The Vicissitudes of ‘Public Understanding of Science’: from ‘Literacy’ to ‘Science in Society’

Martin W. BAUER

[摘　要] “公众理解科学”一词涉及科学与社会的关系，有两个方面的含义。一方面是指有公众参与的各种各样的科普活动。其表现往往带有社会行为的特征，有主导人物、资源和不断扩大的活动储备。另一方面是指一个不断发展的经验性社会研究领域。本文重在论述后者的演变，它分为3个阶段，即科学素养（迄于20世纪80年代）、公众理解科学（20世纪80年代到90年代）和科学与社会（20世纪90年代后）。这里称谓的变化不容忽视。各阶段的陈述均包含针对科学与社会之关系的症结所做出的专门判断，特别要研究的问题以及优先考虑的介入策略；同时可以看出，各阶段之更替在修辞上表现出的是一种“进步”。比较此3个“范式”之后，作者不禁发问：此领域中的研究工作真的有什么进步吗？

[关键词]　科学素养　公众理解科学　科学与社会

Abstract: The term ‘public understanding of science (PUS)’ considers the relationship of science and society with a double focus. On the one hand it refers to a variety of activities that engage the public with science. This takes at times the character of a social movement, involving actors, resources, and a growing repertoire of activities. It is on the other hand a growing field of empirical social research. This paper will trace developments in the latter through three phases, which are associated with a change in language: from science literacy until the 1980s, to public understanding of science from the 1980s into the 1990s, and science and society since the 1990s. Naming matters here. Each period is associated with a particular diagnosis of the problems in the relationship between science and society, particular research questions and preferred intervention strategies, and each period displays a rhetoric of ‘progress’ over the previous one. Comparing the three ‘paradigms’, I will ask the question: is there any progress in this field of research?
Keywords: science literacy; public understanding of science; science and society

3. Public Understanding of Science (mid 1980s - 1990s)

From the critique of the definition and measurement of scientific literacy emerged, in the second half of the 1980s, new concerns with the title public understanding of science (PUS), sometimes with an added T (PUST) for technology.[4] In the UK this transition is marked by an influential report of the Royal Society of London (Royal Society, 1985). PUS shares with the previous literacy phase the diagnosis of a public deficit.

However this time round it is the wrong attitude of the public towards science and less the lack of knowledge that is in focus (Bodmer, 1987) . The public is negative or not enough positive about science and technology and this is of concern to the scientific institutions. Old and new reasons for the promotion of PUS are mobilised: scientific understanding is important for making consumer choices; it enhances the national competitiveness of industry and commerce; and it is part of our tradition and culture (e.g. Thomas & Durant, 1987; Gregory & Miller 1998) . The Royal Society of London and others assumed that more of public understanding activity will be better. Many operated with an implicit model according to which better knowledge guarantees more positive attitudes. The axiom of PUS is ' the more you know, the more you love it '. And this shifted the research agenda away from the measurement of knowledge to that of public attitudes.

Research agenda

The measurement of attitudes has a long tradition in social psychology (see Eagly & Cheiken, 1993) . Thus the measurement of attitudes towards science and technology was informed by standard concerns over ' acquiescent response bias ' , the construction of reliable scales based on item analysis, the dimensions of attitudes (Pardo & Calvo, 2002) , the relationship between general attitudes and specific attitudes (Daamen & vanderLans, 1995) , context effects of preceding questions (e.g. Gaskell, Wright & O ' Muirchearteigh, 1993) , and the relationship between knowledge and attitudes.

Conceptual analysis of the attitude problem suggests that attitudes to science need to be conceived within a wider representation of science. Representations emerge when our common sense accommodates new scientific developments and thus familiarises the unfamiliar (Farr, 1993; Bauer & Gaskell, 1999) . Here the focus shifts from rank ordering people by their attitudes to characterising the diversity of representations (Boy, 1989[5]; Bauer & Schoon, 1992; Durant, Evans & Thomas, 1992) . The quest for studying representations rather than measuring attitudes demonstrated the value of qualitative research such as focus group or in- depth interviewing. The polemic over either quantitative or qualitative research being the sole ' scientific study of PUS ' became a dominant but ultimately a sterile debate.

