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Reception and rejection of science knowledge: choice, style and home culture

Joan Solomon

One reason why there is little public understanding of science concepts could be active personal rejection. There are many informal sources of scientific knowledge, but individual style and choice govern how and whether they are used. Other research shows that groups are interested in particular information, but that they reject science principles. Data from a study of students discussing issues from television show how they present themselves through their preferred knowledge sources. Finally I describe a home study of parents doing science investigations with primary-aged children. Interviews with the parents show that how they react to science and to education depends upon the home culture they have constructed. The parents reproduce this culture in the activities of their children, more or less strongly, and this affects their own acceptance or rejection of the scientific knowledge.

Knowledge on offer

There are more and less subtle ways of offering science to the public. At one end of the scale is insidious life-world knowledge in which the science component has become sanitized by long usage. Through this process phrases like ‘harnessing power’ or ‘feed a cold and starve a fever’ became so deeply embedded in the social stock of knowledge that they have long since shed their science label. How this may have come about has been worked out for the case of energy and its technologies. In the same way as this knowledge lost its science affiliation, it also became inescapable. Maxims and familiar language are not chosen for original knowledge content, only for immediate convenience. On the other hand, newly minted scientific knowledge is more salient and might well be obtrusive in general conversation.

Our society is rich in information sources. Studies of school students in the USA and in Britain have shown that some claim to get most of their scientific knowledge from television, some from school, some from reading and some from talking with friends. They could also have included radio, museums, botanical gardens and hands-on science centres. There is great variety of media. How do people decide whether or not to receive this knowledge?

Even within schools, where, as one contributor to this journal has claimed, science is ‘shoved down your throat’, individual choice is, quite simply, all-powerful. Many children continue to choose not to receive scientific knowledge throughout their school career. The reception of knowledge, whether in school or in the living room in front of the family television set, is not a passive process. It is a committed act of personal
style, a social stance requiring group licence, and a cultural statement about worldview. School and the media can only present an invitation to knowledge: it is the children who, from quite a young age, deliberately accept or reject according to an internal sense of personal style. Later, as adults when the mould is set, the very thought of receiving scientific knowledge may become quite extraordinarily unfamiliar and threatening. This suggestion—that lack of reception of scientific knowledge arises because the intended receivers refuse to receive—does no more than move the question on to another focus: it offers no answer to why they refuse. However, it does identify an important field of enquiry for the public understanding of science.

In schools, rejection does not come about because the concepts are arcane, lacking in relevance to everyday life, or couched in incomprehensible technical language, as superficial apologists for school failure so often claim. It is doubtless true that all those factors make learning more difficult, but long observation makes me doubt if they are the simple immediate causes of science refusal. An illustration may help. A small eleven-year-old pupil who was new in her class, and nervous, was sent to me recently to be calmed down and welcomed. We talked about her last school and all went well. Then I asked, as I had to, what she had done in science. ‘Something with those things, those candle things’. I asked if she meant Bunsen burners. She said that was right, but tossed her head and refused to answer any more questions about it. ‘I’m not into science’, she said. This small cameo is not about the gender question in science—just the strength of the choice, based on some sense of personal style, that one timid little girl had made.

Style and choice

Some research has been carried out on different people’s preferred style of information reception. One ingenious approach by Wober was to consider image construction in the different modes of communication. This research suggested that those who learn best from books or radio do so out of a preference for constructing their own internal images. Quantitative studies suggest that this imaging preference is far stronger than the visual/aural contrast between the two media (book and radio) since there is a substantial overlap between the two populations. There is much less association between those who prefer learning from books (or radio) and others who prefer television. Although Wober and Marks Greenfield imply that this is merely the reverse of the imagery choice, other data suggest that learning from television correlates quite highly with claiming to learn best through talking with other people. This is no chance association. Communication studies indicate that television reception has a great deal to do with personal responses to screen characters, a phenomenon sometimes called ‘para-social interaction’.

