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What little they remember: Understanding science in the life-world

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The physicist Otto Robert Frisch (1979) entitled his memoirs “what little I remember”, reflecting a sentiment that I expect many of us can relate to. Memory is however about more than we are aware we remember - as much of our learning leads to implicit knowledge that may influence our thinking even when we are unaware of the original source of that influence. Joan Solomon writes in this book of “[e]ach and every flow of in-coming messages within a mind...leaving behind a trail of new synaptic linkages [to be] used again and again” (p.176). There is a much repeated dictum along the lines that education is what is left after you have forgotten everything you were taught in school. That aphorism was brought to mind in reading this book about the impact of science education on scientific literacy among the general population - what in the days of less gender neutral language used to be referred to in England as the ‘man on the street’ or the ‘man on the Clapham omnibus’. The person on the omnibus (i.e. public transport) was a hypothetical ‘everyman’ used as a referent in English court cases when considering what a typical non-expert might understand to be reasonable in a particular state of affairs. *Science of the People* in effect explores what the people who might be travelling on a contemporary omnibus make of science.

Science of the People is based upon interviews with 54 adults who at the time of the research lived and/or worked in one anonymous English town. The book is organised into twelve chapters. The first three chapters set out the background to Solomon's work, discussing a range of theoretical perspectives that she draws upon in the study. The fourth chapter describes and illustrates the

Review of Joan Solomon (2013) ***Science of the People: Understanding and using science in everyday contexts***. Abingdon, Oxon: Routledge. pp.236 pages. ISBN 978-0-415-64478-5

methodology used in the study, and the remaining chapters explore a range of themes in terms of the data collected. The work has a strong ethnographic ethos, in that the interviews seem to be largely carried out *in situ* whether potential participants can be accessed, rather than being scheduled to take place in a more clinical setting. This approach probably increased the range of participants prepared to act as informants for the study, and avoided asking people questions in the unfamiliar surroundings of an apparently formal context where the data collection could resemble an interrogation rather than a more 'natural' conversation. This is sensible given how context can cue the mood and direction of an interview, but some of the interview opportunities described in the book do give an impression that the approach was sometimes so spontaneous ("almost serendipitous", p.60) that the participants were responding to questions whilst being more concerned with going about their daily routines.

The domain of the life-world

Science of the People will be Solomon's last book, for sadly she died before seeing the work into production. Joan Solomon was a school teacher who wrote about children's learning in the school laboratory (Solomon, 1980), and who went on to an academic career, including working at the Universities of Oxford, Plymouth, King's College London and the UK's Open University. Much of her work considered how science education should respond to, and engage with, the social implications and aspects of science. Solomon (1992) explored how children talked about energy - a concept known to be highly abstract and so challenging as a school topic. At a time when many other researchers were framing their own work in terms of learners having alternative conceptions or 'intuitive theories' in topics such as these, Solomon adopted a different perspective. Drawing on phenomenological ideas regarding how people operate in the everyday 'life-world' - the world as generally experienced and understood through 'common sense' within a culture (Schutz & Luckmann, 1973) - Solomon interpreted her findings in terms of how the 'natural attitude' that led to common ways of talking and thinking in everyday life was at odds with the scientific perspective. This was not just a matter of the concepts being different, but related to major distinctions at an epistemological level.

The natural attitude adopted in the life-world is to take that which has become familiar - such as "the setting of the sun" (p.169) - for granted, whereas in science there is an imperative to seek explanations even for the mundane. In science there is a premium on abstraction, generalisation,

and logical argument from evidence. However, in the life-world there is less drive to find fundamental, logically supportable, and coherent schemes of explanation. According to Solomon a much greater drive is the social imperative - a drive for social cohesion, rather than for conceptual coherence (Solomon, 1983). People adopt the norms and tropes they find to have currency in social life because these lubricate social interaction, even if at the cost of limiting insight into the phenomena being referred to.