The concern for scientific literacy carried over into PUS. A knowledge measure remains necessary to test the expectation ' the more you know, the more you love it '. However, as we move from ' literacy ' to ' knowledge ' the emphasis shifts from a threshold measure to that of a continuous variable. One is either literate or not, but more or less knowledgeable (Durant, Evans & Thomas, 1989) . The correlation between knowledge and attitudes becomes a focus of research (Evans et al, 1989; Durant et al, 2000) . The results remain inconclusive: most large scale surveys show a small positive correlation between knowledge and positive attitudes to science and technology, but they also show larger attitudinal variance among the literate. The more knowledgeable population holds negative or positive attitudes or even ambiguous attitudes, thus not all informed citizens are also enthusiastic about science and technology. For some ' familiarity breeds contempt ' . It is surprising that anybody ever expected this to be different. Classical attitude theory suggests that knowledge is not a factor of positive attitudes, but rather an indicator of elaborated attitudes that resist change (Eagly & Cheiken, 1993) .

Furthermore, comparative analysis shows that the very correlation between knowledge and attitude is a variable. Cross- national variation on interest, knowledge and attitudes and in the relationships between interest and knowledge and attitudes led to the ' two culture model ' of PUS. The industrial PUS culture is characterised by high correlation between interest, knowledge and attitudes, while the post- industrial PUS culture shows smaller or no correlation (Bauer, Durant & Evans, 1994; Durant et al., 2000; Allum, Boy & Bauer, 2002) . For this type of comparison PUS is not a performance in an international ' horse race ', but a matter

of structural and functional comparison.

The fact that the PUS paradigm followed on literacy provided the legacy of a rich data base. In four contexts, namely the USA (bi-annual since 1979), the UK (1986, 1988, 1996, 2000), France (1972, 1982, 1989, 1996), and the EU (1989, 1992, 2000) repeated surveys were conducted which invite longitudinal analysis. Regrettably, to date no effort has been undertaken to conduct systematic longitudinal analyses of these data. This may partially discouraged by the fact that secondary analysis does not carry much academic kudos. Also presenting the world with the latest news about public knowledge and attitudes is always more attractive from the point of view of immediate publicity.

Finally, PUS research extended the range of concepts, methods and data that are considered relevant. The idea that understanding includes familiarity with the facts and the methods of science, but also with the workings of the scientific institution and politics at large. It emerged that attitudes to science and technology may be determined by general political engagement rather than by a specific scientific literacy (Stergis & Allum, 2002). Focus groups research and discourse analysis of interviews and textual materials become popular during the 1990s, so did attempts to assess the salience and the framing of science in the mass media. Here the idea of literacy indicators and the idea of cultural indicators meet (e.g. Bauer, 2000). Large scale mass media analysis, in particular of newspapers, is cost effective and can be extended into the past and updated into the present very easily. Such analyses reveal longterm trends such as the medicalisation of science news over the last 25 years in Britain (Bauer, 1998).

What is to be done?

The intervention strategies of the PUS model can be divided, risking some caricature, into a rationalist and a realist camp. Both agree with the diagnosis of a public with an attitudinal deficit, i.e. the public is not sufficiently infatuated with science and technology, but they disagree about what to do about it.

For the rationalist social attitudes are the outcome of information processing with a rational core. Hence, negative attitudes towards science - or for that part unreasonable risk perceptions, the fashionable concept of the 1990s - are based either on insufficient information about science and technology, or they are based on heuristics of information

processing that mislead or bias people's judgement against science and technology. There is the assumption that, should people have all the information, and should they process it in an unbiased fashion, they would come to more positive conclusions about scientific developments. They would not hold exaggerated perceptions of risks, and would asically agree with the conclusions of experts, who incidentally do not succumb to these biases as the public does. People need more information, and more training in how to avoid biased information processing. The battle for the public is a battle for the rational minds of the public.