That brief review of research findings goes some way towards establishing the concept of style in information reception. Recent work carried out in the UK Science Policy Support Group linked programme on the public understanding of science takes the idea a small step forward. In the DISS (Discussion of Issues in School Science) project small groups of 17-year-old students recorded their informal discussions of television excerpts about controversial issues. They also answered a short questionnaire about how they most often learnt about ‘science issues’ (defined by examples in the questionnaire).
Thus two sets of empirical data were collected. First there were the discussions tapes, at least four for each student, which were analysed for claims to have already heard something about the topic from one of the information sources. These references were scored as reading or television. (There were no references to radio.) There was also an effect we called ‘collaborative speech’ in which students followed the sense of other’s talk so closely that they were able to finish off each other’s sentences. Secondly, from the questionnaire, the same students could be scored on their responses about the information sources from which they claimed that they learnt. The latter set of figures gave a significant association (0.50) between learning from television and from talking with friends, just as research findings had suggested. However it was disconcerting, at first, to find that these data had so little association with the set of data drawn from the students’ comments during discussion. Those who most often referred to television programmes they had viewed previously were not the same ones who answered on the questionnaire that they learnt most about science issues from television. There was a similar anomalous result for reading.

Lack of correlation between attitude responses and behavioural outcomes is not a new phenomenon. Eiser has commented that it is a common finding, and added that little notice seems to have been taken of this:

Nonetheless such results have generally failed to shake the conviction on the part of most attitude-theorists that attitudes are an important, if not the major, cause of the kinds of behaviour which interest social psychologists. What the results of this study may be showing is that the respondents have a sense of their favoured style of knowledge reception, whether or not it is borne out in practice, which they wish to project to the reader of the questionnaire. Clearly this is an example of the ‘social representation’ of which Moscovici and others have written. That concept is here re-stated in a slightly different way to emphasize that even so small a component of personal style as the preferred method of knowledge reception is both constructed and socially presented.

A choice of two kinds of science knowledge

Young science refusniks may well imagine, as the school door finally shuts behind them, that they will never again have to face the learning of science. Is that true?

The adult has easy control over the television set. Even if what Prewitt has called ‘knob-twiddling’ reveals a programme with some science content, they can instantly turn it off. There may be museums, hands-on centres, or other science shows, but adults do not need to visit them. If it is not their style they stay away—except if they have young and persistent children. Even then they have a skilled repertoire of avoidance mechanisms, including refusing to read explanatory labels, which they can use for protection against formal science knowledge. At a science centre run for primary schools in Faringdon, Oxfordshire, UK, we had a classic example of this avoidance behaviour from a parent governor. She was invited to a room of simple exhibits for primary pupils: a skeleton sitting on an old bicycle, a tank of goldfish magnified by a system of Fresnel lenses, and some foil-coated footballs. She took one look, giggled charmingly and announced she ‘didn’t understand it’ and found it all ‘quite terrifying’. After that no one tried to explain anything. She had scored another victory in her
programme of not accepting science knowledge and making this an item of personal style.

Claims not to understand anything about science, usually couched in self-deprecating terms, are commonly encountered by those who try to interview members of the public. It is too simplistic to interpret these as colourless confessions of ignorance. This point is made in a perceptive study of the public understanding of a radon survey by Michael.12 He writes cautiously that: 'Certainly there is a case to be made for saying that the speaker situates him- or herself at a considerable distance from science.'

Michael concludes by making a sharp distinction between public attitudes to two different kinds of science knowledge: science-in-practice and science-in-general. Members of the public could agree with the intentions of the radon survey, and yet continue to profess a complete lack of interest or understanding of its processes.

What proponents of life-long science education often argue is that modern living requires scientific knowledge, and that the changing circumstances of life may urgently call for learning more science. Until recently there was little evidence to confront this eminently sensible belief that when people really need to understand science they will make an effort to do so. Now, it seems, we know a little better. From studies by Jenkins of pensioners and their thermometers,13 by MacGill of residents of Sellafield,14 and by Lambert and Rose of those with hypercholesterolaemia,15 we can see more clearly how 'science-in-general' is specifically not learnt. In the first two studies mentioned, as with a study of Sellafield apprentices,16 it is easy to understand the incentive to refuse knowledge. Thinking about the science that underlies some personal risk which is quite unavoidable just increases anxiety. This produces the 'ignorance is bliss' syndrome.