Solomon reports in 'Science of the People' how one of her interviewees who had discovered after training as an antenatal consultant that her grandmother had undertaken a similar job, referred to how "I think it must have been that genetic thing that came down, or something" (p.134). Solomon seems bemused by the contrast between the woman's professional role and the informal nature of her talking about this 'genetic' effect with "no suggestion of the mechanism of inheritance" when discussing her own family. A reader may experience something similar when wondering why an ex-school physics teacher such as Solomon would refer in the book to some of her interviewees as having "the moral energy [sic] for joining groups" (p.98) - a turn of phrase likely to make physics teachers grimace.

Many readers of this review with scientific training will be well aware of the incongruity of scientific and much everyday language. Some amongst the scientific are considered by their social acquaintances to be argumentative and pedantic for not tolerating the banal, the tautological, the self-contradicting, the prejudiced, the superstitious, and so forth during social conversation. The more socially aware (or minded) scientists perhaps make better border-crossers (Aikenhead, 1996) and know when to ignore ubiquitous references in everyday discourse to fate, unlucky 13, insects not being animals, water being an element, natural products being inherently safer for humans than synthetic materials, orange juice being pure, and so forth, in the interests of maintaining social pleasantness and not antagonising and irritating our loved ones. Of course, individual scientists may actually subscribe to some alternative and pseudoscientific ideas: scientists are human, and may not always sign-up fully to professional norms regarding which alternative ideas with currency in the life-world scientists should treat sceptically or boldly dismiss (Coll, Lay, & Taylor, 2008).

From personal to social constructivism

Solomon saw her own approach to thinking about learners' informal ideas to be at odds with the predominant personal constructivist perspective on student learning which she felt was more

influential than was healthy for the field. She published a kind of eulogy for the constructivist research programme in this journal (Solomon, 1994), although she seemed to later recognise that perhaps this was premature (Solomon, 2000). Here in her final book she refers to what “was known” (sic, past tense) as personal constructivism (p.185). In retrospect, Solomon’s work can be seen as a contribution to re-energising constructivist work by suggesting new perspectives and approaches - alternative ‘refutable variants’ to stimulate new directions for the wider constructivist research programme (Taber, 2009). Inevitably anyone working in a field, no matter how seminal - think Piaget, think Freud - is likely to be found to be ultimately wrong in some key regards with the passage of time. Being right is not the measure of success of an intellectual - it is being influential enough to move the field forward. Solomon has certainly been influential in science education.

Indeed although Solomon seemed at odds with some of those who championed the label ‘constructivist’, this is more difficult to understand in retrospect if constructivism in science education is seen as a programme exploring the contingent nature of student learning in science rather than simply being a ‘movement’ to characterise ‘alternative conceptions’ (cf. Gilbert & Swift, 1985). She notes here that “in school or college the act of understanding what is being taught always changes it in more or less subtle ways” as “learning is an active process” whereby “the learning process almost always muddies, or equally enriches, the received knowledge and makes it diverse, elusive, uncertified and usually disconnected” (p.5). This characterisation of student learning of science seems largely in keeping with constructivist approaches, apart from Solomon’s emphasis on the lack of connectedness of students’ alternative knowledge which is an over-generalisation in view of the findings from that research programme (Taber, 2009). Certainly the typical novice school student’s ideas about scientific topics are less coherent and integrated than those of the expert scientist, but this is a matter of degree - and by no means are all students’ or lay people’s informal scientific ideas discrete, local, and highly contextualised.

Those who did not fully accept Solomon’s own interpretations of her research findings from listening to children’s talk were still faced with some serious questions arising from her work: questions that certainly helped focus the mind and clarify areas where constructivist thinking needed to be more persuasively set out. Solomon was certainly part of a shift from a (some might suggest blinkered) focus on the individual as lone constructor of personal knowledge, to more expansive perspectives that incorporated social and cultural considerations in understanding the influences on and processes of knowledge construction. That theme resonates through this book,

“...passing on of interest in a scientific topic not only differs from one person to another according to their personal histories, but is also ‘smoothed off’, as we might say, by the processes of living and talking within a generally uniform culture, and so becomes the accepted life-world way of knowing” (pp.136-137).