For the realist, attitudes express an emotional relation to the world. How emotions may relate to rationality is a difficult question, one that is traditionally confused by a received distinction between rational and emotional. More on the practical side of things, the realists work with public emotions by thinking in terms of messages that appeal to people's emotions modeled on the world of advertising. The battle for the public becomes a battle more for hearts than for minds of consumers of scientific news and information. How can we make an issue sexy? How can we attract attention to something many people find naturally boring? The public is modelled as a 'consumer' that is seduced rather than rationally persuaded. There is no difference between science and washing powder, when it comes to communication. The kind of research that is required here is market segmentation, consumer profiling, and targeted campaigning taking into account the tastes and inclinations of segments of the public. In the UK, the latest survey of public followed this logic. The British science

consumers are divided into six groups with different attitudinal and socio-demographic profiles (OST, 2000) : confident believers, technophiles, supporters, concerned, the ‘ not sure ’, and the ‘ not for me ’ The same approach was taken in the recent Portuguese study (Costa, Avila & Mateus, 2002) .

Critique

The critique of PUS phase two continued the focus on measurement of knowledge and of attitudes, thereby pointing to the limitations of large scale survey research (e.g. Irvin & Wynne, 1996) . This critique rightly highlighted the pitfalls of reifying PUS in one type of assessment, namely in the literacy survey. Insisting on contextual understanding of knowledge of science (Ziman, 1991) , and on the need to consider the relationships between the public and scientists pushed the gate open into the third phase, that of ‘ science and society ’ . Much of the polemic over literacy and PUS hit at the so-called the deficit model of the public understanding. Literacy and PUS assume that the public is in a state of deficiency, either lacking the amount of or the right kind of knowledge, or not holding the right attitudes, namely positive attitudes toward science and technology. Wynne (1993) used the term ‘ institutional neuroticism ’ to point at diffuse anxieties and a the lack of trust within scientific communities vis-à-vis the public. This suggested a dynamics of a vicious circle and a self-fullfilling prophecy: the public, defined as deficient, cannot be trusted. Mistrust on the part of scientific actors will be paid back in kind by public mistrust. This is expressed in negative public attitudes, which confirm the initial assumption among scientists that the public is not to be trusted. This functioning of the deficit model as the ‘ institutional unconscious ’ of science led to the call for more reflexivity and ‘ soul searching ’ among scientific actors and in social research in general, endorsing elements of a post-modern discourse.

4. Science in-and-of Society (1990s onwards)

The critique of the literacy and PUS paradigms as ‘ deficit models ’ led to a reversal of the diagnosis. Maybe the deficit is not with the public, but with the scientific institutions and their actors who have lost public trust. This opened the attribution process for other explanations of negative public attitudes. There may be several deficits: not only a public deficit of trust, but an expert deficit on the part of science and technology and its representatives. The focus of attention shifted to the deficit of the technical expert.

Diagnosis

Negative attitudes, explored in large scale surveys and increasingly contextualised in focus group research and quasi-ethnographic observations lead towards an interpretation of the facts that amounted to a ‘ crisis of confidence ’ (House of Lords, 2000) . Science and technology operate in society, are an expression and resource of society, and therefore stand in a relationship with other sectors of society. A crisis of trust of the public vis-à-vis science indicates a breach of contract that needs patching up or redefinition. The implicit and explicit views held by scientific experts of the public, of public opinion, and of the role of public sphere for science come under scrutiny. The trust problem shifts turns the attribution around, and the expert deficit vis-à-vis the public becomes a part of the trust crisis. Misconceptions of the public that are in operations in policy making and that guide communication efforts alienate the public rather than gain the public ’s hearts and minds.

Agenda: research for intervention and ‘ action research ’

Because of the critical nature of much writing on Science and Society, the distinction between research and intervention becomes blurred. This is partly due to a commitment to ‘ action research ’ by many re-

searchers. Action research rejects the separation of analysis and intervention. the aim of any analysis of science and society is to intervene directly to induce change in science policy, among scientists and other actors. This agenda, academically grounded as it may be, is in affinity with political and business consultancy with whom it shares a decidedly pragmatic outlook. Much of this activity takes the form of practical advise sold in a market place.