The medical case-study by Lambert and Rose was even more instructive since here the risk involved certainly was avoidable. The congenital disposition to raised levels of cholesterol, which they examined, is life-threatening, so that both those who are born with it, and their parents, have great need of knowledge. The research showed that the patients actively interpreted information given by their doctors, learnt the skills necessary for identifying foods which contain cholesterol, and gained a quite sophisticated working knowledge of different fats. Yet very few patients were either 'aware of, or displayed any interest in, the scientific details of their metabolic condition which might make sense of their condition'. Even in the face of possible premature death they still exerted their choice not to try to understand science concepts.

This links nicely with Michael's conclusion that lay people may show interest and commitment to the practice of science and yet distance themselves from the principles behind it.

A hole into the home

Thus the question of how adults might approach the understanding of some science, in a sense which included its processes and principles, remained largely unanswered despite the increased volume of research in this field. Consideration of a possible methodology for a new study suggested that an intervention strategy would be needed where the individual could choose whether or not to receive science knowledge (science-in-general) which might be perceived as both simple and useful. Courses in science would not be an appropriate research setting since they would attract only the minority who were already interested in learning in the conventional sense. What was
needed was a more random cross-section of the public which would include those who experienced the usual distance and discomfort in the context of science. The solution was presented by SHIPS, a home-school initiative in primary-school science.

The SHIPS project (School Home Investigations in Primary Science) began in 1990 with funding from ICI. It has produced three books of investigations which can be photocopied so that primary teachers may give them out to the pupils at a moment when they fit into the work being carried out in class. The children’s work—drawing and models—is brought back to school for discussion with the teacher and the class. In this way the activities make a link between home and school. Parental anxiety has also given rise to a range of commercial books of the ‘help your child with science’ type. Not only are these not designed to fit in with school work, they are almost all in the ‘right answer’ category. This may possibly assuage anxiety over the Standard Assessments Tests, but might be having a detrimental effect by reinforcing the public’s perception of scientific knowledge as ‘correct facts’.

The background to the SHIPS project was political. In 1989 science was introduced as a compulsory core subject in the primary school (pupils are aged 5 to 11). The Education Act (1988) which made this mandatory included provisions for a parental involvement in education which seemed designed to ensure that the demands of the Act were not circumvented by teachers. Parent governors were to have a powerful say in the design and running of the schools, and all parents were to receive details of their children’s performance in Standard Assessment Tests reported to them at regular two or three year intervals. These tactics raised parental interest in education as never before. It also produced considerable anxiety among primary teachers whose own science education had often been rather thin, and who were now open to pressure from parents to teach this (almost) new subject in primary schools, exactly as specified.

The recruitment of parents to oversee, as it were, the science education of their children opened up the possibility of both helping the hard-pressed primary teachers, and also introducing science to the parents in their own homes. We conducted a short playground survey to find out how many parents said they would be willing to help their children with school-work at home. Over 90%, not surprisingly, said ‘yes’. When the subject concerned was specified as science the acquiescence level dropped to about 70%, but rose a little when the work was described as ‘an activity in the kitchen’.

Four very different primary schools were recruited to help with the new project and meetings were run to alert the parents to the forthcoming SHIPS investigations. Simple, and sometimes amusing, activities were designed to help with the learning of topics specified by teachers. Then, at the appropriate time, the teachers gave out the activity sheets to be taken home by the pupils and used with their parents. In twenty cases, ten in each of the two years of the project, a researcher entered the homes and watched members of the family (usually but not always the mother) taking part in the science education of their children. The investigations were set twice in each term throughout the school year. At the end of the year, I interviewed the parents. These two sources of data provide some insight into the ways that science knowledge may be accepted into homes.

Home constructs of ‘science’ and ‘education’

Parents (or grandparents, siblings, etc.) were being asked to undertake an unfamiliar activity. In this potentially uncomfortable social situation their first task was to feel
their way into an acceptable role from which to act. For this there were at least three possibilities:

to role-play as a teacher

to remain in role as parent and direct a `homework`

to enter into the activity as a more or less unlearned helper.