Similarly, the strong focus in recent years on highlighting and developing argumentation in science education (Kelly, 2014) would seem to owe a strong debt to Solomon’s emphasis on the distinction between scientific and everyday domains of thinking and knowing (Solomon, 1983).

An unfinished final opus

That a book entitled ‘*Science of the People*’ should be Solomon’s last book seems quite appropriate given her legacy. Solomon died before she could finish the book, leaving a manuscript that was edited for her by Michael Reiss. Reiss praises Solomon’s ability to leave a manuscript that was just a draft yet was none-the-less in a state that made publication possible. Reiss suggests his work was made easy for him by Solomon’s ability to produce a readable text in a first draft. Reiss is probably being too kind. There are some things an editor can do to improve a manuscript - massage prose, add internal links, check on dubious references - but ultimately the editor can do little when the text does not give sufficient guidance. In her final chapter Solomon alludes to the book’s epilogue about science education - which “like all other education, exists to proclaim the possibilities of both hope and creativity” (p.211) but sadly it seems she never got round to writing this. There are places where the reader does suspect that Solomon might well have revisited her text more substantially than just checking for typographical errors had she been given the opportunity. Despite these limitations, Reiss has done the community a service by editing the manuscript into a finished book that does discuss some very interesting data, and adds to Solomon’s contribution to the field.

That there are places where we need to forgive what seems to be provisional text is a small cost for having the work made available. As one example, to describe the teaching force in England at the time of the introduction of the National Curriculum (c. 1990) as an “almost completely untrained force of teachers” (p.7) seems an unfair and ill-judged slur on science teacher preparation in the 1980s and before. However, I suspect Solomon was thinking here of primary education where her comments seem more reasonable as long as we understand ‘untrained’ to be intended to be limited to teaching the new core curriculum subject of science. This is the kind of

point a book editor would be able to raise for clarification with an author were they available to revise their text.

Like many effective communicators, Solomon uses analogies to make points about areas likely to be unfamiliar to her readers - and occasionally these seem not fully honed and would benefit some rethinking (e.g. an extended comparison of science communication to the evolution of tennis into some alternative sport), and I would like to think she might have reconsidered her phrasing in referring (in discussing Ausubel's ideas about learning) to a "partially soluble salt" that on dissolving underwent "ionisation" followed by the reformation of the "molecule" (sic, p.51). The editor of a posthumous work has to make difficult if not impossible choices between leaving something that we might suspect the author would have revised in later versions of a text, or double guessing the author and substituting their own text on a hypothetical basis. We should be grateful to Solomon for leaving a sensible and virtually complete manuscript; to her daughter Bess for approaching Reiss; and to Reiss for bringing this project to publication.

An ethnography of Market Town

Solomon's book explores the ideas and views about science of the inhabitants of one location that she labels 'Market Town'. Solomon compares her study of Market Town to a picture painted by Pieter Brueghel with "a great diversity of busy people scattered across" the canvas (p.3). There is of course no 'everyman' for we are all different, and Market Town contains a range of people who might ride on the omnibus. A town is neither a City, nor desolate rural isolation, of course, but something in between - so perhaps it will not contain the full diversity of modern society. A town though can be a community, and a functioning community includes a wide range of people occupying different niches in its ecology. For Solomon, the town is the subject of her "case study" (p.124).

This is a scholarly book, and Solomon's writing contains the imprints of wide reading well beyond science education - she quotes David Hume for support at one point (p.168). Solomon sets the background for her study with an account (often of a historical nature) of a range of relevant themes such as phenomenology, the public understanding of science, and scientific literacy. This sets out the basis for why we should care about what 'the people' think and know about science. In places her writing is entertaining as well as informative. I especially enjoyed an anecdote telling

how Berzelius visited England to consult with John Dalton about his atomic theory, but found he had to wait around until Dalton - a school teacher - had completed teaching that day's classes.