A burgeoning area of research is the history of popular science and public understanding of science, which requires a literature review in itself. Generally, historical studies reveal the range of activities, the ideology and supporting motives, and the changing relationship between science and society, and the role played by the public understanding movement in that change. Naturally, historical orientation requires a long-term perspective (e.g. Lewenstein, 1992; Bauer, 1998b).

Also remaining within a research remit there are some studies that investigate the misconceptions of the public held by experts. Here the notions of the public, public opinion and the public sphere, with which particular groups of actors operate in public, become the focus of analysis as 'theories enacted'. Deficient notions of the public sphere may be part of the confidence crisis by way of self-fulfilling prophecy and by way of a vicious circle. Reflexive intervention is required to break this dynamic.

The bulk of activity in science and society arises from this fusion of research and sociotherapeutical consultancy. An industry of policy advice emerged during the 1990s over how to handle and to overcome this crisis of confidence between science and the public. Advise is offered on how to rebuild public trust, and to address the paradoxes of trust. Once trust becomes an issue, it is already lost; trust cannot be socially engineered: it is granted to those that are seen to deserve it (Luhmann, 1968). Public deliberation and participation are presented as the King's way of how to rebuild public trust. The House of Lords Report (2000) lists various forms of deliberative public engagement such as citizen juries, deliberative opinion polling, consensus conferencing, national debates, hearings etc. As each of these have considerable financial and organisational implications they become the remit of private consultants who take the role of 'angels' or intermediaries. These angels are age-old go-betweens that intermediate, not between heaven and earth, but between a disenchanted public and the institutions of science, industry and policy making. Where hitherto social scientists were investigating literacy and attitudes, and critically diagnosing deficits on all sides, of judgement social scientists are now in danger to satisfice themselves with the role of angels making sure that more people talk to each other more often. The scope for writing remains wide, but different. The analysis of the governance of science admonishes the imperative of public participation, the ethics of science and technology, and a new deal for science and society (e.g. Fuller, 2000). Many books describe the 'good practice', the financial and organisational implications of public deliberation and public participation for 'angels' as target audience (Seargent & Steel, 1998).

Critique

As 'science and society' is the flavour of the day, there is as yet little critique of its achievements. Recently the enthusiasm for organising public participation is complemented with the concern to evaluate its outcomes. To the utilitarian spirit of modern politics, the ethos of participation is not sufficient. Sooner or later the question arises: and what does this participatory approach bring (effectiveness)? How do these approaches compare? And could one save money with one approach doing equally well as with another (efficiency)? These questions call for the definition of objectives and for measurable criteria so that such activities can be publicly audited.

The call to evaluate participatory science policy making re-opens, ironically as it seems, the door for the

traditional canon of public understanding of science research. Researchers on public participation in science and technology policy come to advocate quasi-experimental designs of deliberative events. They suggest the construction of indicators ranging from the amount of media coverage, to shifts in public attitudes, to changes in the policy agendas in response to public consultation (e.g. Butschi & Nentwich, 2002). This call for measurements of public attitudes, media coverage and agenda setting effects sounds like the re-invention of the wheel, albeit this time for a different car. The focus on impact on the policy agenda is a novel topic in the discussions over science and technology. Considering the past polemics over literacy and PUS research, the re-entry of indicators developed under a literacy and PUS agenda via the backdoor of evaluation research seems ironic but unavoidable. Does the ' democratic ethos ' pay off ? is the question many people will ask sooner or later. And if people ask about costs and benefits, a currency needs to be defined, it just may be that public knowledge, interests and attitudes are such a currency by which public participation can be audited.