These roles overlapped and interacted in interesting ways. The role of teacher, for example, as usually conceived, includes authority over the knowledge involved, which matches nicely with the `right answer` image of science itself. However it became clear that many young mothers (but less often the grandmothers) had begun to understand teaching as suggesting rather than telling. Hence there would be passages where the child’s questions were turned round rather than answered (`What do you think?’), and in active phases of the investigations phrases such as `let’s do this . . .’ or `shall we . . .?’ replaced the more formal mode of the teacher’s imperative. Thus the parent’s adopted role seemed to move towards the third category of an unlearned helper.

The teacher’s role could not be maintained in the face of a perceived inability to answer a `scientific’ question from the child. This might be followed by a somewhat conspiratorial `Well, just put down what you think’, so that the second role of neutral homework director was adopted. Just how satisfactory this was felt to be came out very clearly in one end-of-year interview. This mother had twin girls, and she spoke about the occasion when they had sedimented soil by shaking it with water in a jam jar. They then had to add a chicken bone, in imitation of the first stage of fossil formation. The instruction sheet asked the pupils to suggest in which layer they thought the bone would settle.

It was embarrassing. They asked me where the bone would be and I didn’t know . . . [The twins] are only eight and a half. I should have known.

This discomfort can be understood only not as failure in the role of parent as teacher, but also as evidence of her perception of the nature of science as perfectly correct factual information, even in this rather trivial detail.

These parental roles cannot be fully described without much further discussion of the construction of the process and practice of education which varied widely from home to home. Its analysis would be out of place in this article, but its influence is to be found in all the examples given in the next section.

When the SHIPS project began we received a comment from one of the families not involved in the home observations. The child’s investigation had been to make two simple rain gauges of different shapes and to test them using a bathroom shower or watering can. The parents, who came from the Caribbean and Nigeria, wrote that their child, aged six, had loved the activity, and added: `Afterwards we spoke to him about how important rainfall was in Nigeria’. This accepting comment, welcoming science into the home culture, prepared the ground for understanding other parents’ more general attitudes towards the reception of science knowledge in their homes. It began to seem that the more global concept of ‘culture’ might be more appropriate than the term ‘style’ used previously of people who were presenting a conscious image of themselves. The contrast became clearer as more evidence was collected.

Case studies

When the year was over and the parents were free to speak about their own reactions to the science investigations without their children present, it became possible to assess
how they had reacted to science in their homes. Once again there was freedom for the parents to choose whether to receive knowledge or not.

The parents were asked for

How did it [the investigations] go?
Did you feel that you were teaching your child?
How was your own science education?
Did you talk about the science investigations in the home after they were over?

All the questions were fairly open-ended and designed to explore the results of involving lay parents in their children's science education. The first allowed for general comments about difficulties or enjoyment, and comparisons between the different investigations. The second and third introduced sections of talk which allowed the interviewer to probe the parent's own constructions of education and of science. The last question, which needed some extra unpacking, was looking for anecdotes which might show how the science had been received.

1. The impenetrable home

Mrs A said, when pressed, that her son A enjoyed the 'mucky' one with 'getting dirt in' best (sedimenting soil). She remarked, belittling the activity, 'I think most little boys like getting mucky'.

Her own science education was 'fifteen years ago' and she hadn't enjoyed it much. But the investigations were 'just basic common sense' and didn't require science. She was 'helping him along, I suppose, more than teaching' even though she said later that he did most of it by himself. She stressed that A 'liked getting them over and done with, getting them done as fast as possible, to basically go out and play'.

As for getting science into the home, Mrs A was adamant. Her son had not discussed any of the activities later; he was not the sort of boy who ever asked questions. 'He comes home from school and I say “What did you do at school” and he says “Not a lot”. He might talk about six... goals at football, but that's about all. He's very sporty.' At the end of the interview, as I left at the garden gate, Mrs A remarked that she had been just the same at school. She hadn't enjoyed science much but had been 'very sporty'.