Gossiping about science

Solomon describes how she was “interested in the ways in which members of the public communicate about science with each other quite naturally almost like gossip, using natural language and everyday emotions as seem appropriate” (p.62). The inclusion of the affective as an inherent part of the research focus reflects how Solomon considers people make evaluations in a way which links emotional responses to cognition. By contrast, the scientific way of thinking favours bracketing-off emotional responses so that they do not bias the application of cold logic. (‘Favours’ implying this is the model - certainly not that scientists inevitably behave in ideal ways.) More poetically, Solomon wanted to “explore whether the acres of mental playing fields which science has provided have yet been taken over to exercise the minds and imaginations of us all” (p. 69).

Solomon reports that sometimes interviewees would respond to the researchers’ initial questions by claiming they did not know any science, and did not have any scientific interests. This often turned out not be so. In other cases, an interest in science was said to derive from contingent experiences, such as in the case of ‘Janet’ who explained “I fancied my chemistry teacher! He was gorgeous. Oh he was lovely!” (p.73). The researchers were told that the topic “over the breakfast table” was “more likely to be the daily weather forecast than science” (p.108). This reinforces the challenge the researchers (Solomon, and an unknown confederate that Reiss was not able to identify) faced in teasing out the distinction between a proclaimed level of interest in science, and an active interest in topics and applications that science education would claim as part of its domain. Sometimes, indeed, Solomon seems to ‘go native’ in how she thinks about the realm of science - perhaps writing from the emic when one would expect her to adopt the etic - as when she notes that “[t]here were plenty in Market Town who had no great interest in science, preferring to concentrate on local history, archaeology or wildlife” (p.158). No scientific interests there, then?

At one level a message from this book is that most people have interests related to science (even if they do not always recognise this), but even so they seldom rely heavily on their learning from formal science education. Indeed, reflecting findings from Solomon’s earlier studies, the form of the

everyman's science-related knowledge is often quite unlike formal scientific knowledge. It is less clear what the take-away message should be in this regard. Perhaps science education for scientific literacy has failed. Perhaps science education is even incongruent with (or acts orthogonally to) scientific literacy if the mode in which science is understood and employed in the life-world is so at odds with how science is formally taught - such that it derives from very different kinds of learning opportunities and experiences. Neither of these options would reach the status of convincing conclusions from Solomon's study - but the book certainly offers some grist to that kind of mill.

Of course one problem with a study of this kind is that it may reflect on formal educational experiences as one source of influence, but findings cannot be traced back to any particular educational regime. Even assuming all interviewees were educated in the English education system, that system has itself undergone major shifts over the decades. At least one interviewee claimed "I didn't do science at school" (p.58) which is unlikely to have been the case for quite a few decades. Another refers to having been taught science "back in the sixties" at which time she "didn't really realise that there were ideas in science" (p.138). Another reports losing interest in science on transferring schools between "a grammar school [where] we had separate sciences" and where physics and chemistry were "so exciting" to a school "that did General Science" as a "mish-mash" where science "just lost its fascination" (pp.138-139). The most salient points for the study participant were the change in curriculum organisation and the lessons being "less experimental" - but of course a different school ethos, different teachers, onset of adolescence, trauma of moving to a new school, or any number of other factors might also have been at work.

Researching people as originals, not duplicates

Arguably, a good book about a particular study is also a good book about research itself - in that any detailed account of a research study offers itself as a case study of research: an exemplar that provides insights into the nature and processes of research. Solomon's book offers an account of the kind of research she wanted to undertake and the rationale for the choice of interview approach adopted. Solomon suggests that:

"People can no more talk with strangers about personal questions without them feeling that they know us well, than we can formulate research questions before exploring, perceiving and understanding the possible results of the research.

