA	Programme for International Student Assessment, OECD, Paris
STIC	Strategic Thrust Implementation Committee, Malaysia

Relevant Journals where PUS survey research is reported:

- Public Understanding of Science
- Science Technology and Human Values
- Science Communication
- Public Opinion Quarterly
- International Journal of Public Opinion Research
- Risk analysis

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[1] It would be an interesting study to trace the reception and use of these items in public discourse. I am not aware of any study analysing the reception of PUS surveys. This would amount to an interesting analysis of the rhetoric and pragmatics of survey research.

[2] PUS was also extended to PUST to include 'T' for technology, PUSTE to include 'E' for engineering, or PUSH to include 'H' for the humanities, the latter indicating a more continental understanding of 'science' as

'Wissenschaft'. The dating of these phases is liberal follows mainly the influential UK experience. In the US all through the 1970s the AAAS had a standing Committee on Public Understanding of Science (see Kohlstedt, Sokal & Lewenstein, 1999, p 140ff.

[3] in the UK for example, the large scale GM Nation debate of 2002 cost the government close to £1 Million. A simple survey of public attitudes would cost around £50-100,000, a round of focus group session £25,000. Such cost differentials have to be justified with added value.

[4] I use the capital 'C' to indicate this posture of foundational critique. It is hard to imagine how a critical mind could be the privilege of only on one side of this polemic. And, this dichotomy is already a simplification of a more complex issue which Habermas (1978) caught with the trichotomy of technical-instrumental, practical-normative, and Critical-emancipatory interests of human knowledge.

[5] A historical note: In the UK, the ESRC funded a research programme 'public understanding of science' from 1987-1990 (See Ziman, 1992) with 11 different projects. I joined this effort in 1989 as a 'number cruncher' for John Durant, then at the Science Museum in London. I happened to join the national survey project and recall how some members of the research programme were hardly on speaking terms. Curiously, the fault line fell on whether a team would use a numerical or a qualitative protocol for their observations. The later publication (Irwin & Wynne, 1996), that became the summary of this programme, 'excluded' the three projects with numerical data: the survey of the British adult population (see Durant et al., 1989 and 1992), the survey of British children (see Breakwell & Robertson, 2001), and the analysis of mass media reportage of science (see Hansen & Dickinson, 1992). Alan Irwin recalls (personal communication, January 2007) that the book was intended to counter-balance the over-whelming publicity which the survey of 1988 generated through its *NATURE* piece (Durant et al. 1989), and was not as a statement against quantitative or survey research. But he admitted that an 'urban myth' might have developed in the subsequent reception, not least because the anti-survey polemic resonated with the issue of quantitative and qualitative methodology in the social sciences generally, and the myth might have served the boundary work during the competition over national and European funding steams.