2. The fact-learning home

Mrs B said unequivocally that her daughter 'loved doing them [the investigations]'. She went on to say that her daughter was very curious in a memorable phrase: 'A very curious little girl is B. A very inquisitive little girl is B'.

Mrs B said that she did feel she had been teaching her daughter. At her own secondary school the boys did science and the girls did domestic science. However she did not regret this since 'You can learn it afterwards, can't you?' In this spirit she had supplied both her daughters with books: 'They have got science fact books—which are very expensive. They've got encyclopaedia upstairs and all that, you know, to help them.'

Talking over science at home was interpreted as answering the children's questions. The two girls spoke together about the activities sometimes. B had so liked the activity on 'Hearing Sounds' that she had taught it to her younger brother. Mrs B was pleased about this. 'He's learning what she's learning now, so when he's ten he will have already done them. He will be ahead of everyone.'
On being asked if she had learnt any science from the activities she said she had, and then incorrectly reported that you could get electricity from rubbing foil.

3. The nursery nurse's activity home

Mrs C reported that 'It [the project] frightened the life out of me when I was asked. I mean I'm no scientist at all. I will do anything for the children and I spend a lot of time doing things with them. I said to C's teacher “How complicated is it? because it will lose me”.'

She didn't think about if she was teaching the child at all because she was used to doing things with them, playing with models and crawling all over the floor. 'My husband's quite good at that sort of thing [science], but I was never very good at school and I never think of anything as science. But I mean, yes, lots of things we do.'

At secondary school the Bunsen burners where 'the flames shot up six feet had petrified' her. She said she 'may not have been very bright . . . never grasped it [science]'. Her eldest son, at secondary school, is 'dead keen' about science, which pleases her and her husband.

Like other parents she had some difficulty making the electrostatics experiment work. It seemed that she tried again in the evening, when it 'worked beautifully', and then again the following afternoon when it failed, and in the evening when it worked again, because she didn't like being beaten. Her husband had thought it might be to do with the weather, which was very hot. The activity with bubbles had gone on night after night in the bathroom, and she had similar stories about activities with magnets. But when asked again about being terrified of science she had not changed.

**Interviewer** Do you feel any better about it?

**Mrs C** No.

**Interviewer** You don’t?

**Mrs C** No.

**Interviewer** I'll bet a lot of the things you do with the kids are science.

**Mrs C** Well that's right, but you don't think of them as science, do you? It wasn't until I was actually asked would I do science—I thought AHHHHHH [scream]!

4. The humorous learning home

Mrs D said that she had done about half the activities and her husband had done the others. All of the activities went well, except the one with soil which she said 'It was hard for him to grasp the concept of, you know, what's fossilization, and what have you'. She added that her son had like making models of the animals with long legs and short ones:

I think it brings some humour in. He had fits of laughter for his little man for the shadows. The face—he kept falling about [Mrs D laughs]. So it had some humour in it as well, which was nice. It's not, you know, deadly serious . . .

Whereas I remember from school, you know, science, it was a very serious matter.

When Mrs D was at school she had taken biology. She agreed that most of the activities do not seem like the separate science disciplines but says "You can see the basic principles behind it". It did 'seem like teaching in a way'. The activities were
enjoyable but she didn’t want her son treating everything ‘like a joke’. He was ‘taking it in’. She was keen to talk about her son and how many questions he asked, and about her husband who was more ‘scientific and mathematical’. Finally she spoke about herself.

**Interviewer** Go on, give me an example.

**Mrs D** ... the one, you know, the Elephant’s Ears with the evaporation. You know that was a splendid way to do it [laughs]. Plenty of humour in that too!

**Interviewer** You knew about cooling from evaporation?

**Mrs D** Um. Uh yes. It’s just that, you know, as you get into your everyday life you tend to, or I certainly do, with a young baby and D, to forget all the amazing things you learn at school ... It just sort of jogs your memory you know. It tends to start you thinking again a bit. So perhaps it’s a sort of two way thing.

In this collaborative home where wife and husband shared in the upbringing and science activities, the notion of also sharing in the learning process arose very naturally.