Questions do not necessarily precede answers, curious as it may seem, but they exist in the same reflexive explanatory space, each referring to the other.” (p.53)

Solomon describes the affordances provided by interviewing people rather than simply asking them to complete questionnaires. So, for example, she claims that questionnaires used in previous studies asking whether people trusted scientists more or less than politicians offered limited insight into ticked responses, whereas when participants were asked this in her study “[f]rom the tone of their response we were also able to ascribe scepticism and/or cynicism” (p, 165). Solomon also highlights how interviewing can honour how each person in the study was an “original”. As she argues:

“There can be no duplicates of people so there can be no adding up of numbers and the findings of averages of attitudes towards science. But interviewing is a delicate and almost serendipitous procedure because it is never certain what form of question will trigger some totally different awareness. What can be achieved is only a kind of portrait in words of some aspects of a person and the possibilities of others. Its excellence lies in its ‘truth’ to the subject at the time and circumstances of the interview: and only that.” (p.60)

Research (not) entirely qualitative and expressive

Solomon’s argument suggests there is little point in processing interview responses to distill out numerical results. This also seems sensible given that her sampling was not rigorous enough to produce a statistically representative sample of the town population (and that was not its purpose). Rather, interviews were often a matter of ‘catching’ people when they were prepared to talk - so sometimes during the working day as they were at work or going about their everyday business, and there were “two truncated interviews because of emergencies” (p.69). Questions could not therefore be standardised (which would in any case be antithetical to the “delicate and almost serendipitous procedure”). Moreover, Solomon reports how the interview transcripts showed that she was enquiring into a fluid target as “the ideas and meanings were continually changing within the minds of these people who had come out of their homes, shops, recreation grounds or places of employment to speak with us” (p. 178).

Despite apparently making a strong argument for a stance that eschewed quantification, Solomon does include numerical results - percentages of respondents in different subgroups of the sample said to be interested in different themes as “quantitative analyses may be helpful and useful in some cases” (p.61). That justification can certainly be true in certain circumstances, but given the methodological choices made in this study such findings as that 20% of a group of Church-goers revealed that they had an interest in animals, or 10% of industrial estate workers were interested in computing/ITC (p.92) seems to offer limited insight. The choice of using “rounded percentages” (p.93) was presumably intended to avoid any sense of claiming undue precision - yet actually citing results of the form of 20% of a group of six people or 10% of a group of eight people simply seems obtuse.

Solomon seems aware of there being an issue here of her reporting numbers “too small and variable to be convincing”. Solomon’s justification for this relapse after having claimed “that this whole study was going to be entirely qualitative and expressive” (p.93) appeared to have more to do with the challenges of the “norms and problems of qualitative interpretation” and “the danger of asking questions which trailed their own answers” (p.93) than the merits of any insight offered by quantification. However, the rounded percentages presented in the book are merely coarse abstractions from the inevitably limited analysis of necessarily selective questioning and do nothing to either put right the limitations of qualitative interpretation or to offer a supplement using a complementary approach (such as a survey with a standardised questionnaire - an approach critiqued in the book). Solomon perhaps could have paid more heed to her own intention that “the search for a numeric focus is not allowed to swamp our exploration by providing lists of only half-believable percentages and correlations” (p.125). No correlations are offered, but for this reader the list of percentages falls short of being half-believable. Perhaps this is one area where Solomon may have rethought her choices had she been able to revise her manuscript.