5. Is there any progress in PUS research?

By way of conclusion I ask the question, is the path from ' Scientific Literacy ' to ' Science and Society ' a path of progress? Clearly the protagonists of each phase used a rhetoric of Progress writ large, supposedly leaving behind the modes of outdated thinking. PUS researchers claim that they left behind the single minded obsession with an ill-defined scientific literacy of the public. For PUS researchers the attitudes become the focus and these are not determined by literacy anyway. Furthermore, knowledge is a continuum, not an arbitrarily define threshold measure. For the Science and Society activists, both literacy and PUS commit the fundamental attribution error, conveniently blaming the public for the confidence crisis between science and the public. Public participation and ' angelic ' intermediation becomes the new mission, thus leaving behind empirical social research as a somewhat anachronistic preoccupations.

But, as I hope to have shown, ironically, the old agendas don't go away. Firstly, because literacy and PUS concerns stay around, and secondly, the concerns of literacy and PUS research, namely the measurement of public interest, knowledge and attitudes, see their revival within the Science and Society paradigm. They become indicators of success or failure of deliberative programmes of public engagement. In the audit society no activity goes unevaluated for long, thus even the idea of democratising science and technology policy has to stand the test of effective and efficient use of resources? Raised public interests, improved public knowledge, and more positive public attitudes become the currency to justify a process by its projected positive outcomes.

A closer look at developments in this small, but contested field of research over the last 20 years hardly shows any real progress from one paradigm to the other. There is no ' incommensurability ' between these paradigms. Rather, the progress is more modest: the multiplication of questions and the differentiation of discourse. None of the later discourses make the previous ones obsolete as the polemic wants to have it. However, each step marks a widening of concerns and a shifts in analytic focus: from knowledge, to attitudes, to the blind spots of the observers of public opinion. PUS preserves the relevance of knowledge measurement, but adds the concern for attitudes. Science and Society, whilst rejecting the public deficit model of both literacy and PUS, cannot, once consolidated by the end of the 1990s, avoid the thorny problem of auditing its activities, and ironically, at least partially, in terms of public progress.

One may want to note finally that the international survey of educational achievements (PISA) envisaged for 2006 will focus entirely on ' scientific literacy ', albeit for children in schooling age. These results might well re-launch the discussions over adult literacy. If I dare a prediction, it will be that PUS research,

based on survey, focus group and media analysis, will revive albeit within the wider framework of science and society. Not the public deficit is in focus anymore, but, in the mode of new public administration, the performance of the outsourced ‘angels’ of public participation who spend public money. One can only hope that the polemic over the deficit model and its tendency to turn research methods into the scapegoat, i.e. blaming the survey methods for the attribution error of deficits, has not eradicated the memory of past labour. Where some progress may be found is in the measurement of public interest, knowledge and attitudes across populations, or in the assessment of agenda setting effects. Without such a memory, the ‘angels of participation’ will have to re-invent the wheel out of necessity, which clearly would be inefficient.

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(This is a list of selected reference, it is not intended to be a bibliography of PUS research)

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Notes

① This cannot be an encompassing undertaking, but is informed mainly by a British bias, which is fair to say had considerable influence in Europe and beyond over the last 15 years.

② This is likely to be an incomplete listing. To my knowledge no worldwide listing of comparable surveys and data sets exist.

③ I joined PUS research programme in the late 1980s as a 'number cruncher' to John Durant at the Science Museum in London. I remember observing that many of the members of this research programme were on nonspeaking terms. The debate curiously centred on issues of research methodology and whether a team would use numerical or qualitative verbal presentations of their observations. The publication that came to present the main results of this programme (Irwin & Wynne, 1996) finally excluded three projects that used numerical data to characterise the public understanding of science: the survey of the British adult population (J Durant), a survey of British children (G Breakwell), and the analysis of mass media coverage of science (A Hansen).

④ This is slightly liberal with the historical dates and follows mainly the 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, p140).

⑤ Daniel Boy of CEVIPOF Paris, whose efforts at measuring PUS in France date back to the 1970s, has continued to be sceptical towards scientific literacy measures. He argues that literacy in surveys hardly measure anything more than the level of education of a respondent, and therefore the effort might be better concentrated on measuring attitudes and assessing the level of specific science education in survey research (personal communication).

作者介绍

马丁·鲍尔，英国伦敦经济学研究生院教授，社会与公众传播系主任。

E-mail: M. Bauer@lse.ac.uk