**Conclusion**

Plenty more examples of the variety of home culture could have been given. There were interviews with parents who were more or less knowledgeable about both education and science. There were also interviews with parents of Asian origin which showed strong cultural differences in the more conventional sense. But the variation in approach to science was far broader than just knowledge base or ethnic culture. It depended on what had been accepted as family activity in a sense which might be conceived as a complex social representation, a ‘family culture’. This could embrace attitudes towards humour, child-care, sport, school success and information, among others. Over-arching these is the intention, stronger or weaker, to reproduce in the children the exact shape of the culture which the parents had constructed. This intention was particularly evident in the ‘inpenetrable’ home, but was apparent in the other homes as well.

Children are raised through being acculturated into their homes and families. Much of this they pick up through mimicking those around them. When they transgress its rules parents will say ‘We don’t do that in our home’, ‘We don’t use words like that in this family’. So the child learns that a way of living, thinking and doing things is already in existence in the home. I suspect that many parents only define for themselves their own culture when they start to bring up their first child. However that may be, anything new in the home, from a computer to a primary science investigation, must reflect this special domestic culture if it is to thrive. Silverstone, in his examination of technologies in the home, remarks:

... information and communication technologies do not have uniform effects on family life. The ways [they] are used, and their impact, will depend on family cultures and the stage the family has reached in its life cycle. Newly acquired technologies occupy the cultural spaces already defined.

This paper claims that many of the studies of the public understanding of science, which have advanced knowledge so considerably over the last five years, have failed to do justice to the public’s choice to refuse. Indeed both sides in the argument over the
'deficit model' have skirted round this very question. While the survey studies of Durant et al. have shown surprising and unexplained deficits in the public’s knowledge, the more qualitative researchers have often chosen to explore only how particular understanding are constructed, rather than how and why other knowledge is rejected.

The concept of a ‘social representation’, which is often quoted in this literature, may have to take a share of the blame for this avoidance. If it is defined as 'the way in which knowledge is represented in a society and shared by its members ... and includes common-sense constructions of its knowledge', it becomes all too easy to ignore the rejection of knowledge which is itself also a personal or cultural construction. The argument of this paper is that choice, which includes the possibility of rejection, is complex and important. Negatives, as Wason and others have pointed out, are more than just the inverse of their positives.

Acknowledgment

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References

3 For information about the DIS project (part of the ESRC funded linked research project on the public understanding of science) see Solomon, J., 1992. The classroom discussion of science-based social issues presented on television: knowledge, attitudes and values. International Journal of Science Education, 14(4), 431–444.
4 A special issue of the International Journal of Science Education (1991, Vol. 13 No. 5) covers some recent studies of a variety of different informal sources of science knowledge.
6 This work is contained in research papers commissioned from its own research department by the Independent Broadcasting Authority. See Wober, J., 1985. The Primacy of Print over Screen? (London: IBA).
8 For an excellent summary of work in this field see McQuail, D., 1984. Communication (Harlow, Essex: Longman).
Reception and rejection of science knowledge

17 The SHIPS project books are Solomon, J., 1990. SHIPS (Hatfield: ASE).
18 The literature on taking on roles for simple social purposes is substantial, from the classic work by Goffman, The Presentation of Self in Everyday Life (1969, Penguin), to Harré's Social Being (1979, Blackwell). However, in the present work some of the ethnomethodological studies by Garfinkel and his pupils might be more appropriately used. When a mother takes on a new role which is not recognized by her child, aberrant behaviour is only to be expected. It certainly occurred: but in the SHIPS research other factors, such as the presence of the researcher in the home, may also have contributed to the child's feeling of social unease.
22 In an unpublished lecture given at Chelsea College, London, in 1982 Peter Wason demonstrated just how difficult negative sentences can be to understand. Their logical value and psychological emphasis are quite different from those of positive assertions, a point also made by Johnson-Laird in Mental Models (1983). Recent informal studies of group work in school science show the power of refutation comments which challenge group consensus rather than just assenting to it. Moscovici has also studied the influence of minority dissenters within groups. None of this work is exactly apposite to the problem of public rejection of science knowledge, but it does suggest that this may be a deep and strongly held attitude, rather than just an outcome of diffidence linked to chance ignorance.

Author

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