Identifying groupings within the community

In any case the designation of interviewees to subgroups from within the town community was necessarily forced to give a manageable number of groups - and indeed to provide combinations large enough to count as groups. Sampling of the study participants was largely through convenience (“we found people outside their homes who agreed to talk to us from where they were”) and snowballing (“we ended each interview by asking for suggestions about other people, friends of the interviewee, who might agree to be interviewed”) (p.69): approaches not designed to

offer a rigorous sampling frame. At the end of these opportune processes the sample consisted of 54 people that Solomon subdivided for further convenience into groups she labelled as the education group (6 people); the church-goers (6); the industrial estate (8); parents with young children (5); market traders (8); the new estate (5); the environmentalists (5); farmers (2); life-long learning organisers (3); passers-by (3) and social and day-care (3). These groupings can best be described as impressionistic if not entirely arbitrary. That the “80%” (of 6) church-goers who were “interested in astronomy...rose to an impressive 90 per cent when rounded up” when “two members of the Environmental group who were also church-goers and pacifists” were added to increase “the total to eight” (p.95) adds to the sense that both the patterns and groupings need to be treated with care.

The education group is said to comprise of two practising teachers, two school secretaries, a postgraduate student and a retired headteacher (p.78). However the ‘student’ transpired to be a “young graduate” or “recently graduated student” who having completed a biology degree had undertaken “a long journey to distant parts looking at animals in their natural habitats” (p.84) from which he had recently returned. This makes his fit in the education group somewhat tenuous. One of the Church-goers “described her job in teacher training” (p.97); another is described as being a “school advisory teacher” (p.96); and a third was a retired geography and rural studies teacher (p.98). Arguably these three teachers would fit better with the two primary teachers and retired headteacher in the Education group than the two school secretaries or the “jobless” (p.99) former student. Another separate group, referred to as ‘informal informers of the public’ (pp.196-199) comprised of a retired geology professor who undertook outreach work; a person variously described as “a scientist in informal education”, someone working “in the formal education service” (p.197) and an “educator in science” (p.198); and “a woman physicist...training primary teachers in simple science at the nearby university” (p.198). It seems then there were nine practising or retired teachers in the sample, only three of which ended-up as being placed in the education group.

Researching at the nodes in social networks

Another issue somewhat underplayed in the book, which seems a little odd given Solomon’s stance on the importance of the social to the life-world, is how individual interviews were the preferred choice of method to investigate “the ways in which members of the public communicate about science with each other quite naturally” (p.62). Solomon acknowledges that

“[w]e did not hear much in the way of group discussion directly, but in listening to people taking alternative opposing points of view when ruminating on some problem situation during the interview it seemed as though they had internalised the movements of group discussion and were re-enacting them” (p.160).

Very possibly, but I wonder how Solomon would have treated such a justification for using individual interviews rather than group interviews or focus groups (or, ideally, naturalistic observation) in a student thesis intended to explore “the ways in which members of the public communicate ... with each other”. Solomon reports how research suggests that in group discussions people construct meanings more through “social exchange” than a “neutral” interpretation (p.178). Yet, if that is the nature of how people construct their understanding in the life-world, as Solomon had argued in her earlier study of children talking about energy (Solomon, 1983), then that would seem the natural context for collecting data for a project such as that reported in this book.

Arguably, this notion of knowledge construction through “social exchange” also reflects one way in which some social constructivists and constructionists do have a genuine difference of perspective when compared to the personal constructivists that Solomon has criticised in the past. A personal constructivist perspective problematises knowledge ‘sharing’ or ‘transfer’ as it is considered that each individual has to construct their own knowledge by interpreting - through their own personal cognitive resources - the talk, writing, and other such *public representations* of the knowledge of others (Taber, 2013). By comparison, a focus on the social can often bypass this issue by seeing knowledge as a social commodity that can be shared relatively unproblematically within the collective (Collins, 2010).

According to Solomon people are linked through social networks where “at unpredictable moments the social network reorganises itself so that the social comments exchanged in a previous discussion, and the memories of others, can flow on through their network and cause new conglomerations of knowledge” (p.208). The widespread influence of Vygotsky’s (1978) thinking means that it is now widely considered that through social mediation the individual comes to adopt patterns of thought found in the community (which in general terms at least is reasonable enough) with the often assumed corollary that what appears in the personal psychological plane *must* be an internalisation of what has previously been experienced in the interpersonal social plane. Yet this underplays the role of the individual as sense-maker as much as an earlier over-reliance on the main foci of Piaget’s (1929/1973, 1970/1972) ideas tended to lead to an

underplaying of social processes in learning. Just as learners do not construct hermetically sealed models of the world from within impermeable cognitive bubbles, nor can they make sense of the social mediation of cultural products (such as academic concepts) without grounding this on spontaneous conceptions deriving from individual direct experience of their physical environment (Taber, 2013; Vygotsky, 1934/1986, 1934/1994).

We are all alone in the crowd

For a personal constructivist it is a category error to think that what is internalised can be considered to be the thinking of others (Taber, 2013). We probably all sometimes have mental conversations 'with' others whose ideas or example we respect - when they are not actually present. Yet what we are actually doing is working with a simulation - a mental model of the other person that we have constructed and which we use to 'run' simulations of what they might think or say in various circumstances. Sometimes we may call upon such models without deliberate intention - as when we 'hear' the voice of an absent confidant advise us at a moment of decision-making. Ultimately, for the personal constructivist, that is whom (what) we know: not other people, but our own mental models of them.

All our social conversations are experienced within our own personal mental spaces using *interpretations* of available evidence of what the other actually thinks. When the other person is present and interacting with us we have the potential to update our internal model in real time, but human cognition has evolved to be conservative in response to incongruent evidence - so even when another person is actually present what we think they are telling us can often be more about the mental model of that person that we have brought to the conversation than what the real person is actually trying to tell us.

Perhaps in view of the seemingly unproblematic nature of how knowledge may be shared between different minds adopted in places in this book, it is not so surprising that sometimes Solomon offers interpretations that seem to go well beyond the data she presents to illustrate her arguments. One example concerns the biology graduate who talks about evolution as "the greatest theory there is...fantastic...It explains so much and is just amazing" (p.188). Solomon appears to read "self-doubt as to whether he really does understand it" when the graduate reports being annoyed and almost insulted when others do not appreciate the theory. This may be so, but the

reader is left here, and in quite a few other places, wondering what basis there is for such an evaluation.

One challenge facing any qualitative researcher is to offer an account that balances the need to offer evidence to support interpretations, whilst actually doing the work of the researcher: that is, offering an analysis that draws out insights *built on* data rather than simply an annotated presentation of voluminous data. Interpretative research requires close familiarity with - indeed immersion in - a data set - and the readers of research needs to be convinced this work has been done well without having to themselves wade through the full data set. However, interpretive research is inevitably a reflection of the analyst as well as of the data.

The researcher as unique instrument

Solomon writes about the excitement and frustration of repeated readings of interview transcripts - something that will be appreciated by many researchers reading this book - and of course insightful interpretations often only do emerge from repeated engagement with data. Such interpretations rely upon the analyst as instrument: but a human instrument, a one-off bespoke instrument, cobbled together from and calibrated by all those “trail[s] of new synaptic linkages” formed over a lifetime of reading, thinking, experiencing, discussing, reflecting. In that respect this is a wonderful book offering not only glimpses into the life-world thinking of the diverse individuals that Solomon found taking the metaphorical omnibus in Market Town, but also glimpses into the singular mind of Joan Solomon.

Solomon has been highly influential in arguing for the importance of social factors and processes in influencing learners’ thinking. Yet her own writing, with its idiosyncrasies and its imprint of her wide scholarship, reminds us that arguments within science education on the relative importance of the personal versus the social are (like those debates about whether genes or environment are more important in development) addressing the wrong question. The issue is not whether understanding and learning are individual or social processes: but how the uniquely individual personal and the “smoothing” influence of the social interact in learning and knowledge construction (Taber, 2009). For indeed “there can be no duplicates of people”. Sadly there will be no duplicate of Joan, who certainly was an “original”: but at least she has left a body of work so that her ideas (or at least our imperfect interpretations of her public representations of those ideas) can continue to “flow on through” the science education community.

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